SL2020

StraightLine® **SL2020** Directional Drill

OPERATORS MANUAL

OPERATORS MANUAL

STRAIGHTLINE®

OPSREV01232006

WWW.STRAIGHTLINEHDD.COM 800-654-3484

Finco, Inc. Trademarks

The StraightLine® logo and name are registered trademarks of Finco, Inc.

Use Policy

We make every effort to provide useful and accurate information in this manual. However, product and industry information can change frequently, and can sometimes be subject to differing interpretations. Except as applies directly to the operation of machine controls, Finco, Inc. makes no claim that all information in this manual is up to date. It is your responsibility to make sure that anything you read here is accurate, up-to-date and applies to your situation before making any decisions based on information provided by this web site.

Finco, Inc. Copyright

Licensing and Reprint Rights

If you wish to license or reprint any of the information in this manual (for example, as part of an article, book or pamphlet), please contact us for permission. No such use is authorized without our express written permission. We reserve the right to change the terms of and/or withdraw this permission at any time and for any reason.

Contact Information

Finco, Inc.
1816 E. Wasp Road
Hutchinson, KS 67501

800-654-3484 Toll-free US and Canada
620-802-0200 International
www.straightlinehdd.com

StraightLine® SL2020 OPERATIONS MANUAL

TABLE OF CONTENTS

GLOSSARY

Auger Staking System

A system of auger stakes and their installation/removal mechanism used to secure a drill to the ground.

Back Reamer

Down-hole tool pulled back through a bore hole to enlarge it.

Bar

Metric unit of measurement for pressure (1 bar = 14.508 lb/in^2).

Bentonite

Finely ground clay commonly mixed with water for drilling solution.

Bore Log

Drawing of the proposed bore path in plan view and side view showing entry, exit, depth, existing hazards, steering areas including curve radii, and other information.

Bore Path

Planned or actually traveled location of the drill head/string through the earth.

Breakout

Loosening a section of drill pipe prior to removing it from the drill string.

Breakout Wrench

The rear-most built-in drill pipe wrench. This wrench is hydraulically pivoted to break drill pipe connections loose during removal.

Built-in Drill Pipe Wrenches

System of hydraulically powered wrenches used to break connections between drill pipe sections.

Carriage

Traveling unit which pushes and rotates the drill pipe.

Control Panel

Panel containing gauges, hydraulic valves, switches and buttons required to operate the drill

Cutting Teeth

Hardened cutting burrs, usually carbide, on drill heads and back reamers.

Down-hole Equipment

Same as tooling.

Drill Head

Assembly of cutting bit, steering shoe, and transmitter housing.

Drill Pipe

Sections of high-strength steel pipe with threaded tool joints attached.

Drilling Fluid

A combination of water, polymer and/or bentonite used to stabilize the ground when drilling.

Drill String

Assembly of drill pipe.

Filter Sub

Device between the drill head and the drill pipe which contains a mesh strainer to prevent lumps of material in the drilling fluid from clogging fluid jets.

Feathering

To meter or regulate the speed of a function by precisely controlling the movement of the control lever.

GPM

Abbreviation of gallons per minute, a measure of liquid flow rate.

Ground Rod

Copper/Brass rod which is hand driven into the ground to give grounding protection in case of electrical hit.

Ground Rod Cable

Cable that attaches drill to the ground rod.

HDD

Horizontal Directional Drilling.

Jets

Replaceable fluid outlets found in both drill heads and back reamers.

Locate

1) The operation of using the locator to determine drill head position.

2) The identification of existing underground utilities and hazards done by the utility service company.

3) The hazards identified are commonly referred to as “Locates” and the process of marking the hazards is commonly referred to as “Doing Locates.”

Locator

1) The hand-held receiving portion of the radio detection equipment.

2) The person using the locator equipment.

Makeup

Adding a new section of drill pipe to the in-use drill string.

Makeup Wrench

The forward-most built-in drill pipe wrench. This wrench remains stationary, providing only clamping pressure necessary for makeup and breakout operations.

Mud Mixer

Centrifugal pump and venturi used to introduce bentonite and polymers into the drilling fluid.

Mud Pump

High-pressure pump which delivers the drilling fluid into the drill string.

pH Scale

Index with a range of 0-14 used as a reference for the acidity or alkalinity of a liquid. Pure acid has a pH of 0, pure water is 7, and a pure base has a pH of 14.

Pilot Bore

Process of initially guiding the drill string to a specific location.

Pipe Guide

Tube mounted in front of the drill pipe wrenches to help guide the pipe. Includes a replaceable polyurethane insert to lengthen the life of the drill pipe.

Polymer

Chemical added to water or bentonite mixture used as drilling fluid.

Pull Back

Operation of pulling the material being installed into the finished bore path, usually combined with the back reaming operation.

PSI

Abbreviation of pounds per square inch, an English unit of measure for pressure.

Pushing

Thrusting the drill string without rotation.

Returns

The loose material dislodged when boring or back reaming, usually mixed with drilling fluid that comes back out of the bored hole. Also known as cuttings or spoils.

Rod Wiper

Flexible device mounted in front of the drill pipe wrenches through which drill pipe is passed during pullback to help strip mud and debris from the pipe.

Rotation

Rotating the drill string.

Rotation Motor

Hydraulic motor located on the carriage which rotates the drill string.

Sonde

See Transmitter.

Strike Alert

Alarm system which indicates the presence of electrical current in the drill string.

Sub Saver (or Saver Sub)

Short, relatively inexpensive, replaceable connector sub which attaches the drill pipe to the carriage to save wear on the carriage spindle threads.

Swivel

Device placed at the end of the drill string during back reaming/pullback operations to isolate material being installed from drill string rotation.

Thrust

Force used in moving the carriage and drill string linearly.

Tooling

Drill pipe, drill head, back reamers, swivels, slings, and other equipment that goes into the bore hole during the directional drilling process. Also known as down-hole tooling.

Torque

Force used in rotating the drill string.

Tracking

Monitoring the path of the drill head as it advances along the bore path.

Tramming

Using the tracks to move the drill under its own power.

Transmitter

Radio transmitting device placed inside the drill head housing which provides depth, pitch and roll data.

Utility

1) Public service infrastructure providing essential services such as electricity, natural gas, water, etc.

2) A public or private company that maintains such an infrastructure.

3) The material pulled into the bored tunnel (gas pipe, water pipe, etc.)

Viscosity

Measure of fluid thickness.

Water Swivel

Live swivel that connects the drilling fluid supply to the drill string.

Yield

Change in physical properties of bentonite clay when added to water which allows the particles to remain suspended in solution.

Chapter 1
SAFETY

The StraightLine SL2020 is a powerful tool. Use and maintain it with respect and caution. Your safety and the safety of other persons in the work area are dependent on the proper operation of this machine. The information in this manual is intended to assist you in operating this machine according to established procedures, but does not replace any safety rules and laws used in your area.

This symbol means SAFETY ALERT! This symbol is used both on the machine and in this manual to alert the operator that the message following the symbol concerns safety. Carefully read the message and make sure you understand the causes of possible injury or death.

The safety alert symbol will be used with these words:

⚠ **DANGER** Indicates an imminently hazardous situation which will result in death or serious injury unless avoided.

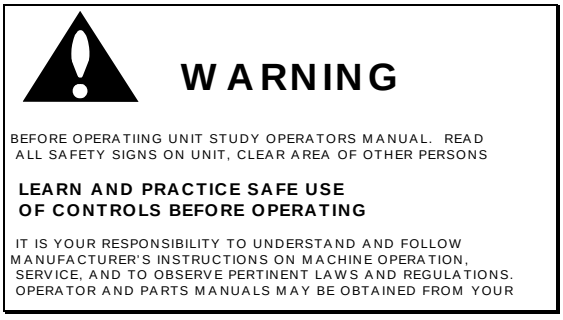
⚠ **WARNING** Indicates a potentially hazardous situation which could result in death or serious injury unless avoided.

⚠ **CAUTION** Indicates a potential hazardous situation which may result in minor or moderate injury if not avoided.

Other important information which can help you do a better job, simplify maintenance, or prevent an unsafe situation will be emphasized by the word **IMPORTANT:** followed by an instruction or information.

Operator Qualifications and Training

⚠ **WARNING** Read this manual carefully before using the SL2020 Directional Drill. Consult your StraightLine Representative for more information.



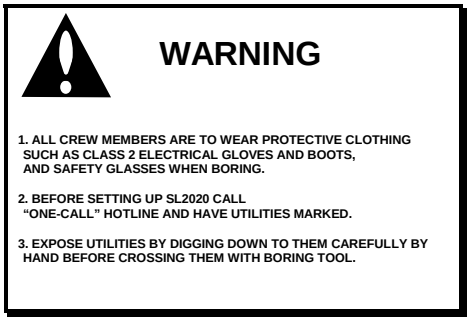
Initial training shall be done at a non-hazardous site such as an open field, free of utility easements. Training shall include the proper use of safety, protective, and locating equipment.

Operator Safety

⚠ **WARNING** Always wear O.S.H.A. approved head gear (not provided) when operating at or near drill.

Always wear safety glasses O.S.H.A. approved safety goggles (not provided) to prevent eye injury.

Always wear the three (3) glove protection system to guard against electrical shock. Always wear the electrical protection boots (not provided) to guard against the possibility of electrical shock caused by the drill pipe contacting an underground utility.



Machine Safety

⚠ **DANGER Turning shaft can crush arms or legs. DO NOT TOUCH DRILL STEM WHILE ROTATING.** Do not wear jewelry, rings, watches or loose clothing when operating drill as these items may catch resulting in serious injury or death.

⚠ WARNING Moving parts can cut off hands, feet, or fingers. DO NOT TOUCH MOVING PARTS.

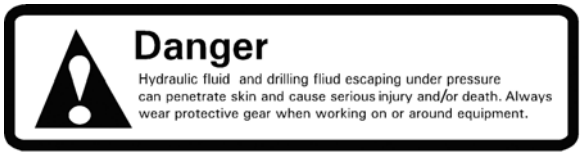
⚠ WARNING Pinch points can crush hands or fingers. KEEP YOUR HANDS AWAY FROM MOVING MACHINERY AND PINCH POINTS.

IMPORTANT Clear all persons and tools from around the drill pipe before starting operation and during operation, keep bystanders at least 10 ft (3 m) away from drill. Do not stand over trench or drill pipe while drilling.

IMPORTANT: During pullback operations, material being installed may rotate if pullback swivel malfunctions. Keep all persons away from material being installed as death or serious injury may result.

⚠ **DANGER POISON!** Hydraulic oil under pressure can penetrate the skin and burn or cause blood poisoning. Use a piece of cardboard to check for leaks, NOT YOUR HAND! Before disconnecting any lines, relieve system pressure. Before pressuring up system, be sure all connections are tight and lines, pipes and hoses are NOT damaged. Oil escaping from a very small hole can be almost invisible.

Wear protective clothing and eye protection. If you are injured by pressurized hydraulic fluid, get IMMEDIATE MEDICAL ATTENTION FROM A DOCTOR FAMILIAR WITH THIS TYPE OF INJURY.



Always make sure that any guards or safety plates are intact and installed properly to insure safe operation.

⚠ **WARNING DO NOT ALTER CONTROLS!** Do not tie down controls. If releasing a control lever does not cause the motion being controlled to stop, shut down power and get the unit repaired immediately.

⚠ **WARNING Crushing weight.** The drilling machinery, tools and equipment are heavy and if moved or operated in an unsafe manner can tip over or fall, killing or crushing you.

IMPORTANT: Maintain control of unit at all times during transport. Be particularly aware of the potential for tipping over when operating on slopes, curbs, uneven or soft ground.

⚠ **WARNING Fire or explosion is possible.** Fuel and fumes can catch fire or explode and cause serious burns or death.

⚠ **WARNING Electrical shock is possible.** Do not operate the equipment when lightning is possible. Serious injury or death may result.

⚠ **CAUTION** Slips and falls possible. Do not step in any spilled material (drilling fluid, hydraulic oil, etc.). Falling on slippery surfaces may cause serious personal injury.

IMPORTANT: Adequate lighting must be provided when operation of this unit occurs beyond daylight hours.

Jobsite Safety

Place jobsite pedestrian and traffic warning barriers in accordance with Federal, State, and Local Regulations. If jobsite workers are exposed to traffic hazards, wear high-visibility safety vests and other protective clothing as required by Federal, State and Local regulations.

⚠ **WARNING** Call your one-call Hotline! Know and comply with regulations covering One-Call service or utility notification before beginning any HDD operation. Notify your company so appropriate safeguards may be taken if any utilities' "One-Call Hotline" does not provide service or represent the call-in zone in your area.

⚠ **DANGER** Be aware of overhead lines. Contacting overhead lines while handling drill pipe may cause death. Know the location of overhead lines and use extreme caution if any are near!

⚠ **DANGER** Be aware of potential buried underground hazards, including the following:

- Electrical power
- Cables, fluid, and gas carrying pipes
- Fiber optic cables

Electrical hits can cause electrocution, pipe hits can cause fire, explosion, asphyxiation or toxic gas or liquid release, and fiber optic cables carry laser-light signals which can cause eye damage.

Jobsite Inspection and Briefing

Take the time to thoroughly check the entire work site yourself for indications of underground hazards. Be alert for "warning signs" such as the following:

- Notices of buried utilities
- Absence of overhead lines near facilities that logically use utilities
- Gas meters
- Water meters
- Junction boxes
- Manhole covers
- Evidence of previous excavation such as "settled" spots

Use utility locating devices throughout your bore area. Remember they are not perfect, even with an experienced operator. Before crossing an underground utility, take the time to carefully expose the underground hazard.

Hold a briefing for all authorized worksite personnel prior to beginning operations. The briefing should include:

- Who is in charge
- Location and type of buried obstructions, services
- Jobsite security, warning signs, barriers, identify authorized personnel
- Safety considerations associated with operation of the unit, personal protective equipment, clothing, emergency procedures, and emergency telephone numbers

Operating Safety

Use 2-way radio contact between the drill operator and the locator to coordinate the drilling operation. Have pre-arranged backup hand signals in case the radios fail or cannot be used.

⚠ **WARNING** Do not trust locating instruments when crossing or drilling close to hazardous services. Expose hazardous utilities by carefully exposing them.

Do not trust locating done previously.

Do not hesitate to contact utilities to shut down services for the duration of the job if there is any doubt to the location of underground hazards.

LOOK for leaks, loose connectors, loosening anchors, changes to drilling fluids, problems with tools or drill pipe, or other equipment.

LISTEN for unexpected engine lugging, bearing noises, high pressure squeals and any unexpected or unusual rattles, knocks,

screeches, or any change to the normal operating noises.

SMELL for unusual odors such as hot oil, burning insulation, natural gas, etc.

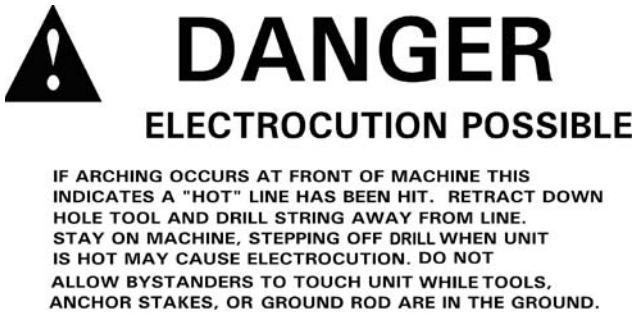
FEEL for changes in the resistance to thrust or rotation during drilling or any changes to how the equipment is operating.

STOP and correct anything you see, hear, smell, or feel that is potentially unsafe.

Emergency Procedures for Hits

⚠ **DANGER Electrocution is Possible.** Unprotected bystanders could be electrocuted if in contact with any part of the drilling equipment, if a "hot" line is hit.

Do not let anyone touch the unit while drilling. All persons who come in contact with the drilling equipment should always wear protective clothing such as Class 2 electrical gloves and boots while drilling.



BE ALERT! Hitting a "hot" line may be indicated by arcing at the front of the drill; a warning on a strike alert device, nearby power outage; smoke, explosion, arcing, etc. on or around nearby electrical transformers and equipment; or nothing at all. Most electrical strikes are not immediately noticeable but are potentially lethal.

Electrical Hits

If an electrical hit occurs, do not panic.

If you are on the machine, stay on the machine.

If you are standing on the ground, stay where you are and don't touch any equipment.

Stepping off a well-grounded equal potential mat (not supplied by manufacturer) may cause electrocution. If you are off the equipment, remain still and stay off the equipment.

Warn everybody in the area that an electrical strike has occurred and to stay away from the equipment.

If the operator is on the mat or otherwise in contact with the drill, he should retract the downhole tool and drill pipe away from the line. Pull back the carriage to the top of the rack to attempt to disengage from the electrical contact.

⚠ **WARNING** Do not try to disconnect a drill pipe or joint until electrical power is shut down. Do not rely on electrical circuit breakers as power can be rerouted and circuit breakers can be reset.

Contact the utility company immediately so they can shut off power and arrange repairs.

Gas or Liquid Line Hits

⚠ **DANGER** Explosion is Possible. If a gas or volatile liquid line hit occurs, immediately shut down any power sources such as generators, hydraulic power packs, or vehicles and leave the area. If the power sources cannot readily be shut down, leave the area immediately!

Contact the utility company immediately and warn people in the area. Do not return to the area until given permission by the utility company.

Fiber Optic Cable Hits

⚠ **CAUTION Do not look into the severed ends of the cable!** Laser light will cause permanent eye damage or blindness. If you do not know what kind of cable you

have cut, do not look into the ends in case it is a fiber optic cable.

Safety Summary

Be Aware

Take obstacles and potential hazards into consideration before you begin work and continue throughout the job. You should be aware of all hazards overhead, on the surface, and underground before unloading the drill from the trailer.

Be Prepared

Take the necessary precautions to protect personnel and bystanders in case of an inadvertent utility hit before anything is driven into the ground. This includes wearing personal protective equipment, proper jobsite security, and proper training of all jobsite workers.

The most important safety element is a well trained crew. Using the proper equipment, the proper tools in the proper manner on a well planned and well prepared HDD job is the best safety policy.

Chapter 2
EQUIPMENT INFORMATION

This chapter describes the location, function, and operation of the SL2020 controls and components. Read carefully and adhere to all notices, warnings, danger decals, and callouts. If you have any questions regarding this equipment or its operation, contact your StraightLine representative for additional information.

Engine Control Panel

The Engine control panel located to the right of the operator's seat contains some of the controls and gauges for the John Deere power unit. See the engine instruction book for complete safety and operation details of the engine.

Operator's Station

1. Thrust Control: Controls drilling (push for forward thrust) and back reaming (pull for rear thrust)

2. Front Wrench: Pull the handle to engage the makeup wrench. Push handle to disengage the makeup wrench.

3. Back Wrench: Pull the handle to engage the breakout wrench. Push handle to disengage the breakout wrench.

4. Breakout Cylinder: Pull and hold the handle to activate the breakout cylinder. Release the handle to retract the breakout cylinder.

5. Ignition Switch: This handle has four positions to control the operation of the engine.

Off - In this position the unit is off, the fuel control solenoid is in the "Kill" position, the electrical system is disconnected and the key may be removed.

Run - Rotate the key one position clockwise. This position connects electrical system.

Heat - Rotate the key counter clockwise and this connects the cold start preheat (glow plug) circuit. When the temperature is below 40° pre-heat the unit until the indicator light goes out.

Start - Rotate the key two positions past off and this engages the starter. Do not crank the engine for longer than 20 seconds at a time.

6. Volt Meter: Displays battery voltage.

7. Fuel: Displays fuel level.

8. Drilling Fluid Gauge: Indicates pressure of the drilling fluid in the drill string and drilling

fluid umbilical hose. Indicated pressure should never exceed 1500 PSI (103Bar).

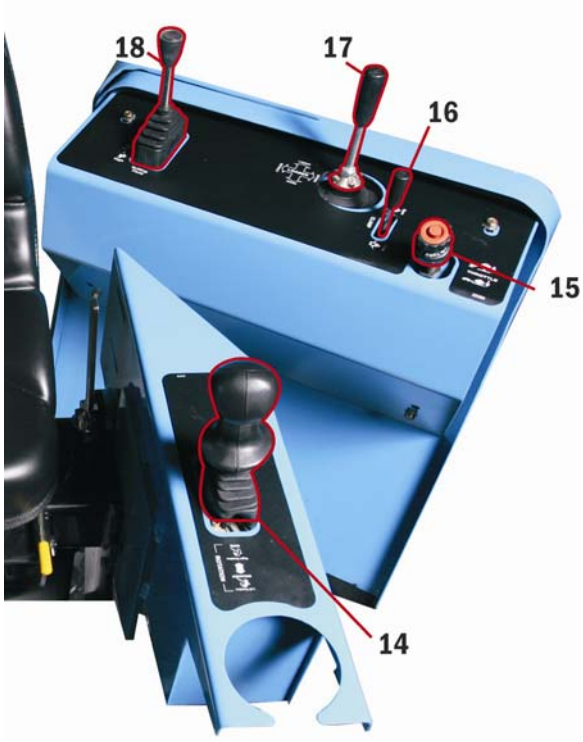
9. Thrust Gauge: Indicates hydraulic pressure in the circuit which is pressurized when in Thrust mode. Indicated pressure should never exceed 3,500 PSI (241 Bar).

10. Rotation Gauge: Indicates hydraulic pressure in the circuit which is pressurized when in the Rotation mode. Indicated pressure should never exceed 3,500 PSI (241 Bar).

11. Engine Water Temperature: Indicates engine water temperature. Should not exceed 230° and should be at least 110°.

12. Oil Pressure Gauge: Displays engine oil pressure.

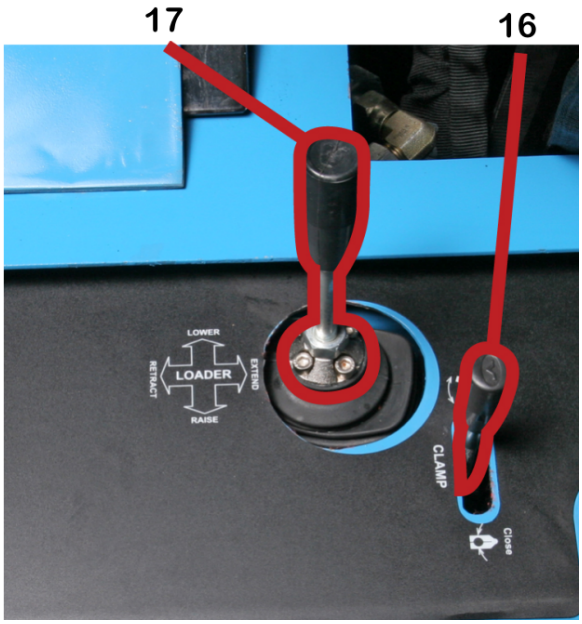
13. Tachometer/Hour Meter: Displays engine RPM and total hours of engine operation.



14. Rotation Control: Pull joystick for clockwise (drilling) rotation. Push joystick for counter-clockwise (breakout) rotation.

15. Throttle: RPM is infinitely variable throughout the range and is adjusted by turning counter clockwise to increase RPM and clockwise to decrease RPM. For full engine RPM, depress cable button and pull control until it stops. Engine RPM should never exceed 2,800 RPM

16. Clamp: Push to open. Pull to close.



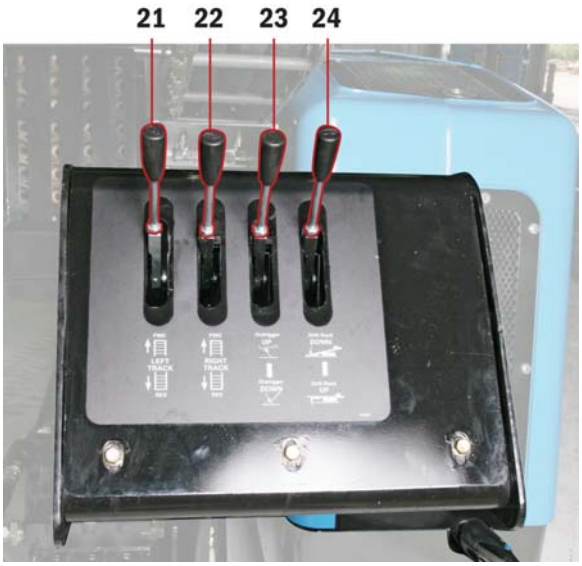
17. Loader: Move toward pipe rack to extend pipe loader, move away from drill to retract. Pull toward operator and move loader down; push away from operator to raise.

18. Mud Pump Control

19. Strike Alert On/Off

20. Strike Alert Sensitivity Dial

Rear Control Station



21. Left Track: Track Control: Move the handle forward to drive forward and back to drive in reverse. Combinations with left and right track control path and direction.

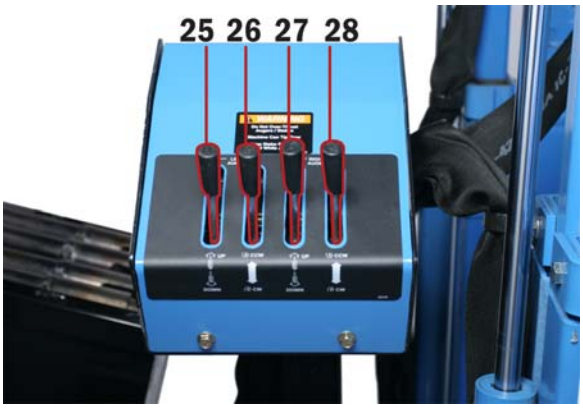
22. Right Track: Track Control: Move the handle forward to drive forward and back to drive in reverse. Combinations with left and right track control path and direction..

⚠ CAUTION The ground drive controls are very sensitive. Take it slow when you are learning the feel of the motions of the machine.

23. Outrigger: Up/Down Push handle forward (Down) to lower the angle of the drill frame. Push handle backward (Up) to raise angle of drill frame.

24. Leveling Foot Control Handle: Push away from operator to lower rear foot and raise the unit, pull toward operator to raise the rear foot and lower the unit.

Auger Control Station



25. Left Auger Raise/Lower: Pull handle to lower auger. Push handle to raise auger.

26. Left Auger Rotation: Pull handle for clockwise rotation. Push handle for counterclockwise rotation.

27. Right Auger Raise/Lower: Pull handle to lower auger. Push handle to raise auger.

28. Right Auger Rotation: Pull handle for clockwise rotation. Push handle for counterclockwise rotation.

29. Work Lights

30. Drill/Tram Seat Lockout: Operator must be in seated position to operate the SL2020. Standing or not being in the seat causes a hydraulic safety override to be triggered and the unit will not operate until operator is seated.

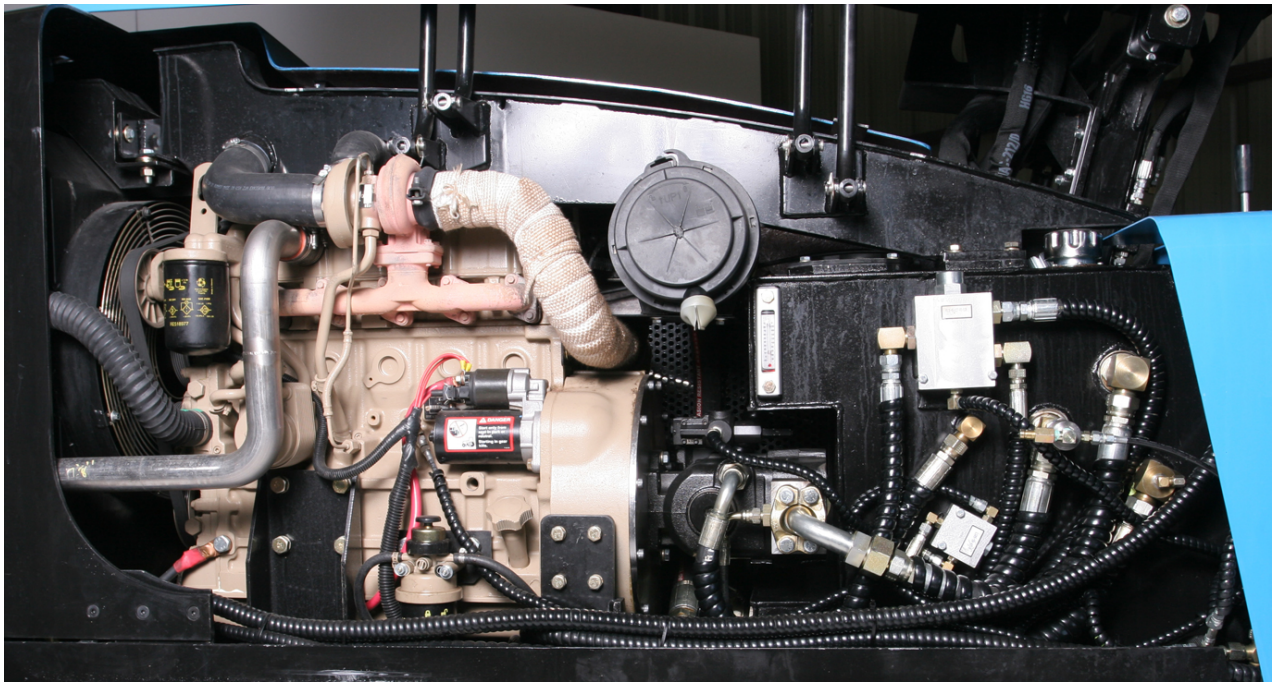
In order to provide maximum protection for the hydraulic safety override seat switch while tramming or transporting the drill, a locking mechanism is provided to secure the seat in the up position.

Drilling Fluid and Ground Rod Connections

Drilling Fluid: The drilling fluid is supplied to the drill by connecting to the suction port on the mud pump.

Ground Rod and Cable: The ground rod and cable connects to the ground lug on the coil box.

Anti-Freeze tank: located above the mud pump and facilitates winterizing the mud pump at the end of daily operations when temperatures fall below freezing.



Engine Compartment

Engine Coolant: The coolant should be a 50/50 mixture of water and anti-freeze. There is an access panel in the top of the engine enclosure to reach the radiator fill neck.

Battery The unit is equipped with a 12v 950 cold cranking amp battery.

Hydraulic Fluid: Hydraulic oil level is shown by a sight glass on the side of the hydraulic oil reservoir. The proper level is the mid point between high and low when the oil is cold.

Engine Oil: Engine oil is shown by a dipstick located on the side of the engine behind the engine enclosure door. Check daily.

Engine Fuel: Diesel fuel tank level is shown by a gauge located on the fuel tank and the operator's panel.

Chapter 3
PLANNING THE BORE

Successful bores begin before the first pipe goes in the ground. Find and review any existing information already available about the job and jobsite. The basic information should include length, depth, and obstacles for the planned bore.

Job Plan: Check for information on existing structures and their elevations. Check for any proposed work that may be taking place. If possible, review their plans or documentation of the jobsite. Contact local authorities about safety procedures and regulations.

Pullback Material: Verify the material you will be pulling back, its bend radius and weight.

One-Call Services: Call area One-Call or similar services and have existing lines located and marked. Call any utilities in your area that do not subscribe to One-Call.

Traffic Control: Contact local authorities about safety procedures and regulations when working near a road or other traffic area.

Emergency Services: Find the telephone numbers for local emergency and medical facilities near the jobsite. Develop an emergency action plan including telephone locations and backup.

Jobsite Inspection

Inspect jobsite before transporting equipment. Check for the following:

- Identify Hazards
- Signs of Utilities (Please refer to Chapter 1, Safety section)
- Observe and comply with any jobsite notices
- Survey the jobsite for changes in elevation
- Identify obstacles such as buildings, roads, streams, railroads tracks, and other potential impedances.
- Access to site
- Traffic near site
- Soil type and condition
- Water supply
- Sources of locator interference (including power lines, railroad tracks, etc.)

⚠ **Warning:** Jobsite hazards could cause death or serious injury. Use correct equipment and operating methods. Use and maintain proper safety equipment.

Plan the Bore Path

The bore path must be planned before boring begins, from entry to exit. The bore path can be marked on the ground with spray paint or flags, or written on paper for operator reference.

The layout of the bore path must take into consideration the depth of the bore, recommended steering limits, entry angle, and set-back distance. The entry and exit points can be marked once the desired depth and set back distances are determined.

Depth: Generally, the conditions found on the jobsite will determine the depth of the bore. To reduce depth, reduce entry angle. To increase depth, increase entry angle and set-back. Also consider the selection of the transmitter.

Steering limits: The 2020 has a minimum bend radius of 130 feet. This translates to no more that a 7% change in grade in one length of drill pipe or 130 feet of forward distance (not 130 feet of pipe) to make a 90 degree turn.

Important: "Over-steering" or bending the pipe more sharply than recommended limits will damage and shorten the life of the pipe. This damage is not always visible. Repeated abuse of the steering limits will result in premature failure.

Entry Angle: The angle of the boring unit as related to the entry point. A shallow entry angle allows you to reach horizontal sooner and with less bending. Increasing entry angle makes bore path longer and deeper.

Set-back distance: This is the distance from entry to where the pipe reaches planned depth. If set-back distance is too short, the steering limits will be exceeded and pipe can be damaged.

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

Slope: Fluid system should be parked on a level site. Consider how slope will affect boring unit set-up, bending pipe and fluid flow out of hole.

Evaluate the Soil Conditions

Soil conditions include (but are not limited to) the following: ability to compact, moisture content, porosity, stickiness, presence of rocks, and underground water formations. These conditions can be determined by several methods.

These methods escalate in complexity ranging from simply inquiring about underground experience in the area, to inspection of local open-cut excavations, to hand digging, and ultimately to core sample drilling with geologic evaluation.

Select the Tooling

The selection of tooling depends on the soil conditions at the jobsite and the material to be installed.

Select the Drilling Fluid

The selection and mixture of drilling fluid also depends on the soil at the jobsite and the material to be installed.

Preparation Checklist

Supplies:

- ❑ Receiver/locator with charged batteries
- ❑ Transmitter and spare batteries
- ❑ Two way radios and spare batteries
- ❑ Wrenches and shear bolts
- ❑ Anchoring equipment and accessories
- ❑ Allen bolts and wrenches
- ❑ Bits, filters, jets
- ❑ Adapters, pipe, transmitter head
- ❑ Marking flags, paint
- ❑ Water and additional hoses
- ❑ Bentonite/polymer
- ❑ Spare Fuses
- ❑ Keys
- ❑ Tooling, back reamers, swivels, pulling devices
- ❑ Wash wand and hose
- ❑ Duct tape
- ❑ Spray lubricant
- ❑ Thread lubricant and brush
- ❑ Notepad and pencil

Equipment

- ❑ Fuel
- ❑ Hydraulic fluid
- ❑ Engine oil
- ❑ Battery
- ❑ Lube points
- ❑ Thrust drive
- ❑ Filters (air, oil, hydraulic)
- ❑ Fluid pump
- ❑ Couplers
- ❑ Tracks
- ❑ Mud mixer
- ❑ Hoses and valves
- ❑ Fluid solenoid
- ❑ Water tanks
- ❑ Wrenches

Brief the Crew

- ❑ Survey the jobsite, locate and mark all underground utilities
- ❑ Brief the crew on all known hazards
- ❑ Expose all proposed crossings
- ❑ Plan the pilot bore, confirm that a bore log is at hand, and mark the proposed bore path
- ❑ Assign adequate manpower where needed
- ❑ Confirm emergency procedures, and access to emergency phones and numbers
- ❑ Location of all safety barriers and the appropriate precautions to secure the jobsite and equipment.
- ❑ Confirm that the crew has and wears appropriate safety gear.

Chapter 4
SETUP AT THE JOBSITE

Upon arrival at the jobsite, park the trailer on a level area that is close enough to where the drill will be anchored to allow the mud supply line to be easily connected. Use wheel chocks and the tongue jack to prevent the trailer from unexpectedly moving before starting to unload the drill. When the trailer has been securely parked, then the safety barriers, traffic cones, hazard lights, etc. around the trailer should be erected and activated to prevent non-authorized personnel from coming in contact with the equipment.

Unload the Drill

⚠ **WARNING** Crushing Weight, if moved or operated in an unsafe manner this equipment can crush operators or bystanders.

Refer to the equipment information (Chapter 2) to identify the controls of the unit. Carefully tram the drill off the trailer and to the bore entry location. Maintain control of the drill at all times.

Position the Drill

If the drill is positioned on uneven terrain, such as an embankment, the setback between the drill and the entry point should be adjusted to compensate for the change in the geometry. If set up on an incline is unavoidable, do not exceed a maximum incline of 30º to maintain proper engine lubrication.

Setup the Strike Alert

⚠ **WARNING** The Strike Alert system indicates only that the drill has come into contact with electrical power, you must wear the proper protective clothing for recommended protection.

Strike Alert

The strike alert is designed with special electronic filters to sense 60 hertz AC power. It uses a siren to alert the operator of current flowing through the grounding cable. The strike alert consists of a control panel mounted on the back of the drill control arm rest, a 100DB alarm, and a three foot long ground rod. The Strike Alert operates with 12VDC electrical power provided by the drilling unit.

Verify that the panel handle is in the "armed" position and the green light is illuminated before setting augers or drilling. If an electrical utility hit is experienced, the siren will activate and must be reset by handling the front panel handle to the "off' position then back to the "armed'* position.

The current sensitivity selector includes the following three positions:

- The ,02A position is the most sensitive selection. This position begins sensing at .017A (17mA)
- The .2A position represents a reduction in current sensitivity which begins sensing at. 17A (170mA)
- The .50 position is the least sensitive position and begins sensing a .47A (470mA)

IMPORTANT: The panel handle must be returned to the "OFF" position prior to switching between the sensitivity levels to avoid possible false triggering.

Assemble Bonding Equipment

If you are not driving two anchors to full depth, drive optional ground rod into soil away from boring unit.

Drive voltage stake into ground at least 3 ft (1 m) away from any part of system.

Attach voltage limiter to voltage stake.

⚠ **DANGER** Electric shock is possible. Wear electrical insulating boots and gloves.

Drive the ground stake into the ground until no more than 1 foot is left exposed. If the ground is extremely dry, pour water down and around the ground rod to help with a proper ground. The earth ground should be tested with a device such as a Megohm Meter to determine the resistance to ground.

Check the Strike Alert system before setting augers. Place the front panel switch in the “test” position and verify the operation of the siren. If the siren does not operate in the “test” position, verify that the key switch is turned on. Also check that the battery is charged and properly connected.

After the unit has operated with the switch in the “test” position, put the switch in the “armed” position and verify the green light is illuminated.

Position Drilling Unit and Frame

Start engine and move unit into position.

Tilt frame to achieve desired entry angle.

Lower stabilizers until stabilizers begin to put pressure on the ground.

Continue lowering to increase entry angle.

Anchor The Drill

⚠ **WARNING** Set both augers before rotating drill pipe. Failure to properly stake down drill can result in tip over which can crush you when the drill string is rotated.

⚠ **WARNING** Always wear safety glasses or O.S.H.A approved safety goggles to prevent eye injury.

Always wear the three glove system to guard against electrical shock.

Always wear the electrical protection boots to guard against possible electrical shock.

Connect the Mud Mixer Supply Hose

The mud mixer supply connection is located at the rear of the drill. Before operating drill, it is important the mud system is connected and checked to confirm flow.

See the mud system operators manual for complete and detailed instructions.

Assemble Drill Head

Select nozzles and bit. A variety of nozzles and bits are available to suit your particular job conditions. Contact StraightLine for more information about available components best-suited for your needs.

JOBSITE SETUP CHECK LIST

- ❑ Brief the crew on all known hazards
- ❑ Survey the jobsite, locate and mark all underground utilities
- ❑ Expose all proposed crossings
- ❑ The proposed bore path is marked, and bore log at hand.
- ❑ Erect all safety barriers and take the appropriate precautions to secure the jobsite and equipment.
- ❑ Check the tooling, is there an adequate amount of drill pipe, thread lube, and supplies to mix drilling fluid.
- ❑ Service the drill and mud skid including the fuel and oil levels
- ❑ Mix the drilling fluid thoroughly using suitable water and test the drilling fluid as required
- ❑ Confirm that the whole crew is wearing all appropriate safety gear
- ❑ Install fresh batteries in the transmitter, and confirm that a fully charged battery pack is in the locator receiver
- ❑ Calibrate the locator receiver per the locator's operator's manual
- ❑ Test the radio communications between the locator and the operator
- ❑ Confirm that the crew is trained in emergency procedures, and has access to emergency phone numbers
- ❑ Secure and anchor the drill

Chapter 5
STARTING THE PILOT BORE

Thread Lube

Apply thread lubricant to the tool joint using the brush provided. The lubricant should coat the threads of the tool joint.

Important: For optimum operation and to prolong the life of the drill pipe, always use thread lube on every stem change beginning with the very first section installed.

If the drill pipe is new or has not been used in three or more days, apply a generous coating to the shoulder and threads of both the male and female ends. Otherwise, apply a generous coating to the shoulder and male threads before the tool joint is screwed together.

Tighten Joints At The Saver Sub.

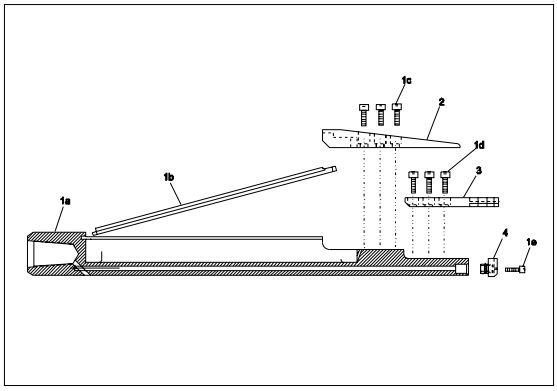
Open both wrenches. Using the pipe loader, move the first piece of pipe into the rod catcher with the front (male) near the wrenches and the rear (female) end positioned directly in front of the saver sub. Slowly advance sub saver into box end of drill pipe. Begin rotation until the sub saver and drill pipe box shoulder up.

Then slowly thrust forward until the front (male) end of the pipe is in the jaws of the makeup wrench. Tighten the section of drill pipe onto the saver sub by locking the makeup wrench. Using forward rotation, rotate pipe until it is tightened to full drill rotation torque.

Set the makeup wrench back to neutral. The drill pipe should be advanced (thrust forward) through the makeup wrench and the drill pipe guide to expose the male threads in front of the drill so that the drill head assembly may be attached.

Assemble the Drill Head

Assemble the drill head with the appropriate filter for the transmitter, drilling fluid selected, bit, and fluid jets. Use thread compound on all bolts.



Apply thread lube to the male end of the drill pipe. Attach the drill head assembly by screwing it on the drill pipe and tighten with hand wrenches.

⚠ **DANGER** Turning shaft can crush arms or legs Do not touch drill pipe while rotating. Do not wear jewelry, rings, watches, or loose clothing when operating drill as these items may catch resulting in serious injury or death.

Check the Jets

Pull the drilling fluid handle and run fluid through the swivel, drill pipe, filter, and jets. Observe the pattern of fluid spray from the jets to make sure that the system is operating properly.

Important: If there is any foreign material clogging the fluid jets, remove and clean the filter as well as the jets before re-testing. Checking the condition of the filter can be done more easily at this point than at any other time during the job. If any restrictions or other problems occur, solve them before continuing the bore.

When you're ready to proceed, set the desired drilling fluid pressure with the drill fluid dial. Apply forward rotation and hold.

I**mportant:** Whenever you are advancing the drill head, you must have fluid (under pressure) flowing through the drill head to insure the jets do not become clogged.

Important: The pressure will register on the drilling fluid gauge even if the drill head jets have become clogged. There is an easy way to check for clogged jets. Engage drilling fluid pump and watch the drilling fluid pressure gauge until it registers pressure. Turn the switch off and monitor the pressure reading on the gauge. If the pressure falls off quickly the jets are not clogged. If the pressure takes some time to drop off the jets are clogged.

Dig A Pilot Hole

Dig a starting hole to give the drill a flat surface into which the bore may begin without deflection.

When beginning the bore, being perfectly aligned is absolutely necessary for fast and easy drill pipe addition during the boring operation. Proper alignment also creates easier stem removal during the pullback operation.

Advance (thrust forward) the drill head slowly by feathering the joystick to control movement and rotating (forward) until the drill head is all the way to the front end of the drill with the back (female) tool joint of the drill pipe in the makeup wrench.

⚠ **DANGER** Do not touch the drill pipe while it is rotating. Do not wear jewelry, rings, watches, or loose clothing when operating drill as these items may catch, resulting in serious injury or death.

⚠ **WARNING** Do not wire, wedge, tape, or tie down controls in any way. Maintain personal control of the boring equipment at all times**.**

Chapter 6
Completing the Pilot Bore

Adding Drill Pipe

To add drill pipe turn the drilling fluid pump off and lock the female tool joint in the make-up wrench.

Apply reverse rotation to break the sub saver joint lose. Continue reverse rotation until the saver sub is completely disengaged from the drill pipe.

Again, using the pipe loader, move a new section of drill pipe in position between the exposed tool joint in the makeup wrench and the saver sub onto the rod catcher. Apply thread lube to the male end of the drill pipe.

Slowly rotate the saver sub into the new drill pipe providing a lose fit. Remove the pipe loader and advance the carriage until the male tool joint of the new section of pipe into the female joint of the exposed pipe. Slowly rotate (forward) to shoulder up the tool joint threads to full rotation torque.

Return the makeup wrench cylinder to the neutral position. Be very careful not to thrust with either of the wrenches locked onto the tool joints. Thrusting in either direction with the wrench jaws locked onto the pipe can cause damage to both the pipe joints and the wrenches.

Important: Do not rotate drill string in reverse, any time the drill string or pipe is in the ground. This can cause the drill pipe to loosen and come apart underground.

Guiding the Bore

Guiding the drill head through the planned bore path is accomplished by connecting straight runs of rotation with curved runs of steering. This process relies on the use of locating equipment and experienced operators.

Steering or “pushing” involves rotating the drill head to orient the steering surface, and pushing the drill head without rotating to cause the head to veer in a controlled direction.

In order to bore (rotate) or steer (push) with accuracy, the direction and pitch and roll of the drill head must be known before thrust force is applied. The locating equipment provide that information and will give precise position and depth information. Refer to the operator’s manual supplied with the tracking or locating equipment to learn how to most accurately guide the drill head.

Boring

When advancing the drill head without steering, the locator tells the operator to “rotate” and reports the distance to advance.

The operator turns the drilling fluid on, and waits until the pressure registers on the drilling fluid pressure gauge. Then engage rotation (forward) and slowly advance thrust (forward) until a new drill pipe must be added or the distance requested by the locator has been advanced.

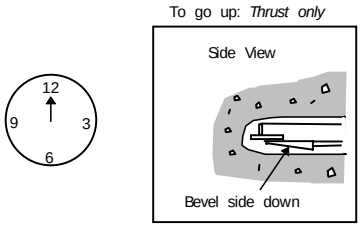
Advancing the drill head at the correct speed is critical when boring or steering. Monitor the thrust and rotation hydraulic pressure gauges, pressure readings will correspond to the amount of resistance in the respective functions. Learning to “read” the information these gauges furnish will help determine how fast you may safely advance the drill string.

At this point, the operator stops thrust first, then allows a few revolutions of rotation to release torque windup in the drill string, and then turns the drilling fluid off.

Steering

The first steer is usually performed to change the grade from the point of entry to the first level run. When the drill head is at the point of the bore path where the steering arc levels off and the desired depth is reached, the operator first stops the thrust. The drill head is then rotated a few revolutions to release windup and the drilling fluid is turned off. The locator marks the position of the drill head and reads the orientation of the steering shoe.

The drill head orientation and steering directions are given in terms of "clock" position with the clock face viewed from the operator position. The drill head will steer in the direction of its clock position with 12 o'clock being straight up, 3 o'clock being a level right turn, etc. Therefore to change from a downward entry bore path to level bore path, the drill head needs to steer to the 12 o'clock direction.



The locator using the locating device will determine the desired drill head position and communicate this to the operator.

The operator notes the orientation of the exposed drill pipe or saver sub and rotates the appropriate number of "hours" in order to put the steering shoe in the correct position for the steer.

Thoroughly clean and flush the drill head. Inspect for damage and wear to the cutting bit and the steering shoe. Open the transmitter housing cover and remove the transmitter. Clean off the transmitter, remove batteries, and return the transmitter and locator receiver to the transport/storage case.

The locator confirms the new orientation of the drill head and tells the operator the distance to push at that clock position.

The operator turns the drilling fluid on, insures that there is pressure on the drilling fluid gauge, then engages thrust (forward) feathering the valve to control speed. The operator pushes the drill pipe ahead for the distance requested, then stops the thrust, and turns the drilling fluid off.

The locator marks the new position, notes the depth (and pitch) and determines the need for any additional steering requirements.

The locator should mark the progress of the bore on the surface at least every 5-6 feet if possible, more often, if necessary. Keep track of the actual bore path in the bore log by recording the depths at each location point.

Finishing the Pilot Bore

The pilot bore can be guided to a pit but is usually accomplished by steering the drill head up to the surface at the planned exit point. Make sure that the upward curve of the bore path at the exit does not exceed the bend radius of the drill pipe or the material to be installed. The last steering curve is the first pullback curve, so all installed material will bend around this curve. It is good practice to maintain as straight a bore path as possible.

When the locator can verify that the drill head is on an upward path and is about to emerge, secure the area around the exit point. When the drill has emerged the operator should shut the drilling fluid pump OFF and advance the drill string until the drill head and filter sub are clear of the ground. Shut down the power unit and remove the key from the ignition switch before starting the preparation for pullback operations.

Chapter 7
PULLBACK OPERATIONS

Pullback operations involve two individual tasks that are usually done together: Back reaming, the process of enlarging the pilot bore; and pullback, the process of pulling the utility into the tunnel with a swivel.

Drilling fluid management and tooling selection are very important to successful pullbacks. The demand on horsepower can be greatly reduced, and the quality of the tunnel can be greatly improved through proper management and equipment.

Pre-reaming

Pre-reaming is back reaming before pulling back the utility. It is done for two reasons:

1. Larger bores can be accomplished using limited horsepower,
2. A tunnel can be positively established before introducing the utility to the tunnel.

Operations requiring pre-reaming are usually operations that also require careful attention to the drilling fluid and hole formation.

Pullback Safety

The pilot bore may have guided the drill string in near proximity to an unmarked hazard that went undetected. Back reaming enlarges the pilot bore, and may now bring the drill string in contact with that hazard . This contact has all the same consequences of a utility hit on the pilot bore. Observe all of the safety rules for the pull back as the pilot bore.

⚠ **DANGER** Electrocution Possible. If arcing occurs at front of machine this indicates a “HOT” line has been hit.

⚠ **DANGER** Turning shaft can crush arms or legs Do not touch drill pipe while rotating. Do not wear jewelry, rings, watches, or loose clothing when operating drill as these items may catch resulting in serious injury or death.

⚠ **WARNING** Keep all persons away from material being installed during pullback operations. The material being installed may rotate unexpectedly if swivel malfunctions.

Assemble the Tooling

Apply a liberal amount of thread lube to the threads of all the tooling. Make sure the threads are fully seated and tightened. Check to see that the jets are properly sized and functioning. The swivel should be properly lubricated and in good condition.

With system shut off, assemble the tooling to the drill pipe and attach the material being installed with the appropriate puller, adapters, or attaching hardware.

Start the Pullback

Position a crew member at the exit hole to communicate the status of the drilling fluid flow to the drill operator, and also to monitor the utility being installed.

Communication of the fluid situation to the operator will help regulate the speed of the pullback.

1. Start the engine. Turn the drilling fluid switch on momentarily to check the jets.

2. Thrust as required to position the next tool joint between the wrenches and disconnect the saver sub from the drill pipe following the procedure used in adding drill pipe.

3. Thrust (forward) to position the saver sub through the breakout wrench and using the procedure used in adding drill pipe, connect the saver sub to drill pipe.

4. Thrust (reverse) slowly to retract the drill string until the back reaming tool contacts the earth at the exit hole.

Important: DO NOT rotate drill string in reverse (counter-clockwise) while drilling, back reaming, or anytime the drill string is in the ground. This may allow the drill pipe sections to loosen and come apart underground.

5. Rotate (forward) at full speed, turn the drilling fluid on and thrust (reverse) retracting the drill string, feathering the thrust valve as required to maintain a steady pull.

Monitor the thrust and rotation hydraulic pressure gauges. Pressure readings will correspond to the amount of resistance in the respective functions. Learning to "read" the information these gauges furnish will help determine how fast you may safely pullback.

NOTE: Drilling fluid management during pullback is critical to prevent excess drag and related problems. The amount of fluid being pumped around the back reamer and material being pulled back is controlled by the setting of the fluid pump speed control and the speed of the pullback.

Removing Drill Pipe

Continue until the next drill pipe tool joint is positioned between the breakout wrench and the makeup wrench. Stop thrust, and rotation, turn the drilling fluid switch off.

Important: Some utility material is "elastic" and may pull the drill pipe back towards the tunnel when the saver sub is disconnected.

1. Slow the speed of the pullback to allow the material to stay normalized

2. Increase fluid flow to better lubricate the material being pulled

3. Pull the pipe joint past the wrenches then push it back into the correct position to relieve the tension before breaking the drill pipe joint.

4. Use the make-up wrench to hold the drill string.

Breakout

1. With the make-up wrench clamped, clamp the breakout wrench and extend breakout cylinder to break the drill pipe loose from the drill string.

Important: Rotate (reverse) slowly as the tool joint loosens between the sections of drill pipe to prevent the releasing action of the pipe from over powering the rotation motor, which helps increase motor life. Set the breakout wrench to its neutral position. Slowly rotate (reverse) to release the threads in the tool joint. Stop movement when the threads clear but the tool joint remains in the jaws of the breakout wrench.

2. Close the breakout wrench, rotate (reverse) to break the joint between the drill pipe and the saver sub. Set the breakout wrench cylinder to its neutral position

3. Grasp the drill pipe with the pipe loader and continue to rotate (reverse) until the drill pipe is completely disconnected from the saver sub, then place the drill pipe in the storage rack.

4. Thrust (forward), and apply thread lube to the saver sub as it moves into position through the breakout wrench to align with the next tool joint.

Important: Always apply thread lube to the saver sub on every joint for optimum operation and to prolong the life of the drill pipe.

5. Retract the makeup wrench, and then slowly rotate (forward) connecting the saver sub to the drill string. Continue to rotate (forward) and tighten the joint to full system torque.

6. Set the Makeup Wrench to its neutral position.

7. Turn the drilling fluid switch on, when pressure registers, rotate (forward) and thrust (reverse) to carefully continue the pullback.

Repeat as necessary until the back reamer is about to emerge from the entry hole.

Completing The Pullback

1. Retract the carriage to the rear of the drill rack then forward to release the tension on the pulling swivel.

2. Shut down the drill and remove the key from the ignition switch.

3. Disconnect the now-installed material from the swivel by removing the pulling connectors from the material and the swivel clevis.

4. Remove the swivel from the drill string, clean, and repack with water resistant grease immediately.

5. Remove the back reamer and the filter sub from the drill pipe.

6. Restart the drill and position the front tool joint of the last section of drill pipe in the breakout wrench.

7. Close the breakout wrench and rotate (reverse) to break the saver sub loose from the last remaining drill pipe and continue until the joint is almost apart. Set the breakout wrench to its neutral position, grasp the drill pipe with the pipe loader and when it releases, place in the drill pipe storage rack.

8. Pullback operations are usually best done as a non-stop operation from start to finish. Before starting, complete this check list to prevent stoppages in your work during pullback.

Pullback Checklist

- ☐ Fuel and oil levels
- ☐ Drilling fluid and supplies
- ☐ Utility supplies and conditions
- ☐ Apply a liberal amount of “Taper-Lube” grease to the threads of all the tooling
- ☐ Check the swivel and lube with water-proof grease
- ☐ Install the drill pipe wiper over the drill pipe at the front of the drill pipe guide
- ☐ Attach the back reamer(s) and pulling swivel to the drill string. Make sure the threads are fully seated and tightened
- ☐ Use the appropriate pullers, adapters and attaching hardware to connect the material to the swivel
- ☐ Test the radio communication between the observer and the operator.

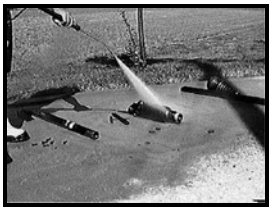
Chapter 8
SHUTDOWN

Auger Staking System

Using the controls (please refer to Chapter 2 for more information) Reverse rotate and retract augers.

Wash Down

Wash down the tooling and unit.



Drilling Fluid

If the unit is not going to be used again the same day, the drilling fluid tank must be emptied and the entire fluid system flushed with clean water or antifreeze in freezing conditions.

IMPORTANT: Drilling Solution is a non-hazardous material but should be disposed of in a responsible manner. Obey all local regulations regarding disposal of drilling fluids.

Chapter 9
MAINTENANCE

Engine

The SL2020 is equipped with a John Deere 5 cylinder diesel engine model number 5030T. Refer to the engine manufacturer's Operation and Maintenance Manual for complete maintenance instructions and procedures.

Oil: Check the engine oil level daily. Use an oil that meets API classification SE. Change the engine oil every 100 hours. The oil must meet API classifications of CD / CE / CF4. Refer to the engine manual to determine the proper viscosity for your local conditions.

Oil Filter: Change the engine oil filter at every oil change.

Air Cleaner: Inspect the air cleaner weekly and replace as required. Check all connections for mechanical tightness. In case of leakage, replace necessary parts or gaskets if adjustment does not correct the fault. Inspect for mud caking or signs of excessive wear or damage

Fuel Filter: This unit is equipped with 1 fuel filters. The main fuel filter is located at the fuel pump and should be replaced every 1000 hours.

Fuel Tank: Check fuel level daily, the capacity of the tank is 26 Gallons (98 Liters). Fuel used in the unit should have a sulfur content of less than 0.5%.

Hydraulics

Hydraulic Fluid in the Sight Gauge: Check hydraulic fluid level daily. The level should be slightly above half full when the oil is cold to allow for normal expansion. Replace the hydraulic oil every 1,000-hours. The factory fill oil is Mobil VG 32.

Hydraulic Reservoir: The reservoir has an 22 gallon (83 Liter) capacity.

Hydraulic Filter: Replace the return filter in the SL2020 after the first 50 hours of operation and every 250 hours thereafter.

Track Drive Motors: The Track Drive Motors are coupled to planetary gearboxes that drive the Track Drive Sprockets. (See Planetary Gearbox Maintenance)

Track Idlers: The Track Idlers are sealed and do not require maintenance.

Track Adjustment: The Tracks will stretch and loosen as they wear in. Visually inspect the Tracks for tightness. Loose Tracks may make popping noises, slip or stick, and possibly slip off the Drive sprocket. Remove the access cover on the side of the track frame.

To change lube in the thrust and gearbox, the drill needs to be in a level position.

1. Remove the lowest plug in each gearbox.

2. On the track drives you will need to rotate the tracks until one of the two plugs is at the bottom, near the ground(the track gear boxes are fixed, just need to remove bottom plug and drain).

3. When the old oil has drained replace the plug and remove one plug on top of, and one near the half way fill point of the gearbox.

4. Fill until the gear lube pours out of the half way port. Be sure to dispose of old oils in a responsible manner.

Planetary Gearbox Maintenance: All of the planetary gearboxes use regular 80-90 weight gear lube. The level of the gear lube should be checked weekly and should be changed after the first 50 hours of operation. Thereafter, it should be changed every 500 hours or six months, whichever occurs first.

To change lube in the thrust gearbox, the drill needs to be in a level position. Remove the lowest plug in each gearbox. The track gear boxes are in a fixed position on the bottom, near the ground. Remove bottom plug on each to drain. When the old oil has drained replace the plug and remove one plug on top of, and one near the half way fill point of the gearbox. Fill until the gear lube pours out of the half way port. Be sure to dispose of old oils in a responsible manner.

Saver Sub: The purpose of the saver-sub (or sub saver) is to allow a replaceable tool joint for protecting drill pipe and the carriage spindle. Always use plenty of thread lube on the threads every time you load another piece of drill pipe. Constantly monitor the threads on the saver sub for wear. When the sharp edges of the threads begin to show rounding or, if the shoulders of the joint will not come together, completely bottoming out, it is time to replace the saver sub. Failure to maintain the saver sub will result in costly damage to the drill pipe. Never run the drill pipe directly to the carriage spindle shaft. Always carry an extra saver-sub to allow servicing when needed. One cause of premature saver sub failure is not anchoring the drill firmly to the ground. The power anchor system should be run down all of the way and kept tight during the drilling process. New operators tend to engage the threads without using the float feature on the carriage. After some operational experience the operator should be able to gently engage the saver sub with the threads of the drill pipe and that will increase thread life of both saver sub and drill pipe. Always use a high quality thread and apply it generously to each joint as the bore is being done.

It is best to replace the saver sub at the end of a day to allow ample curing time for the Loctite. See Maintenance Procedures to replace the saver sub.

Carriage Roller Bearings: Maintain the carriage lubrication intervals as outlined above. Monitor the bearings for flat spots and check for free-play in the carriage daily. Failure to replace worn bearings may result in accelerated wear to the drill stem and saver sub.

Wrench Jaws: Wrench jaws have a varying life expectancy. Depending on the manner of operation and the amount of drilling time they encounter. When the jaws fail to grip they need to be replaced. When new jaws fail to grip the wrench bodies will probably need to be replaced. (It is recommended to carry extra jaws and shear bolts.)

It is a good idea to remove the wrench cylinder covers about once a week and clean the area around the cylinders. This area gets filled with mud and thread lube that can hurt the performance of the wrenches. Again, when doing any kind of maintenance make sure that the engine is off and the key is out of the ignition.

SL2020 Maintenance Schedule

Daily

- ❑ Engine Oil Level
- ❑ Engine Fuel Level
- ❑ Engine & Hydraulics for Leaks
- ❑ Hydraulic Oil level
- ❑ Drilling Fluid Pump Oil Level
- ❑ Drilling Fluid Filter

Weekly

- ❑ Grease Lubrication Points
- ❑ Inspect Engine Air Filter
- ❑ Inspect Wrench Inserts
- ❑ Check oil level in all gearboxes.

Every 100 Hours

- ❑ Change Engine Oil & Filter
- ❑ Inspect & Clean Engine Cooling System

Every 250 Hours

- ❑ Change Engine Air Filter
- ❑ Inspect & Clean Engine Cooling System
- ❑ Inspect & Clean Battery Cables
- ❑ Inspect & Adjust Engine Rpm's
- ❑ Change Fuel Filter

Annually

- ❑ Change Drilling Fluid Pump Oil
- ❑ Replace Hydraulic Oil

WEEKLY GREASE POINTS

1	Spindle Bearing (1)	#121203	1 shot each
2	Carriage Roller Bearings (8)	#121203	1 shot each
3	Water Swivel Bearings (2)	236-7125-02	1 shot each
4	Pipe handler clamp (4)	#121203	1 shot each

Grease: #121203 is a Straightline part number any grease that meets the following criteria can be used where this part number is listed. The grease should not be less than 3% molybdenum disulfide in content. Some examples are: Mobilgrease CMP, Penzoil adhezolith EP, Castrol industrial #860/460-2, Exxon rotenex extra duty moly, Shell oil retenex cmx

Grease: #236-7125-02 is a Straightline part number any grease that meets the following criteria can be used where this part number is listed. The grease should meet ASTM D1264 spec. Some examples are: Mystic JT-6, Jet Lube Alco EP 73 plus.

Chapter 10
MAINTENANCE PROCEDURES

Saver Sub Replacement:

The saver sub should be changed before it becomes worn to the point that the tool joint will no longer shoulder up. If the saver sub continues to be used past this wear point, the drill pipe joints can become rounded and mushroomed making replacement of all tool joints or drill pipe necessary.

Saver Sub Replacement Procedure: Loctite adhesive is required in saver sub installation. Plan on allowing enough time for the adhesive to completely cure. It is best to replace a worn saver sub at the end of the day for overnight curing.

The proper Loctite retaining compound is 680 green. The time needed for a complete cure can be accelerated by using the proper primer.

Loctite 680 Green
Full Cure Without Primer = 8 hours
Full Cure With Primer "T" = 3 hours

1. Install a drill pipe, attach it to the saver sub and run it through the pipe guide during this operation to prevent bending stress on carriage spindle.

2. The best method to break the adhesive seal is to heat the saver sub to approximately 300 degrees. At this temperature, the adhesive begins to liquefy and produce a very distinct odor.

Note: When applying heat to the saver sub, take care not to over heat it. This could transfer too much heat to the carriage spindle shaft and damage the lip seal at the carriage.

3. Lock the saver sub into the break out wrench and reverse rotate to loosen.

4. After allowing the carriage shaft to cool, install the new saver sub using the recommended Loctite and primer (mating surfaces must be perfectly clean).

5. Use the break out wrench to lock the new saver sub onto the carriage shaft.

Wrench Service

The makeup and breakout wrenches use replaceable jaws to safely and securely grip the drill pipe tool joints when adding or removing drill pipe sections from the drill string. The jaws must be replaced when they wear to the point that the tool joint can no longer be securely held against rotation.

Pipe Guide Service

The SL2020 uses a polyethylene pipe guide to lengthen the life of your drill pipe. It can easily be replaced by driving out the old and inserting a new one in its place. Replace the worn insert before it has had a chance to scar the drill pipe.

Drill pipe care & preventative maintenance

Straightline drill pipe has been machined and checked with every possible inspection. However in order for the drill pipe to have maximum life a few procedures must be followed.

1. Inspect both joint members thoroughly before using. Watch for signs of jammed or misaligned threads. All joints need to be thoroughly lubricated before using the first time. Thorough lubrication should continue each time the drill pipe is connected together, including the tooling.

2. Use only a high quality drill pipe thread lubricant. The amount of lubricant is not as important as how it is applied. Use a stiff brush

to apply the thread lubricant evenly to all threads on the joint. Placing a small amount on the joint just before makeup is not adequate.

3. Stab the joints carefully – Use the float feature of the carriage in order to gently mate up the tool joints. Avoid running the carriage down with full force or unscrewing the tool joint against pressure.

4. Make up the joint to the recommended torque. Tighten the tool joint to complete bypass pressure before releasing wrench and continuing to bore.

5. Clean all foreign material off the threads before using the pipe. Excess sand or dirt will cause excessive wear on the joints.

6. If a tool joint does become damaged do not use it while boring. The damaged threads will continue to ruin all of the other threads it comes in contact with.