NOTICE

The information contained is for **DEALER REFERENCE PURPOSES ONLY**.
MANUALS ARE MODEL AND SERIAL NUMBER SPECIFIC.

If additional printed manuals are required for your shop/office location, order by part number through the factory's Parts Center.

If a retail customer needs replacement manual(s) for a specific unit, contact the factory's Customer Data Center at: 800-829-0051 or customerdata@vermeermfg.com

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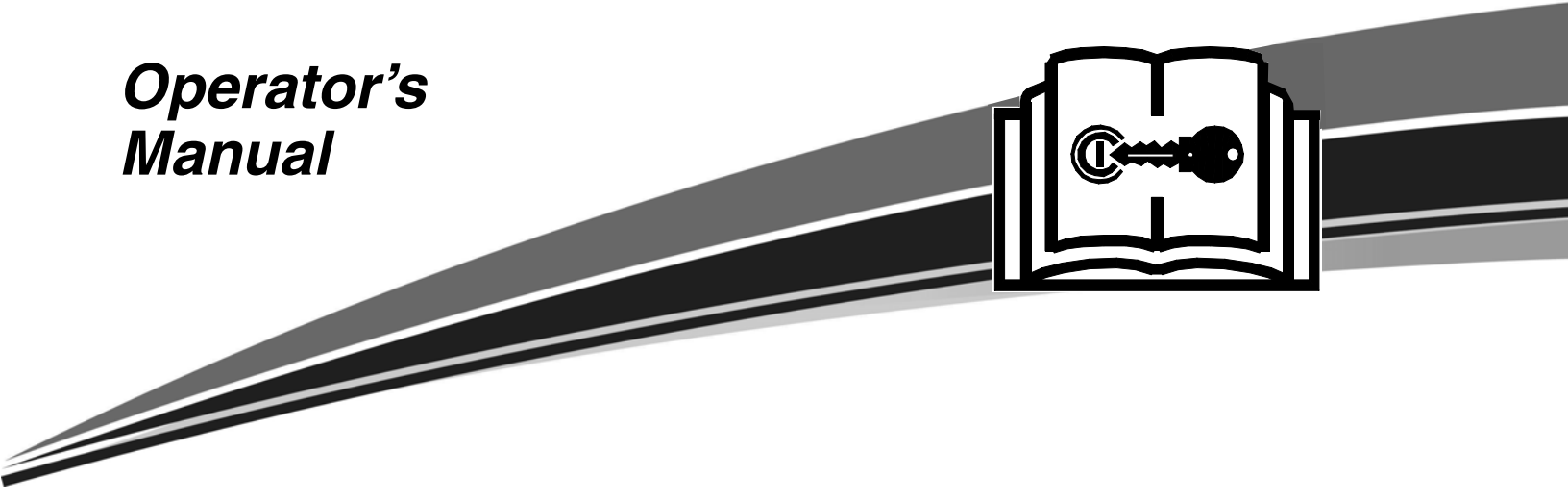
D16x20 Series II/D20x22 Series II

Navigator® Horizontal Directional Drill

Operator's Manual



D16x20_series_ii_D20x22_series_ii_o1_02
Serial No. 101 -
Order No. 105400AD7
Cabled Assembly No. 296297000

Vermeer®

Introduction

This manual explains the proper operation of your machine. Study and understand these instructions thoroughly before operating or maintaining the machine. Failure to do so could result in personal injury or equipment damage. Consult your Vermeer dealer if you do not understand the instructions in this manual, or need additional information.

The instructions, illustrations, and specifications in this manual are based on the latest information available at time of publication. Your machine may have product improvements and features not yet contained in this manual.

Vermeer Corporation reserves the right to make changes at any time without notice or obligation.

Operation instructions are included in the two Operator's Manuals provided with the machine. The tethered (cabled) manual must remain attached to the machine for ready reference. Store it in the manual storage box when not in use.

Lubrication and maintenance procedures are in the Maintenance Manual provided with the machine. Refer to it for all lubrication and maintenance procedures.

Additional copies of the manuals are available from your dealer. Use the reorder number on the front cover to order additional manuals.

Copies of this manual are available in Spanish from your dealer.

Se dispone de ejemplares de este manual en español.

Notice to Owner

You are requested to notify Vermeer Corporation when you have purchased a **used** Vermeer machine. Notify the Customer Data Department by telephone: 800-829-0051 or 641-628-3141; email: customerdata@vermeer.com; internet: www.vermeer.com or www.vermeerag.com; or letter: Customer Data Dept., Vermeer Corporation, PO Box 200, Pella IA 50219 USA. Upon request, an owner of a used Vermeer machine will receive one free set of Operator's, Maintenance and Parts manuals.

NOTE: Right and left sides of the machine are determined by facing the power vises while seated at the controls.

TRADEMARKS

VERMEER, VERMEER Logo and NAVIGATOR are registered trademarks of Vermeer Manufacturing Company.
SPLINELOK and TRIHAWK are trademarks of Earth Tool Company.
KUBOTA is a trademark of Kubota, Ltd.

PATENTS

This machine may be covered by one or more of the following patents:

AU 756,936	US Des. 396,837	US 5,944,121	US 6,435,286	US 6,588,516	US 6,880,430
CA D 79,593	US 5,237,888	US 6,109,367	US 6,439,319	US 6,651,755	US 6,886,644
CC 961801735	US 5,291,964	US 6,119,376	US 6,446,365	US 6,659,202	US 6,910,541
CC ZL00818814.9	US 5,509,220	US 6,154,987	US 6,454,025	US 6,668,946	US 6,929,075
CC ZL01801755.X	US 5,544,055	US 6,161,630	US 6,470,976	US 6,684,538	US 6,948,265
CC ZL01809457.0	US 5,553,407	US 6,195,922	US 6,474,931	US 6,701,647	US 6,975,942
DE 696 11 846.7	US 5,556,253	US 6,247,544	US 6,474,932	US 6,719,069	US 7,036,609
DE 202 14 959.5	US 5,574,642	US 6,289,997	US 6,477,795	US 6,725,579	US 7,044,684
DE Des. 96 006 85.4	US 5,590,041	US 6,308,787	US 6,484,818	US 6,729,050	US 7,055,270
DE 600066479	US 5,607,280	US 6,315,062	US 6,491,115	US 6,749,029	US RE39,259
EP 772,543	US 5,611,496	US 6,332,502	US 6,497,296	US 6,751,553	US 7,121,363
EP 830,522	US 5,659,985	US 6,357,537	US 6,511,260	US 6,751,893	US 7,143,844
EP 885,343	US 5,687,807	US 6,360,830	US 6,516,899	US 6,752,043	US 7,152,348
EP 1,153,194	US 5,704,142	US 6,367,564	US 6,517,733	US 6,755,263	US 7,172,035
EP 1 242 710	US 5,720,354	US 6,374,928	US 6,533,046	US 6,766,869	US 7,182,151
GB 2,053,636	US 5,746,278	US 6,382,330	US 6,533,052	US 6,804,903	WO N1468166
HK 1015859	US 5,768,811	US 6,389,360	US 6,554,082	US 6,814,164	
NL 1153194	US 5,778,991	US 6,390,207	US 6,557,651	US 6,833,795	
RU 2,158,952	US 5,819,859	US 6,408,952	US 6,577,954	US 6,839,991	
SW 524 375	US 5,904,210	US 6,408,954	US 6,585,062	US 6,845,825	
This machine may be covered by one or more of the following licensed patents:					
US 4,694,913	US 4,858,704	US 4,867,255	US 4,953,638	US 5,148,880	US 5,799,740
US 5,867,117	US 6,050,350				

(Other U.S. and foreign patents pending.)

VERMEER NEW INDUSTRIAL EQUIPMENT LIMITED WARRANTY

(EFFECTIVE OCTOBER 1, 2008) **WARRANTY PERIOD: 12 Months / 1000 Hours**

Vermeer Corporation (hereinafter “Vermeer”) warrants each new Industrial product of Vermeer's manufacture to be free from defects in material and workmanship, under normal use and service for one (1) full year after initial purchase/retail sale or 1000 operating hours, whichever occurs first. This Limited Warranty shall apply only to complete machines of Vermeer's manufacture, parts are covered by a separate Limited Warranty. **EQUIPMENT AND ACCESSORIES NOT OF VERMEER'S MANUFACTURE ARE WARRANTED ONLY TO THE EXTENT OF THE ORIGINAL MANUFACTURER'S WARRANTY AND SUBJECT TO THEIR ALLOWANCE TO VERMEER ONLY IF FOUND DEFECTIVE BY SUCH MANUFACTURER**.

EXTENDED WARRANTY OPTIONS ARE AVAILABLE FOR PURCHASE.

WARRANTY TERMS

During the Limited Warranty period specified above, any defect in material or workmanship in any warranted item of Vermeer Industrial Equipment not excluded below shall be repaired or replaced at Vermeer's option without charge by any authorized independent Vermeer dealer. The warranty repair or replacement must be made by a Vermeer independent authorized dealer at the dealer's location. Vermeer will pay for replacement parts and such authorized dealer's labor in accordance with Vermeer's labor reimbursement policy. Vermeer reserves the right to supply remanufactured replacement parts as it deems appropriate.

RETAIL PURCHASER RESPONSIBILITY: This Limited Warranty requires proper maintenance and periodic inspections of the Industrial Equipment as indicated in the Operator’s/Maintenance Manual furnished with each new Industrial Equipment. The cost of routine or required maintenance and services is the responsibility of the retail purchaser. The retail purchaser is required to keep documented evidence that these services were performed.

This Vermeer New Industrial Equipment Limited Warranty may be subject to cancellation if the above requirements are not performed.

Vermeer Industrial Equipment with known failed or defective parts must be immediately removed from service.

EXCLUSIONS AND LIMITATIONS

The warranties contained herein shall **NOT APPLY TO:**

(1) Any defect which was caused (in Vermeer's sole judgment) by other than normal use and service of the Industrial Equipment, or by any of the following; (i) accident (ii) misuse or negligence (iii) overloading (iv) lack of reasonable and proper maintenance (v) improper repair or installation (vi) unsuitable storage (vii) non-Vermeer approved alteration or modification (viii) natural calamities (ix) vandalism (x) parts or accessories installed on Industrial Equipment which were not manufactured or installed by Vermeer authorized dealers (xi) the elements (xii) collision or other accident.

(2) Any Industrial Equipment whose identification numbers or marks have been altered or removed or whose hourmeter has been altered or tampered with.

(3) Any Industrial Equipment which any of the required or recommended periodic inspection or services have been performed using parts not manufactured or supplied by Vermeer or meeting Vermeer Specifications including, but without limitation, engine tune-up parts, engine oil filters, air filters, hydraulic oil filters, and fuel filters.

(4) New Industrial Equipment delivered to the retail purchaser in which the warranty registration has not been completed and returned to Vermeer within ten (10) days from the date of purchase.

(5) Any defect which was caused (in Vermeer's sole judgment) by operation of the Industrial Equipment not abiding by standard operating procedures outlined in the Operator's Manual.

(6) Engine, battery, and tire Limited Warranties and support are the responsibility of the respective product's manufacturer.

(7) Transportation costs, if any, of transporting to the Vermeer dealer. Freight costs, if any, of transporting replacement parts to the Vermeer dealer.

(8) The travel time of the Vermeer dealer's service personnel to make a repair on the retail purchaser's site or other location.

(9) In no event shall Vermeer's liability exceed the purchase price of the product,

(10) Vermeer shall not be liable to any person under any circumstances for any incidental or consequential damages (including but not limited to, loss of profits, out of service time) occurring for any reason at any time.

(11) Diagnostic and overtime labor premiums are not covered under this Limited Warranty Policy. Oils and fluids are not covered under this Limited Warranty.

(12) Depreciation damage caused by normal wear, lack of reasonable and proper maintenance, failure to follow operating instructions, misuse, lack of proper protection during storage.
(13) Accessory systems and electronics not of Vermeer's manufacture are warranted only to the extent of such manufacturer's respective Limited Warranty if any.
(14) Downhole toolage is not covered under this warranty.
(15) Wear items which are listed by product group as follows:

ENVIRONMENTAL: Bearing Seals, Bearings, Belts, Brake Pads, Bolts/Torqued Parts, Chain, Clutches, Clutch Components, Curtains, Cutter Wheels, Discharge Conveyor Belts, Fuel Filters, Hammers, Hoses, Infeed Conveyor Belts, Infeed Conveyor Chains, Knives, Oil Filters, Pockets, Rods, Rollers, Rotor Plates, Screens, Service Items, Shear Bar/Bedknife, Sprockets, Teeth, Wear Blocks, Wear Strips.

TRACK: Base Plates, Boom Wear Items, Buckets, Cable Fingers, Conveyor Belts, Clutches, Cups, Digging Chain, Digging Rims, Drums, End Idler, Flashings, Pins and Bushings, Pivot Rings, Plastic Wear Strips, Rooter Bands, Scraper Knives, Sprockets, Teeth, Track Chain, Track Rollers, Trench Cleaner (Crumber), Trip Cleaners, Truck Rollers, Wear Plates.

TRENCHLESS: Brushes, Clamping Vise Parts, Dies, Drive Chuck, Earth Stakes, Fan Belts, Jaws, Leaf Chain, Lights On Light Kits, Packing Assemblies, Rod, Rod Loader Parts, Rollers, Tooling, Track Chain, Track Guides, Track Idlers, Track Pads, Track Sprockets, Valve Seats, Wear Bars, Wear Blocks, Water Hoses, Water Swivels, Wear Bars.

UTILITY PRODUCTS: Augers, Belts, Bearings, Booms, Brake Pads, Bucket, Bushings, Chains, Clutches, Conveyor Belts, End Rollers, Flashings, Pins, Pivot Rings, Plow Blades, Rubber Shielding, Sprockets, Teeth, Tires, Track Chain, Track Idlers, Track Sprockets, Trench Cleaner (Crumber).

PARTS WARRANTY:

Parts replaced in the warranty period will receive the balance of the first year New Industrial Equipment Limited Warranty, during the first (12) months or 1000 hours, whichever comes first. Replacement parts after the original machine warranty, are warranted to be free from defects of material for ninety (90) days or the part will be repaired or replaced, without labor coverage for removal and reinstallation.

EXCLUSIONS OF WARRANTIES: EXCEPT FOR THE WARRANTIES EXPRESSLY AND SPECIFICALLY MADE HEREIN, VERMEER MAKES NO OTHER WARRANTIES, AND ANY POSSIBLE LIABILITY OF VERMEER HEREINUNDER IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. VERMEER RESERVES THE RIGHT TO MODIFY, ALTER AND IMPROVE ANY PRODUCT WITHOUT INCURRING ANY OBLIGATION TO REPLACE ANY PRODUCT PREVIOUSLY SOLD WITH SUCH MODIFICATION. NO PERSON IS AUTHORIZED TO GIVE ANY OTHER WARRANTY, OR TO ASSUME ANY ADDITIONAL OBLIGATION ON VERMEER'S BEHALF.

NO DEALER WARRANTY. The selling dealer makes no warranty of its own and the dealer has no authority to make any representation or promise on behalf of Vermeer or to modify the terms or limitations of this warranty in any way.

MANUFACTURED BY:
VERMEER CORPORATION
Pella, Iowa 50219 USA

VERMEER EQUIPMENT LIFETIME LIMITED WARRANTY RIDER (INCLUDE THIS IN NAVIGATOR BOOKS ONLY)

(Parts only coverage during extended term)

Vermeer Corporation (hereinafter “Vermeer”) agrees to extend only the parts coverage of the applicable Vermeer Industrial New Equipment Limited Warranty (the “Standard Limited Warranty”) for the Covered Components of the Specified Models of New Vermeer Industrial Equipment for the Lifetime of the Equipment provided that such Equipment is operated and maintained in accordance with the directions and instructions set forth in the Operator's and Maintenance Manuals. All conditions, exclusions and limitations of the Standard Limited Warranty apply.

Models	**Serial Numbers of Included Units**
D7x11 Series II	464 and above
D16x20 Series II	101 and above
D20x22	143 and above
D20x22 Series II	101 and above
D24x40 Series II	281 and above
D36x50 Series II	143 and above
D80x100 Series II	122 and above
D100x120 Series II	123 and above
D200x300	110 and above
D300x500	111 and above
D330x500	101 and above

Specified Models: . . . . . All Vermeer Navigator Horizontal Directional Drills built with rack and pinion

Covered Components: . . All rack gears and pinion gears. (Excludes carriage, carriage rollers and guide rollers)

Extended Term:. . . . . Lifetime of Equipment. This warranty is extended to the original purchaser only. It is not transferable.

EXCEPT FOR THE STANDARD LIMITED WARRANTY AND THIS RIDER, VERMEER MAKES NO OTHER WARRANTIES, AND ANY POSSIBLE LIABILITY OF VERMEER HEREUNDER IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABLILITY OR FITNESS FOR A PARTICULAR PURPOSE.

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Receiving and Delivery Report

DEALER PREP

Check or perform the following:

___ Check for shipping damage or shortage.
___ Check that work area cones are supplied with the machine.
___ Check that certificates for electrically insulated gloves (1 pair) and boots (2 pairs) are supplied with the machine.
___ Check machine for loose bolts.
___ Check installation and condition of all shields.
___ Check tracks for proper tension.
___ Check condition of all safety signs.
___ Check Strike Alert system.
___ Check that Operator Presence system functions.
___ Check Remote Lockout system.
___ Check oil in rotation gearbox.
___ Check operation of rod loader.
___ Check operation of drilling fluid systems.
___ Check operation of locator system if supplied.

Engine

___ Check engine oil level.
___ Check condition of air cleaner.
___ Check battery charge and electrolyte level.
___ Check belts for proper tension.

___ Check coolant level and antifreeze concentration.
___ Check engine for proper operation.

Hydraulics

___ Check hydraulic fluid level.
___ Check controls for proper operation.
___ Check all hydraulic components for leaks or damage.
___ Check vise cylinder pressure and operation of vises.
___ Check maximum thrust/pullback pressure.
___ Check operation of stakedown units.

DELIVERY

Check and perform the following with the customer:

___ Review contents of the 2-volume HDD Resource Library.
___ Review all sections of the *Operator's Manual*.
___ Ensure second *Operator's Manual* is tethered to machine.
___ Review welding alert and location of electronic modules to unplug.
___ Grease or oil all lubrication points.

Review and demonstrate with the customer:

___ overall explanation of how the machine works
___ directional drilling safety
___ preparing the Navigator HDD for operation

DEALER/CUSTOMER INFORMATION

dealer	owner
address	address
city	city
state / province	state / province
zip / postal code	zip / postal code
country	country

MACHINE IDENTIFICATION NUMBER - RECORD

Model Number_____

Serial Number_____

ENGINE IDENTIFICATION NUMBER - RECORD

Engine Model Number_____

Engine Serial Number_____

Table of Contents

Section 10: Safety Messages

General safety messages appear in this Safety Messages section. Specific safety messages are located in appropriate sections of the manual where a potential hazard may occur if the instructions or procedures are not followed.

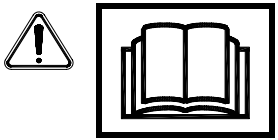
A signal word "**DANGER**", "**WARNING**", or "**CAUTION**" is used with the safety alert symbol.

Safety signs with signal word "**DANGER**", "**WARNING**", or "**CAUTION**" are located near specific hazards.

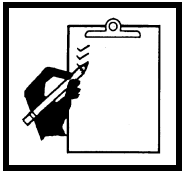
DANGER	Imminent hazards which, if not avoided, will result in serious personal injury or death.
WARNING	Potential hazards or unsafe practices which, if not avoided, could result in serious personal injury or death.
CAUTION	Potential hazards or unsafe practices which, if not avoided, could result in minor personal injury or product or property damage.

Safety Symbol Explanation

This is the safety alert symbol. This symbol is used in combination with an exclamation mark or other symbols to alert you to the potential for bodily injury or death.



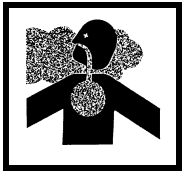
WARNING: Read Operator's Manual and safety signs before operating machine.



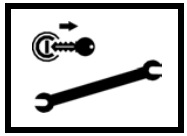
WARNING: Check machine before operating. Machine must be in good operating condition and all safety equipment installed and functioning properly.

WARNING: Wear personal protective equipment. Dress properly. Refer to “Personal Protection,” *page 40-5*.

WARNING: Keep spectators away.

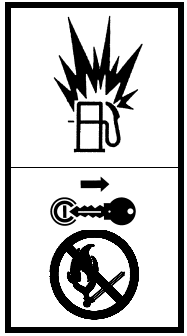


WARNING: Engine exhaust can asphyxiate. Operate only outdoors.



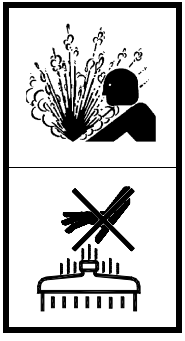
WARNING: Use Shutdown Procedure before servicing, cleaning, repairing or transporting machine. Refer to *Shutdown Procedure, page 50-3,* for instructions.

WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.



WARNING: Fuel and fumes can explode and burn.

Shut off engine before refueling. No flame. No smoking.



WARNING: Hot fluid under pressure can scald.

Allow engine to cool before opening radiator cap.

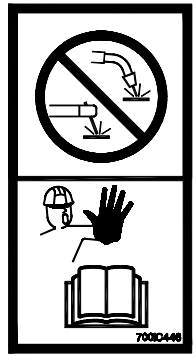
WARNING: Failure to follow any of the preceding safety instructions or those that follow within this manual, could result in serious injury or death. This machine is to be used only for those purposes for which it was intended as explained in this Operator's Manual.

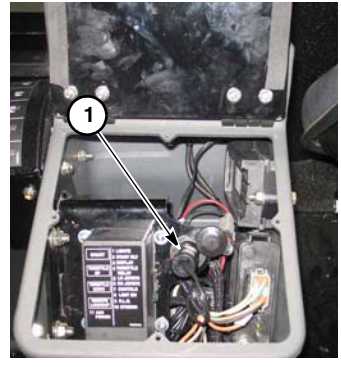
FIRE EXTINGUISHER

A fire extinguisher (not supplied with machine) can be mounted on the foot platform at the console operating station.

Section 11: Welding Precautions

WELDING ALERT - ELECTRONIC COMPONENTS





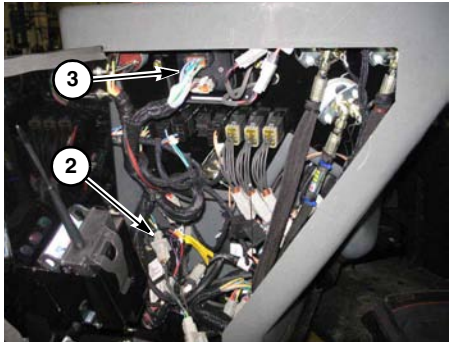
Attention: Electronic modules and controllers will be damaged from stray voltages and currents generated during welding if not unplugged ***before welding***.

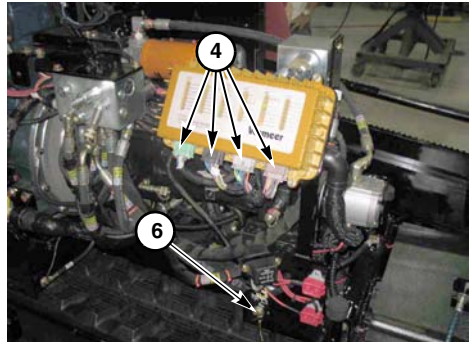
To prevent extensive and costly damage to the electrical components, connectors to the Remote Lockout (RLO) module **(1)** (in compartment to the left of seat), console controller **(2)**, display **(3)**, the Engine Control Units (ECU) **(4)**, and Tethered Transport Control **(5) must be unplugged**.

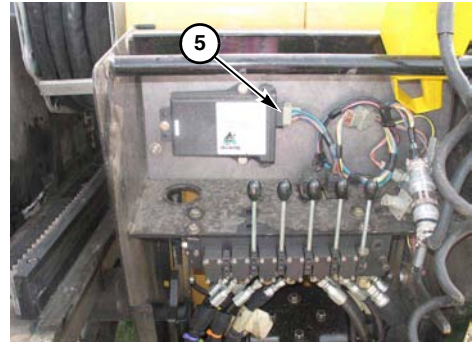
Disconnect battery using *Battery Disconnect Switch* **(6)**.

Connect welding ground as close to work as possible.

IMPORTANT: Disconnecting the battery ground with the battery disconnect switch will not prevent damage to the electronic components during welding. Each of the modules must have the electrical connector unplugged from the module.







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Section 15: Intended Use

The Vermeer D16x20 Series II and D20x22 Series II Navigator Horizontal Directional Drills are designed solely for use in creating horizontal bores through the earth. Utilities are typically installed in these underground bores during pullback.

Always use the machines in accordance with the instructions contained in this Operator's Manual, safety signs on the machine, and other material provided by Vermeer Corporation.

Proper maintenance and repair is essential for safety, and for efficient operation of the machine. Do not use the machine if it is not in suitable operating condition.

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Section 20: Electronic Controller

This section shows locations and identification of control keys and indicator lights on the electronic controller, as well as symbols used on the display screen. Refer to *Machine Controls, page 21-1*, for information on controls and lights within each function.

CONTROLLER KEYS

(1) Service Screen Key
Refer to "Service," *page 20-15*.

(2) Strike Alert Test Key
Press to test voltage and current sensing circuits. Alarm on drill unit must sound.

(3) Strike Alert Alarm Cancel Key
Press after Strike Alert alarm sounds and the cause has been corrected.

(4) Manual Pressure Limit Key
Activates and toggles between Thrust/Pullback Pressure limit, Rotation Pressure limit, and no pressure limits. Use *Trim Switch* (page 21-19) to adjust limits.

(5) R.A.T.T. Mode Key (D20x22 only)
Activates R.A.T.T. Oscillation mode and then toggles between Oscillation mode and Straight Drilling mode

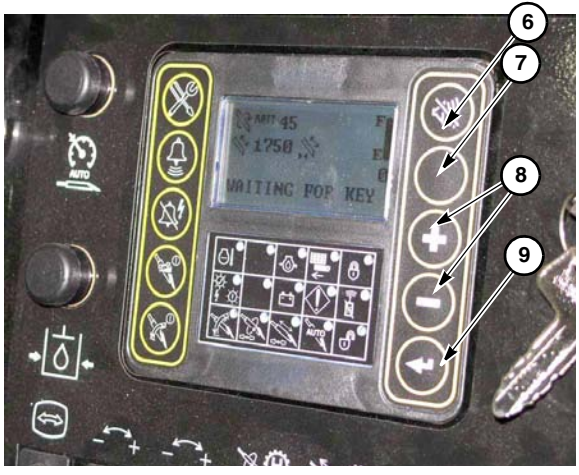
Controller Keys (Continued)

(6) Remote Lockout Alarm Cancel Key
Press to cancel continuously sounding alarm when radio communication is not established.

(7) Not Used

(8) Increase/Decrease Keys
Use these switches to increase or decrease the degrees of oscillation, or use with *Service Screen Key* to move through Service Menu.

(9) Enter Key - Use this to choose options.



CONTROLLER LIGHTS

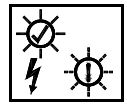
(1) Coolant Temperature Warning Light (red)
Comes on if coolant becomes too hot

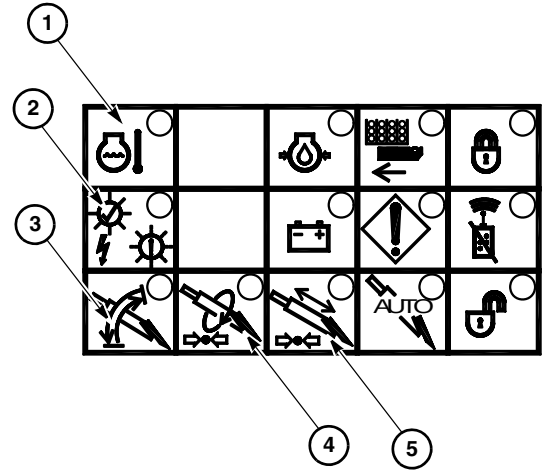
(2) Strike Alert Indicator Light (green)
ON: Strike Alert system test passed
FLASHING: Sensor failure, voltage stake not in ground, or voltage stake wiring problem
OFF: Bulb burned out or problem in wire harness

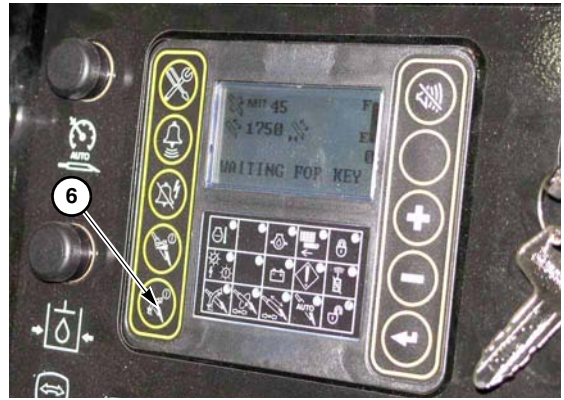
(3) R.A.T.T. Oscillation Mode Enabled Light (green) (D20x22 only)
Indicates that R.A.T.T. Oscillation mode is enabled Light goes OFF (indicating Straight Drilling mode) when *R.A.T.T. Mode Key* **(6)** is toggled.

(4) Rotation Limiter Light (green)
Indicates that rotation pressure limiter is active

(5) Thrust Limiter Light (green)
Indicates that thrust/pullback pressure limiter is active







Controller Lights (Continued)

(6) Oil Pressure Warning Light (red)
Comes on when oil pressure is low

(7) Alternator Warning Light (yellow)
Comes on when voltage not sufficient

(8) Anti-Crash Warning Light (red)
Comes on when rod loader arms are extended

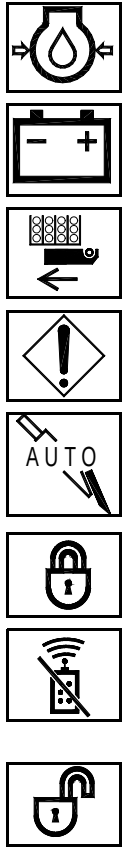
(9) Warning Light (yellow)
Comes on when engine shuts down due to low engine oil pressure or high coolant temperature

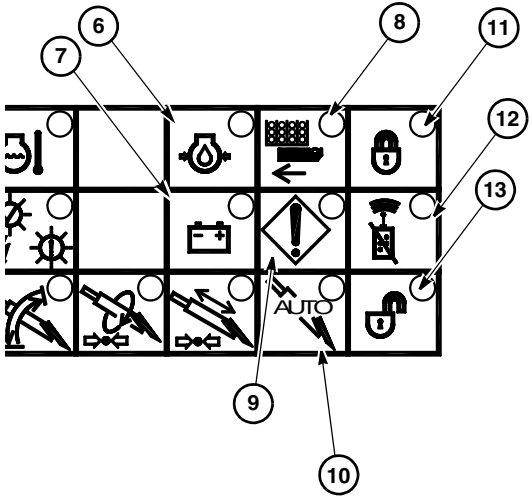
(10) AutoDrill Light (green)
Solid. . . . . indicates AutoDrill mode is active
Flashing . . . . . indicates AutoDrill mode in standby
Off . . . . . AutoDrill OFF

(11) Remote Lockout Mode Light (red)
Steady . . . . . drill rotation, thrust/pullback, & fluid locked out

(12) Remote Lockout Processing Light (yellow)
Flashing . . . . . machine state unknown;
. . . . . attempting to establish radio communication
NOTE: Double flash rate indicates Registration mode.

(13) Remote Lockout RUN Mode Light (green)
Steady . . . . . drill control returned to operator
Flashing . . . . . lockout requested, waiting for confirmation





SCREEN SYMBOLS

(1) Rotation active

(2) Thrust/Pullback active

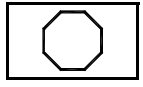
(3) Drilling Fluid Pump ON

(4) Thrust/Pullback Pressure Limit in PSI

(5) Drilling Fluid Pump Flow in GPM

(6) Drill Carriage Position Indicator

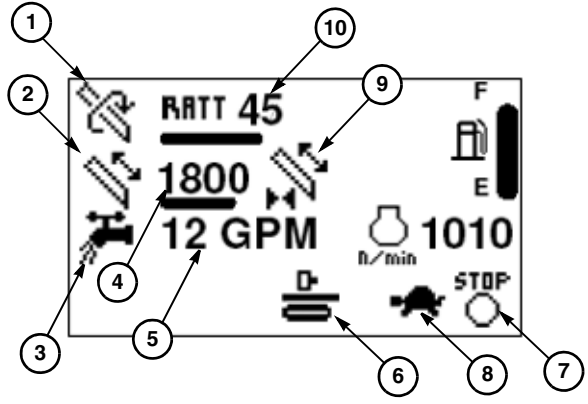
(7) Carriage at stop switch position . . . . . .



(8) Carriage between slowdown switch position and carriage stop switch position . . . . . .

(9) R.A.T.T. Thrust Pressure Limiting Enabled (D20x22 only)

(10) R.A.T.T. Mode Oscillation Angle in degrees; (D20x22 only)
Adjust with *Increase / Decrease Keys*



Screen Symbols (Continued)

(11) **High Speed Rotation**

(12) **High Speed Thrust**

(13) **Wash Wand Available**; flow in GPM

(14) **Bar Graph** - indicates amount of thrust output

(15) **Glow Plug Indicator**

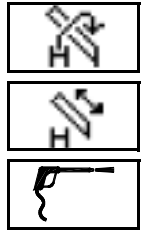
(16) **Save Set Pressure Limit**

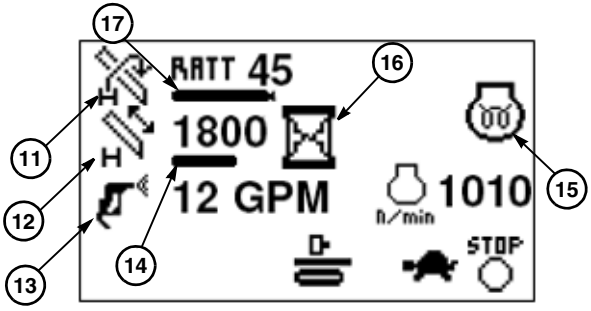
(17) **Bar Graph** - indicates amount of rotation output

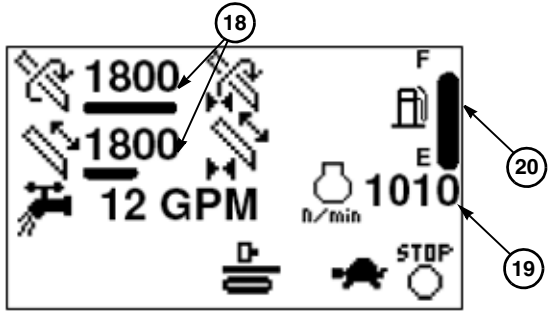
(18) **Normal Rotation and Thrust Limiting**
Adjust using *AutoDrill Selector Switch* for normal rotation pressure limiting and *Speed / Pressure Trim Switch* for thrust pressure limiting.

(19) **Engine RPM**

(20) **Fuel Gauge**



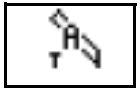




Screen Symbols (Continued)

(21) AutoDrill Mode Select

Constant Thrust/Pullback Pressure Mode Active



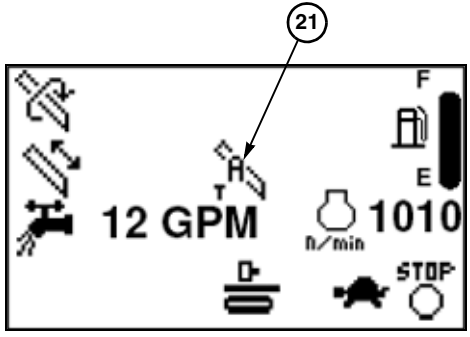
Constant Rotation Pressure Mode Active

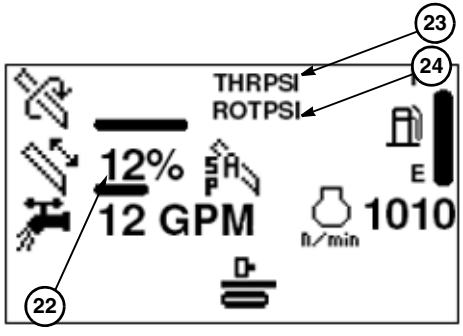
Constant Thrust/Pullback Speed Mode Active

(22) Thrust/Pullback Output
Use *Speed/Pressure Trim Switch* to increase or decrease value.

(23) Thrust/Pullback Pressure changing, which decreases thrust speed output

(24) Rotation Pressure changing, which decreases thrust speed output

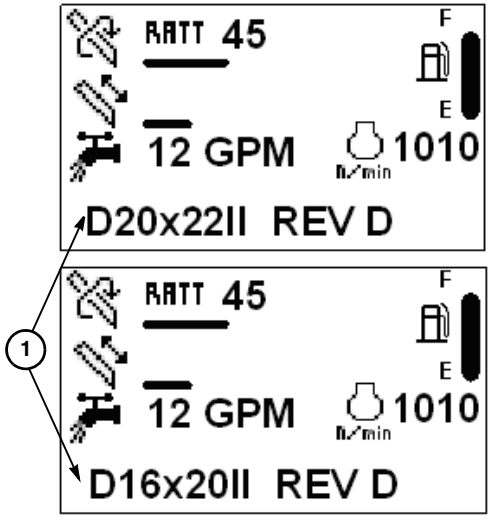




START-UP SCREEN

Later models:

One of these two screens will be displayed at start-up. If your machine model is not displayed **(1)** at the bottom, use the *Increase* or *Decrease Key* to choose the other model. Then press *Enter Key.*



Other messages that are displayed at bottom of screen:

Waiting for Key . . . . . .controller waiting for key switch to be turned ON

Waiting for Seat. . . . . controller waiting for operator to sit in seat

Engine Shutdown . . . . . .Lockout system has initiated engine shutdown

Hydrlc Shutdown. . . . . Lockout system has initiated hydraulic shutdown

Stopped . . . . . .controller has shut down the engine

E-Stop. . . . . E-Stop button has been pressed and engine shut down

-- Vise -- . . . . . Trying to start RATT Oscillate mode
. . . . . or restart AutoDrill while the front vise is closed

INFORMATION SCREENS

(1) **Active Fault Display**
When this screen appears a fault is present. Refer to Fault Codes chart, *Service, page 20-15*, and determine next action. Press *Service Screen Key* to cycle through the next four screens.

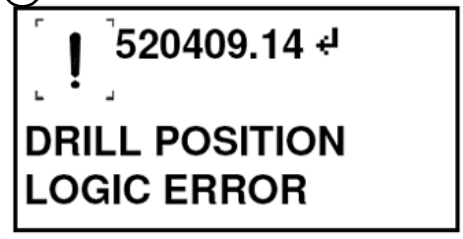
(2) **Options Menu**
Displays rotation pressure, thrust/pullback pressure, hours. Adjust thrust speed in slowdown zone, R.A.T.T. On/Off with + and - keys, and R.A.T.T. tool calibration.

(3) **Information Menu**
Read information on software revisions of Remote Lockout, Strike Alert, DP10, or controller.

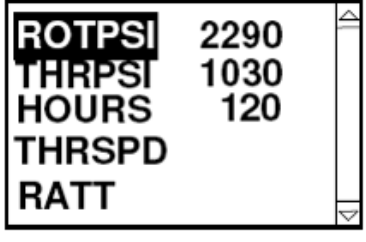
(4) **Fault Log**
View fault codes and clear.

(5) **Override Menu**
Manually operate vise or rod loader solenoids.

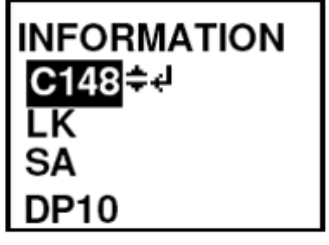
1



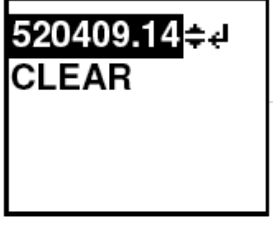
2



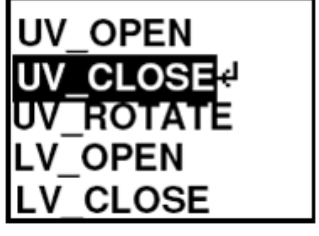
3



4



5



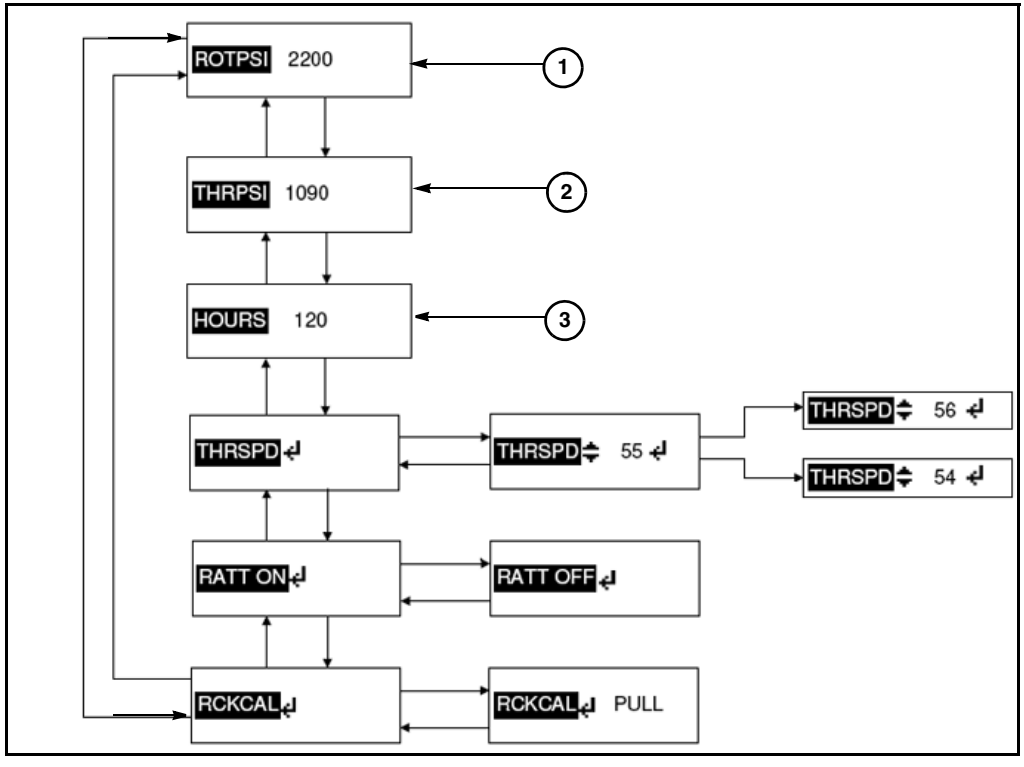
Options Menu

- To scroll through screens in left column, use *Increase* or *Decrease Key.*
- To modify options, use *Enter Key.*

(1) Current Rotation Pressure

(2) Current Thrust/Pullback Pressure

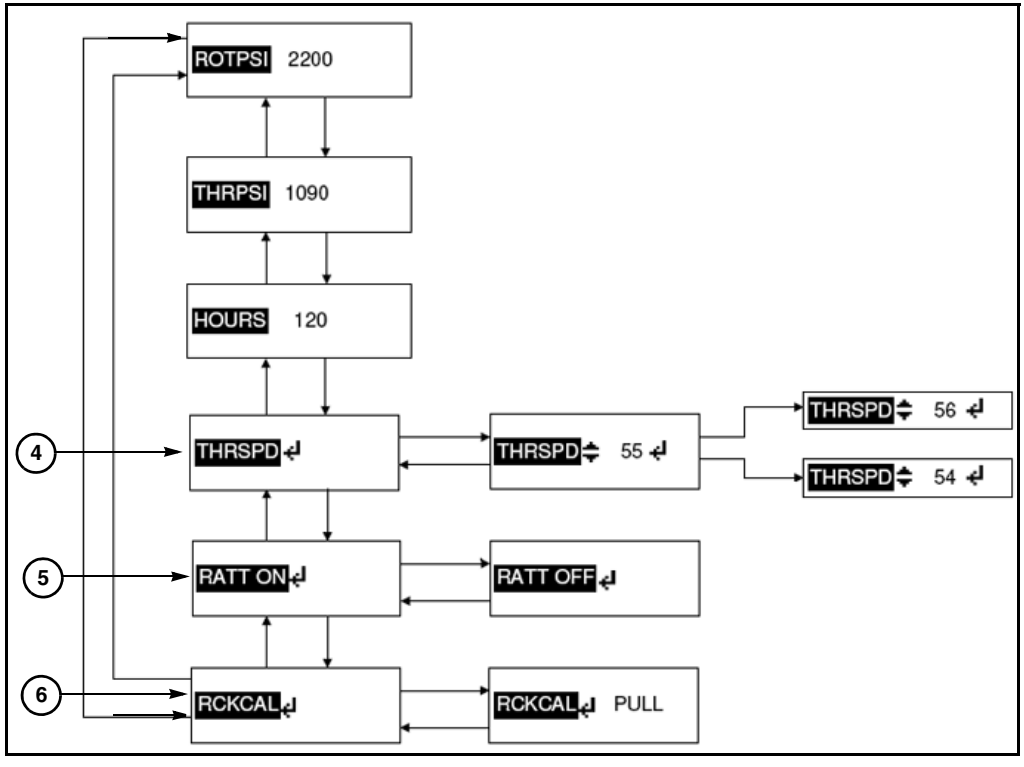
(3) Current Engine Hours



(4) Thrust/Pullback Output in Slowdown Zone
Press *Enter Key* to view current speed; press *Increase* or *Decrease Key* to adjust.

(5) R.A.T.T. ON (D20x22 only)
Press *Enter Key* to turn R.A.T.T. ON/OFF at start-up.

(6) R.A.T.T. Calibration (D20x22 only)
Press *Enter Key* to calibrate R.A.T.T. sensor ring; refer to "Maintenance As Required" in the *Maintenance Manual*.



Information Menu

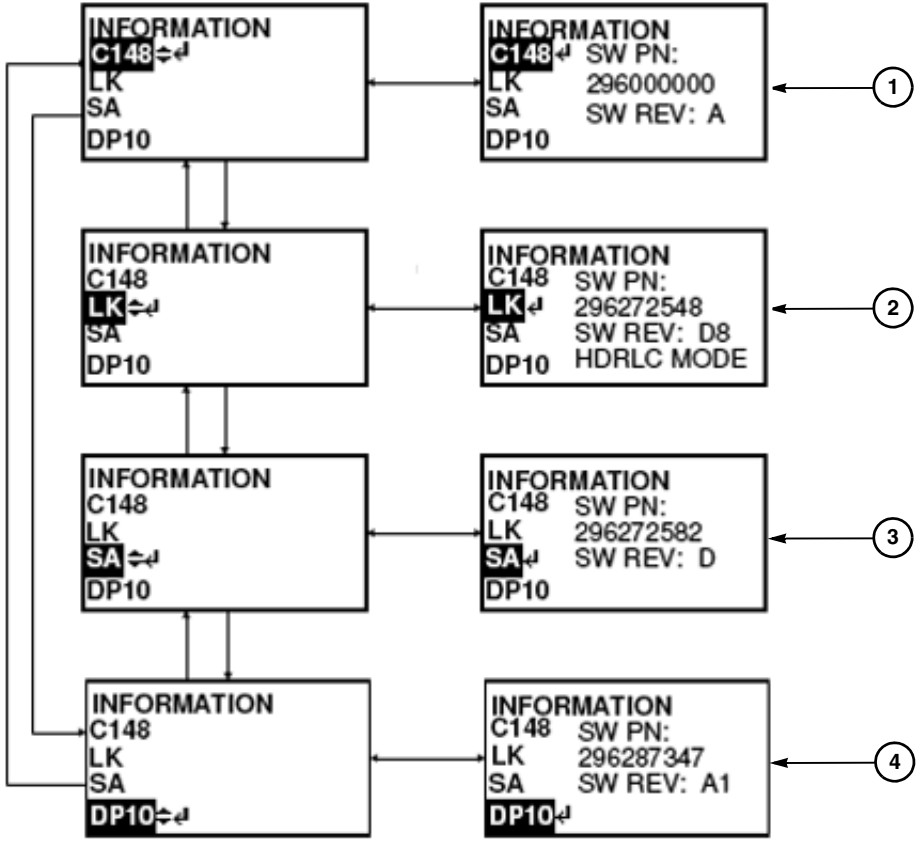
- To scroll through screens in left column, use *Increase* or *Decrease Key*.
- To modify options, use *Enter Key*.
- All display software part number and revision

(1) Controller

(2) Remote Lockout

(3) Strike Alert

(4) DP10 Controller

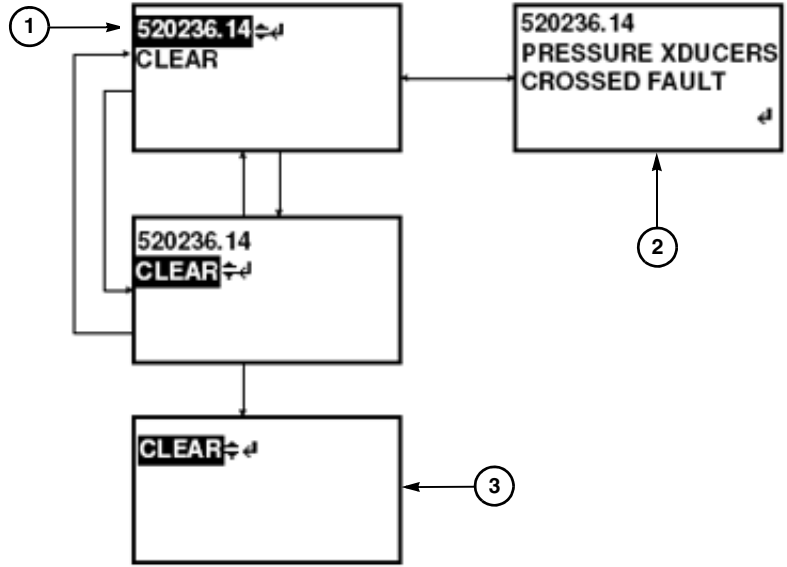


Fault Log

(1) Press *Enter Key* to select fault code. Press *Increase* or *Decrease Key* to scroll or to Clear.

(2) Fault code is displayed.

(3) Press *Enter Key* to clear log of all fault codes.



Overrides Menu

Step 1: To scroll through screens in left column, use *Increase* or *Decrease Keys*.

Step 2: To modify options, use *Enter Key*.

Step 3: Press *Increase* or *Decrease Keys* to manually activate or deactivate each control.

NOTE: Engine must be shut off for this procedure.

(1) Upper (Rear) Vise Open

(2) Upper (Rear) Vise Closed

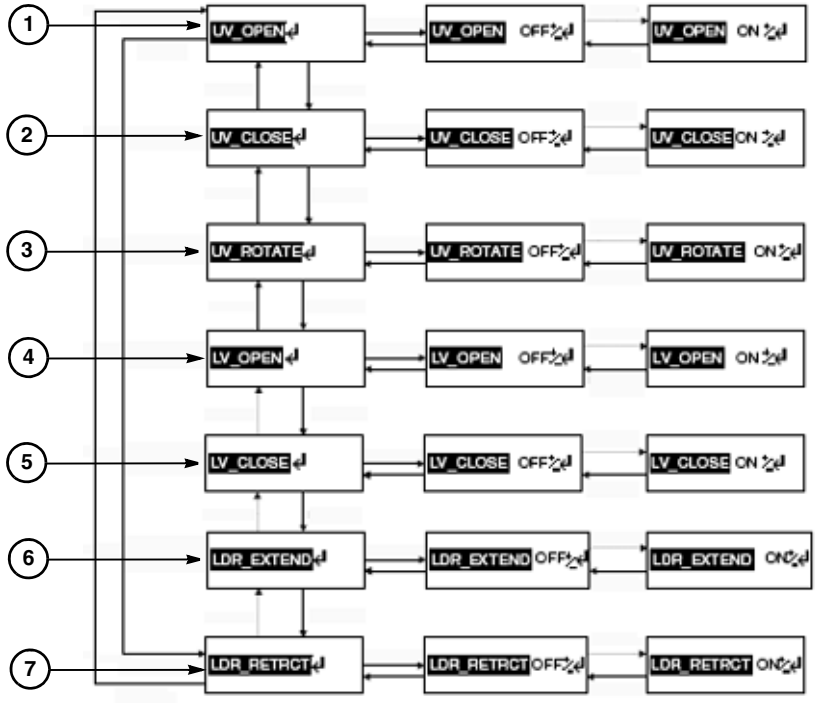
(3) Upper (Rear) Vise Rotate

(4) Lower (Front) Vise Open

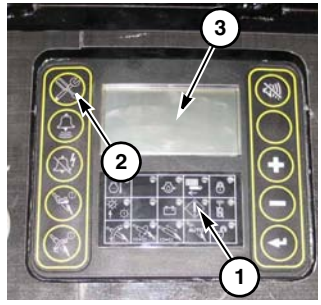
(5) Lower (Front) Vise Closed

(6) Rod Loader Extended

(7) Road Loader Retracted



SERVICE



Engine shuts down when warning light **(1)** is solid. Press *Service Screen Key* **(2)** to view message from table below on display **(3)**. Contact your Vermeer dealer for solutions.

Operator Warnings and Fault Messages

Right joystick voltage low	High speed thrust solenoid current low
Right joystick voltage high	Torque limiter solenoid current low
Right joystick must be in NEUTRAL to start	Lockout off-line
Left joystick voltage low	Strike alert off-line
Left joystick voltage high	Rod loader retract solenoid current low
Left joystick must be in NEUTRAL to start	Rod loader extend solenoid current low
Rotation pressure transducer voltage low	Hydraulic enable solenoid current low
Rotation pressure transducer voltage high	Ball valve solenoid current low
Thrust pressure transducer voltage low	Track enable solenoid current low
Thrust pressure transducer voltage high	Water valve solenoid current low
Oil pressure sensor low	Upper vise close solenoid current low
Engine temperature sensor high	Upper vise rotate solenoid current low
Forward thrust while anti-crash active	Lower vise open solenoid current low
Drill position logic error	Lower vise close solenoid current low
Rotation/thrust pressure transducers connections reversed	Thrust EDC current low
Upper (rear) vise open solenoid current low	Rotation EDC current low
Battery low	Fuel solenoid current low
High speed rotation solenoid current low	

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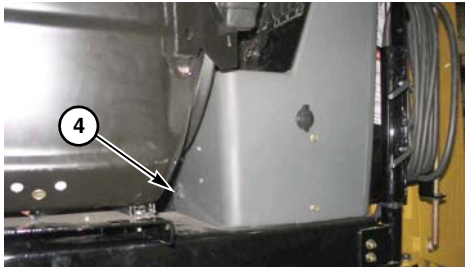
Section 21: Machine Controls

STRIKE ALERT CONTROLS



(1) Alarm Cancel Key
Press after Strike Alert alarm sounds and the cause has been corrected.

(2) Test Key
Press to test voltage and current sensing circuits.
Alarm on drill unit must sound.

(3) Green Indicator Light
ON: Strike Alert system test passed.
FLASHING: Sensor failure, voltage stake not in ground, or voltage stake wiring problem.
OFF: Bulb burned out or problem in wire harness.

(4) Strike Alert Horn
Located at bottom of right console.
When alarm sounds, the drill may have contacted an electrical line.
Alarm will also sound once when operator presses the *Test Key*.

NOTE: Test Strike Alert system with the voltage stake fully inserted into the ground. Do not test with stake in its storage cradle, lying on the machine, or lying on the ground. If machine is on a dry hard surface, the auger stakes may need to be inserted into the ground, or the ground under the tracks moistened to increase electrical conductivity between machine and ground.

Remote Lockout Controls

Remote Transmitter Controls

NOTE: In order for the remote transmitter to function, machine ignition key must be ON.

(1) Power ON/OFF Button (black)

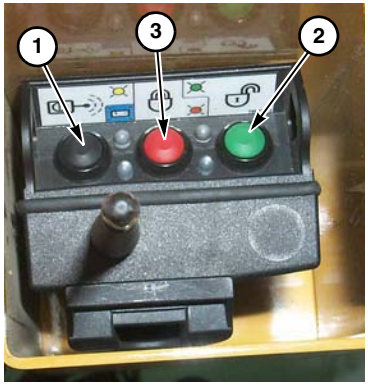
Press and hold until yellow light flashes. . . . . ON
Press and hold until all lights are off . . . . . OFF
NOTE: Remote shuts off automatically if there is no communication with machine after 20 minutes.

(2) Run Button (green)

With transmitter ON:
Press and hold until yellow light flashes. . . . . RUN mode requested
When green light comes on, Remote Lockout system is in RUN mode.
With transmitter OFF:
Press and hold. . . . . TEST mode
to initiate testing of transmitter buzzer, vibrator and indicator lights

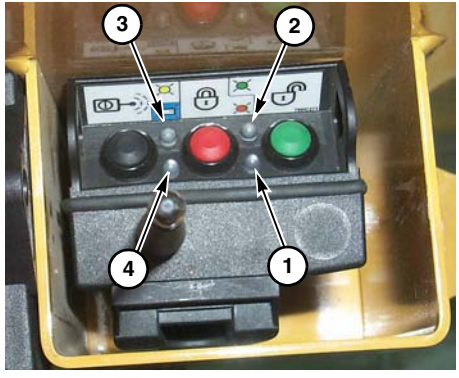
(3) Lockout Button (red)

With transmitter ON:
Momentarily press and release . . . . . LOCKOUT mode requested
When lockout is complete, red light will come on (takes approximately 2–5 seconds).
With transmitter OFF:
Press and hold until yellow light flashes. . . . . turns transmitter ON and
. . . . . requests LOCKOUT mode
When lockout is complete, red light will come on (takes approximately 2–5 seconds).



Indicator Lights

Flashing or steady lights indicate various operating conditions.

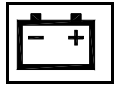


(1) LOCKOUT Mode Light
Red steady. . . . .drill rotation, thrust/pullback, and fluid locked out

(2) RUN Mode Light
Green steady. . . . . drill control returned to operator
Green flashing . . . . . .lockout requested, waiting for confirmation

(3) Processing Light
Yellow flashing . . . . . machine state unknown; attempting to establish radio communication
NOTE: Double flash rate indicates Registration mode.

(4) Low Battery Light
Blue flashing. . . . . battery power less than 10%



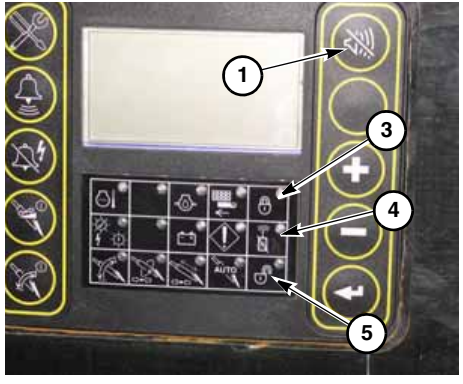
REMOTE LOCKOUT MACHINE CONTROLS

(1) Alarm Cancel Key

Press to cancel continuously sounding alarm **(2)** when radio communication can not be established.

(2) Alarm

Alarm sounds with a series of beeps or continuous tone to indicate various operating and Remote Lockout system conditions.



Indicator Lights

Flashing or steady lights indicate various operating conditions.

(3) LOCKOUT Mode Light

Red steady . . . . . drill rotation, thrust/pullback, and fluid locked out

(4) Processing Light

Yellow flashing . . . . . machine state unknown; attempting to establish radio communication

NOTE: Double flash rate indicates Registration mode.

(5) RUN Mode Light

Green steady . . . . . drill control returned to operator

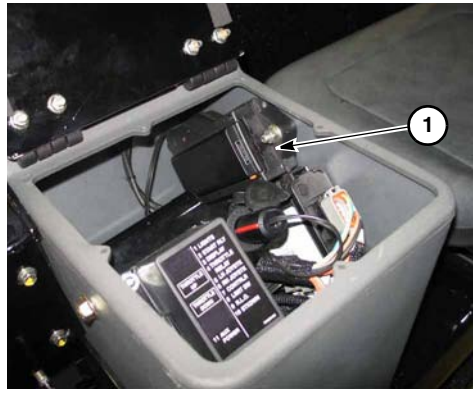
Green flashing . . . . . lockout requested, waiting for confirmation

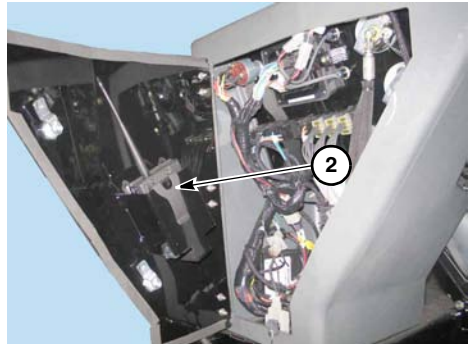
REMOTE LOCKOUT BATTERY CHARGER

(1) **Battery Charger**
Located inside compartment to the left of the seat.

Charges transmitter battery. Insert battery into charger.
Amber light flashes when battery is fully charged.
Green light indicates charger is receiving power.

(2) **Transmitter Storage**
Located inside compartment behind right controls console.





REMOTE LOCKOUT INDICATORS

TRANSMITTER INDICATORS	INDICATION	FUNCTION/STATUS
Green RUN Light	Steady	RUN mode. Machine not locked out.
	Flashing	Lockout requested; waiting for confirmation.
Red LOCKOUT Light	Steady	LOCKOUT mode. Machine is locked out.
Yellow Light	Flashing	No radio communication between transmitter and machine.
	Double flashing	Remote is in Registration mode.
Blue Light	Flashing	Battery low.
Sound	2 seconds	RUN mode. Machine not locked out.
	3+3+3 beeps	LOCKOUT mode. Machine is locked out.
	60 seconds	Lockout denied. Attempt to lock out machine has failed.
Vibration	60 seconds	Lockout denied. Attempt to lock out machine has failed.

MACHINE INDICATORS	INDICATION	FUNCTION/STATUS
Green RUN Light	Steady	RUN mode. Machine not locked out.
	Flashing	Lockout requested; waiting for confirmation.
Red LOCKOUT Light	Steady	LOCKOUT mode. Machine is locked out.
Yellow Light	Flashing	No radio communication between transmitter and machine.
	Double Flashing	Registration mode.
Sound	2 seconds	RUN mode. Machine not locked out.
	3+3+3 beeps	LOCKOUT mode. Machine is locked out.
	60 seconds	Lockout denied. Attempt to lock out machine has failed.

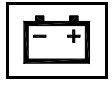
Engine Controls

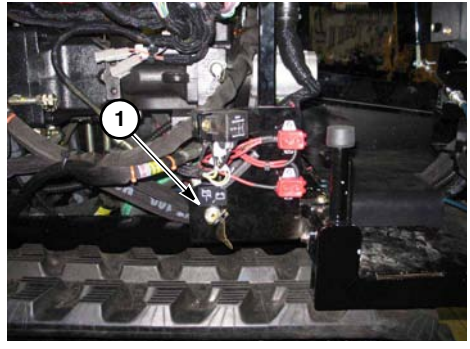
BATTERY GROUND DISCONNECT

(1) Battery Disconnect Switch

Rotate key counterclockwise . . . . . disconnect ground

Rotate key clockwise . . . . . connect ground

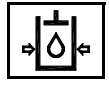




HYDRAULIC ENABLE BUTTON

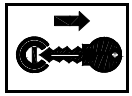
(1) Hydraulic Enable Button

After starting, press button to enable accessory hydraulic circuits. The accessory circuits include power vise, stabilizer, rod loader, and drilling fluid ON/OFF ball valve.



ENGINE CONTROLS - DRILL STATION

(1) Key Switch . . . . . .



1st position counterclockwise . . . . . .glow plugs on

Center/straight up position. . . . . .engine stop

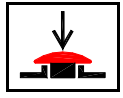
1st position clockwise . . . . . .engine run, electrical system ON

2nd position clockwise. . . . . engine start

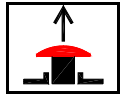
EMERGENCY SHUTOFF SWITCH

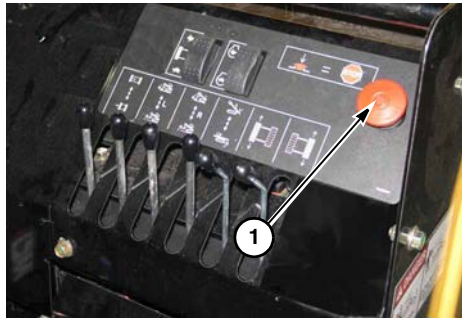
(1) Emergency Shutoff Switch, Transport Station

Push . . . . . .to shut off engine



Pull out. . . . . .before restarting the engine



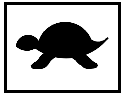


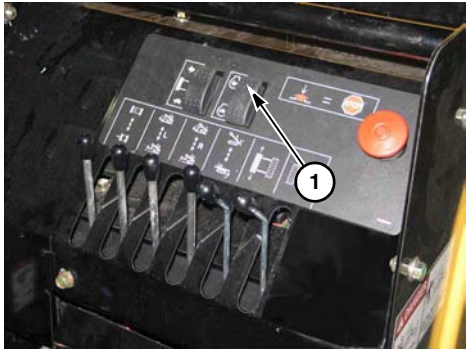
THROTTLE

(1) Throttle Switch - Transport Station

Press top. . . . . increase engine RPM

Press bottom . . . . . decrease engine RPM





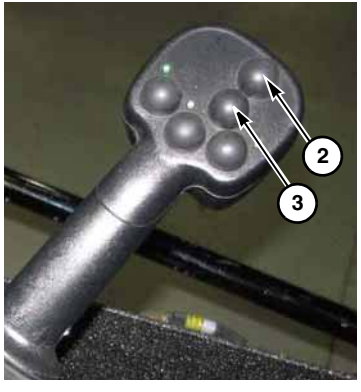
Rotation Handle

(2) Throttle Up Button

Press. . . . . increase engine RPM

(3) Throttle Down Button

Press. . . . . decrease engine RPM



ENGINE MONITORS

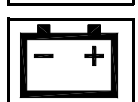
(1) Coolant Temperature Warning Light (red)
Comes on if coolant becomes too hot

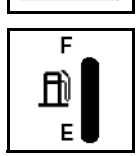
(2) Oil Pressure Warning Light (red)
Comes on when oil pressure is low

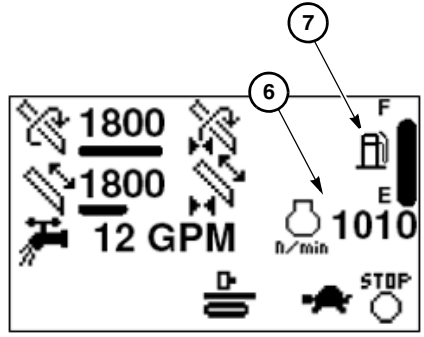
(3) Alternator Warning Light (yellow)
Comes on when voltage not sufficient

(4) Display
Shows engine hours, engine RPM **(6)** and fuel level **(7)**

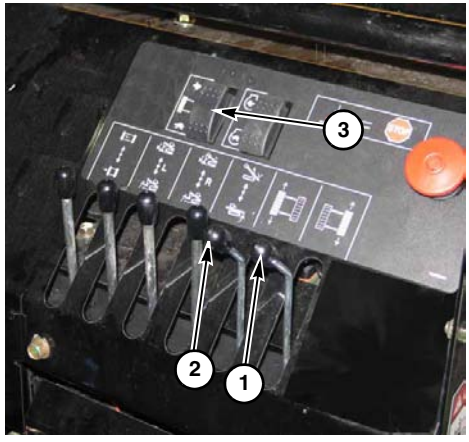
(5) Warning Light (yellow)
Comes on when engine shuts down due to low engine oil pressure or high coolant temperature



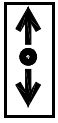




TRANSPORT STATION CONTROLS

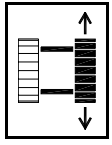


(1) Right Track Lever

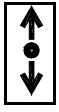


Push . . . . . move forward

Pull . . . . . move backward

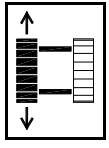


(2) Left Track Lever



Push . . . . . move forward

Pull . . . . . move backward



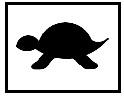
NOTE: Push one lever ahead and pull other lever back to counter-rotate tracks. The levers will self-center when released.

NOTE: The ground drive controls do not function with an operator in the seat.

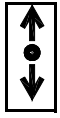
(3) Ground Drive Range Switch

Press up . . . . . .high

Press bottom . . . . . low



(4) Rack Angle Lever

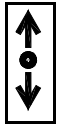


Push . . . . . tilts rack

Pull . . . . . levels rack

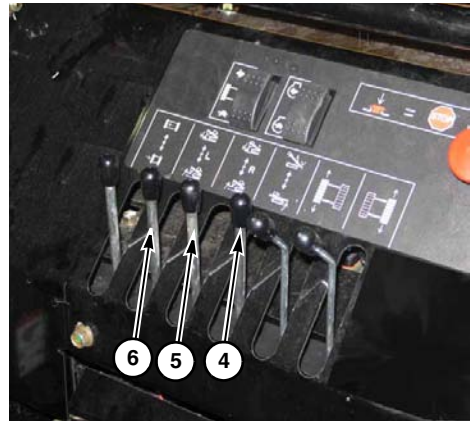
(5) Right Rear Stabilizer Lever

(6) Left Rear Stabilizer Lever



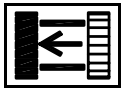
Push . . . . . lower stabilizer

Pull . . . . . raise stabilizer

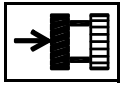


(7) Tracks Extend Lever (D16x20 only)

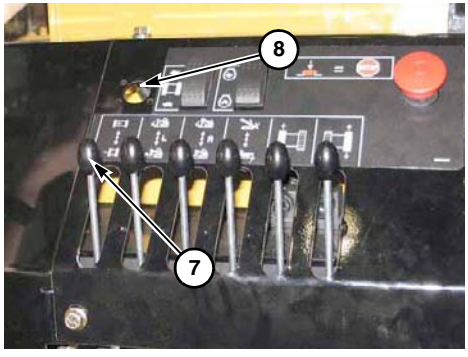
Push . . . . . tracks out



Pull . . . . . tracks in



(8) Tethered Transport Control (Option) Connector



TETHERED TRANSPORT CONTROL (OPTION)

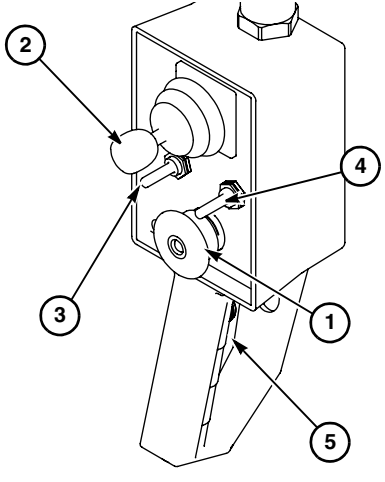
(1) Engine Stop Switch

(2) Transport Joystick
Multi-directional: push in the direction you wish to drive.

(3) Throttle
Press up . . . . . increase
Press down . . . . . decrease

(4) Ground Drive Range Switch
Press up . . . . . high
Press bottom . . . . . low

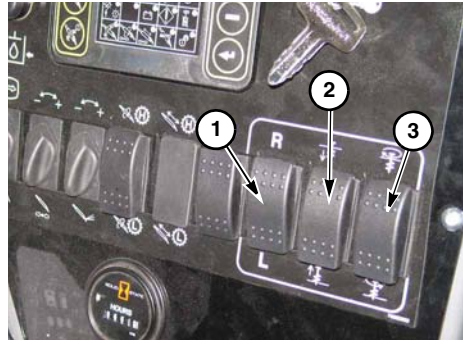
(5) Operator Presence Switch (on back of control)
Press . . . . . tethered controls enabled
Release . . . . . tethered controls disabled



NOTE: *Engine Stop Switch* is functional at all times when tethered transport control is connected.

Setup Controls

STAKEDOWN CONTROLS



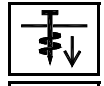
(1) Stakedown Control Selector

Push top . . . . . select right stakedown

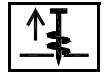
Push bottom . . . . . select left stakedown

(2) Stakedown Driver Cylinder Switch

Push top . . . . . drive stake into the ground



Push bottom . . . . . remove stake from the ground

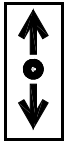


(3) Stakedown Driver Motor Switch

Push top . . . . . stake turns clockwise

Push bottom . . . . . stake turns counterclockwise

THRUST/PULLBACK CONTROLS



(1) Thrust/Pullback Handle (Right Handle)

Pull . . . . . pull back (retract) drill

Push . . . . . drill forward

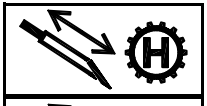
The *Thrust/Pullback Handle* automatically returns to the NEUTRAL position when released.

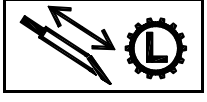
(2) 2-Speed Thrust Button (D20x22 only)

Press top . . . . . high

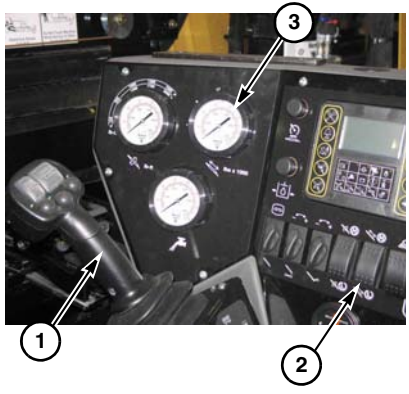
Press bottom . . . . . low

Speed is automatically switched to HIGH when front vise is clamped.

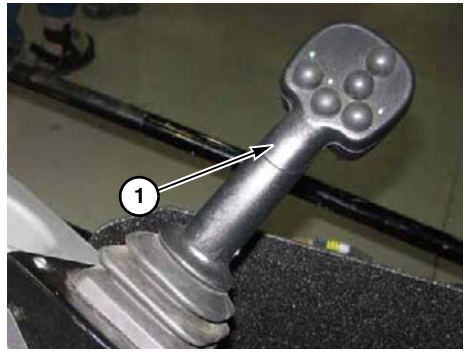




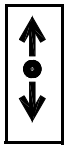
(3) Thrust/Pullback Pressure/Force Gauge . . . . . .



ROTATION CONTROL



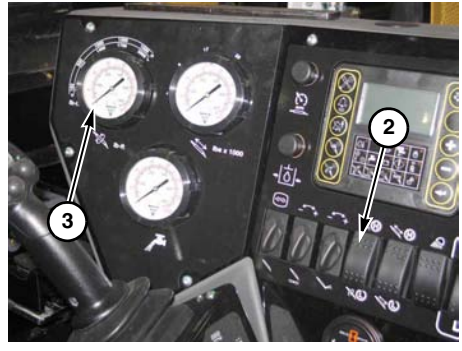
(1) Drill Rotation Handle (Left Handle)



Pull . . . . . rotate clockwise
Use for drilling forward or backreaming.

Push . . . . . .rotate counterclockwise
Use for uncoupling threaded drill rods.
The *Drill Rotation Handle* automatically returns to the NEUTRAL position when released.

IMPORTANT: Never rotate drill string counterclockwise while drilling, pulling back, or backreaming. The threaded rods will come apart.



(2) 2-Speed Rotation Button

Press top . . . . . .high
Press bottom . . . . . .low
Speed is automatically switched to LOW when front vise is clamped.

(3) Drill Rotation Pressure/Torque Gauge

AUTODRILL CONTROLS

(1) AutoDrill Button

Press and release . . . . . activate AutoDrill mode

NOTE: Move either *Rotation* or *Thrust*/*Pullback Handle* to pause AutoDrill mode.

(2) AutoDrill Resume Button

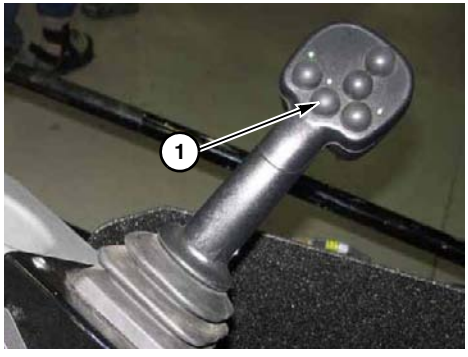
Hold for 1.5 seconds to resume AutoDrill after pausing. Rotation will start 2–3 seconds before thrust or pullback starts.

(3) AutoDrill Light

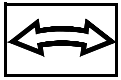
Solid . . . . . indicates AutoDrill mode is active

Flashing . . . . . indicates AutoDrill mode in standby

Off . . . . . AutoDrill OFF

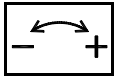


(4) AutoDrill Selector Switch



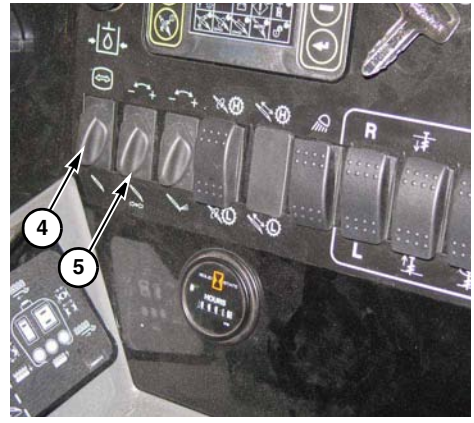
Toggle . . . . . Constant Thrust/Pullback Speed
. . . . . SPEED shown on display
Toggle second time . . . . . Constant Thrust/Pullback Pressure
. . . . . (default in R.A.T.T. mode)
. . . . . THRUST shown on display
Toggle third time . . . . . Constant Rotation Pressure
. . . . . ROTATE shown on display

(5) Speed/Pressure Trim Switch

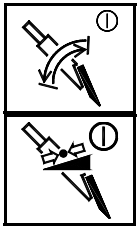


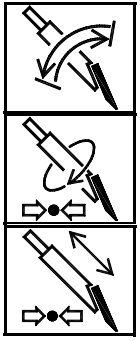
Clockwise . . . . . increase speed/pressure
Counterclockwise . . . . . decrease speed/pressure
Hold, either direction . . . . . continuously ramp up or down

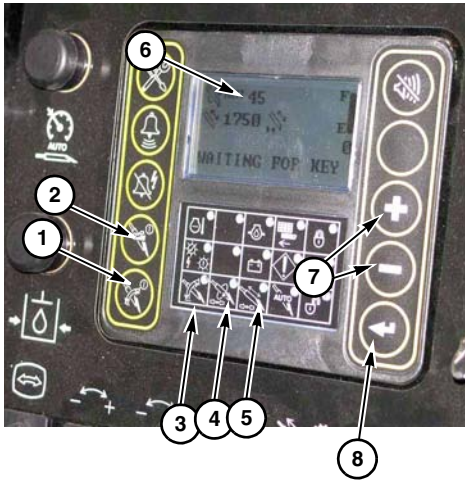
First toggle will display mode of operation code and set point value.
For example:
ASPD25 . . . . . auto speed @ 25% of maximum pump flow
T-1900 . . . . . thrust pressure @ 1900 psi
R-2050 . . . . . rotation pressure @ 2050 psi
Second toggle will increase or decrease the value displayed on the screen. Holding the toggle in either direction will ramp up or down the rate of change of the value displayed.

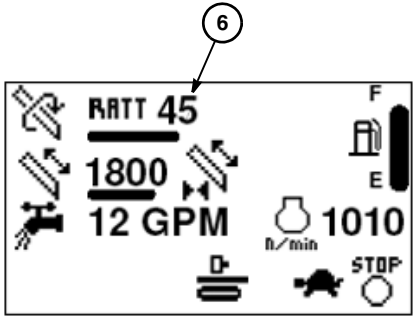


R.A.T.T. Controls (D20x22 Only)









(1) R.A.T.T. Mode Key
Activates R.A.T.T. Oscillation mode and then toggles between Oscillation mode and Straight Drilling mode

(2) Manual Pressure Limit Key
Activates and toggles between Thrust/Pullback Pressure limit, Rotation Pressure limit, and no pressure limits. Use *Trim Switch* (page 21-19) to adjust limits.

(3) R.A.T.T. Oscillation Mode Enabled Light
Indicates R.A.T.T. Oscillation mode is enabled. Light goes OFF (indicating Straight Drilling mode) when **(1)** is toggled.

(4) Rotation Limiter Light
Indicates rotation pressure limiter is active

(5) Thrust Limiter Light
Indicates the thrust/pullback pressure limiter is active

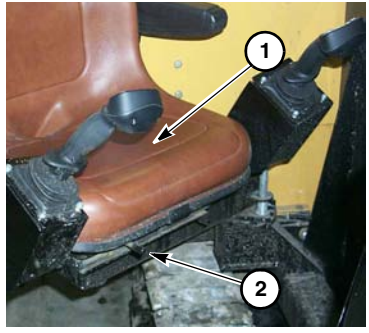
(6) Oscillation Degrees
Degrees are displayed on upper left side of screen. Adjust in 6° increments using *Increase / Decrease Keys* **(7)**.

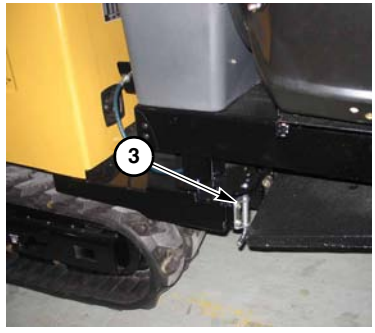
(7) Increase/Decrease Keys
Use these switches to increase or decrease degrees of oscillation, or use with *Service Screen Key* to move through the Service Menu.

(8) Enter Key - Use this to choose options.

Drill Station Controls

OPERATOR PRESENCE/SEAT CONTROLS





(1) Operator Presence Switch
The machine is equipped with an Operator Presence system in the seat. The operator must be sitting in the seat for drill rotation, drill thrust, and rod loader to function.

This system is intended for your safety and must be maintained in good functional condition.

(2) Adjustment Lever
Push to the side so seat can be moved forward or backward.

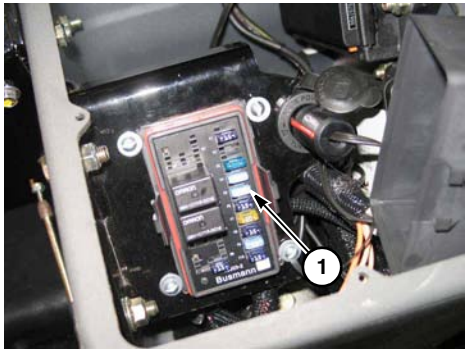
(3) Pivot Latch
(S/N 101–163 on D16x20; S/N 101–165 on D20x22)
Rotate handle back to lift lock pin.

- Transporting—Lift pin and push seat assembly in until pin locks.
- Operating—Lift pin and pull seat assembly out until pin locks.

(4) Seat Rotation Lever
(S/N 164 – on D16x20; S/N 166 on D20x22)
Push down on lever and rotate seat until it locks in desired position.

FUSES

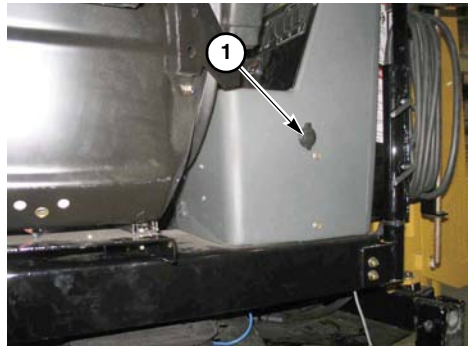
Fuses **(1)** protect electrical circuits and are located in compartment under left armrest. When replacing them, use fuses with the correct rating to prevent damaging electrical system.



Fuse Location	Function	Fuse Location	Function
F01-15A	Run	F02-15A	Auxiliary Power
F03-15A	Lights	F04-15A	Lockout Receiver
F05-30A	for future use	F06	for future use
F07	for future use	F08	for future use
F09-15A	Starter	F10-5A	Lockout Charger
F11-15A	Spare	F12-5A	Spare

AUXILIARY OUTLET

(1) 12-Volt Auxiliary Outlet
Use outlet to operate 12-volt 150-watt electrical accessories. A 15-amp breaker protects the circuit.



LIGHTS

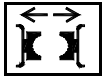
(1) Switch
Press top . . . . . lights on
Press bottom . . . . . lights off

POWER VISE CONTROLS

(1) Front Vise Switch

Push top . . . . . .clamp front drill rod

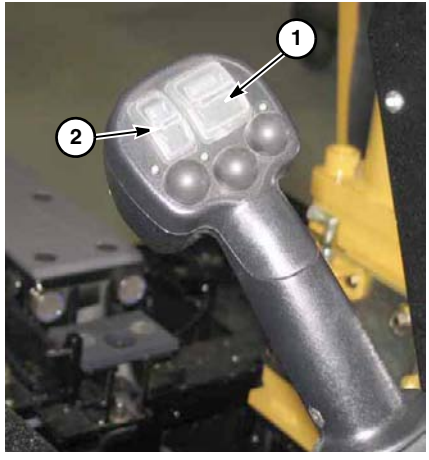
Push bottom . . . . . .release



(2) Rear Vise Switch

Push top . . . . . clamp and rotate rear drill rod

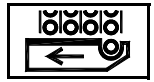
Push bottom . . . . . .release clamp and rotate to home position



ROD LOADER CONTROLS

(1) Rod Transfer Arm Retract Button (on back of right joystick)

Press and hold . . . . . shift rod transfer arm in to rod box



Release . . . . . stop rod selector

(2) Rod Transfer Arm Extend Button

Press and hold . . . . . shift rod transfer arm out to drill string

(3) Rod Lower Button

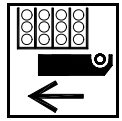
Press and hold . . . . . lower rod from rod box onto transfer arm

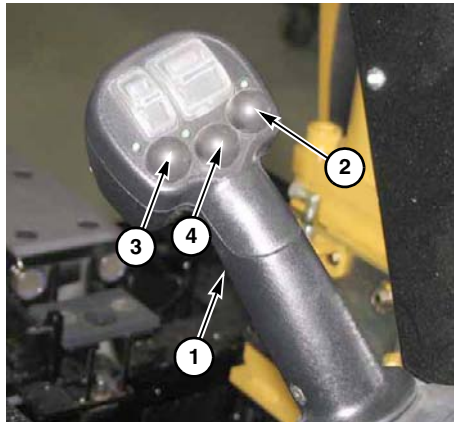
(4) Rod Lifter Button

Press and hold . . . . . lift rod into rod box from transfer arm

(5) Anti-Crash Light (red)

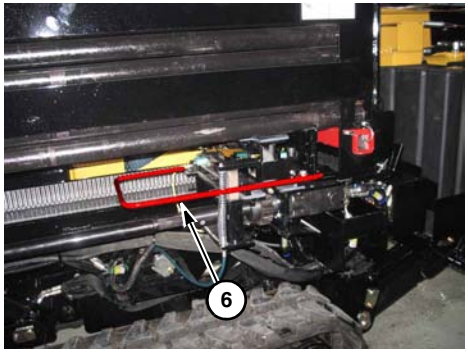
Indicates carriage will not move outside rear slowdown zone because rod loader arms are extended.





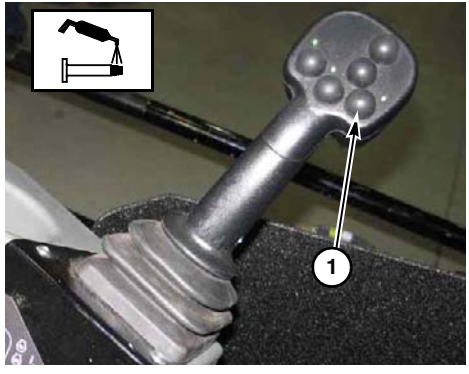
(6) Rod Transfer Arm Barrier

The barriers automatically move out with the first movement of the rod loaders arms. Fold barriers back in manually before transporting.



AUTO GREASE BUTTON (OPTION)

The machine may be equipped with an auto greaser for lubricating drill rod threads. Press *Auto Grease Button* **(1)** on left joystick to release grease.



ROD LOADER ROW SELECTOR

(1) **Position 1**. . . . . loader under first row

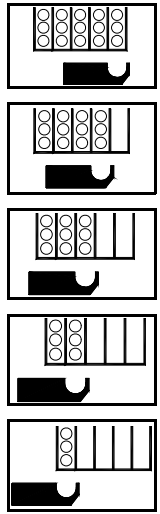
(2) **Position 2**. . . . . loader under second row

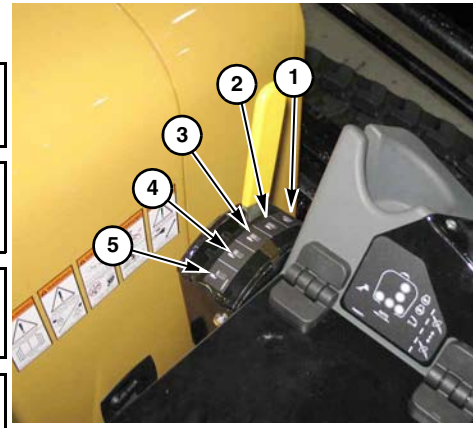
(3) **Position 3**. . . . . loader under third row

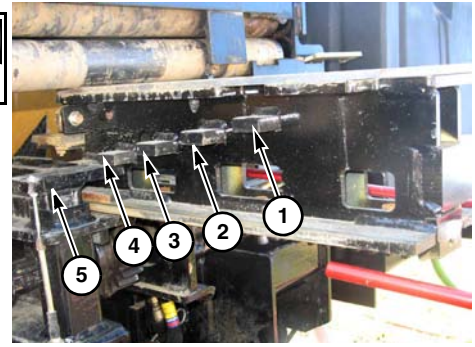
(4) **Position 4**. . . . . loader under fourth row

(5) **Position 5**. . . . . loader under fifth row

NOTE: D16x20 has four rows; D20x22 has five rows.



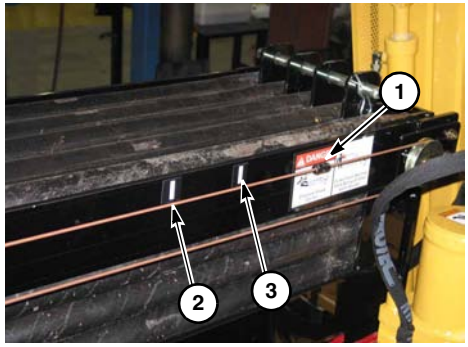




ROD JOINT POSITION INDICATOR

Earlier Models

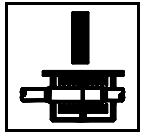
- When marker **(1)** is at rear white decal **(2)**, rod joint is positioned between rear and front vises. The power vises can clamp drill rods and loosen lower joint.
- When marker **(1)** is at front white decal **(3)**, upper rod is retracted enough to clear downhole rod. The upper rod joint can be loosened by clamping rod with the rear vise and rotating the drive chuck.



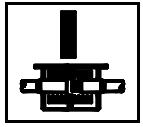
S/N 101–121 on D16x20
S/N 101–122 on D20x22

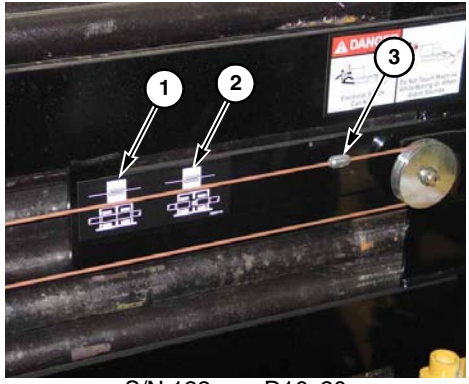
Later Models

(1) Position 1 . . . . . .
When marker **(3)** is at left decal **(1)**, rod joint is positioned between rear and front vises. The power vises can clamp drill rods and loosen lower joint.



(2) Position 2 . . . . . .
When marker **(3)** is at right decal **(2)**, upper rod is retracted enough to clear downhole rod. The upper rod joint can be loosened by clamping rod with the rear vise and rotating the drive chuck.





S/N 122– on D16x20
S/N 123– on D20x22

DRILLING FLUID CONTROLS

(1) Fluid Full Flow Button

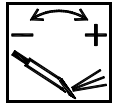
Press and hold . . . . . full flow
Released . . . . . full flow OFF
NOTE: Defaults to variable flow setting when button is released

(2) Pressure Gauge

Indicates drilling fluid pressure.
NOTE: Gauge displays drilling fluid pump drive motor hydraulic pressure. Drilling fluid pressure is 60 percent of hydraulic pressure shown on gauge.

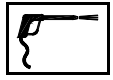
(3) Drilling Fluid Pump Trim Switch

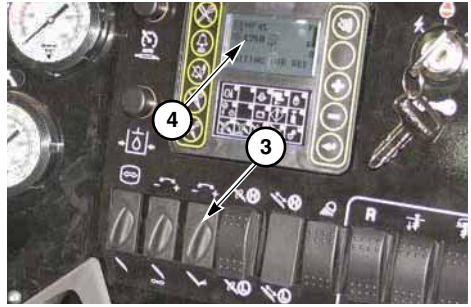
Clockwise . . . . . increase by 1 gpm
Counterclockwise . . . . . decrease by 1 gpm
Hold, either direction . . . . . continuously ramp up or down

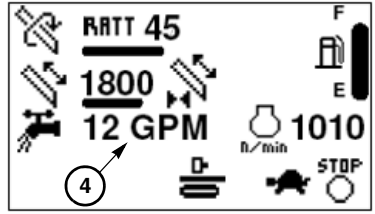


(4) Drilling Fluid Pump Flow Rate Display

0 . . . . . no flow
1 to maximum rated flow of pump. . . . . drilling fluid flow set point; adjust with *Drilling Fluid Pump Trim Switch*
WW . . . . . wash wand ON







(5) Wash Wand Quick Coupler

(6) Fluid Tank System Valve

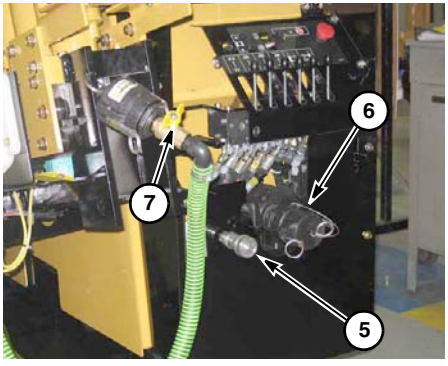
Rotate down (handle 90º to valve body) . . . . . flow OFF
Rotate up (handle in-line with valve body) . . . . . flow ON

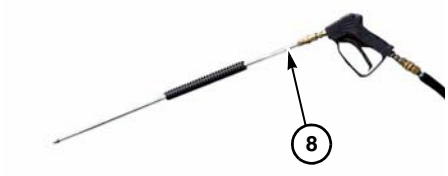
(7) Antifreeze Supply Valve

Rotate handle in-line to valve body . . . . . open
Rotate handle perpendicular to valve body . . . . . close

(8) Wash Wand

Squeeze. . . . . wash wand ON
Release . . . . . wash wand OFF





Section 30: Overview

Remote Lockout Overview

IMPORTANT: The Remote Lockout system is not intended to replace good verbal radio communication. Radio communication is essential to the Remote Lockout system process. Refer to the *Preparation* section, “Radio Communication Requirements,” *page 40-3*, for complete information.

Remote Lockout System Intended Use

The Remote Lockout system is a communication and control tool that allows a worker anywhere along the bore path or at the exit site, to directly lock out drill rod rotation, thrust, and fluid flow. Lights, sound, and vibration indicate various modes so the machine operator and remote user know that the Remote Lockout system is operating properly and whether drilling functions are locked out.

NOTE: When in Transport mode, the machine will not respond to Remote Lockout system commands until machine is returned to Drill mode.

Although the Remote Lockout system can stop thrust, rotation, and fluid flow while drilling, the purpose of the system is to prevent these functions from being started in the first place.

IMPORTANT: Do not rely on the Remote Lockout system as an emergency stop. It is very unlikely that disabling thrust and rotation could be done quickly enough to prevent death or serious injury.

IMPORTANT: The Remote Lockout system will not shut down the power units on stand-alone drilling fluid systems or air compressors. These external power units must be manually shut off.

Use the Remote Lockout system to lock out the machine before working on or near drill string. Examples include:

- Before approaching the drill head.
- Before attempting any tooling change or attaching a product to be pulled in.
- Before attempting to apply any wrench or other tool to drill string.
- Before manually adding or removing drill rod from drill string.
- Before entering an exit pit.

Remote Lockout System Component Identification

Refer to “Remote Lockout Controls,” *page 21-2*, for information about Remote Lockout system components and controls.

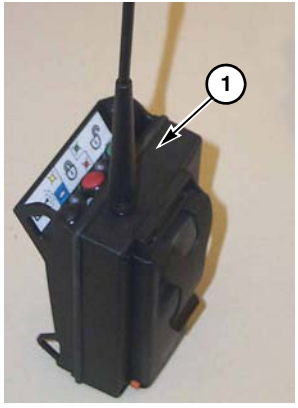
Remote Transmitter

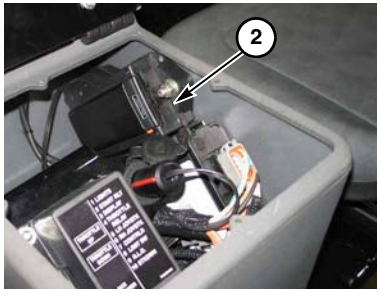
The remote transmitter **(1)** clips onto the user’s belt and has a range of 3300 ft (1 km). The range is dependent on usage in urban or rural areas, and on weather and environmental conditions.

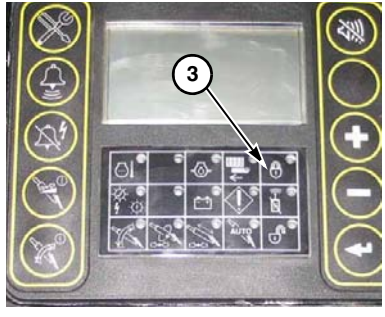
The remote transmitter user can select either RUN or LOCKOUT mode, indicated by lights and buzzer.

A battery charger **(2)** for the transmitter location is located under the left armrest; transmitter storage is behind right operator console. Refer to “Battery Condition,” *page 30-12*.

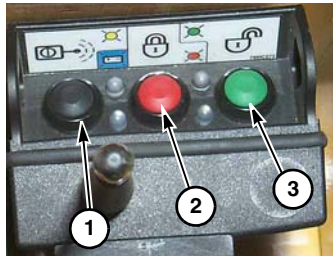
NOTE: A steady warning buzzer will sound at the machine if radio communication is not established within 10 seconds of entering Drill mode and machine is not locked out. Refer to “Remote Lockout - Hydraulic Lockout Test,” *page 30-5*, and “Remote Lockout - Engine Shutdown Test,” *page 30-6*. If machine is locked out, the audible lockout signal will sound and red lockout light **(3)** will be on.







Power ON/OFF Button



The Remote Lockout system can be turned on by pressing *Power ON/OFF Button* **(1) and holding for 2 seconds,** or by pressing *Lockout Button* **(2)**.

Press *Power ON/OFF Button* **(1) and hold for 2 seconds** to shut off transmitter power.

When the remote transmitter power is on, at least one light should be illuminated. If no lights are illuminated on the remote, the power is off, the battery is dead or the remote is not functioning.

Run Button

The drill unit ignition key must be ON before the Remote Lockout system is turned on. If not, a loss of radio signal will be indicated at the remote transmitter. Refer to "Remote Lockout - Hydraulic Lockout Test," *page 30-5*.

When Remote Lockout system is on, press green *Run Button* **(3) and hold for 2 seconds** to transfer control of drilling functions to the machine operator. Green lights on transmitter and machine come on, and buzzers at each location sound for two seconds.

When remote transmitter is OFF, pressing and holding the *Run Button* **(3)** for 2 seconds will test the remote transmitter buzzer, vibrator, and indicator lights. Refer to "Remote Transmitter Indicators - Test" in the *Maintenance Manual*.

Lockout Button

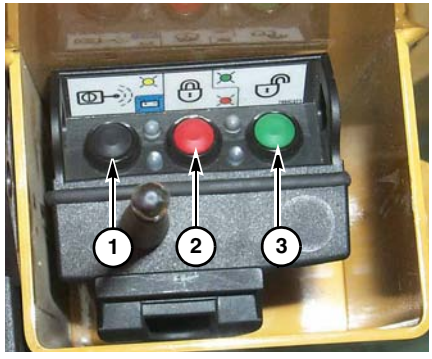
With the remote lockout transmitter power turned on, pressing and releasing the red *Lockout Button* **(2)** sends a lockout command to stop drill string rotation, thrust and pullback, and fluid flow.

When remote transmitter is OFF, pressing and holding *Lockout Button* until the yellow light begins flashing will turn on the remote transmitter, then send a lockout command.

When the machine has confirmed successful lockout, the red light comes on steady, followed by three short beeps (beep, beep, beep, pause) repeated three times (9 beeps total).

The Remote Lockout system can take up to 5 seconds to process the lockout. During this time the green lights will flash. The lockout is not complete until the 9 beeps occur and the red light is on.

Remote Lockout - Hydraulic Lockout Test



The Remote Lockout system is equipped to operate as either a hydraulic lockout (default) or an engine shutdown system. Refer to “Hydraulic Lockout or Engine Shutdown Option,” *page 30-9*.

Step 1: Start machine and remain in operator’s seat.

Step 2: Press and hold black *Power On / Off Button* **(1)** for two seconds.

Step 3: Press and hold green *Run Button* **(3)** for two seconds. Green light will illuminate.

NOTE: Machine is now in Drill mode.

Step 4: Test thrust and rotation controls. They should work.

Step 5: Press and release red *Lockout Button* **(2)**. Red light will illuminate.

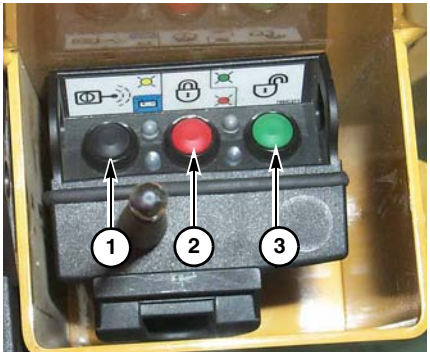
NOTE: Machine is now in Lockout mode.

Step 6: Test lockout of thrust and rotation by moving *Thrust* and *Rotation Levers* out of NEUTRAL. ***Thrust and Rotation must not function***. If Thrust or Rotation moves, contact your Vermeer dealer.

After successful Lockout test, press and hold the green button **(3)** for two seconds to return to Drill mode.

IMPORTANT: Perform Remote Lockout Test before drilling each day.

Remote Lockout - Engine Shutdown Test



The Remote Lockout system is equipped to operate as either a hydraulic lockout (default) or an engine shutdown system. Refer to "Hydraulic Lockout or Engine Shutdown Option," *page 30-9*.

Step 1: Start machine and remain in operator's seat.

Step 2: Press and hold black *Power On / Off Button* **(1)** for two seconds.

Step 3: Press and hold green *Run Button* **(3)** for two seconds. Green light will illuminate.

NOTE: Machine is now in Drill mode.

Step 4: Test thrust and rotation controls. They should work.

Step 5: Press and release red *Lockout Button* **(2)**. Red light will illuminate and engine will shut down.

NOTE: Machine is now in Lockout mode. ***Engine must shut down.*** If engine does not shut down, contact your Vermeer dealer immediately.

After successful Lockout test, press and hold the green button **(3)** for two seconds to return to Drill mode.

IMPORTANT: Perform Remote Lockout Test before drilling each day.

LOSS OF REMOTE TRANSMITTER SIGNAL

A loss of signal indicates that the remote transmitter and machine are not communicating with each other. Reasons for a loss of signal are:

- The remote transmitter is too far away from the machine (3,300 ft/1,000 m).
- The remote transmitter signal is blocked by an obstruction between the transmitter and machine.
- The transmitter battery is fully discharged.
- The remote transmitter is turned on when machine is off.
- The system is not operating correctly.

NOTE: Range of signal can be significantly affected by any obstructions, such as buildings or equipment, located between the remote transmitter and machine.

When a loss of signal occurs in LOCKOUT mode and the *Run Button* is pressed, yellow light **(1)** will flash and the system will remain in LOCKOUT mode. If in RUN mode, yellow light will flash and the system will continue to allow drill operation. If *Lockout Button* is pressed, a “failure to lockout” signal is given.

Remote Lockout Indicators

Refer to the *Machine Controls* section, “Remote Lockout Indicators,” *page 21-6*, for a table illustrating all Remote Lockout system indicators.

Fault Check/Processing Lights

When green and/or yellow lights are flashing without the buzzers sounding, the system is processing a transition from one mode to another.

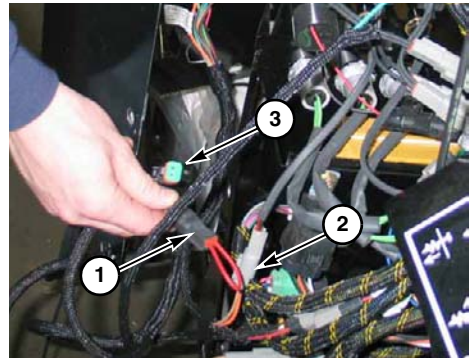
Green light flashing on remote transmitter and machine console indicates that a lockout request is in process and has not yet been confirmed.

When the yellow light flashes on the transmitter and the alarm sounds continuously at the operator station, either the transmitter is out of range or no radio communication is occurring between the transmitter and the machine. The lack of communication means the transmitter is either not turned on or not functioning.

NOTE: If the remote transmitter is damaged and cannot be turned on and transmitting, the continuously sounding alarm at the operator station can be cancelled by pressing *Alarm Cancel Key* **(1)**. The yellow light will continue to flash, a reminder that the Remote Lockout is not functioning or communicating. Turn on remote transmitter or contact your Vermeer dealer for repair of the lockout system.

Refer to “Troubleshooting” section in the *Maintenance Manual* for more information.

HYDRAULIC LOCKOUT OR ENGINE SHUTDOWN OPTION



The Remote Lockout system is equipped with an option to operate as either a hydraulic lockout (default) or an engine shutdown system. Plugs and connectors are located in the compartment behind right controls console.

To change the system to engine shutdown:

Step 1: Move ignition key to OFF position.

Step 2: Open compartment behind right controls console.

Step 3: Remove 2-pin jumper plug **(1)** from hydraulic shutdown connector **(2)** (with orange wire), and attach jumper plug to engine shutdown connector **(3)** (with black wire).

Step 4: Follow *Starting Procedure, page 50-1.*

When machine is in Drill mode, a lockout command will disable the fuel and start circuits. To restart machine after lockout, select Run mode and wait for the solid green light, then turn ignition key to START position.

To change system back to hydraulic lockout:

Step 1: Move ignition key to OFF position.

Step 2: Remove jumper plug **(1)** from engine shutdown connector **(3)** (with black wire), and attach jumper plug to hydraulic shutdown connector **(2)** (with orange wire).

Step 3: Follow *Starting Procedure.*

A lockout command will now disable hydraulic functions.

Hydraulic Lockout Backup Engine Shutdown

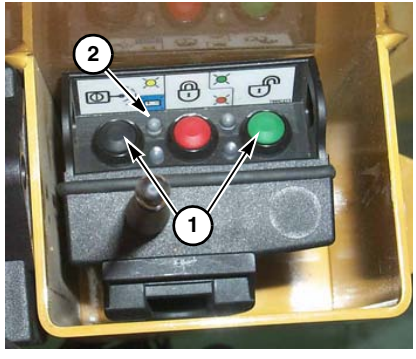
To ensure drill remains locked out during a confirmed hydraulic lockout, rotation water pump, and thrust hydraulic pressures are monitored. If any of the hydraulic pressures increase, or if drilling fluid system is turned on, engine will be shut down. The engine cannot be started in Drill mode until *Run Button* on the remote transmitter is pushed and Run mode is confirmed.

Engine Shutdown Lockout

The engine can be started in Transport mode but will stop immediately when operator sits in seat.

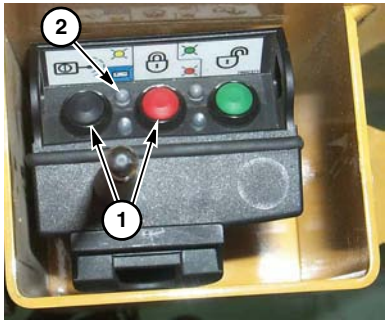
RADIO CHANNEL - CHANGE

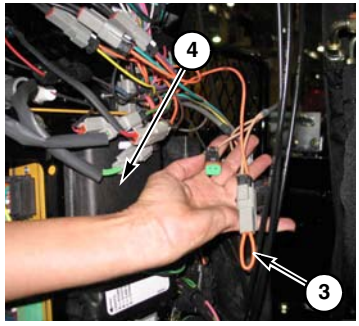
When operating two machines in close proximity, communication may be affected. Changing radio channels will correct this problem. Changing radio channel is possible only when remote is communicating with machine (yellow light is not flashing). With remote transmitter near the machine, push and hold black *Power ON/OFF Button* and green *RUN Button* **(1)** simultaneously until yellow light **(2)** flashes. Wait for yellow light to turn off. Channel is now changed.



REMOTE REGISTRATION

If the Remote Lockout system base or transmitter are replaced, registration of the two components must take place.





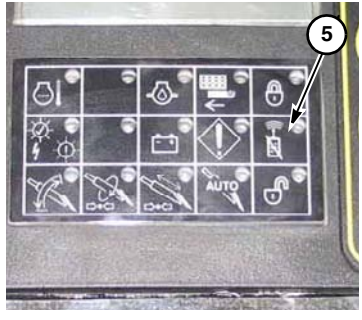
Step 1: Turn *Remote* ON.

Step 2: Push and hold red *Lock* and black *Power* buttons **(1)** simultaneously for two seconds until yellow "No Communications" light **(2)** begins to double flash. Remote is in the Registration mode.

Step 3: Open compartment behind right console.

Step 4: Turn *Ignition Switch* to ON. Wait for more than five seconds.

NOTE: Engine does not need to be running.



Step 5: Remove 2-pin jumper **(3)** used to select Hydraulic Lockout or Engine Lockout mode. Wait for three seconds.

Step 6: Insert jumper back into same connector.

In about three seconds Light B on the base controller **(4)** begins to double flash red. Base controller is in Registration mode.

NOTE: Light B on the base controller and yellow "No communications" lights on the remote **(2)** and machine **(5)** will be flashing.

Step 7: Wait for registration results. Within 10 to 30 seconds, the yellow "No communications" lights on the remote and the machine should turn off. Remote is now registered to the base and all previous registration has been erased.

Battery Condition

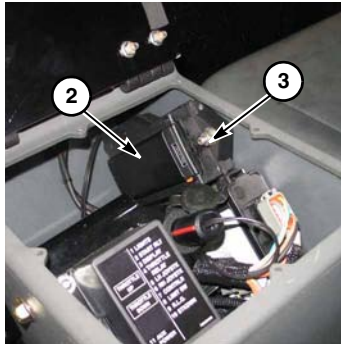
Low Battery

NOTE: Low battery indication is only displayed on the remote transmitter.

When approximately 10% of battery power is left, blue light **(1)** will flash.

Discharged Battery

If battery discharges and a loss of signal occurs in RUN mode, the system will allow drilling to continue uninterrupted. If battery discharges in LOCKOUT mode, a new battery must be installed and RUN mode selected before drilling can continue.



Recharge Battery

Install battery **(2)** into battery charger **(3)**. Battery will recharge even when machine has been shut down. A spare battery may be kept in the charger for use in the event of battery failure.

NOTE: Battery will not charge if battery ground is disconnected with *Battery Disconnect Switch*.

Amber light on side of charger will flash when battery is charging, and will be on solid when fully charged. Green light in same location will come on to indicate power to the charger.

NOTE: Additional chargers may be purchased from your Vermeer dealer for charging the battery in an auxiliary vehicle.

REMOTE LOCKOUT SYSTEM - START

Step 1: Remove battery from charger and install in remote transmitter.

Step 2: Sit in the operator's seat and turn ignition key to RUN position.

Step 3: Turn remote transmitter on by pressing *Power ON/OFF Button* **and holding for 2 seconds.**

Step 4: Press and hold *Run Button* for 2 seconds to select Run mode.

Step 5: Follow machine "Starting Procedure," *page 50-1*.

REMOTE LOCKOUT SYSTEM - SHUT DOWN

IMPORTANT: If the machine is shut down in Lockout mode, the remote transmitter must be available upon machine start-up to cancel Lockout mode and enter Run mode.

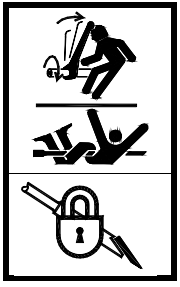
Step 1: Shut off machine and remove key.

Step 2: Press *Power ON/OFF Button* **and hold for 2 seconds** to shut off remote transmitter.

Step 3: Remove battery pack from remote transmitter and install in charger.

Step 4: Place remote transmitter in docking station.

LOCKOUT PROCEDURE - WITH REMOTE LOCKOUT



DANGER: Rotating drill string can kill. Unexpected start-up possible.

Lock out before working on drill string.

It is essential that the machine is locked out before entering an exit pit, changing tools, repairing drill rod, manually adding or removing drill rod, or performing any other work on the drill string or tools.

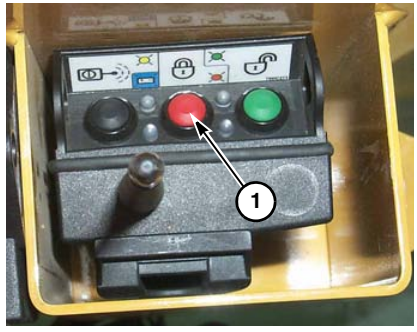
IMPORTANT: The Remote Lockout system will not shut down the power units on stand-alone drilling fluid systems or air compressors. These external power units must be manually shut off.

The following Lockout Procedure must be performed by remote transmitter operator.

Step 1: Communicate by radio with the machine operator that you intend to lock out the machine.

Step 2: Direct machine operator to idle engine down.

Step 3: Press red *Lockout Button* **(1)** on remote transmitter. Wait for 9 beeps to sound and red lockout light to come on, which indicates lockout is successful. Confirmation could take up to five seconds.



NOTE: To ensure maximum communication range of the transmitter, lock out machine before entering an exit pit.

Step 4: If lockout is not successful, a warning buzzer will sound and transmitter will vibrate for 60 seconds. The green light will flash until lockout is achieved or LOCKOUT command is canceled.

IMPORTANT: Never approach drill string or attempt to apply a tool to drill string until after Remote Lockout is confirmed by the 9 beeps and red lockout light is ON, and by radio communication between the remote transmitter operator and the machine operator.

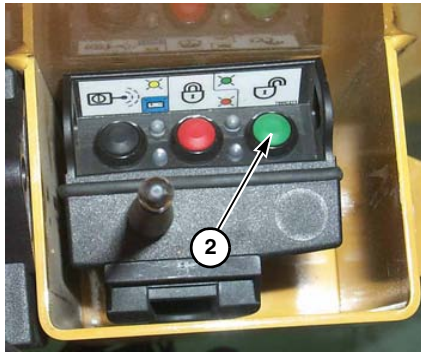
Step 5: If lockout is unsuccessful using Remote Lockout system, follow “Lockout Procedure - Without Remote Lockout System,” *page 30-17*.

NOTE: Anytime a remote lockout command is not successful, ensure machine is running, is in Drill mode (operator seated at controls), and that transmitter is within range. If problem still exists, contact your Vermeer dealer to determine the source of the problem.

NOTE: The Remote Lockout system is not operational when in Transport mode.

Step 6: Complete whatever work is required to change tools or repair and replace drill rod or tooling only after the machine is locked out.

Resuming Operation after Remote Lockout



Step 1: Verify that drill rod and cutting tools are ready for operation.

Step 2: Warn everyone who may be exposed to drill string or cutting tools that operation will resume.

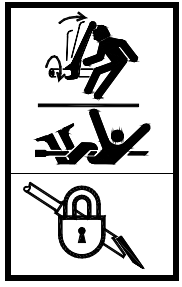
Step 3: Confirm everyone has evacuated the exit pit and is away from drill string and cutting tools, and that no wrenches or breakout tools are attached to drill string or cutting tools.

Step 4: Press *Run Button* **(2)** on transmitter **and hold for 2 seconds** to return control of drilling functions to the machine operator.

NOTE: If RUN command is not successful, communicate with the machine operator to determine cause.

Step 5: Communicate by radio with machine operator that normal operation can resume.

LOCKOUT PROCEDURE - WITHOUT REMOTE LOCKOUT SYSTEM



DANGER: Rotating drill string can kill. Unexpected start-up possible.

Lock out before working on drill string.

It is essential that the machine is locked out before entering an exit pit, changing tools, repairing drill rod, manually adding or removing drill rod, or performing any other work on the drill string or tools.

Step 1: Shut off machine and remove key.

Step 2: Bring key to the exit location where work will be performed on drill string or cutting tools. The key must remain at this location until start-up is permitted.

Resuming Operation after Lockout

Step 1: Verify that drill string and cutting tools are ready for operation.

Step 2: Confirm everyone has evacuated the exit pit and is away from drill string and cutting tools, and that no wrenches, tongs, or breakout devices are attached to drill string or cutting tools.

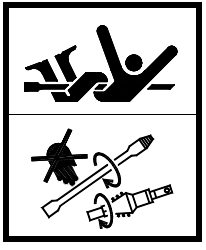
Step 3: Warn everyone who may be exposed to the drill string or cutting tools that operation will resume.

Step 4: Return key to the machine.

Step 5: Refer to and follow “Radio Communication Requirements,” *page 40-3*, before start-up.

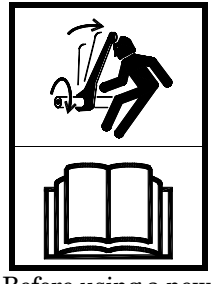
Drill Rod and Tools

DRILL ROD



DANGER: Rotating drill string or cutters can kill.

Stay away from rotating drill string and cutting tool.



DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result.

Use only drill rods, drilling tools, and breakout device described in this manual or approved by Vermeer Corporation.

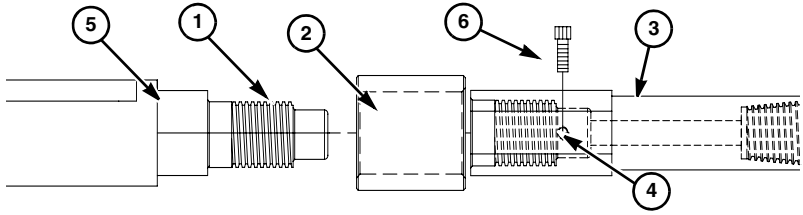
- Before using a new drill rod, tap drill rod against a hard surface, such as a wood block, to dislodge scale and rust inside. Hard pounding of the rod ends on steel or rock will damage threads.
- Protect rod interiors by installing rod box cover when shutting down for the day and during transport.
- Ensure rods have been cleaned prior to use. Refer to the *Operation* section, “Drill Rods - Clean and Store,” *page 50-38*.
- Refer to the *Fundamentals of Horizontal Directional Drilling User’s Guide* for tool selection guides.

DRILL TOOL CONNECTIONS

Drill tools that must be removed to attach a backreamer to the drill string must have either the straight thread joint with hex collar or the Splinelok connection.

Drill tools with a straight thread joint and hex collar connection are not torqued and do not require breakout tools to uncouple the joint.

Hex Coupler - Connect



Step 1: Ensure all connecting surfaces are clean.

Step 2: Apply small amount of grease to threads **(1)**.

Step 3: Slide hex coupler **(2)** completely onto starter rod **(3)**.

Step 4: Turn tool **(5)** into starter rod **(3)** hand-tight.

Step 5: Line up flats and slide hex coupler **(2)** back over hole and onto tool **(5)**.

Step 6: Install and tighten cap screw **(6)** in tapped hole **(4)** to hold hex coupler in place.

Hex Coupler - Disconnect

Step 1: Remove cap screw **(6)**.

Step 2: Tap hex coupler **(2)** with hammer to loosen. Apply heat, if necessary, to loosen coupler.

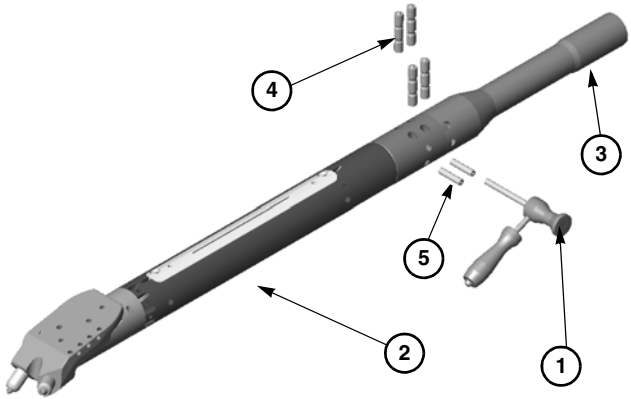
Step 3: Unthread tool **(5)**.

SPLINELOK DRILLING HEAD

Removing and attaching drill tools with the Splinelok connection requires only a hammer and a suitable punch tool **(1)**.

Step 1: Attach drill head **(2)** to the drill string starter rod **(3)** with solid pins **(4)**.

Step 2: Lock solid pins **(4)** in place with roll pins **(5)**.



Splinelok Connection - Assemble

Step 1: Ensure mating areas and components are clean.

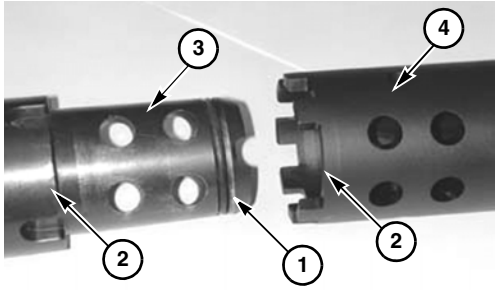
Step 2: Check O-ring **(1)** and replace if damaged.

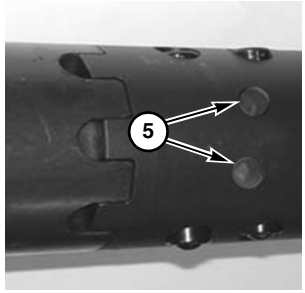
Step 3: Note keyed points on splines **(2)**.

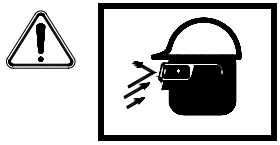
Step 4: Apply anti-seize to pin end **(3)** of starting rod.

Step 5: Match up splines and slide box end of tool **(4)** onto starting rod pin end **(3)**.

Step 6: Push together, ensuring holes **(5)** line up.





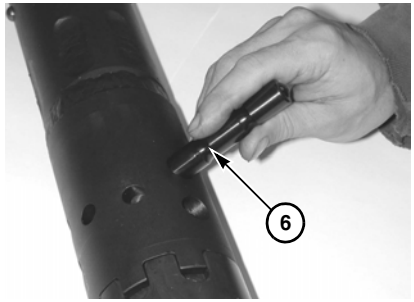


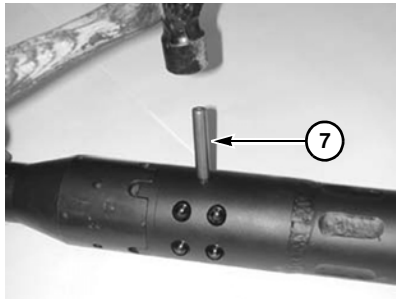
WARNING: Eye protection must be worn when removing and installing roll pins. Serious eye injury can occur if struck by steel chips from the hammer, punch, or roll pin.

Step 7: Ensure holes are free of debris.

NOTE: Solid pins **(6)** and roll pins **(7)** can be installed/removed from either end of hole.

Step 8: Apply anti-seize to two solid pins **(6)** and insert, flat end first, into the two holes closest to the cutting head of the tool.





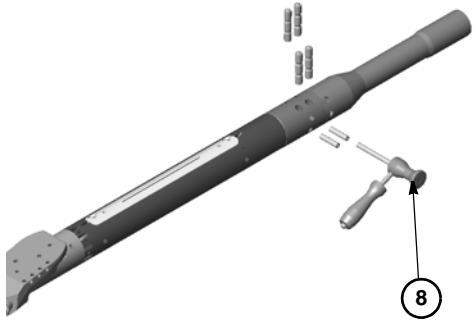
NOTE: If necessary, lightly tap on carbide crown with hammer. If the pin does not go into the hole easily, check bore and pin for cause of interference. Hitting the flat end of the pin hard may cause mushrooming.

Step 9: Align hourglass feature of solid pin to the cross (roll pin) hole. Use shaft of pin driver **(8)** to hold pins in place.

Step 10: Drive roll pin **(7)** into hole until centered to secure solid pins **(6)**.

Step 11: Repeat process for the other two holes.

Step 12: Verify all four solid pins and two roll pins are centered and secure in holes.



Splinelok Connection - Disassemble

Step 1: Using suitable punch, drive out roll pins.

Step 2: Pull connection apart.

Step 3: Clean dirt and debris out of splines. Check for damaged or broken splines.

Step 4: Check roll pins and replace if damaged.

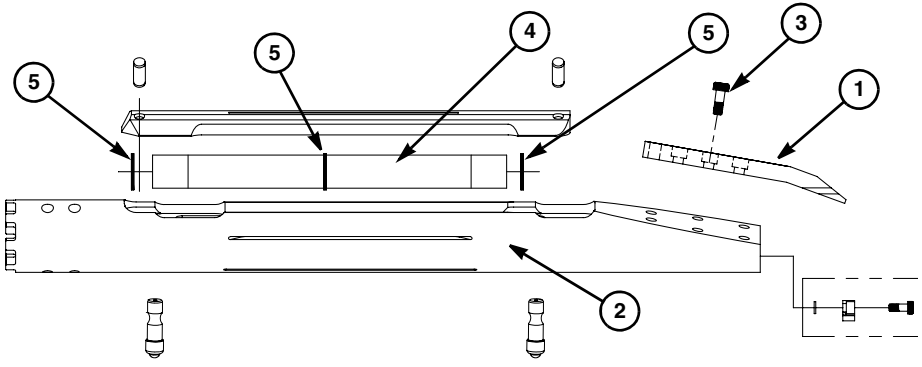
DRILL TOOL ASSEMBLIES

Refer to *Fundamentals of Horizontal Directional Drilling* manual for tool selection guidelines.

Drilling Head Assembly

Step 1: Choose a bill **(1)** to match soil conditions, desired hole size, and type of service.

Step 2: Attach bill to drill head **(2)** using mounting bolts **(3)**. Torque bolts to 35 ft-lb (47 Nm).



NOTE: A variety of transmitters **(4)** are available that will fit inside drill head cavity.

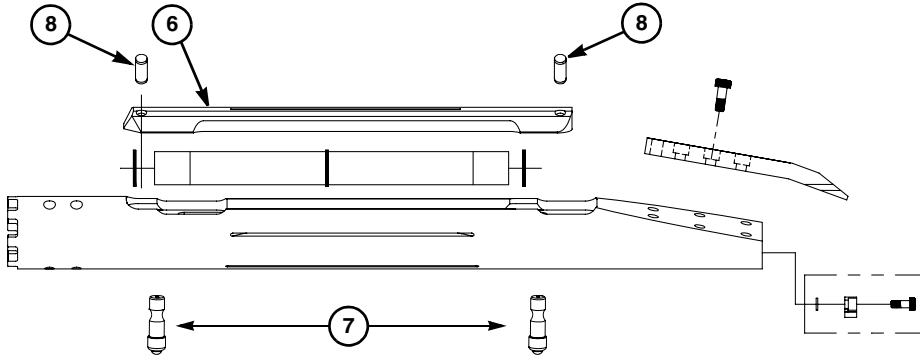
Step 3: Follow instructions for transmitter **(4)** battery installation, and check function of transmitter.

Step 4: Either install three O-rings **(5)**, or wrap electrical tape at each end and in center of transmitter to protect it from side load shock.

Step 5: Install transmitter in drill head cavity.

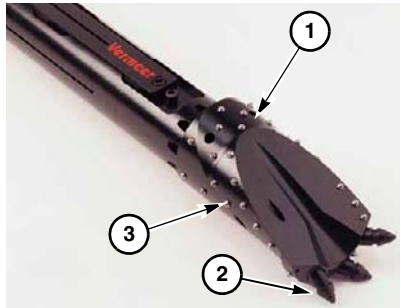
WARNING: Eye protection must be worn when removing and installing roll pins. Serious eye injury can occur if struck by steel chips from the hammer, punch, or roll pin.

Step 6: Install drill head cover **(6)** and secure with retaining pins **(7)** and roll pins **(8)**.



Trihawk Drill Head Assembly

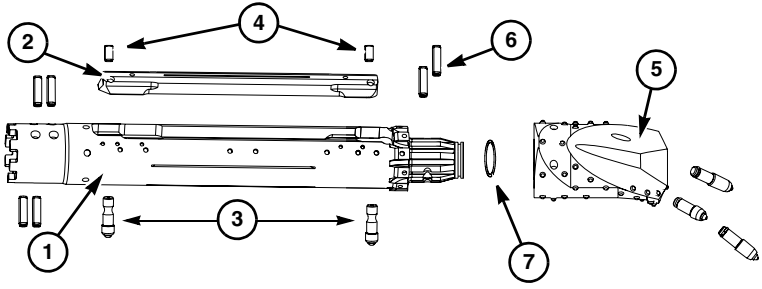
The Trihawk drill head **(1)** is used for digging in conditions too extreme for conventional drill heads. The Trihawk drill head uses different lengths of teeth **(2)** for different conditions encountered. The bit contains carbide buttons **(3)** for greater drill head durability.



Cutting teeth recommendations:

- Short Teeth - Greatest strength, smallest chip, for hard and cobble conditions.
- Medium Teeth - Medium strength, larger chip, better steerability in conditions such as sandstone and coral rock.
- Long Teeth - Aggressive steerability in hardpan or soft rock. **Not recommended for use in cobble or hard rock conditions.**

Trihawk Drill Housing Assembly



Step 1: Attach housing **(1)** to drill string starter rod. Refer to "Splinelok Connection - Assemble," *page 30-20*, in this section.

NOTE: A variety of transmitters are available that will fit inside drill head cavity.

Step 2: Follow instructions of transmitter for battery installation and check function of transmitter.

Step 3: Either install three O-rings or wrap electrical tape at each end and in center of transmitter to protect it from side load shock.

Step 4: Install transmitter in drill head cavity.

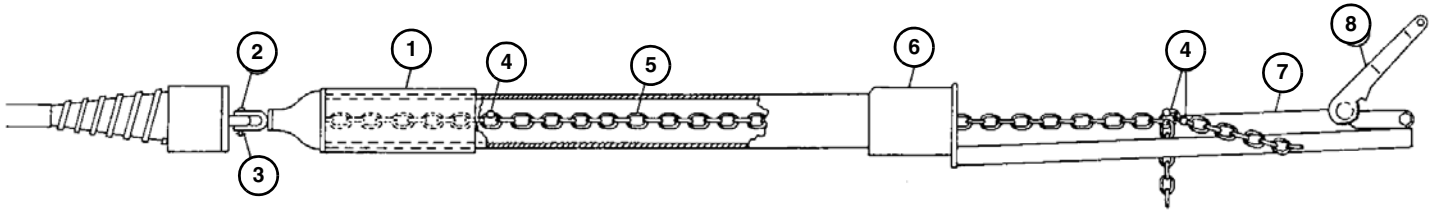
Step 5: Attach cover **(2)** with lid-retaining pins **(3)** and roll pins **(4)**.

Step 6: Ensuring O-ring **(7)** is present, attach bit **(5)** to housing using **new** roll pins **(6)**.

NOTE: Bit **(5)** can be removed from the transmitter housing **(1)** by using a suitable punch tool to drive out roll pins **(6)**.

PVC Pipe Pulling (Option)

The PVC puller assembly is used to pull PVC pipe back through the bored hole. Three different sizes of PVC pipe can be pulled by using the respective size pulling kits for 2″, 3″, or 4″ PVC pipe.



Step 1: Assemble pipe lengths (if more than one) with the PVC puller **(1)**.

Step 2: Pass pull chain **(5)** through pipe.

Step 3: Assemble PVC puller to backreamer with a clevis pin **(2)** and cotter pin **(3)**.

Step 4: Connect pull chain to PVC puller with a quick link **(4)**.

Step 5: Pull chain tight between the puller and tensioner **(6)** with nylon strap **(7)** and ratchet **(8)**.

Step 6: Connect tensioner anchor chain to pull chain with a quick link **(4)**.

NOTE: Use caution when tensioning pipe together to prevent pipe from breaking.

Step 7: Release ratchet.

Step 8: Pull pipe into the bore.

Step 9: After backreaming is complete, release tension on quick link with the ratchet. If ratchet will not release tension, cut the link with a saw or bolt cutters.

Reamer Installation

Swivel

The reamer must be equipped with a swivel to prevent trailed rod from turning while reaming. If reamer does not have a built-in swivel, an external swivel must be installed. Refer to the *Operation* section, “Swivel Use,” *page 50-24*, for information on swivel installation and safety.

Reamer Carrier - Intended Use

Vermeer reamer carriers are used to lift heavier reamers weighing more than 50 lb (23 kg). The carrier provides an easy method of installing or removing reamers at the exit site while the machine is locked out. While holding the reamer with the carrier, the reamer can be turned by hand without rotating the drill string.

DANGER: Serious injury or death will result if you are struck by a wrench or entangled in the drill string or reamer. Never rotate drill string while installing or removing a reamer. Heavy reamers must be lifted using the Vermeer reamer carrier or similar device and turned by hand while the machine is locked out.

Reamer Carrier Styles

P/N 296255-490: Weight Limit 1000 lb (450 kg)

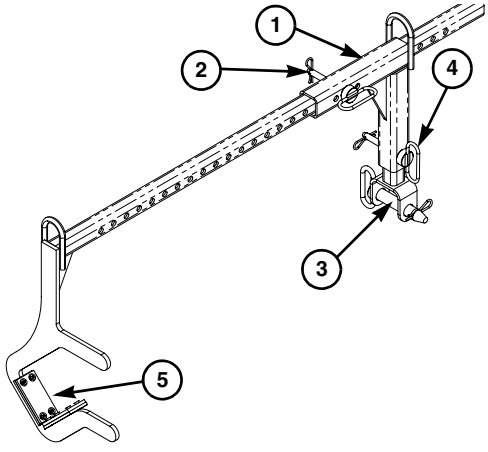
P/N 296260-037: Weight Limit 2400 lb (1100 kg)

Reamer Carrier Components

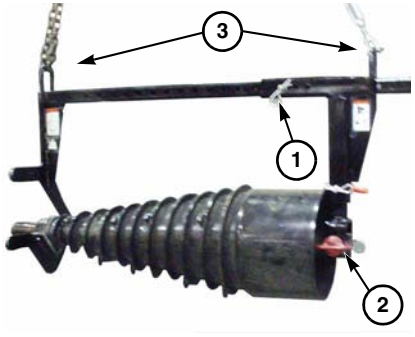
The reamer carrier has a sliding frame **(1)** for adjustment to fit various size reamers and drill tools. Remove hairpin and pin **(2)** to adjust slide.

The pin end **(3)** of reamer carrier, located at bottom of sliding frame, connects to the reamer. Remove pin **(4)** to install other connectors for various reamer types. These include swivel, Splinelok connection, and several threaded connections.

At the opposite end of carrier, the reamer connector rests in a cradle with replaceable wear pads **(5)**.



Reamer Carrier - Install/Remove



NOTE: Using the reamer carrier requires a minimum of two persons, one to attach and guide reamer carrier, and one to operate the lifting device. It is recommended that two persons work together to install the reamer carrier onto the reamer.

To install reamer carrier:

Step 1: Remove hairpin **(1)** and pin. Remove sliding frame from end of reamer carrier.

Step 2: Remove pin **(2)**. Attach back side (often swivel end) of reamer to connector and reinsert pin. Ensure reamer carrier connector is correct for reamer being used.

Step 3: Slide frame bar into sliding frame, inserting cradle underneath reamer as shown.

Step 4: When cradle is positioned securely beneath connector end of reamer, install pin and hairpin **(1)**.

Reamer Carrier - Lift

Step 1: Ensure drilling machine has been locked out.

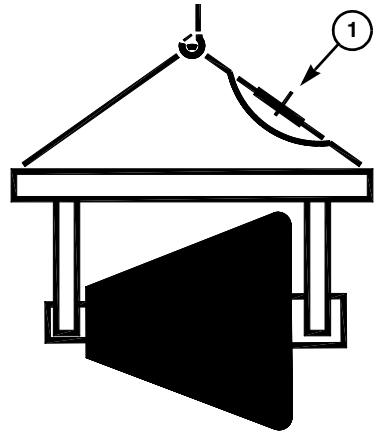
Step 2: Attach chain to lift points **(3)** on reamer carrier.

Step 3: Securely attach chain to hook on a suitable lifting device, such as a backhoe.

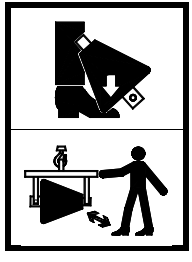
Step 4: Carefully lift reamer carrier and position reamer to align reamer with drill string.

Turnbuckle - Adjust

A turnbuckle **(1)** may be used for angular adjustment of reamer to drill string. Use appropriate-sized chain and turnbuckle for reamer and reamer carrier weight.



WARNING: Do not lift a reamer that exceeds the weight limit of the carrier.



WARNING: Falling load can injure you.

Do not work under raised load.

Reamer - Connect with Threaded Connection

Step 1: Ensure drilling machine has been locked out.

Step 2: Ensure components are clean.

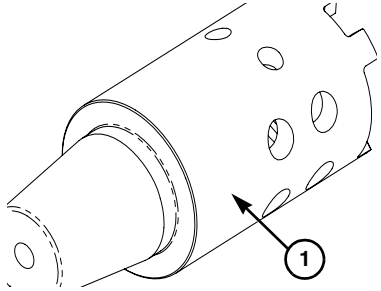
Step 3: Lubricate threaded end of reamer.

Step 4: Align reamer with drill string and manually turn reamer by hand until reamer is completely threaded onto drill string.

Step 5: Remove reamer carrier.

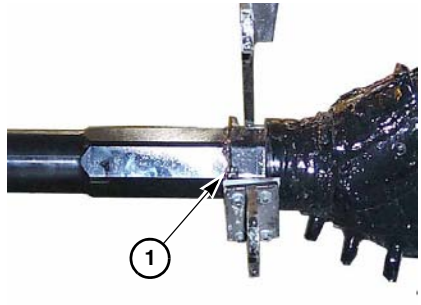
Step 6: Use Portable Breakout system to tighten connection. Refer to the *Supplemental Operations* section, "Portable Breakout System," *page 60-4*, for procedures. Refer to the following chart for makeup torque.

IMPORTANT: If using an API crossover connector **(1)**, it is important to be aware that proper makeup torque of the crossover sub to the reamer is crucial. Failure to torque API joints to the following minimum specifications can result in joint separation or other failures of tooling. Properly torquing the joints will require the use of a Portable Breakout system.



API Connection Size	Minimum Makeup Torque	Suggested Maximum Operating Torque
2-3/8″ API Regular	1,560 ft-lb (2115 Nm)	2,600 ft-lb (3526 Nm)
2-7/8″ API Regular	3,000 ft-lb (4068 Nm)	5,000 ft-lb (6780 Nm)
3-1/2″ API Regular	7,200 ft-lb (9763 Nm)	12,000 ft-lb (16272 Nm)

Reamer - Connect with Hex Collar Connection



Step 1: Ensure drilling machine has been locked out.

Step 2: Ensure components are clean.

Step 3: Lubricate threaded end of reamer.

Step 4: When aligned with rod, manually rotate reamer to begin threading reamer into rod.

Step 5: Continue manually threading reamer onto rod by hand until shoulders touch. Then back off to align to the nearest hex flat **(1)**.

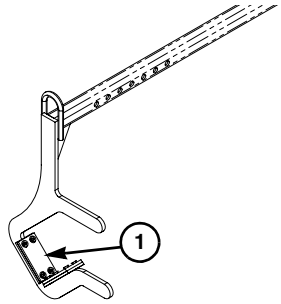
Step 6: Slide hex collar over the connection, then install bolt. Torque to 35 ft-lb (47.5 Nm).

Reamer - Connect with Splinelok Connection

Refer to “Splinelok Drilling Head,” *page 30-20*.

Reamer Carrier Wear Pads - Replace

Replace wear pads **(1)** when worn.

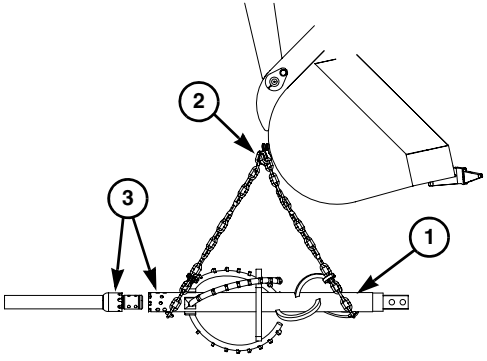


Step 1: Remove four bolts and worn pad.

Step 2: Install new pad. Install bolts; torque to 10 ft-lb (13.6 Nm).

Chain Sling Alternative to Reamer Carrier - Splinelok Only

IMPORTANT: Tool installation using the chain sling should only be used when installing HDD tooling that have the Splinelok connection. This connection does not require the reamer to be turned. A chain sling on a reamer with a hex collar connection may prevent the reamer from being threaded by hand.



Step 1: Before lifting the tool with the chain sling, position tool or starter rod so that the splines line up (remember there is one master spline). Rotation up to 180° may be required to line up the spline on the joint and starter rod.

Step 2: Lift HDD tool (reamer) **(1)** with chain sling **(2)** positioned as shown. Align joints **(3)** and push joint together. The spline will engage.

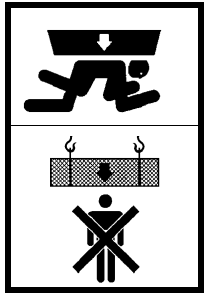
Step 3: Install four solid pins. (Refer to “Splinelok Connection - Assemble,” *page 30-20*). Install two retaining pins (coiled roll pins).

Step 4: Remove chain sling.

Locator System

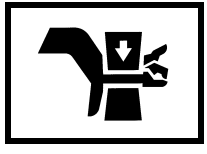
The ability to locate the drill head is paramount to the success of any bore. Failure to use proper locating techniques can result in the drill head becoming lost, coming out in the wrong location, or missing the intended target altogether. Refer to the *Fundamentals of Horizontal Directional Drilling User’s Guide* for information on locator systems.

Rod Loader



WARNING: Falling load can crush. Never lift rod box over people.

Do not stand or work under raised rod box.



WARNING: Pinch points can result in serious crushing injuries. Keep hands and feet away from pinch points of rod loader. Keep shields in place and properly secured.

Always store drill rods in the rod box to avoid contact with the ground. Avoid dropping the rod on the pin end or dropping something onto the joint. Scarring of the shoulder can cause leaks, premature joint failure, and damage to mating surfaces.

Rod Box

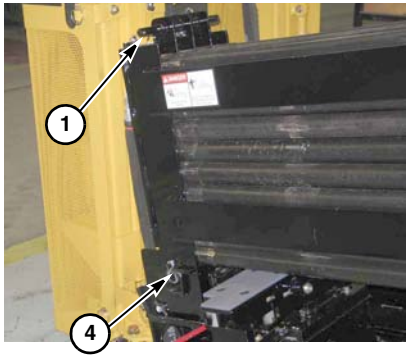
Rod Box - Load

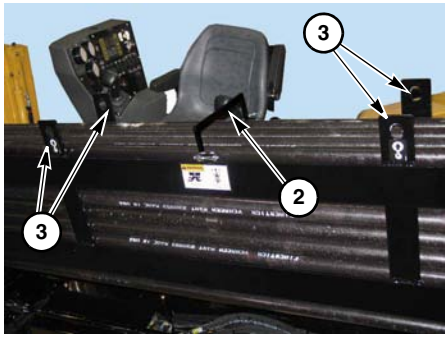
Step 1: Remove two top rod keeper pins **(1)** from top of rod box.

Step 2: Unlatch and swing up bar **(2)** in middle of box.

Step 3: Load rods into rod box.

Step 4: Replace top pins and bar.





Rod Box - Install

Step 1: Connect hoist chain to all four lift eyes **(3)**.

IMPORTANT: Lift rod box by top lift eyes only.

Step 2: Carefully lower rod box between guide plates.

NOTE: Install rod box with male threads to front.

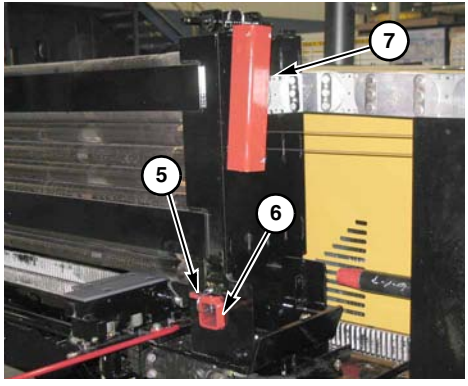
Step 3: Install two lower rod box keeper pins **(4)**.

Step 4: Remove hoist chain.

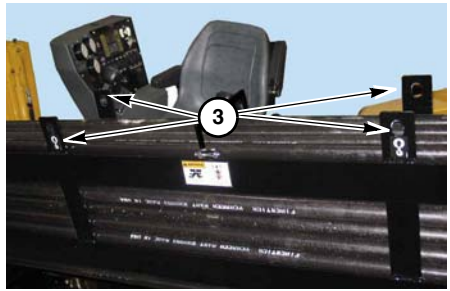
Step 5: Raise rod box cylinders to push rods into box.

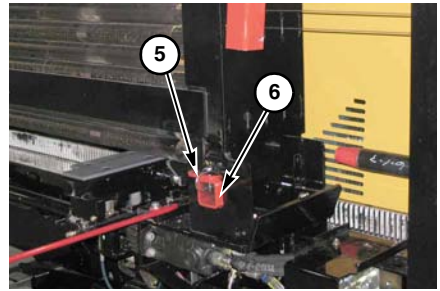
Step 6: Shut off engine.

Step 7: Remove bottom rod support keeper pins **(5)** and support bars **(6)** and place in storage position **(7)** before drilling.



Rod Box - Remove





Step 1: If rod box is not empty, raise rod box cylinders to push rods into rod box.

Step 2: Shut off engine.

Step 3: Install bottom support bars **(6)** and keeper pins **(5)**. Lower rod box cylinders and shut off engine.

Step 4: Connect hoist chain to all four lift eyes **(3)**.

IMPORTANT: Lift rod box by top lift eyes only.

Step 5: Remove lower rod box keeper pins.

Step 6: Remove rod box.

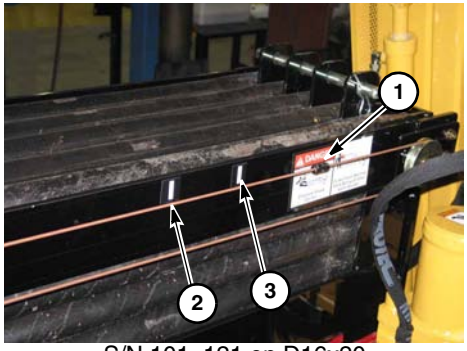
Rod Joints

Rod Joints - Tighten

Refer to *Drill Rotation Pressure / Torque Gauge* **(1)** when tightening rod joints to check rotation torque pressure. Tighten rod joints to 2200–2500 psi (152–172 bar).

Rod Joint Position Indicator - Earlier Models

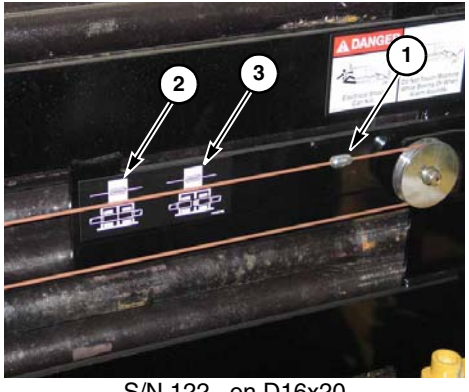
- When marker **(1)** is at rear white decal **(2)**, rod joint is positioned between rear and front vises. The power vises can clamp drill rods and loosen lower joint.
- When marker **(1)** is at front white decal **(3)**, upper rod is retracted enough to clear downhole rod. The upper rod joint can be loosened by clamping rod with the rear vise and rotating the drive chuck.



S/N 101–121 on D16x20
S/N 101–122 on D20x22

Rod Joint Position Indicator - Later Models

- When marker **(1)** is at rear decal **(2)**, rod joint is positioned between rear and front vises. The power vises can clamp drill rods and loosen lower joint.
- When marker **(1)** is at front decal **(3)**, upper rod is retracted enough to clear downhole rod. The upper rod joint can be loosened by clamping rod with the rear vise and rotating the drive chuck.



S/N 122– on D16x20
S/N 123– on D20x22

DRILLING

Drill Rods - Add to Drill String

To unload rod from rod box for drilling:

Step 1: Set *Row Selector Lever* **(1)** to unload from first row (row closest to operator).

IMPORTANT: Rows must be emptied sequentially, from first row through the fifth row, to prevent rods from being dumped out of the rod box.

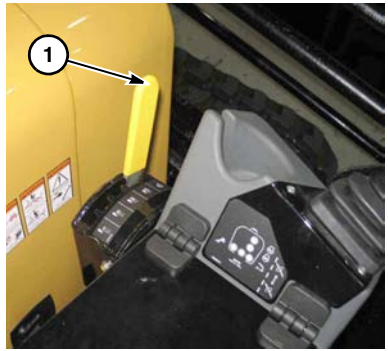
NOTE: As each row is emptied, move the *Row Selector Lever* to the next numbered row.

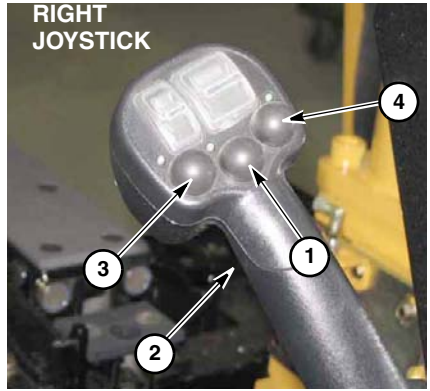
Step 2: Press *Rod Lifter Switch* **(1)** to lift rod off rod transfer arm.

Step 3: Press *Rod Transfer Arm Retract Button* **(2)** (on back of joystick) to move rod transfer arm to the selected row for removing rod.

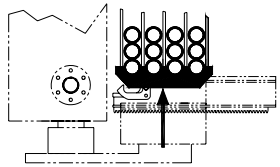
Step 4: Press *Rod Lower Switch* **(3)** to lower rod lifter to load a rod onto transfer arm.

Step 5: Press *Rod Transfer Extend Button* **(4)** to move rod transfer arm to drill string.

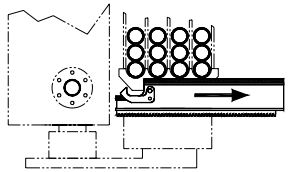




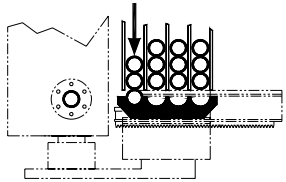
(Step 3)



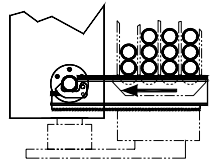
(Step 3)



(Step 4)



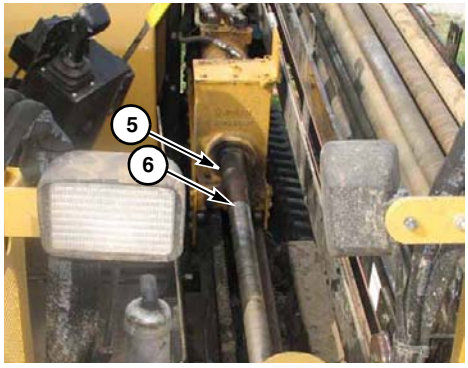
(Step 5)



Step 6: Insert drive chuck **(5)** into upper rod end **(6)**.

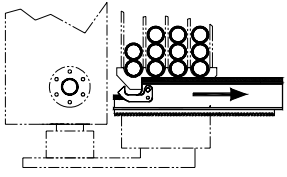
Step 7: With minimum thrust and full rotation, begin to thread upper end of rod.

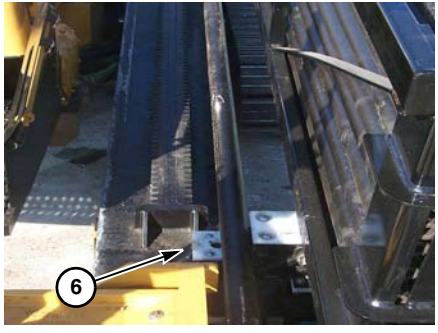
Step 8: While upper end is threading, slowly thrust rod forward until pin end is entered into box end of downhole rod.



Step 9: When rod begins to rotate, move rod transfer arm **(6)** back under rod box.

(Step 9)





IMPORTANT: Failure to fully move rod transfer arm back under rod box will damage rod transfer arm.

Step 10: With minimum thrust, full rotation, and with front vise clamped on downhole rod, thread upper rod into downhole rod and tighten to 2000–2300 psi (138–159 bar). Refer to "Rod Joints - Tighten," *page 30-35*.

Step 11: Unclamp and drill rod into ground.

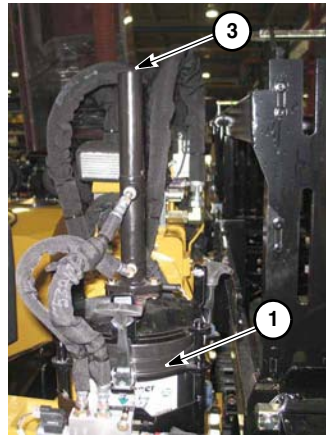
Step 12: Repeat previous steps to drill in additional rod.

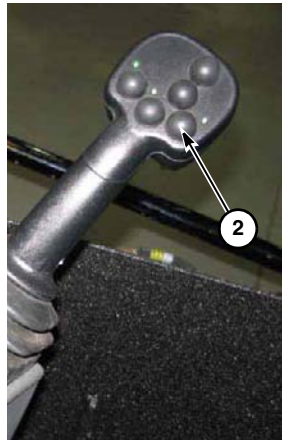
Auto Greaser (Option)

The machine may be equipped with an auto greaser bucket **(1)** for lubricating drill rod threads. Press *Auto Grease Button* **(2)** on right joystick to release grease.

To adjust, remove plug **(3)** at top of tube with Allen wrench, and rotate threaded screw inside IN to increase grease amount, or OUT to decrease grease amount.

Refill or replace cartridge as needed. Refer to the *Maintenance Manual* for procedures.



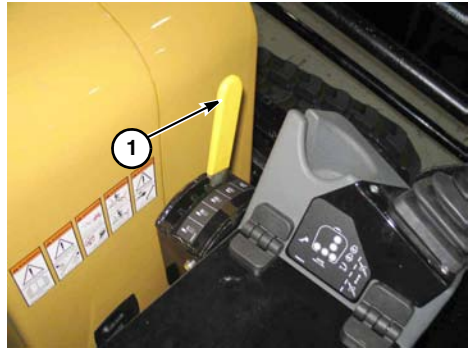


Drill Rods - Remove from Drill String

To remove rod from drill string and load into rod box:

Step 1: Move *Row Selector Lever* **(1)** to load into row farthest from operator that is not full of rods.

NOTE: As each row is filled, move *Row Selector Lever* to the next lower numbered row.



Step 2: Pull drill string from ground until rod joint position marker **(2)** is at rear decal **(3)**. The rod joint is now centered between the front and rear vises.

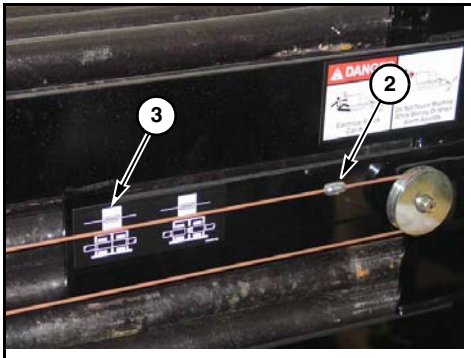
Step 3: Stop rotation.

Step 4: Press top of *Front Vise Switch* **(4)** to clamp onto downhole rod.

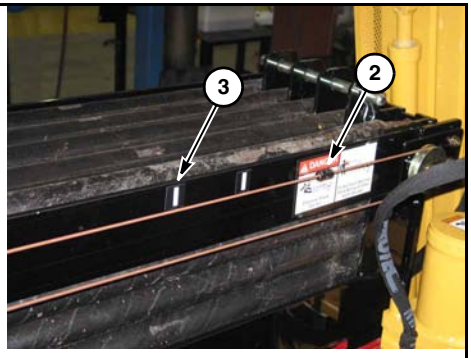
Step 5: Press top of *Rear Vise Switch* **(5)** to clamp upper drill rod and release rear vise.

Step 6: Press *Rod Transfer Arm Extend Button* **(6)**.

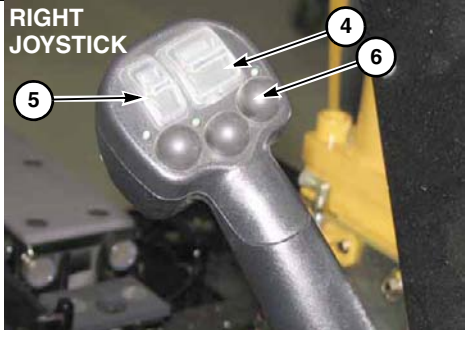
Step 7: Open rear vise and rotate back to home position.



D16x20: S/N 122–
D20x22: S/N 123–

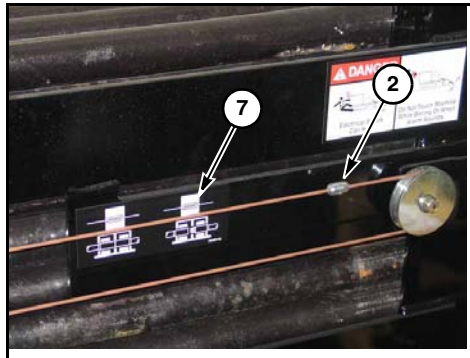


D16x20: S/N 101–121
D20x22: S/N 101–122

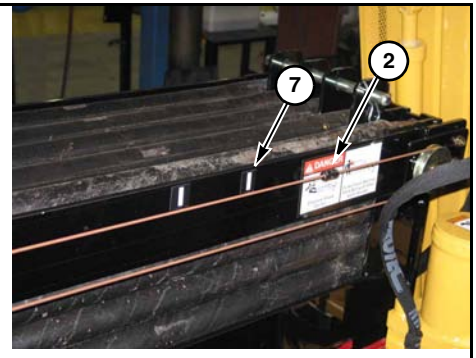


Step 8: Using only rotation, unthread joint until rod joint position marker **(2)** stops moving rearwards. While continuing to rotate in reverse, pull rod back until marker **(2)** is at front decal **(7)**.

Step 9: Stop rotation and pullback.



D16x20: S/N 122–
D20x22: S/N 123–



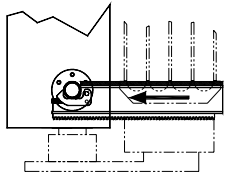
D16x20: S/N 101–121
D20x22: S/N 101–122

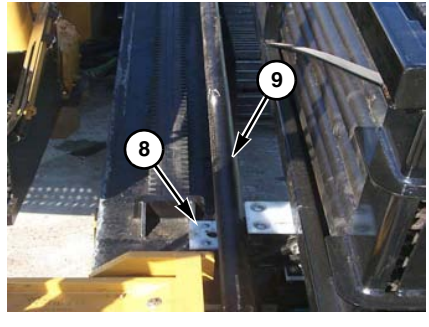
Step 10: Press *Rod Transfer Arm Extend Button* to move rod transfer arm **(8)** from under rod box to rod **(9)** in the drill string.

Step 11: Engage rear vise by pressing top of *Rear Vise Switch* **(5)**.

Step 12: Lower rod lifter.

(Step 10)

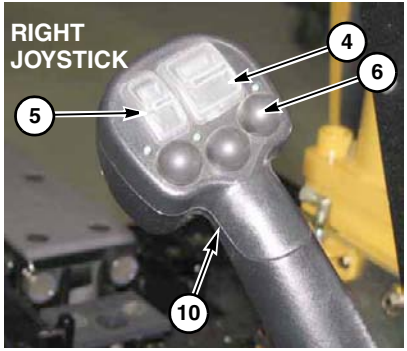


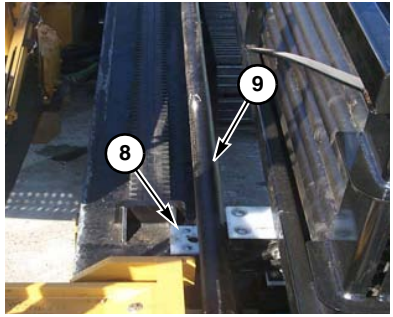


Step 13: Use reverse rotation to break and unthread upper end of rod. When joint indicator stops moving backwards, continue reverse rotation and pullback until gearbox is retracted completely back.

Step 14: Disengage rear vise using switch **(6)** and remove drill rod using *Rod Loader Arm Retract Button* **(10)** on back of right joystick.

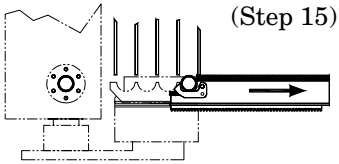
Step 15: Press *Rod Transfer Arm Retract Switch* to move rod transfer arm **(8)** away from drill string to position rod **(9)** under rod box column to be loaded.

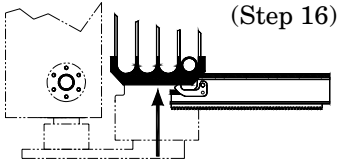


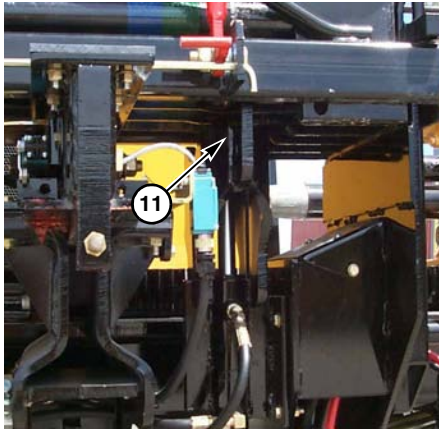


Step 16: Press *Rod Lifter Switch* to raise rod lifter **(11)** and lift rod into rod box.

Step 17: Repeat previous steps to remove additional rods from drill string and return rods to rod box.







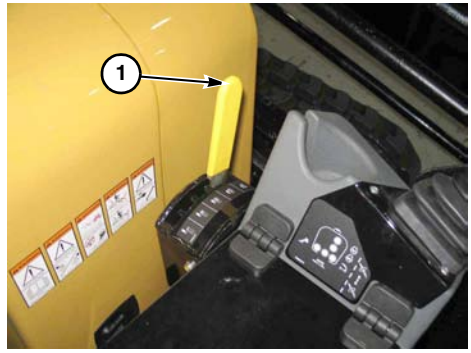
Row Selector Lever - Pulling Back

Move *Row Selector Lever* **(1)** when row has been completely filled.

Step 1: Extend rod transfer arm.

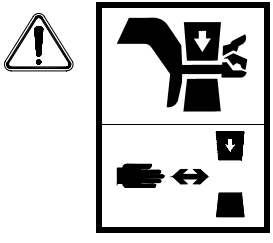
Step 2: Raise rods with rod lifter.

Step 3: Move lever to next row.



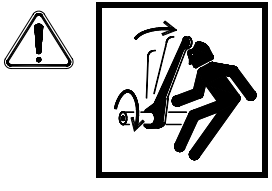
POWER VISE OPERATING GUIDELINES

- Inspect vise jaws and grips and replace worn or damaged components before drilling.
- Stake drill unit down securely. If rack shifts during drilling, the rod will become misaligned between the jaws. Check alignment to prevent jaw or rod damage.
- Do not rotate a clamped rod.
- Do not thrust a rod through a closed vise.
- Keep rod centered between guide rollers. Do not continue the bore unless rod is centered between rollers.



WARNING: Pinch points in vise can crush.

Keep hands away.



DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Always use the power vise to make or break joints at the machine.

Drilling Modes Overview

Manual Mode

In the default Manual mode, thrust and rotation pressures are determined by the drilling conditions and are limited by the system pressure (6000 psi/413 bar). No display lights are ON.

R.A.T.T. Mode (D20x22 Only)

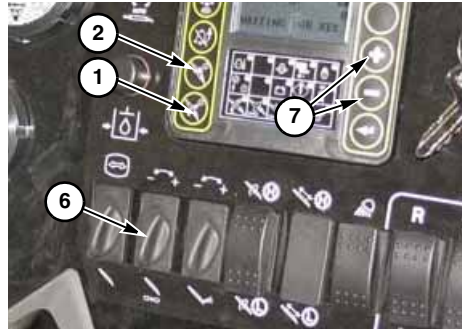
To switch from Normal Drill mode to R.A.T.T. mode, press *R.A.T.T. Mode Key* **(1)** once to activate Oscillation mode. Lights **(3)**, **(4)**, & **(5)** will turn ON, indicating that Oscillation mode and pressure limiters are ON.

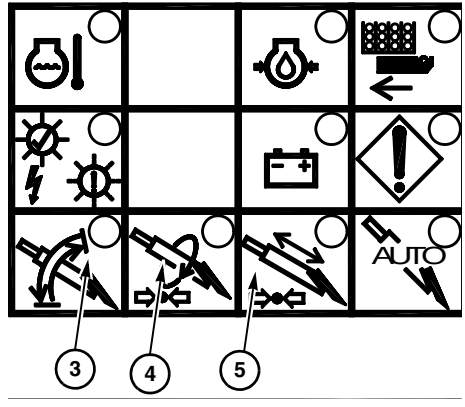
- Rotation pressure is limited to a preset value and is not adjustable by the operator. Thrust pressure limits may be adjusted to 3300 psi (227 bar) with the *Speed/Pressure Trim Switch* **(6)**.
- The display will show oscillation in degrees. This can be adjusted using the *Oscillation Adjustment Keys* **(7)**.

Press *R.A.T.T. Mode Key* **(1)** a second time to activate Straight Drilling mode. Light **(3)** will turn OFF and R.A.T.T. icon will be displayed.

Pressing *R.A.T.T. Mode Key* **(1)** again will toggle between Oscillation and Straight Drilling modes.

IMPORTANT: Never operate with rotation limiter OFF and the R.A.T.T. tool attached. The tool will be damaged if rotation torque exceeds the capacity of the tool.





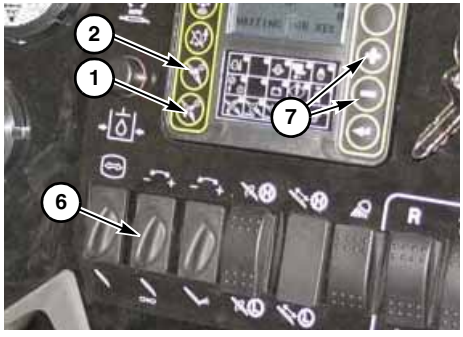
Disabling R.A.T.T. Drilling Mode When Oscillation Mode Is Active

If R.A.T.T. Oscillation mode is active (lights **3, 4 & 5** ON), the following sequence must be followed to disable it:

Step 1: Press **(1)** once to go from Oscillation to Straight Drilling mode. Light **(3)** will turn OFF.

Step 2: Press **(2)** once to turn off thrust limiter. Light **(5)** will turn OFF.

Step 3: Press **(2)** again to turn off rotation limiter. Light **(4)** will turn OFF; light **(5)** remains off.

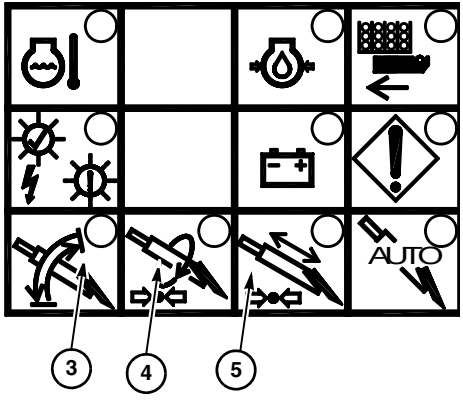


Disabling R.A.T.T. Drilling Mode When Straight Drilling Mode Is Active

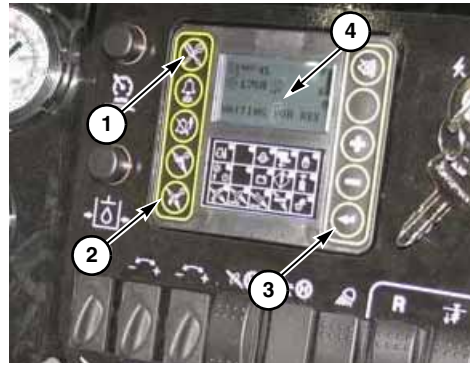
If R.A.T.T. Straight Drilling mode is active (lights **4 & 5** ON), the following sequence must be followed to disable it:

Step 1: Press **(2)** once to turn off thrust limiter. Light **(5)** will turn OFF.

Step 2: Press **(2)** again to turn off rotation limiter. Light **(4)** will turn OFF; light **(5)** remains off.



Default R.A.T.T. Drilling Pressure Limits



The factory-set default rotation and thrust pressure limits corresponding to the R.A.T.T. Straight Drilling mode are automatically activated when the engine is started.

To deactivate the factory default rotation and pressure limits on engine start-up, use the following procedure:

Step 1: Press *Service Screen Key* **(1)**.

Step 2: Press and hold *R.A.T.T. Mode Key* **(2)**.

Step 3: While holding *R.A.T.T. Mode Key*, press *Enter Key* **(3)**. *Display* **(4)** will flash RATOFF.

To change back to RATON, repeat Steps 1–3, or, while holding *R.A.T.T. Mode Key* **(1)**, press *Enter Key* **(3)**. The RATON message will be displayed.

Press *Service Screen Key* **(2)** to exit the procedure.

NOTE: If the default settings are bypassed (RATOFF), they will become active (RATON) when the *R.A.T.T. Mode Key* **(2)** is pressed. However, if the engine is turned off in the RATOFF mode and then restarted, the RATOFF setting will be active and the rotation pressure is not limited.

IMPORTANT: Always have the RATON setting active when using the R.A.T.T. drilling tool. The tool will be damaged if the rotation torque exceeds the capacity of the tool.

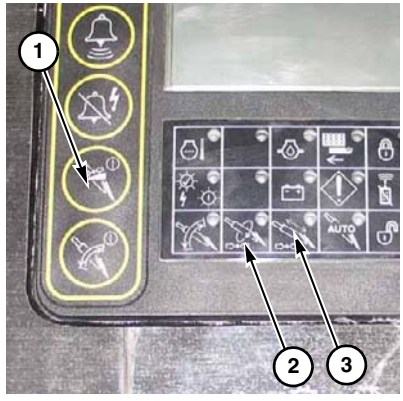
Rod Wrap and R.A.T.T. Oscillation

As drilling distance increases, drill string windup increases with the longer drill string. The result is rod wrap and the drill head rotates fewer degrees than the drive chuck.

To maintain the drill head rotation angle when steering with a long drill string, the drive chuck rotation angle must be increased to compensate for rod wrap. Failure to increase drive chuck rotation angle as the bore length increases may result in decreased productivity and eventual stoppage.

Rod wrap will vary based on drilling conditions and drill pipe diameters. Adjust rotation angle with *Increase/Decrease Keys* **(1)** as needed to compensate for rod wrap.

Setting Manual Pressure Limits



(1) Manual Limit Key

(2) Rotation Limiter Light

(3) Thrust Limiter Light

Press **(1)** once . . . . . enable both Thrust/Pullback and Rotation limits;
. . . . . Rotation **(2)** and Thrust/Pullback **(3)** lights are ON

Press **(1)** a second time . . . . disable Rotation limit, Thrust/Pullback limit enabled;
. . . . . Rotation light **(2)** OFF, Thrust/Pullback light **(3)** ON

Press **(1)** a third time . . . . . disable both Thrust/Pullback and Rotation limits;
. . . . . Rotation **(2)** and Thrust/Pullback **(3)** lights are OFF

When the *Manual Limit Key* **(1)** has been pressed, the *Rotation Limiter Light* **(2)** and *Thrust Limiter Light* **(3)** will turn ON.

The following table shows the maximum and/or range of thrust and rotation values which can be manually set:

Maximum Value/Range of Rotation and Thrust Pressure Limits (psi/bar)			
Manual Limit Key	**R.A.T.T.**	**Thrust**	**Rotation**
OFF	OFF	3300/228	3300/228
ON	OFF	300-3300/20-228	300-3300/20-228
OFF	ON	300-3300/20-228	Fixed*
ON	ON	300-3300/20-228	Fixed*
* Rotation limited by range of rotation gearbox (Low or High)			

Setting Manual Thrust Limits

Step 1: Select drilling mode to be adjusted.

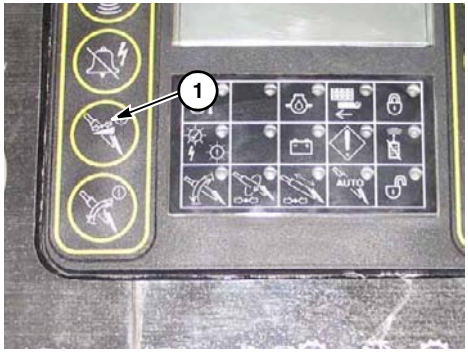
Step 2: Press *Manual Pressure Limit Key* **(1)**.

Step 3: Turn R.A.T.T. ON or OFF as needed.

Step 4: Place *AutoDrill Selector Switch* **(4)** to the THRUST position.

Step 5: Adjust the thrust pressure limit with the *Speed / Pressure Trim Switch* **(5)**.

The last displayed thrust pressure value will automatically be saved to permanent memory.



Setting Manual Rotation Limits

Step 1: Select drilling mode to be adjusted.

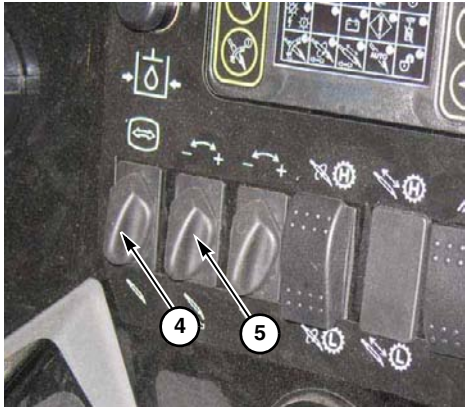
Step 2: Press *Manual Pressure Limit Key* **(1)**.

Step 3: Turn R.A.T.T. ON or OFF as needed.

Step 4: Place *AutoDrill Selector Switch* **(4)** to the ROTATE position.

Step 5: Adjust rotation pressure limit with the *Speed / Pressure Trim Switch* **(5)**.

The last displayed rotation pressure value will automatically be saved to permanent memory.



AUTODRILL

In AutoDrill mode, the operator can release the *Thrust/Pullback* and *Rotation Handles* and the drill will continue to operate.

The AutoDrill may be used in all drilling modes and in combination with both R.A.T.T. modes (Oscillation and Straight Drilling).

The operator can set one of three constant control operating modes:

- constant thrust/pullback speed
- constant thrust/pullback pressure
- constant rotation pressure

AutoDrill Mode Uses

Constant Thrust/Pullback Speed mode may be used when drilling pilot holes with a tri-cone rock tool in ground formation that is not too hard.

Constant Thrust/Pullback Pressure mode may provide better productivity when drilling or pulling back in hard conditions.

Constant Rotation Pressure mode may be best suited for pulling back in formations with loose chunk rock that may move and bind the tool.

How AutoDrill Works

In all three modes, the AutoDrill program maintains the constant speed or pressure by limiting the thrust pump output.

The AutoDrill program monitors both the rotation and thrust/pullback pressures for:

- how rapidly the pressures are rising
- the duration of the pressure increase
- whether the pressures are continuing to increase over time

If these values exceed their limits, then the thrust pump output is reduced until drilling conditions come back within limits.

When thrust pump output is reduced by 10%, the display screen will flash THRPSI (thrust pressure) or ROTPSI (rotation pressure). When the thrust pump output is reduced by 30%, THRPSI or ROTPSI is displayed steady.

When drilling slows or stalls, a flashing or solid THRPSI or ROTPSI message is displayed and the pressures can be reset manually with the *Speed / Pressure Trim Switch* **(1)**. The pressure is allowed to increase for whichever function is displayed.

If operation is in *Constant Thrust / Pullback Speed* mode and there is no THRPSI or ROTPSI message, either flashing or solid, then the carriage *speed* set point can be increased or decreased with the *Speed / Pressure Trim Switch*.

AUTODRILL - ENABLE (NORMAL DRILLING)

Step 1: Select AutoDrill mode (Constant Thrust/Pullback Speed, Constant Thrust/Pullback Pressure, or Constant Rotation Pressure) using *AutoDrill Selector Switch* **(2)**.

Step 2: Move and hold *Rotation* and *Thrust/Pullback Handles* to obtain the desired rotation and thrust/pullback motion for the current drilling conditions.

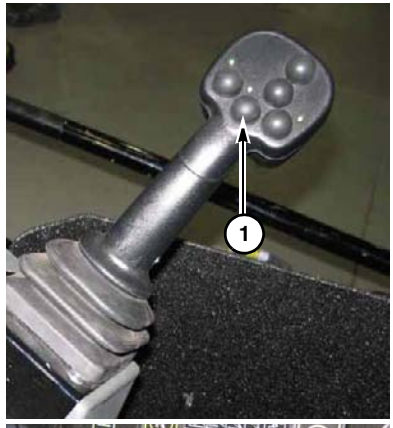
Step 3: Momentarily press and release *AutoDrill Button* **(1)** and immediately release the *Rotation* and *Thrust/Pullback Handles*. When the *AutoDrill Button* **(1)** is pressed, the present thrust/pullback and rotation pressure set points are stored.

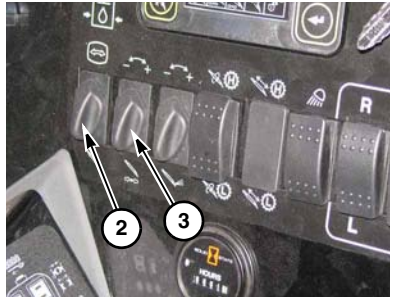
NOTE: The *Rotation* and *Thrust/Pullback Handles* **must be centered within one second from the time the *AutoDrill Button* was pressed**, not from the time the button was released.

Step 4: Use *Speed/Pressure Trim Switch* **(3)** to increase or decrease the speed/pressure settings. Holding the *Trim Switch* for 2 seconds initiates a process of ramping speed/pressure up or down.

If the R.A.T.T. mode has been activated, then the display will show the current oscillating degree setting.

Step 5: Move either *Rotation* or *Thrust/Pullback Handles* **out of NEUTRAL** to stop drill string motion and PAUSE AutoDrill.





AUTODRILL - ENABLE (R.A.T.T. OSCILLATION MODE) (D20X22 ONLY)

Step 1: Locate sonde and determine steering direction.

Step 2: Enable R.A.T.T. Oscillation mode with *R.A.T.T. Mode Key* **(1)**.

NOTE: Selecting R.A.T.T. mode will cause AutoDrill mode to default to Constant Thrust/Pullback Pressure.

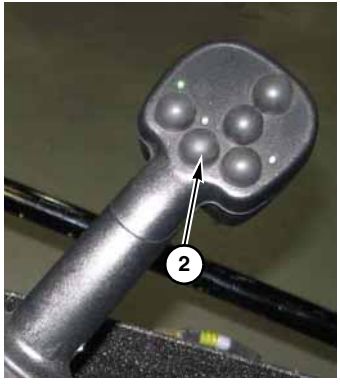
Step 3: Pull *Rotation Handle* for clockwise rotation. Drill string will oscillate clockwise and counterclockwise.

Step 4: Apply desired thrust.

Step 5: Momentarily press and release *AutoDrill Button* **(2)** and immediately release the *Rotation* and *Thrust/Pullback Handles*.

The controller will drive the thrust/pullback pump output to maintain the pressures at which this mode was initiated.

NOTE: The *Rotation* and *Thrust/Pullback Handles* **must be centered within one second from the time the *AutoDrill Button* was pressed**, not from the time the button was released.



Step 6: Adjust thrust pressure limit with *Speed / Pressure Trim Switch*. Rotation pressure limit **cannot** be adjusted in R.A.T.T. mode (oscillation or straight drilling).

IMPORTANT: The rotation pressure limiter must be turned ON when using the R.A.T.T. tool in order to prevent damage to the tool components.

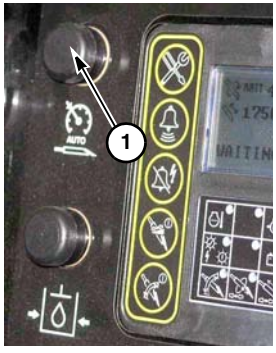
NOTE: To start AutoDrill in the R.A.T.T. Straight Drilling mode, the *R.A.T.T. Oscillation Mode Enabled Light* must be OFF. Press *R.A.T.T. Mode Key* twice, first to activate Oscillation mode, then press again to toggle to Straight Drilling mode.

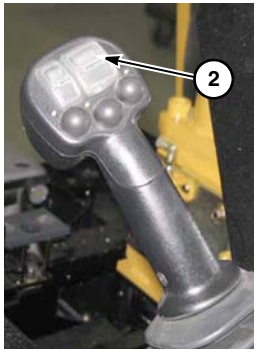
AutoDrill - Pause

Move either *Rotation* or *Thrust / Pullback Handle* out of NEUTRAL to pause AutoDrill mode.

NOTE: The *Thrust / Pullback* and *Rotation Handles* must **both** be returned to NEUTRAL for at least 1/2 second before the handles are enabled for manual control of rotation and thrust/pullback.

AutoDrill - Resume



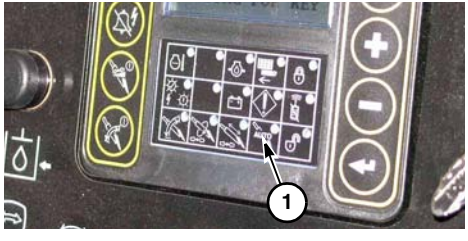


If the engine has not been shut off since the AutoDrill feature has been turned on, then AutoDrill may be RESUMED after PAUSING by holding the *AutoDrill Resume Button* **(1)** for 1.5 seconds. AutoDrill will resume to the last stored thrust/pullback and rotation set points. Rotation will operate for 2–3 seconds before thrust or pullback starts.

NOTE: If thrust or rotation has not been active for five minutes, the AutoDrill mode will need to be reset.

Restarting the AutoDrill function by using the Resume command is only possible if the *Front Vise Switch* **(2)** is in the RELEASED position. If the front vise is clamped and the operator tries to resume, the AutoDrill function will not work and the display will flash “VISE” until the operator moves the *Front Vise Switch* to the RELEASED position. When front vise is released, the AutoDrill function can be restarted by pressing the *Resume Button* **(1)** for 1.5 seconds.

AutoDrill - Disable



AutoDrill set points are cleared by shutting off the engine.

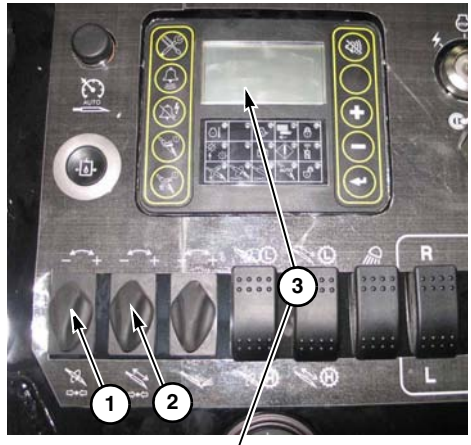
It is also disabled if both *Thrust/Pullback* and *Rotation Handles* have been placed in NEUTRAL for more than 5 minutes after pausing in AutoDrill. *AutoDrill Light* **(1)** will turn off.

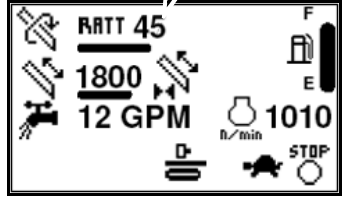
AUTODRILL - ADJUST

The speed and pressure set points can only be adjusted while AutoDrill is enabled.

The first input from the *AutoDrill Selector Switch* **(1)** shows which AutoDrill mode is being controlled. The first input from the *Speed/Pressure Trim Switch* **(2)** changes the display screen **(3)** to show the current speed or pressure set point. Refer to "AutoDrill Controls," *page 21-18*.

- If *Constant Thrust/Pullback Speed* is selected, additional inputs from the *Trim Switch* **(2)** result in approximately 1% increases in pump output (thrust speed).
- If *Constant Thrust Pressure* or *Constant Rotation Pressure* is selected, additional inputs from the *Trim Switch* **(2)** result in 10-psi (70-kPa) changes in the value of the initial pressure set point for the corresponding function.
- In all three modes, the changed value is displayed for 3 seconds.
- Holding the *Trim Switch* **(2)** for 2 seconds initiates a process of ramping speed/pressure up or down.
- To switch between modes, pause AutoDrill and place joysticks in NEUTRAL before selecting new mode. Use normal AutoDrill enabling procedures to set new drilling parameters, or press the AutoDrill RESUME button. If RESUME is used, drilling will resume at values used during the previously selected Constant Auto Drilling Mode.





The last set point is stored and becomes the set point when AutoDrill is resumed. (Refer to “AutoDrill - Resume,” *page 30-56*.) If the drilling conditions change since the AutoDrill was paused, then new set points corresponding to the new drilling conditions can be set by repeating Steps 1–4 in “AutoDrill - Enable (Normal Drilling),” *page 30-53*.

AutoDrill set points are stored until the engine is shut off. When the engine is started, the initial AutoDrill set points are zero.

If the R.A.T.T. mode has been activated, then the display **(3)** will show the current degree setting.

Constant Thrust/Pullback Speed - Adjust

Initial Speed

When *Constant Thrust/Pullback Speed* mode is selected, the carriage speed will be limited to the initial carriage speed used when AutoDrill was started. This feature prevents the thrust/pullback from over-speeding when the load is suddenly reduced.

When AutoDrill is turned ON, the initial thrust and rotation pressures are reference pressures and are allowed to change depending on drilling conditions. The rotation and thrust reference points are continually updated by the controller.

Limits Exceeded

If drilling conditions change rapidly, the thrust and rotation pressures are allowed to change, within allowable limits, while maintaining a constant carriage speed. Provided the actual rotation or thrust pressures remain within allowable limits, the rotation or thrust reference pressures are nearly the same as the function's actual gauge pressure.

If the allowable thrust or rotation pressure limits are exceeded, THRPSI or ROTPSI message will be displayed as a flashing or solid light and the thrust speed will be reduced.

- A **flashing** message means the thrust pump has reduced its output capacity (speed) by 10% from when AutoDrill was turned ON.
- A **solid** message means the thrust pump has reduced its output capacity (speed) by 30% from when AutoDrill was turned ON.

When a flashing or solid ROTPSI or THRPSI message is displayed, the corresponding pressure will be greater than the previously updated reference pressure. However, depending on drilling conditions, the ROTPSI or THRPSI messages may be displayed even if actual drilling pressures are less than the original pressures recorded when AutoDrill was turned ON.

Adjusting to Higher Values

If the operator wants to continue drilling at this higher pressure, the *Trim Switch* may be used to increase the set point pressure. Then the thrust pump output will be allowed to increase back to the value used before the message was displayed. The thrust speed will not increase more than the original thrust speed recorded when the AutoDrill system was turned ON.

If neither the ROTPSI or THRPSI message is displayed, the *Trim Switch* may be used to adjust thrust speed to more than the original speed when the AutoDrill was turned on.

Constant Thrust/Pullback Pressure - Adjust

Initial Pressure

When *Constant Thrust/Pullback Pressure* mode is selected, the thrust/pullback pressure is maintained by the AutoDrill system changing the thrust/pullback speed.

When AutoDrill is turned ON, the desired drilling thrust pressure, thrust pump output (speed) and rotation pressure are recorded. The speed is normally controlled by thrust set point pressure. However, the controller continually monitors the actual rotation pressure and compares this value to the reference rotation pressure point. The rotation and thrust reference points are continually updated by the controller.

Limits Exceeded

Depending on drilling conditions, rotation pressure is allowed to increase within allowable limits. If the allowable rotation pressure limit is exceeded, the ROTPSI message will be displayed as a flashing or solid light, and the thrust speed will be reduced. Provided the actual rotation pressure remains within allowable limits, the thrust reference pressure is the same.

- A **flashing** message means the thrust pump has reduced its output capacity (speed) by 10% from when AutoDrill was turned ON.
- A **solid** message means the thrust pump has reduced its output capacity (speed) by 30% from when AutoDrill was turned ON.

NOTE: Even though ROTPSI may be on, the actual thrust pressure may be equal to the original thrust set point pressure, depending on the drilling conditions.

When a flashing or solid ROTPSI message is displayed, the rotation pressure will be greater than the previously updated reference pressure. However, depending on drilling conditions, the ROTPSI message may be displayed even if actual drilling pressure is less than the original pressures recorded when AutoDrill was turned ON.

Adjusting to Higher Values

If the operator wants to continue drilling at this higher rotation pressure, the *Trim Switch* may be used to increase the rotation set point pressure.

When the rotation pressure set point is increased, the thrust pump output will be allowed to increase back to the value used before the ROTPSI message was displayed. The thrust speed will increase until the thrust pressure has been reached. However, the thrust speed will not increase more than the original thrust speed recorded when AutoDrill was originally turned ON.

If the ROTPSI message is **not** displayed, the *Trim Switch* may be used to adjust the drilling thrust set point pressure. Depending on the drilling conditions, the carriage speed may also change.

Constant Rotation Pressure

Initial Pressure

When *Constant Rotation Pressure* mode is selected, the rotation pressure is maintained by the AutoDrill changing the thrust/pullback speed.

When AutoDrill is turned ON the desired drilling rotation pressure, thrust pump output (speed), and thrust pressure are recorded. Rotation pressure is normally controlled by changing the thrust pump output (carriage speed). However, the controller continually monitors the actual thrust pressure and compares this value to the reference thrust pressure point. The rotation and thrust reference points are continually updated by the controller.

Limits Exceeded

Depending on the drilling conditions, the thrust pressure is allowed to increase within allowable limits. If the allowable thrust pressure limit is exceeded, the THRPSI message will be displayed as a flashing or solid light and the thrust speed will be reduced. Provided the actual thrust pressure remains within allowable limits, the rotation reference pressure is nearly the same as the function's actual gauge pressure.

- A **flashing** message means the thrust pump has reduced its output capacity (speed) by 10% from when AutoDrill was turned ON.
- A **solid** message means the thrust pump has reduced its output capacity (speed) by 30% from when AutoDrill was turned ON.

NOTE: Even though the THRPSI message may be on, depending on the drilling conditions, the actual rotation pressure may be equal to the original rotation set point pressure.

When a flashing or solid THRPSI message is displayed, the thrust pressure will be greater than the previously updated reference pressure. However, depending on drilling conditions, the THRPSI message may be displayed even if actual drilling pressure is less than the original pressures recorded when AutoDrill was turned ON.

Adjusting to Higher Values

If the operator wants to continue drilling at this higher thrust pressure, the *Trim Switch* may be used to increase thrust set point pressure.

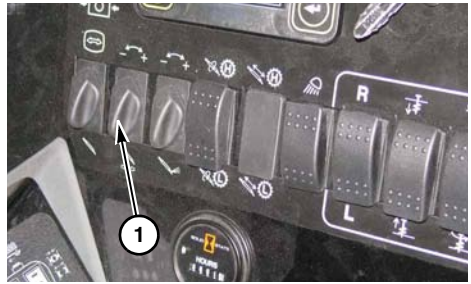
When the thrust pressure set point is increased, the thrust pump output will be allowed to increase back to the value used before the THRPSI message was displayed. The thrust speed will increase until the rotation pressure has been reached. However, the thrust speed will not increase more than the original thrust speed recorded when the AutoDrill system was turned ON.

If the THRPSI message is **not** displayed, the *Trim Switch* may be used to adjust the drilling rotation set point pressure. Depending on the drilling conditions the carriage speed may also change.

MEMORY SETTINGS FOR THRUST/ROTATION PRESSURE

Default thrust/rotation pressure settings for various drill modes can be adjusted. The settings are displayed on the controller, and are saved to permanent memory.

To adjust, place the machine in the preferred drill mode and use the *Speed / Pressure Trim Switch* **(1)** to increase or decrease in increments of 10 psi.



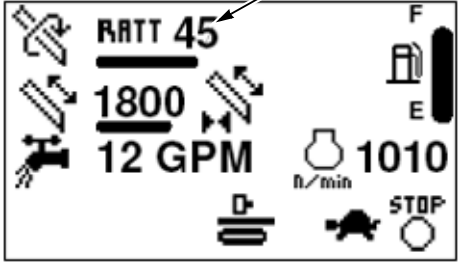
Drilling Fluid

Drilling fluid increases drilling efficiency in several ways. Refer to *Fundamentals of HDD Manual* for drilling fluid and drilling fluid system information.

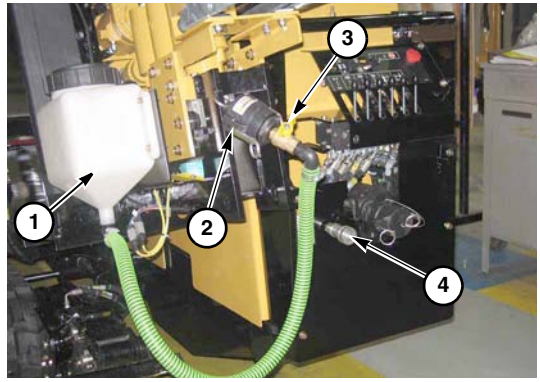
Drilling Fluid Pump Output Flow

Use *Drilling Fluid Trim Switch* **(1)** to increase flow. The initial switch input changes the display screen **(2)** to show the current pump output flow set point.

The second input from the increase/decrease of the *Trim Switch* results in a 1-gpm (3.8-L/min) change in the value of the initial set points.



Adding Antifreeze to Drilling Fluid System



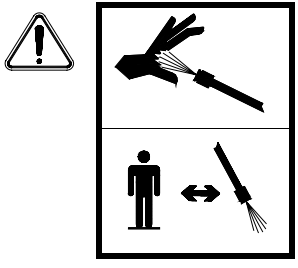
Store RV-type antifreeze in tank **(1)**. It can be reused as necessary. Replace antifreeze when it is too diluted to protect system.

Step 1: Drain and flush drilling fluid tank and pump. Refer to the *Operation* section, "Flushing Bentonite/Polymers from Drilling Fluid System," *page 50-38*.

Step 2: Fill tank **(1)** with 6 gal (23 L) of RV-type antifreeze. Use at full strength; it will become diluted as it is used.

Step 3: Install cap **(2)** on coupler, open valve **(3)**, and operate pump until antifreeze comes out of drive chuck.

Step 4: Connect wash wand to quick coupler **(4)**.



WARNING: High pressure water can penetrate skin. Serious injury possible. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Keep nozzles away from body.

Step 5: Spray fluid into tank until antifreeze is visible in the spray from wand.

Step 6: Close valve and follow *Shutdown Procedure, page 50-3*.

Step 7: Point wash wand away from people and squeeze handle to release pressure remaining in wand.

Step 8: Remove wash wand from drilling fluid pump quick coupler and store wash wand.

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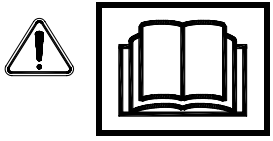
Section 40: Preparation

Preparing Personnel

OPERATOR QUALIFICATIONS



WARNING: Read Operator's Manual and safety signs before operating machine.

Allow only responsible, properly instructed individuals to operate machine.

Become familiar with the controls, operation, and use of the machine under the supervision of a trained and experienced operator.

The operator must be familiar with the workplace's safety rules and regulations, and must be mentally and physically capable of operating the machine safely.

Safety Conscious Operators and Workers

Operators and workers should exercise reasonable accident-prevention measures. This includes properly locating all underground utilities.

TRAINING

Before operating the drill unit, the operator and crew should be trained in the operation of horizontal directional drills. Initial training should be conducted at a site free of underground utilities and should cover:

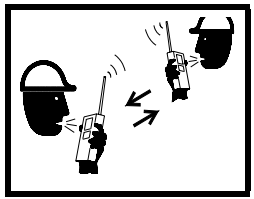
- all sections of this manual and the *Fundamentals of Horizontal Directional Drilling User's Guide*
- processes and procedures used to locate underground utilities
- jobsite safety, including safety barriers and protective clothing, as well as operating and emergency procedures
- machine lockout procedure and Remote Lockout system
- two-way radio communication
- transportation of drill unit
- setup of drill unit
- drilling and backreaming, including selection and installation of tools

Safety Signs and Operating Instructions

Safety signs and operating instructions provide information on potential safety hazards and safe operating instructions.

RADIO COMMUNICATION REQUIREMENTS

IMPORTANT: The Remote Lockout system is not intended to replace good verbal radio communication. Radio communication is essential to the Remote Lockout system process.



WARNING: Proper communication is essential to prevent unplanned start-up of the drill string and/or tool. Serious injury or death could result. Always follow communication requirements as explained below.

Use good quality two-way radios with sufficient range to provide clearly understood communication. Test radios at the site to ensure communications can be heard above background noise.

The radio at the exit location must be assigned to one designated person. This person will always communicate with the machine operator.

When sending a message, identify yourself and the receiver by name. This will help avoid confusion if more than one machine is operating on a jobsite.

All radio messages must be confirmed by the receiver. Confirmation from the receiver must acknowledge that the message was received and properly understood. Proper understanding must be demonstrated by repeating the original message back to the sender. The sender must always require confirmation of the message.

Radio Communication to Stop Drilling Operation

When the crew at the location of the exposed drill string or tool requests the operator to stop operation:

Step 1: The crew must communicate a stop command to the operator.

Step 2: When stop command is received, the operator must immediately stop the machine. After machine has stopped, the operator must return a message confirming that the message was received and understood.

Radio Communication to Resume Drilling Operation

If start-up is requested by the machine operator:

Step 1: The operator must request authorization from the crew at the location of the exposed rod or tool to resume rotation or thrust.

Step 2: The crew at the location of the exposed rod or tool must respond as appropriate, but must not give authorization to resume until everyone is away from the rod or cutting tool and everyone has been informed that start-up will occur.

Step 3: If authorization to resume has been received by the machine operator, the operator must require confirmation for start-up from the crew at the exit location.

Step 4: When confirmation is received, the operator may resume operation.

If start-up is requested by the crew at the location of the exposed rod or tool:

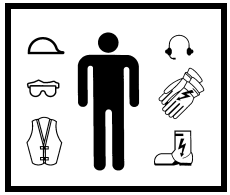
Step 1: After checking that everyone at the location of the exposed rod or tool is away from the cutting tool and everyone has been informed that start-up will occur, a start-up command may be sent to the operator.

Step 2: When the start-up command is received, the operator must return a message confirming that the message was received and understood.

Step 3: The crew at the location of the exposed rod or tool must respond by providing confirmation of the machine operator's intention to start-up.

Step 4: When confirmation is received, the operator may resume operation.

PERSONAL PROTECTION



WARNING: Wear personal protective equipment. To reduce the risk of being caught and entangled in moving components, wear close-fitting clothing and confine long hair. Avoid jewelry, such as rings, wristwatches, necklaces, or bracelets.

Operating the machine will require you to wear protective equipment. Always wear a hard hat, wraparound eye protection or goggles, and electrically insulated boots. If working near traffic, you may need to wear reflective clothing.

The operator is not required to wear electrically insulated gloves while seated on this self-contained directional drilling machine. However, the operator must always wear electrically insulated boots to provide protection against electrical shock in case of inadvertently stepping off the machine during an electrical strike.

Hearing protection must be worn by machine operator. Other crew members may need to wear hearing protection when working close to the machine and/or support equipment.

Eye protection must consist of wraparound safety glasses or goggles.

Other workers in the immediate area must also wear hard hats and eye protection.

Wear close-fitting clothing and confine long hair.

Avoid wearing jewelry, such as rings, wristwatches, necklaces, or bracelets.

Sound and Vibration Levels

D16x20 Series II

Equivalent Continuous A-Weighted Sound Pressure as specified by ISO 6394
at Operator's Ear . . . . . .Tier 2 and Tier 3 engines: 91 dB(A);
at Control Station at rear of machine . . . . . 92 dB(A)

Guaranteed Sound Power Level
as determined by directive 2000/14/EC . . . . . Tier 2 engine: 110 dB(A); Tier 3 engine: 109 dB(A)

NOTE: The stated sound levels are representative for a given operating condition. Operating conditions may vary at each jobsite. The actual sound levels for your application and operating conditions may be different.

Hand/Arm Vibration Level as determined by ISO 5349 . . . . . .less than 2.5 m/s^2

Whole Body Vibration Level as determined by ISO 2631-1 . . . . . .less than 0.5 m/s^2

D20x22 Series II

Equivalent Continuous A-Weighted Sound Pressure as specified by ISO 6394
at Operator's Ear . . . . . Tier 2 engine:89 dB(A); Tier 3 engine: 90 dB(A)
at Control Station at rear of machine . . . . . 92 dB(A)

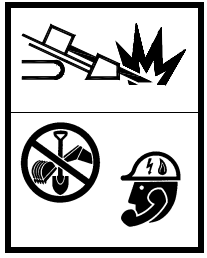
Guaranteed Sound Power Level as determined by directive 2000/14/EC . . . . . 108 dB(A)

NOTE: The stated sound levels are representative for a given operating condition. Operating conditions may vary at each jobsite. The actual sound levels for your application and operating conditions may be different.

Hand/Arm Vibration Level as determined by ISO 5349 . . . . . .less than 2.5 m/s^2

Whole Body Vibration Level as determined by ISO 2631-1 . . . . . .less than 0.5 m/s^2

UNDERGROUND UTILITY CONTACT



WARNING: Electricity or gas explosion can kill. Laser light in cut cable can result in eye damage.

Locate utilities before drilling. Call 811 (U.S. only) or 1-888-258-0808 (U.S. or Canada) or local utility companies or national regulating authority.

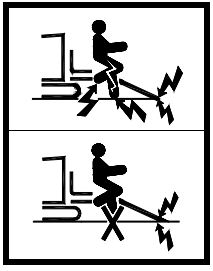
Before you start any digging project, do not forget to call the local One-Call system in your area and any utility company that does not subscribe to the One-Call system. For areas not represented by One-Call Systems International, contact the appropriate utility companies or national regulating authority to locate and mark the underground installations. If you do not call, you may have an accident or suffer injuries; cause interruption of services; damage the environment; or, experience job delays.

The One-Call representative will notify participating utility companies of your proposed digging activities. Utilities will then mark their underground facilities by using the following international marking codes:

Red	Electric	Green/Brown	Sewer
Yellow	Gas, Oil or Petroleum	White	Proposed Excavation
Orange	Communication, Telephone, TV	Pink	Surveying
Blue	Potable Water		

OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

ELECTRICAL SHOCK PROTECTION



DANGER: Electric shock can kill.

If strike occurs, do not step down. Keep feet on platform while operating.

DANGER: Contact with the drilling machine while standing on the ground could result in electrocution if an electrical strike occurs. Do not touch the drill unit or remote fluid mixing system while drilling or after an electrical strike occurs. See other portions of this manual regarding procedures and personal protection equipment to avoid electrocution.

Electrocution Avoidance

Electrocution is possible. Serious injury or death may result if the drilling tool strikes an energized power line. Refer to the operating instructions, and take the following precautions to prevent electrocution:

- Call your One-Call system, and any utility company that does not subscribe to the One-Call system, before the start of your drilling project. Locate underground utilities by qualified persons.
- When drilling operation approaches the estimated location of a utility, the exact location of the underground installation must be determined by safe and acceptable means.
- Always wear the necessary electrically insulated gloves and boots that are required for each job function. Refer to “Electrically Insulated Gloves,” *page 40-10*, and “Electrically Insulated Boots,” *page 40-12*.
- Never stand on the ground and touch metal parts on drilling unit or water truck when operating.
- If a strike occurs, never leave the cab and step off the machine.
- Anyone standing on the catwalk for the drill rack must never step off the catwalk if electric strike occurs. Never step onto the machine if electrical strike occurs.
- Always test Strike Alert system before the start of every bore. Refer to “Strike Alert System - Test,” *page 50-9*. Never operate if Strike Alert system is not in operation and tested.
- Disconnect from public water supply before drilling where electrical cables may be buried.

If a strike occurs while you are touching the ground, you could be electrocuted when your body becomes a direct current path to the ground. Keep feet on the foot platform.

Anyone assisting the operator while standing on the ground during the bore must wear electrically insulated gloves and boots.

The drilling tool locator must wear electrically insulated boots. The ground may become electrically charged if a strike occurs.

Electrically Insulated Gloves

NOTE: If electrically insulated gloves are not available locally, they can be obtained through Vermeer Corporation. A one-pair purchase voucher is supplied with the machine.

Rubber electrically insulated gloves, when in good condition and properly used, help protect the wearer from serious injury, death, and electrical burns. Gloves must be at least Class 2, with a voltage rating of 17,000 volts or more. Wear leather protectors over gloves. They provide protection for the gloves, but do not provide any protection against serious injury, death or other potential dangers from electric shocks or burns.

The operator is not required to wear electrically insulated gloves while seated on this self-contained directional drill unit. Anyone assisting with installation of rack anchor stakes or assisting the operator during drilling must wear electrically insulated gloves and boots.

Proper care of gloves is essential to wearer safety.

- Visually inspect gloves and leather protectors prior to each use (see the following instructions).
- Do not fold gloves. Folding causes dangerous cracking damage. Store gloves in glove bag when not in use.
- Do not store gloves inside out. This causes damage from ozone and severely strains the rubber.
- Keep gloves clean. The gloves will be more comfortable to wear, and any damage will be more visible.
- Avoid snags. Do not wear rings, watches, jewelry, or other sharp objects on hands or arms when wearing gloves.
- Avoid wood or metal splinters or other sharp objects which may damage gloves.
- Avoid chemicals, which can damage gloves. If contact is made with chemicals, wipe gloves off immediately. Clean gloves with a mild soap, then rinse with clear water and let them air dry.

NOTE: The ASTM In-Service specifications call for an electrical retest of gloves at a test lab every six months. This test is to recertify the non-conductivity of the gloves. Contact your Vermeer dealer for the location of the test lab in your area or a listing of the test labs.

Electrically Insulated Gloves - Inspect

Visually inspect insulated gloves and leather protectors prior to each use.

- Check for any signs of physical damage or chemical deterioration such as swelling, softness, hardening, stickiness, ozone deterioration, or sun-checking from prolonged exposure to sunlight.
- Check whether red or yellow inner layer shows through black outer layer, indicating gloves have been cut or snagged. If damaged at all, do not use them.
- Check leather protectors. Look for metal particles, imbedded wire, abrasive materials, or any substance that could cause puncture, abrasion, contamination, or deterioration. Adequate flashover distance of 2″ (5 cm) between the top of protector and the bead of rubber glove should be maintained. Minimum uncovered distance must be 1″ (2.5 cm) above the protector cuff top for each 10,000 volts.
- Check insides of each glove and air test for pinholes:

Step 1: Place glove on your hand, and pull cuff up over your fingers, turning glove inside out.

Step 2: Holding glove downward, grasp cuff and twirl it upward toward your body to close the cuff.

Step 3: Squeeze rolled cuff into a “U” shape to trap air inside glove. Hold cuff with one hand and squeeze glove with your other hand. Hold glove near your ear and listen and feel for air escaping through a hole. Pop out glove fingers by squeezing inflated glove and check for damage.

Step 4: Turn glove right side out.

Step 5: Repeat with other glove.

Electrically Insulated Boots

NOTE: If electrically insulated boots are not available locally, they can be obtained through Vermeer Corporation. A two-pair purchase voucher is supplied with the machine.

Rubber electrically insulated boots, when in good condition and properly used, also protect the wearer from serious injury, death, and electrical burns. The boots must meet or exceed electrical hazard protection requirements when tested at 14,000 volts.

Inspect boots before each use. Check for cracking, holes, and unusual wear on the sole. If there is any damage, discard boots. Damaged boots will not provide adequate electrical protection.

After each use, rinse boots with water to remove mud, chemicals, and debris. Because of the natural rubber in the boots, it is crucial to use a rubber protectant or furniture polish to keep rubber soft and help prevent pinholes, stress cracks, dry rotting, and ozone deterioration.

Strike Alert System Functions

The Strike Alert is only a warning device, not a protective device.

The Strike Alert system detects voltage on the machine and/or current running through the drill string in the event of drill striking an underground power line. An alarm sounds alerting operator and other personnel of a potentially dangerous situation.

The Strike Alert will not be set off by coming near a power source. If the *Strike Alert Horn* sounds, the drill may have contacted an energized electrical line. Other indications of an electrical strike are electrical arcing, explosion, smoke, or popping noises.

When an electrical strike occurs, large voltage differences may exist on the ground surface near machine and along drill string. Standing or walking in these areas may cause electrical shock from the difference in voltage between your feet. Anyone in the work area, including the locator, must wear electrically insulated boots. Keep all other personnel away from work area.

Soil Conductivity

For the system to function properly, voltage stake must be fully inserted in soil through which a current can pass. If the machine is located on asphalt, the voltage stake or the drill string must be inserted into the ground through which current can pass. If the machine is on a dry hard surface, the auger stakes may need to be inserted into the ground, or the ground under the tracks moistened to increase electrical conductivity between machine and ground.

To improve the conductivity of dry and loose sand, dry soil, or asphalt:

- Ensure voltage stake is fully inserted into the ground.
- Soak soil around the stake with water.

Hydraulic System Shutoff

Hydraulic controls will not function if the voltage is too low for the Strike Alert system to operate (approximately 10.2 volts).

Preparing the Machine

Operator Presence System

The machine is equipped with an Operator Presence system. The track drive will not function if the operator is seated at the controls. Thrust and rotation will not function if the thrust and rotation controls are pushed when the operator is not in the seat. This system is intended for your safety and must be maintained in good functional condition.

Remote Lockout System Preparation

Remote Lockout System

For information on Remote Lockout system intended use, refer to the *Overview* section, “Remote Lockout System Intended Use,” *page 30-1*.

Range - Test

Test the range of radios and remote lockout transmitter along bore path to ensure good communication will be available between the operator, locator, and other crew members throughout the bore.

Remote Transmitter - Prepare

The remote transmitter operator must do the following:

Step 1: Ensure transmitter battery is fully charged at the beginning of the day. Approximate operational time for the battery is 30 hours. If unsure of remaining battery charge time, install a fully charged battery in the transmitter.

Step 2: Press *Power ON/OFF Button* to turn remote transmitter on.

Step 3: Test Remote Lockout system at the machine (refer to the following module).

Step 4: Clip remote transmitter onto user’s belt. The transmitter should remain ON throughout the bore.

Remote Lockout System - Test

IMPORTANT: Test Remote Lockout system at least once daily and at the start of every bore. Machine operator must be seated for machine to be in Drill mode.

NOTE: The Remote Lockout system is not operational when machine is in Transport mode.

Complete the following steps with transmitter located near the machine.

Step 1: Start engine and turn on remote transmitter.

Step 2: Press *Lockout Button* on remote transmitter. The red light must come on, and buzzer must sound 9 beeps to indicate that the machine is locked out.

Step 3: Machine operator must attempt to begin drilling. Drilling functions should remain stopped (locked out).

Step 4: Press *Run Button* **and hold for 2 seconds.** Green light comes on, and buzzer sounds for 2 seconds. Operator will be able to resume drilling.

IMPORTANT: Perform Remote Lockout Test before drilling each day.

If test is not successful, ensure transmitter is within range and that machine is running and is in Drill mode (operator seated at controls). If a problem still exists, contact your Vermeer dealer to determine source, and use the "Lockout Procedure - Without Remote Lockout System," *page 30-17*, until the Remote Lockout system is repaired.

Preparing the Work Area

JOBSITE - CHECK

The operator or job foreman should inspect the jobsite for:

- notices of underground placements
- manhole covers
- drop boxes
- recent trenching activity
- any evidence of possible underground placements

Jobsite Assessment

Examine work area for any obstructions, conditions, or situations which may impair machine operation or create a safety hazard for the operator or other persons. Use information in this manual combined with your own good judgment when identifying these hazards and implementing hazard avoidance measures.

Warning Cones

Check that orange warning cones with warning safety signs are available for placement around the drill unit work area. Four orange warning cones are provided.

Set up orange cones around the machine with warning safety signs facing outward before starting operation.

Place pedestrian and traffic warning barriers around the jobsite in accordance with Federal, State, and local laws and regulations.

Power Line Locator System

A locator system to locate underground power lines is not included with the system but may be purchased from Vermeer dealerships.

Laws and Regulations - Check

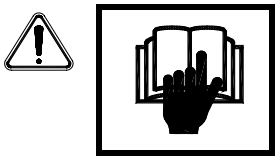
Know and obey all federal, state, and local laws and regulations that apply to your work situation.

Planning the Bore

Carefully plan the bore before drilling. Refer to *Fundamentals of Horizontal Directional Drilling User's Guide* for information on bore planning.

Section 50: Operation

Starting Procedure



WARNING: Read Operator's Manual and safety signs before operating machine.

STARTING THE ENGINE

Step 1: Shut off drilling fluid pump.

Step 2: Set *Throttle* at IDLE.

Step 3: Ensure *Rotation* and *Thrust/Pullback Handles* are in NEUTRAL.

Step 4: Start engine. Shut off engine if oil light does not go out within 15 seconds.

IMPORTANT: Never run starter motor for more than 30 seconds at a time. Allow starter motor to cool 2 minutes between attempts.

Step 5: Adjust *Throttle* to get an even idle speed and allow engine to warm up for 3–5 minutes.

IMPORTANT: Once engine reaches operating temperature, do not idle engine for more than 5 minutes. Low combustion chamber temperatures can cause crankcase oil dilution due to fuel not burning completely and permits formation of gummy deposits on valves, pistons, and piston rings.

Step 6: Turn remote transmitter ON.

NOTE: The Remote Lockout system self-tests upon start-up, indicated by two short beeps, and then enters whatever mode it was in when the machine was shut down.

Step 7: If machine was shut down in Lockout mode, press *Run Button* **and hold for 2 seconds** to select RUN mode.

Step 8: Press *Hydraulic Enable Button*.

WARNING: Pressing *Hydraulic Enable Button* will result in vise movement if the vise control switch positions were changed while the engine was off. Crushing injury may result. Keep everyone clear of machine.

COLD WEATHER STARTING

Engine

Before operating in cold weather, refer to the Engine Operation Manual for recommended engine oil, fuel, and starting procedures.

On a cold engine, turn key to HEAT position for approximately five seconds to activate glow plugs.

Hydraulic Fluid

Refer to “Lubricants” in the Specifications section of the *Maintenance Manual* for recommended hydraulic fluids.

When using ISO 68 hydraulic fluid below +23°F (-5°C) or ISO 100 hydraulic fluid below +41°F (+5°C):

- Warm up engine.
- Gradually increase engine RPM for up to 30 minutes to allow hydraulic oil to warm up. To assist in warming up the hydrostatic system, move control levers back and forth.

NOTE: Slow down engine if hydraulic pump squeals because it does not get enough oil.

For frequent starts below 10°F (-12°C), consult your Vermeer dealer.

Shutdown Procedure

Step 1: Shut off drilling fluid pump.

Step 2: Reduce engine speed to idle.

Step 3: Wait two minutes to shut off engine when shutting down after operating at full power.

Step 4: Shut off engine and remove key.

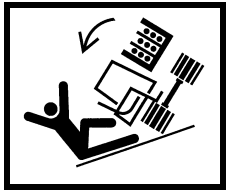
For your safety and the safety of others, use shutdown procedure before working on the machine for any reason, including servicing, cleaning, unplugging, or inspecting.

IMPORTANT: If working on the drill string or drill tools at a remote location away from the machine, follow "Lockout Procedure - With Remote Lockout," *page 30-14*, or "Lockout Procedure - Without Remote Lockout System," *page 30-17*.

A variation of the above procedure may be used if instructed within this manual or if an emergency requires it.

Transporting the Machine

DRIVING THE MACHINE

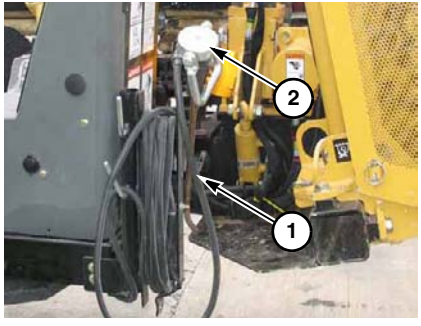


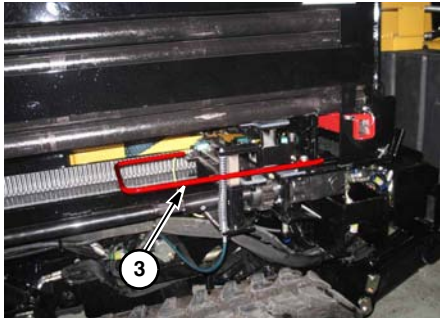
WARNING: Rollover possible. Be alert and use extreme caution when operating on hillsides, or near ditches, gullies, holes, or obstructions where rollover could occur. Serious injury or death can result if crushed under the machine. Never allow anyone to be on the downhill side of the machine.

Drive the machine at a speed suitable for the terrain. Never operate machine faster than you can comfortably walk. Keep feet clear of the track when driving in reverse. Avoid sudden stopping, starting, or turning unless it is necessary.

Preparing for Transport

- Store cable **(1)** and voltage stake **(2)** in storage bracket on drill unit.
- Ensure rod retainers are installed in top of rod box to prevent drill rods from coming out of rod box during trailering.
- Extend rod loader arms toward drill rack.
- Rotate operator console fully towards drill rack.
- Fold in rod transfer arm barriers **(3)**.

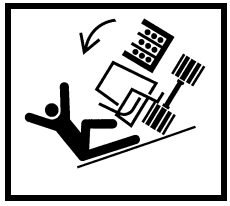




TRAILERING THE MACHINE

Loading/Unloading

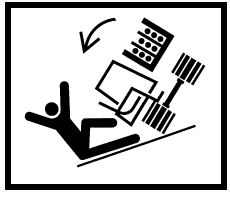
Before transporting machine on a trailer, read trailer manual for safety precautions and information. Ensure trailer bed and ramps are free of debris that will interfere with the loading process.



WARNING: Machine may slide down loading ramps or off trailer deck. Serious injury or death can result if struck or crushed by machine. Do not load onto slick trailer surface.

Ensure gross weight of the machine is within gross weight limits of the trailer and towing vehicle. Load and unload machine with the trailer on a level surface and with trailer attached to the towing vehicle.

Step 1: Align centerline of machine with centerline of trailer to minimize steering while loading.



WARNING: Do not attempt to steer machine while its weight is balanced on the end of the trailer. Slight steering changes may cause the machine to turn abruptly and slide off the loading ramps. Serious injury or death can occur if crushed under the machine.

Step 2: Set engine throttle at IDLE.

Step 3: Place *Ground Drive Range Switch* in LOW.

Step 4: **SLOWLY** drive machine squarely onto trailer.

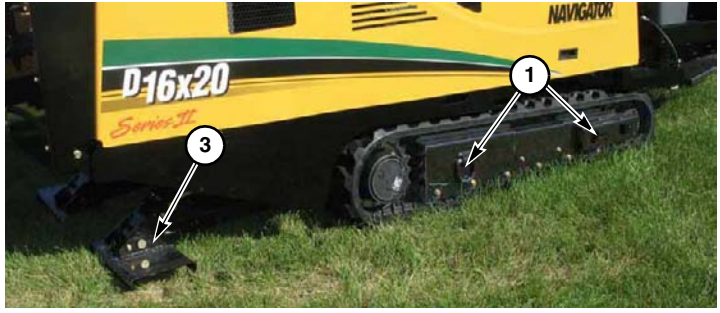
NOTE: When loading using the manual control levers, adjust the rack angle to keep levers at a comfortable height and within reach.

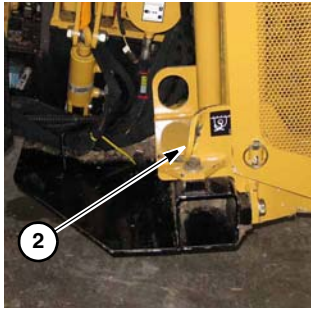
Step 5: Stop machine when tie-down position is reached. The tie-down position distributes weight on the trailer as recommended by trailer manufacturer.

Step 6: Lower rear stabilizer and drill rack frame.

Step 7: Follow "Shutdown Procedure," *page 50-3*.

Step 8: Use tie-down points on the track frames **(1)**, each side of stakedown towers **(2)**, and the rear stabilizer **(3)** to secure drill unit to the trailer with chains and binders.



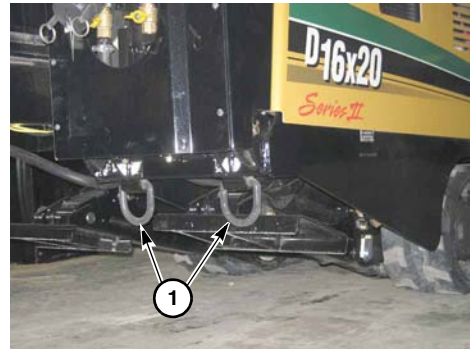


TOWING/RETRIEVING MACHINE

Never tow a disabled machine farther than is required to move the machine a short distance to locate the machine out of traffic and to where repairs can be performed safely.

WARNING: Serious injury or death could result when retrieving or towing a disabled machine incorrectly.

- Attach towing cables to tie-down/towing lugs **(1)** on rear of machine.
- If the brakes must be released, securely block the machine before releasing brakes to prevent unintended movement.
- If the planetary gears are removed, the machine no longer has park brakes.
- Use only wire rope cable with sufficient strength. Inspect cable for fraying and wear. Do not use if frayed or worn.
- Use a towing machine with sufficient power, weight and braking capacity to maintain control of the disabled machine. The towing machine should be at least as large as the disabled machine. If retrieving on a downhill grade, use a second machine on the opposite end of the disabled machine to prevent the disabled machine from overrunning the towing machine.



- Provide barriers to prevent injury to machine operators if cable fails. Keep anyone on the ground at least two times the length of the cable away.
- Never try to jerk the disabled machine in order to get the machine to move. Sudden cable overload may cause cable to fail.
- The strength of the towing cable must be at least 150% of the towing machine.

Towing procedure requires special tools and fittings and is detailed in the *Service Manual*. Contact your Vermeer dealer for assistance in bypassing the ground drive pumps and releasing the brakes.

IMPORTANT: Do not tow machine more than 500 ft (150 m), and do not exceed 1 mph (1.5 km/h).

Lifting Machine

No provisions are made for lifting the machine. If transport requires that machine be lifted, it must be loaded onto an appropriate skid.

Setup

Bore Path - Walk

Be sure to walk the bore path to double-check for signs of utility lines, potential causes of locator interference, and general assessment. Look for the following visual signs that could indicate presence of utility lines:

- Ditch lines or depressions where the ground has settled from previous excavation.
- Buildings that have lights but no overhead wires; the power lines may be buried in the bore path.
- Patch repairs in the street, which could indicate digging to bury or repair a utility line.
- Poles with wires extending into the ground, which might power traffic-sensing loops or traffic lights.
- Manholes, which can be used for utility line connections, not only for sewer connections.
- Water and gas shutoff valves, likely indicators of utility lines in the area.

Drill Unit Setup

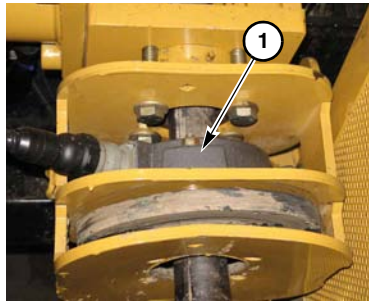
Step 1: Move drill unit to site and position it for drilling.

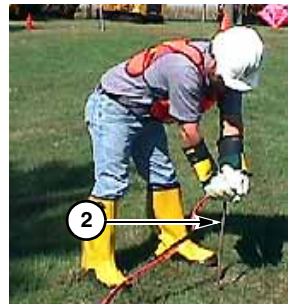
Step 2: Completely lower rack.

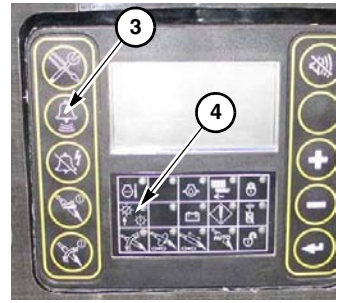
Step 3: Lower rear stabilizers until rack is at desired angle.

Step 4: Inspect power vise jaws and grips. Replace worn or damaged components before drilling. Refer to “Maintenance - As Required” section in the *Maintenance Manual*.

Strike Alert System - Test







NOTE: Test the Strike Alert system before operating the drill unit. Do not operate drill unless the Strike Alert test confirms the system is operational.

Step 1: Ensure current sensing coil **(1)** and coil connectors are not damaged.

Step 2: Unwind voltage stake cable. Ensure cable and connections are clean and undamaged.

Step 3: Insert voltage stake **(2)** into the ground at least six ft (2 m) away from machine and not over the drill string.

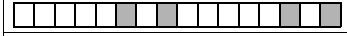
NOTE: The voltage stake must be inserted in the ground for Strike Alert system test to pass.

Step 4: Press *Test Key* **(3)**. The Strike Alert alarm must sound. Release key to silence alarm.

NOTE: The alarm must sound when operator presses the *Test Key*. A successful test is indicated when the green light **(4)** remains steady ON after the test key is released. If there is a flashing green light after releasing the test key, the Strike Alert system is not functioning correctly. Confirm that the voltage stake is fully inserted into the ground. The soil at the stake may need to be moistened to improve conductivity of the earth. Retest the system. If the test fails to pass, contact your Vermeer dealer.

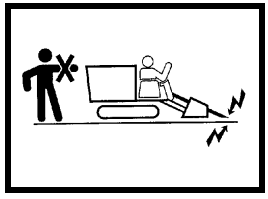
NOTE: The Strike Alert system automatically runs a system check whenever the machine is powered up (ignition key turned from OFF to RUN). If the system is properly set up, a successful check is indicated by a steady ON green light. Failure to properly insert the voltage stake into the ground will result in a flashing green light. ***The alarm does not sound during the power-up system check***.

STRIKE ALERT - INDICATORS AND CONTROLS

INDICATOR	INDICATION	SIGNIFICANCE
2-Tone Horn	On	Electrical strike occurred or *Test Key* pressed
	Silent	No voltage detected above threshold
Green Light	Off	Test in progress, light burned out, or wiring harness problem
	Flashing 	Ground Stake is not in the ground.
	Double Flashing 	Current Sensor failed
	Triple Flashing 	Ground Stake wiring problem
	On	Power-up check or Test passed. System is ready.

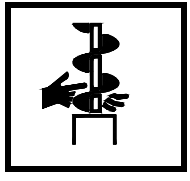
CONTROL	FUNCTION
Alarm Cancel Key	Turns alarm off (only when an external voltage and current are not present)
Test Key	Tests sensors, controller, and alarm

Machine - Anchor with Stakes



DANGER: Contact with drill unit while standing on the ground may result in serious injury or death from electrical shock if anchor stakes make contact with underground electric power.

- Drive anchor stakes only while seated at controls with both feet on platform.
- Keep everyone away from machine when anchors are being installed.



WARNING: Contact with moving anchor stakes can result in serious injury. Stay away from rotating stakes. Ensure anchor stake shields are closed and everyone is away from anchor stakes before operating.

While seated at the controls, drive stakes completely into the ground.

Warning Cones

Check that orange warning cones with warning safety signs are available for placement around drill unit work area. Four orange warning cones are provided.

Set up orange cones around the machine with warning safety signs facing outward before starting operation. The safety sign warns unauthorized persons to stay away.

DANGER: Electrically charged ground surface can kill.

Unauthorized persons must stay away.

Place pedestrian and traffic warning barriers around the jobsite in accordance with Federal, State, and local laws and regulations.

Locating Equipment - Prepare

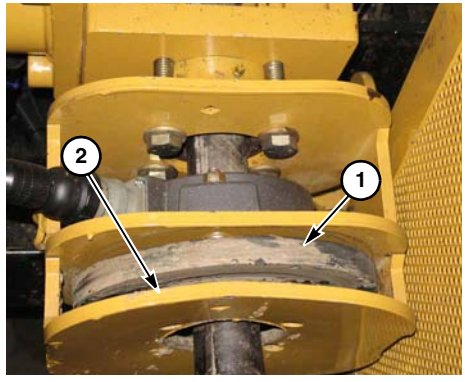
Ensure locator batteries are fully charged at the beginning of the day. Install new batteries in the transmitter every day. Standard “C” batteries generally last up to 15 hours.

Some locating systems need to be calibrated before drilling begins. Failure to do so could result in inaccurate depth readings on the locator. Refer to literature provided with locator device.

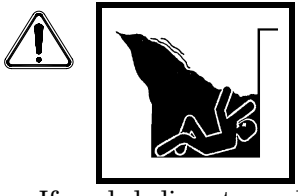
NOTE: It may be necessary to calibrate the locator while the drill head is lying on the ground with the transmitter in it.

Rod Wiper - Install

Use rod wiper **(1)** to clean drill rod when drilling. Install rod wiper into rod wiper holder **(2)**.



Entrance and Exit Sites - Prepare



WARNING: Do not work in trench with unstable sides which could cave in. Specific requirements for shoring or sloping trench walls are available from several sources, including federal and state O.S.H.A. offices. Be sure to contact suitable authorities for these requirements before working in the trench.

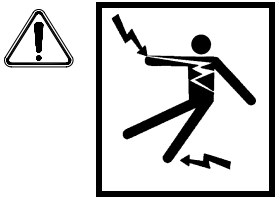
If needed, dig entry and exit pits at the correct location and depth to properly complete the bore.

Pilot Bore

Read Overview Section

Read and become familiar with *Overview, page 30-1*, before drilling. That section contains important information which is not repeated in this section.

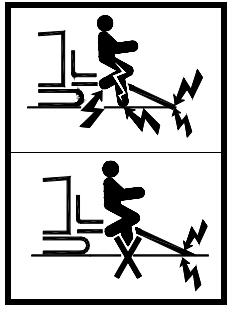
Safety Precautions



DANGER: Contact with the drilling machine while standing on the ground could result in electrocution if an electrical strike occurs. Do not touch the drill unit or remote fluid mixing system while drilling or after an electrical strike occurs. See other portions of this manual regarding procedures and personal protection equipment to avoid electrocution.

Utility Line Contact

Electrical Line



DANGER: Electric shock can kill.

If strike occurs, do not step down. Keep feet on platform while operating.

DANGER: Electric shock can kill.

Workers standing on the ground must not touch machine when alarm sounds.

IMPORTANT: If a strike occurs, do not allow anyone to approach machine. The machine and ground will be electrically charged.

If seated on the machine:

- **Do not get off machine.** Contacting the machine and ground while stepping off may result in injury or death.
- Fully retract drill or extend backreamer to try breaking contact with the electrical power line.
- Have someone who is clear of the work area contact the utility company to shut off electrical power.
- Do not shut off Strike Alert until utility company has confirmed that electrical power has been locked out.

IMPORTANT: Do not continue drilling until utility company has declared the area safe to resume operation.

DANGER: If the power has not been properly shut off, an automatically resetting circuit breaker could re-energize the power line, causing the equipment and ground to again become charged if the drilling tool is close to, or in contact with, the power line.

After Utility Company Has Shut Off the Power

Step 1: Push Strike Alert *Alarm Cancel Key* to shut off alarm.

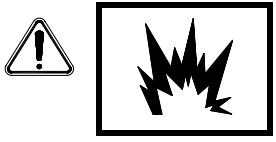
Step 2: Push Strike Alert *Test Key* to test Strike Alert system. If alarm sounds while key is pressed and green light remains ON steady when the key is released, the Strike Alert system is undamaged. Release key to silence alarm.

IMPORTANT: The Strike Alert system may not sense an electrical strike if the cutter shorts out a live voltage phase directly to the ground wire of the same power line. The only indication that a strike has occurred may be loss of power in the area.

If you strike an underground power line, it is possible to trip the power line circuit breaker, which will interrupt electrical power to that line. Many circuit breakers automatically reset and will re-energize the line.

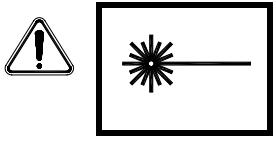
If horn has sounded and you have pressed the reset key, horn will stop if circuit breaker has not yet reset automatically. Do not assume that power to the line has been permanently disconnected until you have confirmed that the utility company has locked out power to that line.

Gas



DANGER: Gas explosion can kill. If you strike a gas line, shut off engine and evacuate area immediately. Contact utility company and do not return until the utility company gives permission to do so. Do not attempt to disengage drill tool from buried line.

Fiber Optic Cable



WARNING: Laser light may damage eyes. Do not look into the end. Fiber optic cables carry laser light which may damage your eyes. If you are not sure what kind of cable it is, do not look into the end. Contact appropriate utility company for assistance.

Jobsite Assessment

Examine work area for any obstructions, conditions, or situations which may impair machine operation or create a safety hazard for the operator or other persons. Use information in this manual combined with your own good judgment when identifying these hazards and implementing hazard avoidance measures.

Drill Mode - Select

Refer to “Drilling Modes Overview,” *page 30-45*, to select drilling mode.

Drill Head - Connect to Starter Rod

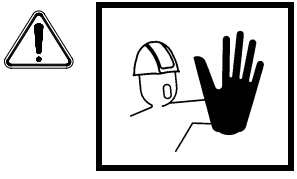
Step 1: Connect drill head to starter rod. Refer to “Drill Tool Connections,” *page 30-19*, and “Drill Tool Assemblies,” *page 30-22*, in the *Overview* section.

Step 2: Lubricate drive chuck threads and starter rod threads.

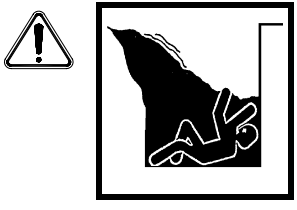
Step 3: Slide starter rod into front vise and clamp.

Step 4: Connect first drill rod to starter rod. Refer to gauge and tighten rod joints to 2200–2500 psi (152–172 bar). Disengage front vise.

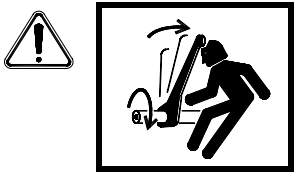
Before the Bore



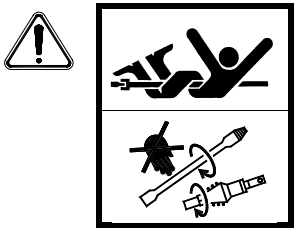
WARNING: Keep spectators away.



WARNING: Do not work in trench with unstable sides which could cave in. Specific requirements for shoring or sloping trench walls are available from several sources including federal and state O.S.H.A. offices. Be sure to contact suitable authorities for these requirements before working in the trench.



DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Always use the power vise to make or break joints at the machine.



DANGER: Rotating drill string or cutters can kill.

Keep away.

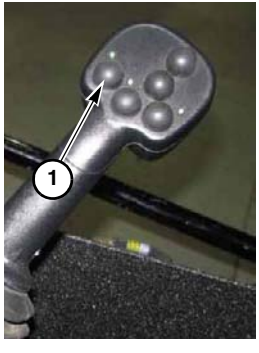
- If needed, dig an exit pit at the correct location and depth to properly complete the bore.
- If the drill is starting at a shallow angle or the ground is hard, dig a small hole so drill bit can start drilling perpendicular to the soil.

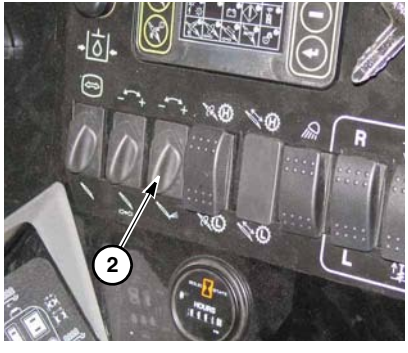
Drill Rod - Flush

If the drill rod has not been used within the last 24 hours, or if there is debris inside the drill rod, slowly rotate rod and flush it with drilling fluid before connecting it to the drill head.

Step 1: Press *Fluid Full Flow Button* **(1)** on left joystick to turn on fluid. Press and hold button 2–3 seconds for full flow to fill drill rod with fluid and keep the nozzle from plugging.

Step 2: Use *Drilling Fluid Pump Trim Switch* **(2)** to adjust fluid flow.





Drill Rod - Lubricate

Refer to *Specifications* section “Lubricants” in the *Maintenance Manual* for specifications.

Lubricate male rod threads and shoulders. Apply lubricant to clean, dry threads.

IMPORTANT: Keep electrically insulated gloves from coming in contact with lubricant. Petroleum-based products will chemically damage gloves.

NOTE: Do not thin lubricants to make them easier to apply. Thinning reduces the amount of available metal filler and makes lubricant ineffective.

Starting the Bore - First Rod

Step 1: With the bill at 6:00, thrust until the drill rod just enters the ground.

Step 2: Stop pushing and rotate drill head until the rod is centered in the rod guide rollers.

Step 3: When centered, rotate and push remainder of drill rod into the ground.

IMPORTANT: If the drill rack moves during drilling, reposition rack so drill rod is centered in the rod guide rollers before continuing.

IMPORTANT: To prevent the rod joint from pulling apart, never rotate drill rod counterclockwise while drilling, pulling back, or backreaming.

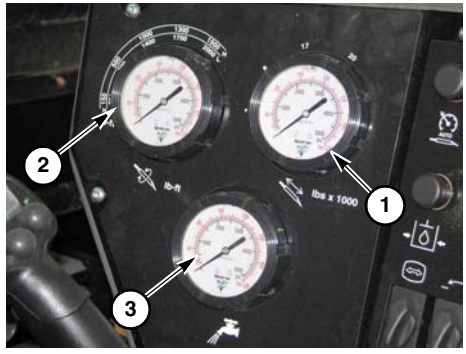
Step 4: Stop rotation, shut off fluid, and engage front vise to clamp rod.

Step 5: Engage front vise and rotate drive spindle in reverse to unthread from drill rod. The drive chuck will move backward as rod unthreads. Lubricate drive chuck threads.

Step 6: Move drive chuck fully back.

WHILE DRILLING

Gauges - Monitor



Monitor gauges during drilling operation to ensure a good pilot bore. Watching the gauges will help establish a baseline for rotation and thrust/pullback pressures. Generally, the operator should try to keep rotation and thrust/pullback pressures as low as possible throughout the bore.

Thrust/Pullback Pressure/Force (1)--Thrust/pullback pressure can be affected by product size and weight, bore path lubrication, soil conditions, and bends in the bore. If the pullback gauge hits the maximum pressure, maximum pullback force is being exerted, and the bore will be unable to continue.

Rotation Pressure/Torque (2)--Rotation pressure will naturally rise as the bore progresses due to friction on the increasing length of the drill string. But if rotation pressure rises substantially, even when not attempting to make forward progress, it could be a sign that soil is taking on water and swelling around the drill string. If this happens, it may be necessary to reevaluate the drilling fluid additives, increase flows, and redrill the pilot bore.

Drilling Fluid Pressure (3)--The drilling fluid pressure gauge is best used as an indicator that flow is occurring. Pressure can vary based on flow rates and nozzle sizes used in the tooling. A maximum indication on the drilling fluid pressure gauge could be an indicator that flow has become restricted. **NOTE:** Gauge reads hydraulic oil pressure. Pressure of 2350 psi (162 bar) is equal to 750 psi (52 bar) drilling fluid pressure.

Obstructions - Investigate

Closely monitor the drilling rate and investigate any obstruction to determine if it might be hazardous. Check to ensure tool is not in contact with a gas line, water line, electrical line, or some other underground obstruction that can be damaged or cause personal injury.

Plugged Drill Rod

If a drill rod becomes plugged, follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*. Either dig down to drill head, back out the drill string and drill head, or attempt to use fluid pressure to force out the plug. Ensure drill rod joint has been broken to relieve drilling fluid pressure in the drill string before unclogging or removing nozzle.

WARNING: Relieve drilling fluid pressure in the drill string before cleaning out nozzles with a tip cleaner. Drilling fluid under pressure can penetrate body tissue and result in serious injury or death. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Clean out drill head nozzle with a tip cleaner. A plugged drill can become too hot and damage the drill head transmitter.

Rod Box - Changing

Refer to the *Overview* section, “Rod Box - Remove,” *page 30-35*, and “Rod Box - Install,” *page 30-34*.

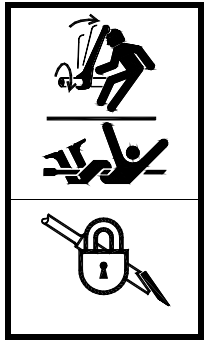
Exiting the Bore

It is critical to maintain good communication between the machine operator and locator operator. When the bore reaches the exit point, crew must ensure everyone is clear of the area.

The operator should be ready to turn off drilling fluid pump as drill head exits the ground. Once drill head exits the ground, follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*, so that inadvertent start-up and rotation do not occur during the tooling change.

Changing Tools at Remote Exit Pit

Extreme care must be taken during any tooling changes on the machine. Clear and understandable communication between members of the directional drill unit’s crew is crucial for proper, complete, and efficient installation of the utility in a safe and timely manner. The distance between drill unit and drill string exit location may prevent visual contact and direct voice communication between the crew at the exit location and the machine operator.



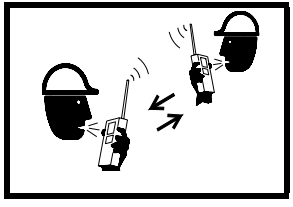
DANGER: Rotating drill string can kill. Unexpected start-up possible.

Lock out before working on drill string.

Drill Lockout

Always follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*, before changing tools.

Communication Requirements



WARNING: Proper communication is essential to prevent unplanned start-up of the drill string and/or tool and to coordinate the pull of the exit site machine to maintain tension on the drill pipe. Serious injury or death could result. Always follow communication requirements as explained in the *Preparation* section, “Radio Communication Requirements,” *page 40-3*.

Swivel Use

The reamer must be equipped with a swivel to prevent trailed rod or tension cable from turning while push reaming. If reamer does not have a built-in swivel, an external swivel must be installed.

DANGER: Entanglement in rotating drill string can result in death or serious injury. Rotating trailed string could whip and strike you. A properly functioning swivel is necessary to prevent the trailing drill string from turning.

Step 1: Grease swivel and check that it turns freely by hand. A tool can be used to initially loosen swivel rotation. If, after loosening, swivel does not turn freely by hand, repair or replace it. If the product attached to the swivel rotates along with the reamer, replace swivel.

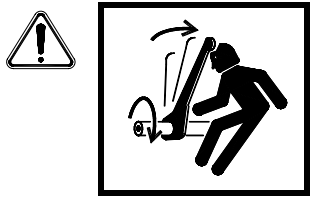
Step 2: Follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*.

Step 3: Turn drilling fluid system OFF.

Step 4: Remove drill head from the drill string. Refer to “Splinelok Connection - Disassemble,” *page 30-22*, or “Hex Coupler - Disconnect,” *page 30-19*.

Pullback Tool - Install

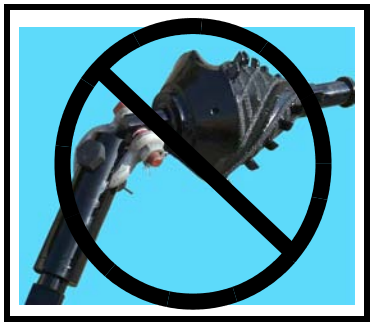
The drill unit must be equipped with the Vermeer Splinelok or hex collar connection. This connection between the drill rod and drill/pullback tools eliminates the use of pipe wrenches or power tongs to make or break the connections. Drill tools with a straight thread joint and the hex collar connection are not torqued and do not require breakout tools to uncouple the joint. Removing or attaching drill tools with the Splinelok connection requires only a hammer and suitable punch tool.



DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Never install tooling that requires the use of pipe wrenches or tongs. Always use tools which have the Splinelok or hex collar connection.

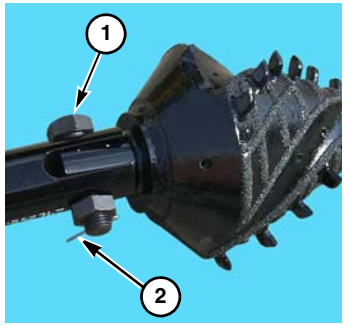
IMPORTANT: Use proper communication procedures as explained in “Radio Communication Requirements,” *page 40-3*.

Step 1: Install backreamer. Refer to “Splinelok Connection - Assemble,” *page 30-20*, or “Hex Coupler - Connect,” *page 30-19*).



WARNING: Death or serious injury could occur if you are struck by whipping pipe or product. Never use a shackle when attaching swivel to backreamer. Shackle will not keep the swivel aligned with the reamer and may result in whip and rotation of trailing drill string or product.

Step 2: Attach swivel to reamer as shown, by inserting bolt **(1)** through clevis end of swivel. Secure with pin **(2)**. Swivel must be aligned with the reamer before rotating the reamer.



NOTE: Vermeer double eye swivels are designed for use with Vermeer reamers to limit the angle between the reamer and swivel. Vermeer swivels and reamers aligned within this limited angle will reduce the possibility of whipping and rotation of the trailed product. The use of other swivels and reamers may not provide this inherent benefit.

Resuming Operation

Step 1: Verify that drill string and cutting tools are ready for operation.

Step 2: Confirm everyone is away from the exit pit, drill string, and cutting tools, and that no wrenches or tongs are attached to the drill string or cutting tools.

Step 3: Warn everyone who may be exposed to the drill string or cutting tools that operation will resume.

Step 4: Press and hold *Run Switch* on Remote Lockout transmitter **for two seconds** to enable drilling operation, or return ignition key to machine if Remote Lockout was not used.

Step 5: Follow all communication requirements before resuming operation.

Pullback

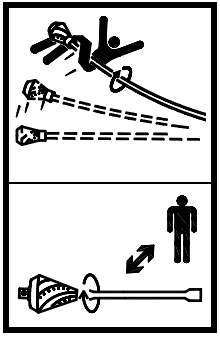
WARNING: Backreamer may not follow the bore path exactly. Because of increase in bore size and change in bore path, the backreamer may make contact with underground hazards that were missed during drilling.

IMPORTANT: Never rotate drill string counterclockwise while pulling back or backreaming. Counterclockwise rotation will uncouple the drill string.

PULLBACK - START

Step 1: Turn on drilling fluid.

To prevent reamer from moving sideways, pull tooling up to exit hole before rotating.



DANGER: Drill string and tooling can rapidly move sideways along the ground at the exit location if rotation is started when drill rod or tooling is on the ground, away from the exit hole. The larger the diameter of the reamer and the more drill string exposed the faster and farther the reamer and drill string can travel. Death or serious injury will occur if anyone is entangled or struck by drill string or tooling.

Pull tooling up to exit hole before rotating. Everyone must be well away from exposed drill string and tooling before rotation is started.

NOTE: Each rotation of the drill rod can cause an 8″ (20 cm) diameter reamer to rapidly travel 2 ft (60 cm) and a 16″ (41 cm) reamer to travel 4 ft (1.2 m)

Step 2: Rotate clockwise and retract the drill rods from the ground.

Step 3: Stop rotation.

Step 4: Actuate rear and front vises to break rod joint.

Breaking Rod Joint

If for any reason a drill rod joint cannot be broken at the vise, repair the vise. Never put a pipe wrench or tong on the drill string and use drilling machine torque to break the joint. Never use a pipe wrench or tongs and apply force by using a backhoe. The wrench could slip off the drill string and strike you.

If a problem arises in drilling out or pullback which requires making or breaking a joint between the tool and the machine, it is very important not to use a pipe wrench, but to use only a compact remote breakout system.

A compact remote breakout system is required whenever you loosen a joint away from the machine. Serious injury or death can occur if drill string rotation starts and you are struck by the wrench.

TRAILING ROD WHILE PRE-REAMING

Pre-reaming can be used in difficult drilling conditions when the desired bore diameter cannot be attained with one pullback. One or more intermediate pre-reams can be made with increasingly larger reamers until reaching the full diameter. Time can be saved by pulling in additional rod behind each pre-reaming pass. The next size reamer can then be attached to the rod already in the bore. This process can be repeated as many times as needed.

Swivel Use

Refer to "Swivel Use," *page 50-24*, for information on swivel use when pre-reaming.

NOTE: Some swivels, such as a double-eye swivel, can be improperly aligned with the reamer. If swivel is not straight in-line with the reamer, it might not swivel as intended. Instead it could turn like a crank, causing the product to turn and whip. Before starting rotation of the drill string, it is very important to position the reamer and product or trailing pipe so that the swivel is extended to be straight in-line with the reamer before pulling in.

WARNING: Product or trailing drill rod can turn or whip. Death or serious injury could occur if you are struck by a wrench, entangled, or struck by whipping pipe or product. Ensure swivel is straight in-line with reamer before pulling back.

Short-String Method of Adding Drill Rod for Pre-Reaming

Step 1: Pre-assemble as many rods as practical at the exit location. These will be attached later to reamer swivel. Before assembling rod joints, clean and lubricate threads.

Step 2: Join rods using pipe wrenches, and apply at least 400 ft-lb (540 Nm) torque to tighten snugly. It is not necessary to tighten joints to a higher torque.

WARNING: Never attach a pipe wrench or tool and apply force from a machine such as a backhoe to tighten or break a connection. If the wrench slips off the bucket, the wrench could rotate or be thrown and strike you. Death or serious injury may result.

Step 3: Attach rod recycler adapter to the first drill rod and tighten snugly.

Step 4: Follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*.

Step 5: Attach rod recycler adapter to swivel.

Resuming Operation

Step 1: Verify drill rod and cutting tools are ready for operation.

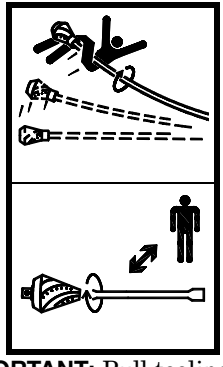
Step 2: Confirm everyone is away from the exit pit, drill string, and cutting tools, and that no wrenches are attached to the drill string or cutting tools.

Step 3: Warn everyone who may be exposed to the drill string or cutting tools that operation will resume.

Step 4: Press *Run Button* on transmitter **and hold for two seconds** to enable drilling operation.

Step 5: Follow all communication requirements before resuming normal operation.

Pulling Back with Trailing Rod



DANGER: Drill string and tooling can rapidly move sideways along the ground at the exit location if rotation is started when drill rod or tooling is on the ground, away from the exit hole. The larger the diameter of the reamer and the more drill string exposed the faster and further the reamer and drill string can travel. Death or serious injury will occur if anyone is entangled or struck by drill string or tooling.

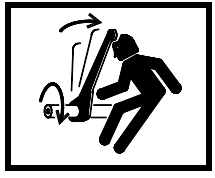
Pull tooling up to exit hole before rotating. Everyone must be well away from exposed drill string and tooling before rotation is started.

IMPORTANT: Pull tooling up to exit hole before rotating.

Step 1: Begin reaming.

Step 2: Crew must watch trailing rods as they are drawn into the bore. If they rotate, the swivel must be repaired or replaced.

Step 3: Install additional drill rod and continue pulling back until reamer reaches drill unit.



DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Before installing additional drill rods and using pipe wrenches:

- Swivel must be functioning properly, and
- Machine must be locked out.

Step 4: Remove reamer and attach trailing drill string to drill unit.

Step 5: Attach a larger reamer, and continue until bore is completed.

Push-Through Method of Adding Drill Rod for Pre-Reaming

Step 1: When drill head exits the pilot bore, rotate drill head to 12:00 position.

Step 2: Continue adding more drill rods at the machine and pushing rods through the bore hole.

DANGER: Entanglement in rotating drill string or cutters can kill. Rotating trailed rods could whip and strike you. Do not rotate when the drill string and cutting tool have exited the bore. Keep everyone away from the exposed drill string.

Step 3: Do not rotate drill string while pushing the drill head across the ground. If needed, the extending rod can be steered by pushing on the side of the drill string with a backhoe bucket.

Step 4: After enough drill rod have been pushed through, follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*.

Step 5: Position or support trailing drill string to relieve bending load at the joint where reamer will be installed.

WARNING: If there is a bending load at the joint, the drill rods on both sides of the joint could move suddenly when the joint is separated. Serious injury could occur if you are struck.

Step 6: Use a compact remote power breakout device to loosen joint.

Resuming Operation

Step 1: Remove breakout device and ensure no tools are attached to drill string.

Step 2: Press *Run Button* on transmitter **and hold for two seconds** to enable drilling operation to resume.

DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Ensure all tools are removed from the drill string before rotation is started.

Step 3: Ensure everyone is away from entire length of the drill string, then use drill unit to slowly reverse rotate the drill string until the two halves are fully separated.

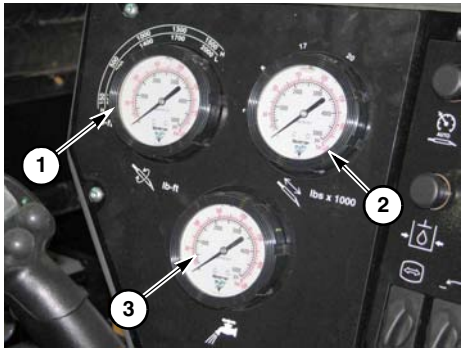
Step 4: Separate the two drill strings far enough for reamer installation.

Step 5: Follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*, and install reamer and swivel.

Step 6: Attach rod recycler adapter to drill rod and then attach to swivel.

Step 7: Follow Step 3 through remaining steps of “Short-String Method of Adding Drill Rod for Pre-Reaming,” *page 50-31*.

Gauges - Monitor During Pullback



Monitor gauges during drilling operation to ensure a good pilot bore. Watching the gauges will help establish a baseline for rotation and thrust/pullback pressures. Ideally, the pullback pressure will remain low while the reamer mixes drilling fluid with the soil to form a good slurry flow through the annular space.

Rotation Pressure (1)--If rotation pressure is spiking, you may be pulling back too fast for the ground conditions. A rise in rotation pressure can also mean that the reamer has encountered harder ground.

Thrust/Pullback Pressure (2)--A steady rise in pullback pressure could indicate a loss of fluid flow through the annular space, causing the product to become stuck or a frac-out to occur.

Drilling Fluid Pressure (3)--The drilling fluid pressure gauge is best used as an indicator that flow is occurring. Pressure can vary based on flow rates and nozzle sizes used in the tooling. A maximum indication on the drilling fluid pressure gauge could be an indicator that flow has become restricted. Drilling fluid pressure is approximately 50% of hydraulic pressure shown on gauge.

Drill Rod - Remove

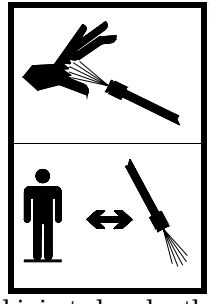
Refer to “Drill Rods - Remove from Drill String,” *page 30-39*.

Rod Box - Changing

Refer to“Rod Box - Remove,” *page 30-35*, and “Rod Box - Install,” *page 30-34*.

After Each Bore

Power Vises - Clean



WARNING: High pressure water can penetrate skin. Serious injury is possible.

Keep nozzles away from body.

Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Flush power vise assemblies with clean water to remove accumulated polymers or dirt. Refer to “Machine - Wash,” *page 50-40*, for information on using the wash wand.

IMPORTANT: The service life of the power vise is dependent on proper operating techniques and cleanliness of the mechanism.

Inspect vise jaws and grips and replace worn or damaged components before the next bore. Refer to “Maintenance - As Required” section in the *Maintenance Manual*.

Drill Rods - Clean and Store

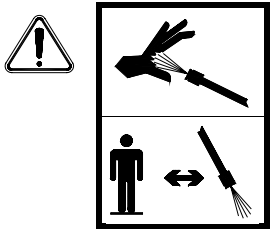
- Clean and lubricate drill rod threads to prevent rusting. Refer to *Specifications* section, “Lubricants,” in the *Maintenance Manual*.
- Protect drill rod from damage.
- Store drill rods in the rod box on drill unit.
- Install keeper pins to prevent drill rods from falling out during transport.

Flushing Bentonite/Polymers from Drilling Fluid System

If bentonite or polymers were added to drilling fluid, flush system with fresh water before stowing equipment.

To drain, clean, and add fresh water:

Step 1: Turn water system on and flush water through drill unit hoses and drive plate. Shut off water system.



WARNING: High pressure water can penetrate skin. Serious injury possible. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Keep nozzles away from body.

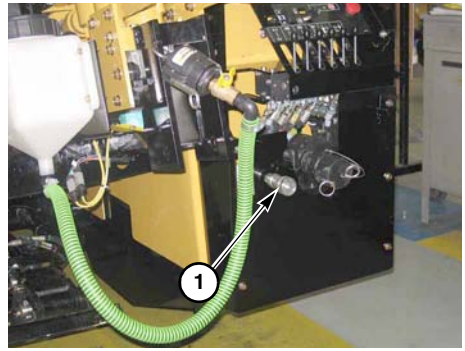
Step 2: Connect wash wand to drilling fluid pump quick coupler **(1)**.

Step 3: Turn water system on and flush water through wash wand until water is clean and clear.

Step 4: Shut off water system.

Step 5: Point wash wand away from people and squeeze handle to release water pressure remaining in wand.

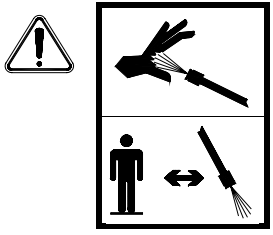
Step 6: Remove wash wand from drilling fluid pump quick coupler and store on transport vehicle.



NOTE: If freezing weather is expected, remove all water from drill unit or add RV-type antifreeze. Refer to the *Overview* section, “Adding Antifreeze to Drilling Fluid System,” *page 30-65*.

Machine - Wash

Before loading onto transport vehicle, wash drill unit with clean water to remove accumulated polymers and dirt.



WARNING: High pressure water can penetrate skin. Serious injury possible. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Keep nozzles away from body.

Step 1: Connect wash wand to drilling fluid pump quick coupler **(1)**.

Step 2: Turn water system on.

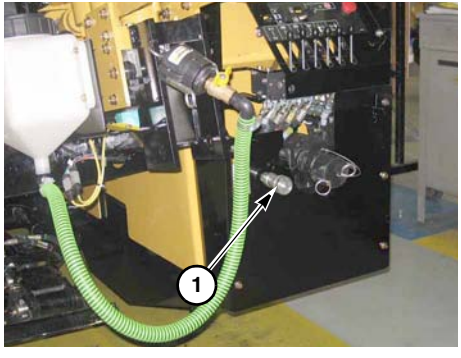
Step 3: Wash drill unit to remove accumulated polymers and dirt.

Step 4: Shut off water system.

Step 5: Point wash wand away from people and squeeze handle to release water pressure remaining in wand.

Step 6: Remove wash wand from drilling fluid pump quick coupler and store on transport vehicle.

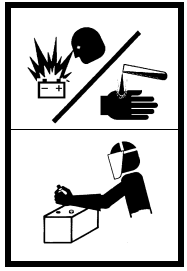
Step 7: Install cap on drilling fluid pump quick coupler to prevent dirt from entering high pressure fluid lines.



Section 60: Supplemental Operations

Jump-Starting

BATTERY EXPLOSION - AVOID



WARNING: Battery fumes are flammable and can explode. Keep all burning materials away from battery. Battery explosion can blind. Acid can blind and burn. Tools and cable clamps can make sparks.

Do not smoke. Shield eyes and face. Read instructions.

Do not jump-start or charge a battery that is frozen or low on electrolyte.

Avoid explosion hazard.

Do not allow vehicle used to jump-start to be in contact with the disabled machine. Vehicles in contact have a ground connection which allows a spark to occur at the battery when the positive jumper cable is connected or removed. If equipped with battery caps, they must be in place and tight to reduce risk of battery explosion.

IMPORTANT: Use only a 12-volt system for jump-starting.

BATTERY BURNS - AVOID

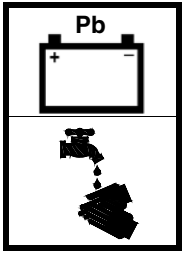
Battery contains sulfuric acid which can cause severe burns. Avoid contact with eyes, skin, and clothing.

In case of acid contact:

External: Flush with plenty of water. If eyes have been exposed, flush with water for 15 minutes and get prompt medical attention.

Internal: Drink large quantities of water or milk, follow with milk of magnesia, beaten egg, or vegetable oil. Call a physician immediately.

JUMP-STARTING PROCEDURE



WARNING: Battery post, terminals, and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm.

Wash hands after handling.

IMPORTANT: Review battery service safety guidelines before jump-starting machine (refer to battery maintenance instructions in the *Maintenance Manual*).

Step 1: Turn ignition key OFF.

Step 2: Turn *Battery Ground Disconnect Switch* counterclockwise to disconnect battery ground.

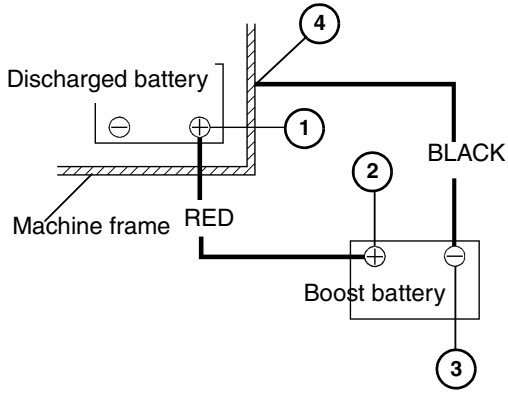
Step 3: Connect jumper cables in the following order:

a. Red to discharged battery POSITIVE (+) terminal **(1)**.

b. Red to boost battery POSITIVE (+) terminal **(2)**.

c. Black to boost battery NEGATIVE (-) terminal **(3)**.

d. Black to frame of machine with discharged battery **(4)**. Make connection away from battery, fuel lines, and moving parts. Do not attach to the negative terminal of the discharged battery.



NOTE: To avoid sparks near the battery, always disconnect black jumper cable from the frame before adjusting red jumper cable.

Step 4: Turn *Battery Ground Disconnect Switch* clockwise to connect battery ground.

Step 5: Start engine.

Step 6: Remove cables in REVERSE order and install red cover over positive battery cable clamp.

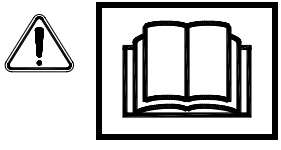
Portable Breakout System

Portable Breakout System Intended Use

The Vermeer Portable Breakout system is a compact powerful breakout system with a hydraulic pump. This system provides a convenient method to loosen or tighten a threaded connection. In addition, the shorter length of breakout tools provides an inherent safety benefit compared to longer tools. Longer breakout tools are more likely to strike and injure workers if improper work practices result in unexpected drill rod rotation. There are three models of the Vermeer Portable Breakout system:

Model	Torque	Outside Diameter (O.D.)
2.6 K	2,600 ft-lb (3526 Nm)	1-3/4–2-1/4″ (45 mm–57 mm)
7.5 K	7500 ft-lb (10170 Nm)	2.875–4.875″ (73 mm–124 mm)
15 K	15000 ft-lb (20340 Nm)	3.25–5.375″ (83 mm–137 mm)

For more information, contact your Vermeer dealer.



WARNING: Improper use can cause device to fail. Read Operator's Manual. Use device properly. Proper use and maintenance of device is important to prevent failure of device.

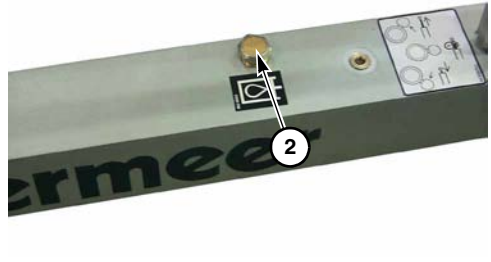
PORTABLE BREAKOUT CONTROLS

(1) Pressure Gauge

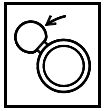
Gauge displays hydraulic pressure as handle is pumped.

(2) Hydraulic Oil Fill/Drain/Breather Fitting . . . . . fill/drain hydraulic oil

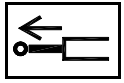
NOTE: For replacement oil, use an ISO 10 or ISO 22 oil.

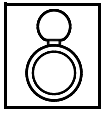


(3) Hydraulic Control Lever

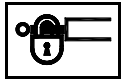


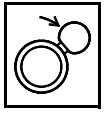
Left . . . . . extend cylinder



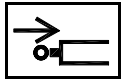


Middle . . . . . lock hydraulics





Right . . . . . retract cylinder



(4) Hand Lever

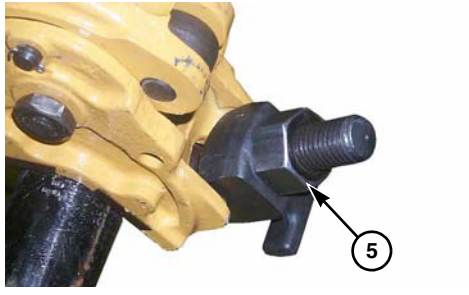
Push down . . . . . pumps hydraulic fluid

Pull up. . . . . draws fluid into pump

(5) Chain Adjustment Nut

Clockwise . . . . . tighten chain

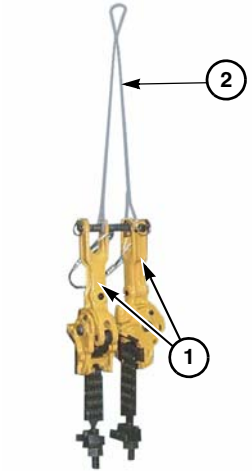
Counterclockwise . . . . . loosen chain



Portable Breakout System Setup

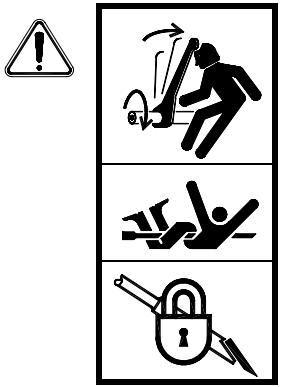
The Portable Breakout system requires little assembly. The hydraulic pump and tongs are fully assembled. The operator must install tongs on drill rod to be separated/torqued, then install hydraulic cylinder that connects tongs. Hoses connect cylinder to pump.

IMPORTANT: It is recommended that a two-person team position the tongs. Each tong weighs 17 lb (7.7 kg) for the 2,600 ft-lb (3526 Nm) model, 41 lb (18.6 kg) for the 7,500 ft-lb (10170 Nm) model, and 57 lb (26 kg) for the 15,000 ft-lb (20340 Nm) model.



Tongs - Position on Drill Rod Joint

Step 1: Remove tongs **(1)** from storage. If desired, use a backhoe or other lifting device with lifting eye and hanger cable **(2)**.



DANGER: Unexpected rotation of drill rod can kill.

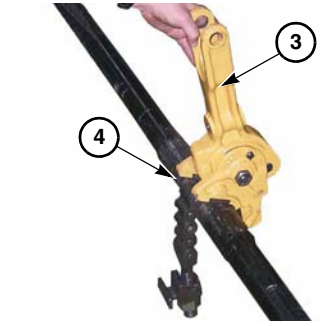
Lock out machine before using a breakout device.

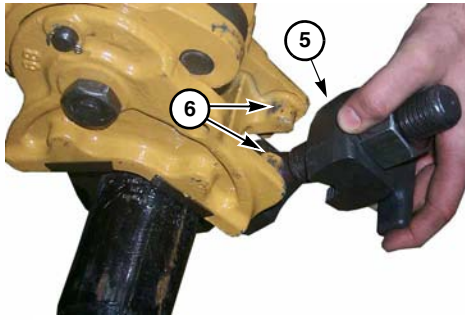
Step 2: Position tong **(3)** on drill rod.

NOTE: Position tongs one on each side of joint in either makeup or breakout position.

Step 3: Wrap chain **(4)** over top of drill rod.

Step 4: With tong head on top of drill rod, wrap chain under drill rod and connect chain hook **(5)** onto tong head **(6)**.





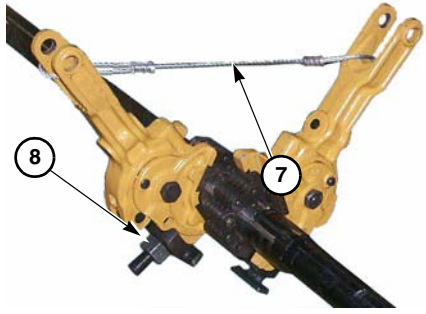
NOTE: If chain is too short or too long, refer to “Portable Breakout System Tong Chain - Adjust,” *page 60-15* for information on shortening or lengthening chain.

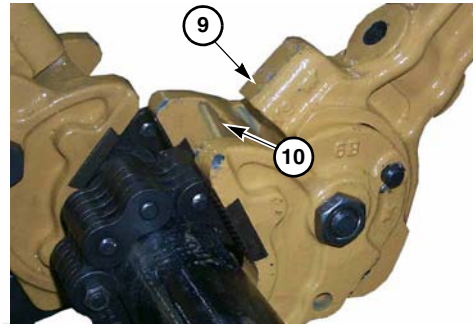
Step 5: Repeat Steps 2–4 to install other tong.

Step 6: Install limit cable **(7)** on tong handles.

NOTE: Limit cable prevents tongs from rotating farther than cylinder can reach.

IMPORTANT: In order for the cylinder to properly fit between the clevises, the cable loops must be put on opposite clevis legs of the two tongs, as shown.





Step 7: Hand-tighten adjustment nuts **(8)**.

Step 8: Slightly lift up on tong head and pull back on handle while hand-tightening adjustment nut so that handle knob **(9)** is well off head rest **(10)**.

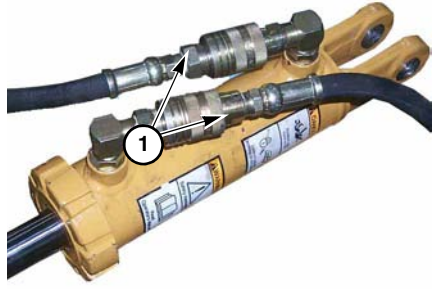
Hydraulic Pump - Install

Step 1: Connect hoses **(1)** to cylinder.

Step 2: Move control lever **(2)** to EXTEND.

Step 3: Pump hand lever **(3)** to extend cylinder.

IMPORTANT: While extending cylinder, pressure may reach 800 psi (55 bar) or higher, especially in cold weather operations.



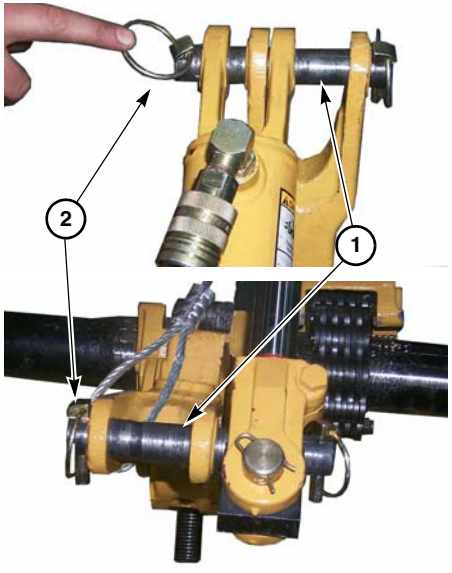
Cylinder - Install

Step 1: Install cylinder by sliding tong pins **(1)** through tong and cylinder clevises, as shown.

NOTE: Small adjustments to tong positions will probably be necessary in order to align tong and cylinder clevises with tong pins.

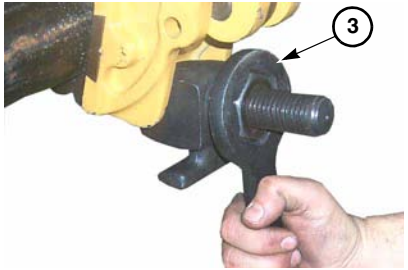
Step 2: When tong pins are installed, secure with safety pins **(2)**.

IMPORTANT: Tong dies and chains must adequately engage cylindrical portion of drill rod. Tong chains must be parallel to tong handles. Tong dies and chains must not be placed on transition area of drill rod. Failure to follow these instructions may result in decreased component life and/or overloading of components.

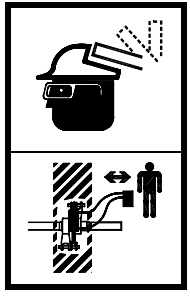


Step 3: Tighten adjustment nut with wrench **(3)**.

NOTE: The 2.6 K model does not come with a wrench. A 1-1/8″ wrench is required.



Operating the Portable Breakout System



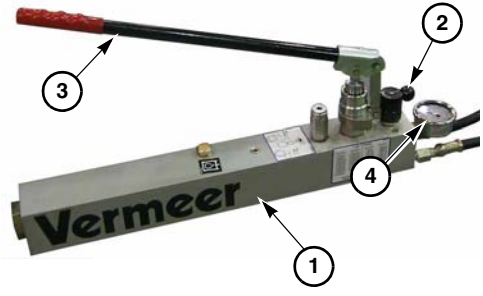
WARNING: Failure of the remote breakout device can result in injury or death.

Operate with prohibited area clear.

Step 1: Move hydraulic power unit **(1)** away from breakout tongs.

NOTE: Place hydraulic pump on level, stable ground near drill rod. Pump needs to be close enough for hydraulic hoses to reach cylinder. Never position pump next to breakout tongs.

IMPORTANT: Always operate portable breakout pump away from breakout device. Operator needs to be positioned on side of pump away from breakout device.



Step 2: Move control lever **(2)** to RETRACT.

Step 3: Pump hand lever **(3)** to retract cylinder.

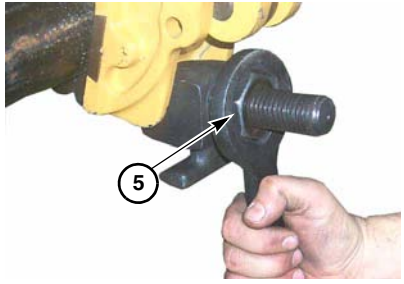
Pressure gauge **(4)** should show a rise in hydraulic pressure. To determine torque, refer to decal on hydraulic pump or “Portable Breakout System Torque Values,” *page 60-13*.

Step 4: Continue pumping hand lever and monitoring gauge until specified pressure is reached.

NOTE: ***If breaking a joint:*** At or near the maximum pressure, the pressure gauge will show a sudden large decrease in pressure, indicating that joint has been broken. If joint does not break, do not exceed maximum pressure of breakout system. ***If tightening a joint:*** The joint is fully tightened when specified pressure is reached.

NOTE: Torque will vary based on drill rod characteristics. Refer to International Association of Drilling Contractors, IADC, Drilling Manual, eleventh edition, 1992, Chapter B, Section 1, pages 30–34 for drill rod torque specifications. IADC can be contacted at P.O. Box 4287, Houston, TX, e-mail info@iadc.org, phone (281)-578-7171 or fax (281)-578-0589.

Step 5: ***If breaking a joint:*** Continue extending and retracting cylinder until drill rod joint is judged to be loose enough to separate by hand.



NOTE: Operator may have to loosen nut **(5)** in order to extend cylinder.

Or:

Step 6: ***If tightening a joint:*** Continue extending and retracting cylinder until specified pressure is reached.

PORTABLE BREAKOUT SYSTEM TORQUE VALUES

Torque for 2.6K Tongs			
Min/Max Dia. (in.):		1-3/4″ (4.5 cm) to 2-1/4″ (5.7 cm)	
psi	torque (ft-lb)	bar	torque (Nm)
100	146	10	287
200	292	15	431
300	438	20	574
400	584	30	861
500	730	35	1005
600	876	40	1148
700	1022	50	1436
800	1168	55	1579
900	1314	60	1723
1000	1460	70	2010
1100	1606	75	2153
1200	1752	80	2297
1300	1898	90	2584
1400	2044	95	2727
1500	2190	100	2871
1600	2336	110	3158
1700	2482	115	3302
1800	2628	125	3589

Torque for 7.5K Tongs			
Min/Max Dia. (in.):		2-7/8″ (7.3 cm) to 4-7/8″ (12.4 cm)	
psi	torque (ft-lb)	bar	torque (Nm)
100	432	10	850
200	864	15	1274
300	1296	20	1699
400	1728	30	2549
500	2160	35	2973
600	2592	40	3398
700	3024	50	4248
800	3456	55	4672
900	3888	60	5097
1000	4320	70	5947
1100	4752	75	6371
1200	5184	80	6796
1300	5616	90	7646
1400	6048	95	8070
1500	6480	100	8495
1600	6912	110	9345
1700	7344	115	9769
1800	7776	125	10619

Torque for 15K Tongs			
Min/Max Dia. (in.):		3-7/8″ (9.8 cm) to 5-3/8″ (13.7 cm)	
psi	torque (ft-lb)	bar	torque (Nm)
100	943	10	1826
200	1886	15	2740
300	2829	20	3653
400	3772	30	5479
500	4715	35	6393
600	5658	40	7306
700	6601	50	9132
800	7544	55	10046
900	8487	60	10959
1000	9430	70	12785
1100	10373	75	13699
1200	11316	80	14612
1300	12259	90	16438
1400	13202	95	17352
1500	14145	100	18265
1600	15088	110	20091
		115	21005

Portable Breakout System True Torque

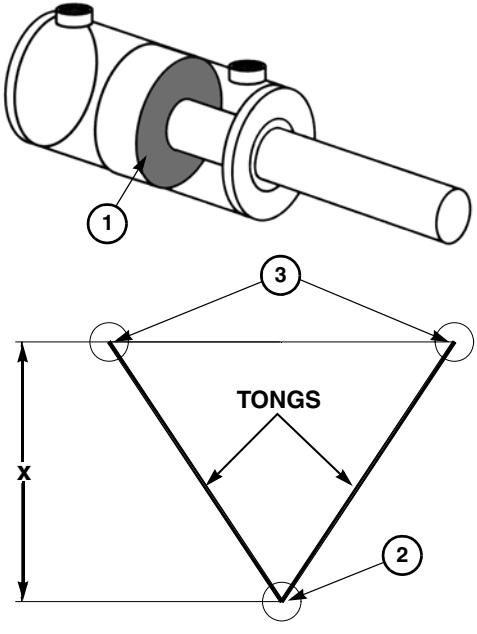
Since tongs rotate while being used, actual torque applied to a joint is affected by the change in geometry during use. For most applications, torque table provided in this manual or on pump unit will be sufficiently accurate. However, if it is desirable to obtain True Torque, use the following formula:

1. For ft-lb use the following formula: True Torque (ft-lb) = Pressure on gauge (psi) x Effective Piston Area **(1)** x Moment Arm Length (ft)
2. For Nm use the following formula: True Torque (Nm) = 10 x Pressure on gauge (bar) x Effective Area **(1)** (cm^2) x Moment Arm Length (m)

Moment Arm Length **(x)** = Distance from drill rod joint center **(2)** to the center of the line between pin locations **(3)**.

Effective Piston Area Table:

Tong	Effective Area
2.6K	2.15 in^2 (13.9 cm^2)
7.5K	3.91 in^2 (25.2 cm^2)
15K	8.39 in^2 (54.1 cm^2)



Portable Breakout System Tongs - Remove

Step 1: Move control lever to EXTEND.

Step 2: Use hydraulic pump to slightly extend cylinder to remove pressure in order to remove the cylinder.

NOTE: Cylinder does not have to be fully extended in order to be removed.

Step 3: Remove cylinder.

Step 4: Loosen adjustment nut.

Step 5: Disconnect chain.

NOTE: Spray moving parts with a light lubrication oil to keep tongs in good operating order.

Portable Breakout System Tong Chain - Adjust

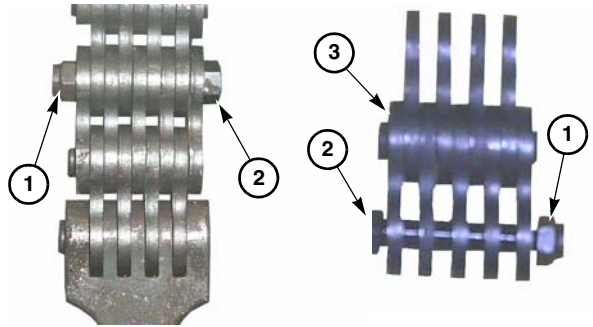
Tong chains have limited adjustment range. If chain is too long or short for connection, links must be added or removed.

Step 1: Remove chain pin nuts **(1)** with wrenches.

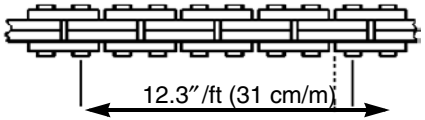
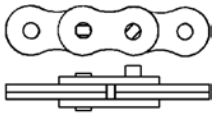
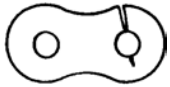
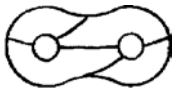
Step 2: Remove pins **(2)**.

Step 3: Add or remove Vermeer-approved chain links **(3)** as necessary.

Step 4: Install chain pins and tighten nuts.



PORTABLE BREAKOUT SYSTEM CHAIN - PERIODIC INSPECTION

Appearance and/or Symptoms	Probable Cause	Correction
Excessive Length (Elongation) 	Normal wear	Replace chain.
	Permanent deformation (stretch) from overload.	Replace chain and correct cause of overload.
Abnormal Protrusion of Pins 	Overloading	Replace chain and correct cause of overload.
	Inadequate lubrication	Replace chain and improve lubrication.
	Side loading	Replace chain, correct cause of side loading.
Cracked Plates (fatigue) 	Overloading	Replace chain and correct cause of overload.
	Side loading	Replace chain and correct cause of side load.
Arc-Like Cracked Plates (Stress Corrosion) 	Severe rusting or exposure to acidic or caustic medium, plus static stress at press fit between pin and plate.	Replace chain and protect from hostile environment.
Enlarged Holes 	Overloading	Replace chain and correct cause of overload.
Cracked Plates (Corrosion Fatigue) Perpendicular to Pitch Line, plus rust or other evidence of chemical corrosion 	Corrosive environment	Replace chain and protect from hostile environment.

Appearance and/or Symptoms	Probable Cause	Correction
Fractured Plates (Tension Mode) 	Overloading	Replace chain and correct cause of overload.
Tight Joints 	Dirt or foreign substance packed in joints.	Clean and relubricate.
	Corrosion and rust	Replace chain and protect from hostile environment.
	Bent Pins	Replace chain.

Replacing Broken Drill Rod Underground

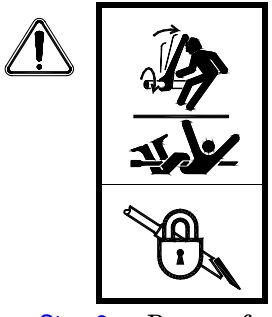
Step 1: Retract drill string back to the drill unit until broken rod exits the ground. Keep track of the length of drill rod retracted so you can determine the location of the underground break. Use power vises to break the joint and remove broken rod.

Step 2: Dig to the break location underground.

Step 3: Use a compact remote power breakout device to loosen joint of broken rod in the ground. Use a compact remote power breakout device to loosen joint of broken rod remaining in the ground. The use of a pipe wrench to continue to unthread the broken rod after it has been loosened with the breakout device is permitted.

Step 4: Install drill rod hole guide, such as a “football” or “balloon”, onto drill rod at the machine. Push it through pilot bore to the drill string still in the ground.

Step 5: Follow “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*.



DANGER: Rotating drill string can kill. Unexpected start-up possible.

Lock out before working on drill string.

Step 6: Remove football/balloon.

Step 7: Follow steps in “Lockout Procedure - With Remote Lockout,” *page 30-14*, or “Lockout Procedure - Without Remote Lockout System,” *page 30-17*, to resume machine operation after lockout.

DANGER: Wrench on rotating drill string can strike you. Death or serious injury will result. Ensure all tools are removed from the drill string before rotation is started.

Step 8: Ensure everyone is away from the exposed drill string. Use machine to push drill rod forward until male threads have engaged the downhole rod.

Step 9: Use slow forward rotation to turn drill string together until joint is tight. Proper makeup torque will be attained due to resistance provided by cutting tool on the far end of drill string.

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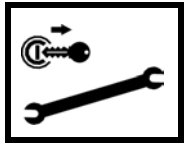
Section 70: Maintenance Schedule



WARNING: Use Shutdown Procedure before servicing, cleaning, repairing, or transporting machine. Refer to “Shutdown Procedure,” *page 50-3,* for instructions.

Visually inspect machine daily before starting the machine.

Make no modifications to your equipment unless specifically recommended or requested by Vermeer Corporation.

Safety Signs Maintenance

Safety signs located on your machine contain important and useful information that will help you operate your equipment safely.

To assure that all safety signs remain in place and in good condition, follow the instructions given below:

- Keep safety signs clean. Use soap and water - not mineral spirits, abrasive cleaners, or other similar cleaners that will damage the sign.
- Replace any damaged or missing safety signs. When attaching safety signs, temperature of the mounting surface must be at least 40°F (5°C). The mounting surface must be clean and dry.
- When replacing a machine component with a safety sign attached, replace the safety sign also.
- Replacement safety signs can be purchased from your Vermeer equipment dealer.

MAINTENANCE MANUAL

Before performing any maintenance, refer to the *Maintenance Manual* for safety guidelines and correct procedures.

HOURMETER - CHECK FOR MAINTENANCE INTERVAL

The hourmeter on the machine is used to determine machine maintenance intervals. The hourmeter indicates the total number of hours engine has been in operation.

Maintenance intervals are based on normal operating conditions. When operating under severe conditions, the maintenance intervals should be shortened.

MACHINE - GREASE

As a general rule, grease machine after it is shut down for the day or at 50 service hours if required. This protects metal under seals from corrosion caused by condensation as temperature drops.

Ensure all fittings and nozzle of grease applicator are clean before applying grease. If any grease fittings are missing, replace them immediately.

RECOMMENDED FLUIDS

Refer to the *Specifications* section in the *Maintenance Manual* for fluid and lubricant requirements.

ENGINE MAINTENANCE INTERVALS

Refer to the Engine Operation Manual, supplied with each machine, for maintenance instructions that are not included in this manual.

MAINTENANCE INTERVALS

Initial = Initial maintenance on new machine. Regular maintenance interval may be different.

● = Regular maintenance interval.

Service	Maintenance Interval - Service Hours									
	10 or Daily	50 or Weekly	100	250	500	1000	2000	3000	6000	As Required
Machine - Grease	●									
Engine Oil Level - Check	●									
Hydraulic Fluid Level - Check	●									
Coolant Level - Check	●									
Fuel Tank - Fill	●									
Air Cleaner Restriction Indicator - Check	●									
Drill Rod Care	●									
Auto Greaser (Option) - Check/Refill	●									
R.A.T.T. Maintenance (D20x22 only)	●									
Fuel Tank Water and Sediment - Drain		●								
Track Gearbox Oil Level - Check		●								
Drilling Fluid Pump Crankcase Oil Level - Check		●								
Control Levers Linkage - Oil		●								
Power Vise - Grease		●								
Rotation Gearbox Oil - Check		●								
Cooling System - Check			●							
Drilling Fluid System - Check			●							
Drilling Fluid Pump Oil - Change			Initial							
Control Levers - Check			●							

Service	Maintenance Interval - Service Hours									
	10 or Daily	50 or Weekly	100	250	500	1000	2000	3000	6000	As Required
Overall Machine - Check			●							
Safety Signs Maintenance			●							
Indicator Lights - Check			●							
Emergency Stop Switch - Check			●							
Neutral Start Interlock - Check			●							
Battery Voltage - Check			●							
Operator Presence System - Check			●							
Hydraulic System - Check			●							
Ground Drive System - Inspect			●							
Engine Oil Sample - Obtain				●						
Cooling System Additive - Add				●						
Hydraulic Fluid Filters - Replace				Initial						
Alternator and Fan Belts - Check/Adjust/ Replace					●					
Engine Protective Devices - Check					●					
Fuel Transfer Pump Strainer - Clean					●					
Hoses and Clamps - Check/Replace					●					
Fuel Filter - Replace					●					
Engine Oil and Filter - Change/Replace					●					
Battery Terminals/Electrolyte Level - Clean/Check					●					
Hydraulic Fluid Filter - Replace					●					
Drilling Fluid Pump Oil - Change					●					
Engine Valve Lash - Check/Adjust						●				
Cooling System - Drain and Clean						●				

Service	Maintenance Interval - Service Hours									
	10 or Daily	50 or Weekly	100	250	500	1000	2000	3000	6000	As Required
Planetary Gearbox Oil - Change						●				
Hydraulic Fluid - Change						●				
Alternator - Inspect							●			
Crankshaft Vibration Damper - Inspect							●			
Engine Mounts - Inspect							●			
Fuel Injection Nozzles - Test/Exchange							●			
Coolant Extender (ELC) - Add							●			
Coolant (DEAC) - Change								●		
Cooling System Coolant Temperature Regulator - Replace								●		
Starting Motor - Inspect								●		
Water Pump - Inspect								●		
Coolant (ELC) - Change									●	
Engine Crankcase Breather - Clean										●
Fuel System - Prime										●
Engine Compartment - Clean										●
Battery - Replace										●
Engine Air Cleaner Elements - Replace										●
Track Tension - Adjust										●
Rod Guide Plate - Replace										●
Vise Dies - Replace										●
Stakedown Drivers - Remove/Install										●
Rotation Sensor Phase - Adjust										●
Storage										●

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Index

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Revision History

Revision	Date	Page(s)	Description
to1_00	07/07	All	Temporary Operator's Manual released.
to1_01	09/07	All	D20x22 Series II added; other updates.
o1_00	09/07	All	First edition Operator's Manual released.
o1_01	08/08	15-1, 20-3, 20-4, 20-5, 20-8, 20-9, 21-4, 21-12, 21-14, 21-16, 21-17, 21-21, 21-28, 30-9, 30-18, 30-26, 30-26, 30-35, 30-36, 30-40, 30-41, 30-45, 30-57, 40-6, 50-2, 50-5, 50-7, 50-11, 50-21, 50-36, 60-18, 70-1	Corrected information; new start-up screen; pressure gauges have new decal; rod position indicator decal changed; sound levels added; Autodrill instructions updated.
o1_02	09/08	Warranty	Updated Warranty

WARNING

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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.

When operated in California, any off-road diesel vehicle may be subject to the California Air Resources Board In-Use Off-Road Diesel Vehicle Regulation. It therefore could be subject to retrofit or accelerated turnover requirements to reduce emissions of air pollutants. For more information, please visit the California Air Resources Board website at http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm.

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