

DD-240™ Directional Drill



Operation & Safety Instruction Manual

WARNING

Unsafe use of this equipment could result in serious injury or death. This manual contains important instructions for the safe operation and recommended maintenance of your directional drill. All who operate the directional drill must carefully read and understand this manual before starting the machine. Keep this manual available both as a reminder for your experienced operator and as a training aid for your new staff.

Replacement manuals are available by calling American Augers.



INTRODUCTION

American Augers was established in 1970 to provide a full line of modern equipment for the trenchless excavation construction industry. The company is organized in three product divisions to serve the full range of trenchless technology. American Directional Drill is the division producing the leading line of Horizontal Directional Drills. We are proud of our equipment and the job it can do. We encourage you to call us for any and all of your drilling needs. Every effort has been made to cover adequately the

operation of the DD-240™ directional drill. Specifications are subject to change without notice or obligation to retrofit units already in the field. This manual will be constantly updated to remain current with new operations. Please call if there are areas requiring further explanation or instruction. Material contained herein may not be reproduced in whole or in part without the express written permission of American Augers Inc., the Innovative Leader in the Trenchless Industry.

Machine Serial Number _____

Engine Serial Number _____



Machine Serial Number Location



Location of Engine Serial Number

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1.0 GENERAL INFORMATION
1.1 USE AND MAINTENANCE MANUAL
1.1.1 DATA OF MANUAL

TITLE: Operation & Safety Instruction Manual,
Model DD-240 Horizontal Directional Drill
EDITION: 2006
Part number: DD100240BOOK-01

1.1.2 CONTENTS OF MANUAL

- Section 1 General Information
- Section 2 Description
- Section 3 Storage and Transport
- Section 4 Use
- Section 5 Maintenance
- Section 6 Diagnostic
- Section 7 Demolition

1.1.3 WHO SHOULD USE THIS MANUAL

1.1.3.1 TRANSPORTER

The transporter is not authorized to handle the machine nor start the engine. Only trained personnel having a written authorization are allowed to load and unload the machine from the transport vehicle (see: USER). Relevant parts of the manual are in Section 3 Storage and Transport.

1.1.3.2 USER

At consignment of the machine, a technician either from the authorized dealer or from American Augers is available for training one or more operators.

Only trained personnel are qualified to operate and maintain the machine.

We recommend following the procedure of the acceptance and test-run certificate, which must always come with the machine together with the manual for any other subsequent training. The authorized dealer is always available for any further information or instruction. The user must read and follow the manual.

1.1.3.3 MAINTENANCE TECHNICIAN

The technician in charge of maintenance must get acquainted with operation and handling of the machine, he must be able to check that there are no faults in order to carry out maintenance work with adequate equipment and protection. In case the technician is not qualified, he must inform a qualified person so that skilled personnel are called for special work (example: adjustment of Caterpillar engine, welding, etc.). The technician must read and follow the manual.

1.1.4 OWNERSHIP OF INFORMATION

American Augers, Inc. reserves all rights to the information in this manual.

The manual cannot be reproduced or photocopied in part or in whole without previous written authorization from American Augers Inc. The use of the manual is restricted to the customer who received it and only for purposes of installation, use and maintenance of the relevant machine.

American Augers declares that the information contained in this manual fits the technical and safety specifications of the machine. American Augers disclaims responsibility for direct or indirect damages to persons or property caused when the manual or the machine are used in violation of the information contained herein.

The information contained in the manual refers only to the machine mentioned in Paragraph 1.3. MACHINE IDENTIFICATION DATA.

American Augers reserves the right to modify or improve the manual and the machines without notice.

1.2 MANUFACTURER IDENTIFICATION DATA

AMERICAN AUGERS, INC.
135 U.S. Rt. 42, P.O. Box 814
West Salem, Ohio 44287 USA
Tel. 419-869-7107 • Fax 419-869-7425

1.3 MACHINE IDENTIFICATION DATA

Type: Directional Drill

Model: DD-240

Serial number:

Year of manufacture:

Location of identification plate: See photos on page 2.

1.4 DECLARATION OF EC CONFORMITY

If required, the declaration of EC conformity is issued at consignment of the machine together with the manual. REFER TO: Figure 1 Declaration of EC Conformity.

1.5 GENERAL INFORMATION ON SAFETY

1.5.1 SAFETY STANDARD

In designing and construction of the machine, standards have been adopted in order to satisfy essential safety requirements with subsequent modifications under applicable directives. In particular, suitable measures to prevent risks for operators during transport, use, maintenance and demolition of the machine have been completed.

The complete documentation of the measures adopted for safety purposes is contained in the technical file of the machine, registered by the manufacturer.

The detailed analysis of risks carried out by the manufacturer are intended to eliminate most of the risks connected with the conditions of use of the machine, both foreseen and reasonably foreseeable.

The manufacturer recommends that the user carefully follows instructions, procedures and advice contained in the manual and the laws in force on the work site, as well as the use of all protective equipment, both integrated in the machine and personal protective equipment.

1.5.1.1 SAFETY AWARENESS PROGRAM

UNDERSTANDING OPERATION SAFETY

All references throughout this manual are to current models of the DD-240 directional drill. Please call American Augers if you encounter problems not addressed in this manual.

Refer to the Safety Awareness Program in this manual before attempting to operate this machine.

BE AWARE OF SAFETY INFORMATION



This is the safety alert symbol. This symbol is placed in the manual to alert you to the potential for bodily injury or death.

UNDERSTAND SIGNAL WORDS

Signal words are used to identify safety information within the text of this manual, and are used on the hazard alert signs used on the machine.

DANGER

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

WARNING

indicates a potential hazard or unsafe situation which, if not avoided, could result in death or serious personal injury.

CAUTION

indicates a potential hazard or unsafe practice, which if not avoided may result in minor personal injury or product or property damage.

If you are the owner, operator, or the helper using an American Directional Drill, it is important that you recognize that your drill is a powerful piece of construction equipment. (IT MUST BE OPERATED WITH RESPECT AND CAUTION.)

All operators or trainees must carefully read and thoroughly understand this Operation Manual before starting or using this machine. Thorough training of both operators and helpers is essential for the safe operation of this equipment. Never allow inexperienced personnel to operate or work near the machine unless they are carefully supervised during training. In the United States, workplace safety is regulated by the Occupational Health and Safety Administration (OSHA). OSHA regulations are found in the *Code Of Federal Regulations*, Chapter 29. This is known as 29CFR1910. Information can be obtained from your Regional U.S. Department of Labor Office.

Please note the limited warranty included in this manual. If you have questions on the warranty or about any part of the machine operation, please contact American Augers.

NOTICE

Location of Hazard Alert Signs The drawings on Fig. 7 and Fig. 8 show the locations of hazard alert signs as they are placed on the DD-240.

These hazard alert signs are placed on the machine to inform your operator and other personnel of potential hazards that exist while these machines are in operation. These signs must be kept clean and legible. Replacement signs are available from American Augers.

NOTICE

American Augers disclaims any responsibility for damages to persons or property caused by operation in violation of safety advice contained in the manual.

1.5.2 QUALIFICATION OF PERSONNEL

If skilled personnel operate the machine according to the advice and instructions supplied in the manual, the machine will operate safely. All the operations of transport, use and maintenance must be carried out only by skilled and authorized personnel, after studying and understanding the instructions supplied by the manual.

NOTICE

American Augers disclaims any responsibility for damages to persons or property caused by the operation of the machine by untrained personnel.

1.5.3 USE OF PERSONAL PROTECTIVE EQUIPMENT

WARNING

If personal protective equipment is not used, serious injury or death of personnel can occur.

The operator and all other personnel on the worksite must use proper protective equipment

according to their duties.

In addition to safety shoes, helmets and safety glasses, it is necessary to wear hearing protection. The driller, locating device operator and others in contact with the machine should wear electric insulating boots in case of striking a buried electric cable.

1.5.4 DANGEROUS ZONES—SAFE DISTANCES

Any zone inside or near the machine where the presence of a person means a risk for his health and security.

All the areas concerned with handling of parts or machine.

During transport, keep a distance of at least 2 m (6.5 feet) away from the drill.

While drilling, some drilling fluid can be sprayed from the cutting head.

In addition, in case of striking a buried electric cable, the earth around the drill can become electrically charged. Keep spectators at least 8 m (25 ft) from the drill and associated equipment.

During maintenance, use adequate supports before releasing bolts, pins, valves, pipes and pistons.

Safety distances during transport: 2 m (6.5 ft)

Safety during self-moving: 2 m

Safety distances during use: 8 m (25 ft)

Safety distances during maintenance: 8 m

1.6 LEGAL ASPECT OF THE MANUAL

NOTICE

American Augers disclaims any responsibility for damages to persons or property caused by the operation of the machine in violation of the instructions contained in this manual

1.7 USES ALLOWED

Work allowed:

Installation of drill pipe into the earth. Rotation of drill pipe. Use of bentonite fluid to create the pilot bore. Removal of drill pipe from the earth.

Use of bentonite fluid to back ream the bore.

Pulling a reamer through the pilot bore.
Pulling product pipe or cable through the bore.

1.7.1 FEATURES OF THE SOIL TO BE DRILLED

1.7.1.1 TYPE OF GROUND

The machine is suitable for working in the following types of soil:

-Sand -Gravel -Loam -Clay -Shale -Rock

1.7.1.2 GROUND LEVELLING

Max. transversal inclination (lateral) : 10°
Max. longitudinal inclination (frontal): 15°
Max. height the machine will climb: 150mm (6in.)

1.7.1.3 AMBIENT CONDITIONS

Allowed temperature between -15°C and +40°C [5°F and 105°F] (with oils and coolants recommended).

For temperature lower than 0°C [32°F] REFER TO Paragraph 4.21. OPERATION WITH TEMPERATURES BETWEEN -40°C AND -15°C [-40°F AND +5°F]. For temperatures not included in this range, get in touch with American Augers.

Relative humidity allowed during work: 100%

Max. altitude: 2000 m [6500 ft] above sea level

Atmospheric conditions must allow adequate visibility within the safety area. It is inadvisable to use the machine during rainy conditions where lightning is present.

1.7.2 FEATURES OF TRANSPORT

The machine must be transported on a truck trailer, according to the Highway laws in force in the relevant country. It must be properly secured onto the trailer deck.

The thrust frame must be in the retracted position.

The front foot must be lowered to the trailer deck. REFER TO : Section 3 STORAGE AND TRANSPORT

If the drill exceeds overall dimensions allowed, it is necessary to flag it according to the Highway laws

of the countries involved in the transport.

1.7.3 MACHINE HANDLING PROCEDURES

1.7.3.1 TRANSPORT

When the machine is loaded on a trailer, only one operator is allowed to operate the tramming controls for safety reasons.

1.7.3.2 USE

When the machine is used, only one operator is allowed to operate the drilling functions for safety reasons. Other trained personnel may work near the drill if they are wearing personal protective equipment.

1.7.3.3 MAINTENANCE

During maintenance with the machine running, only one qualified technician is allowed to operate the controls for safety reasons.

For maintenance operations with the machine off, other trained personnel may work on it.

1.8 USES NOT ALLOWED

The machine is not designed and built for any uses not specified in Paragraph 1.7. USES ALLOWED.

In particular the uses not allowed are the following:

- 1) Drilling on sandy, collapsing or incoherent ground.
- 2) Drilling on boggy ground or with too much water that compromises the grip or the support of the tracks.
- 3) Use of the machine for pulling or pushing other machines.
- 4) Movement of the machine pulled or pushed by other machines.
- 5) Use of the machine in explosive and/or inflammable area.
- 6) Use the front foot to lift the tie down stakes out of the earth.
- 7) Any time when there are vibrations which compromise the safety of the operator or the integrity of the machine.
- 8) Use when other persons different than the operator are present within the dangerous zones indicated in Paragraph 1.5.4. DANGEROUS ZONES—SAFE DISTANCES.

▲ CAUTION

It is the responsibility of the user to decide whether to use the drill in conditions which can cause excessive wear or damage to the machine.

▲ CAUTION

Stop working when any situations compromise the safety of the operator or the integrity of the machine.

NOTICE

American Augers does not bear any responsibility for damages caused by the incorrect use of the machine, nor for wear and damage caused by the particular quality of the drilled material.

1.9 WARRANTY

1.9.1 GENERAL CONDITIONS

Any warranty is subject to the conditions specified in the warranty certificate. Except for the specified exclusions and limitation, the warranty certificate covers all the material supplied for a period of 6 months beginning from the shipping date.

Extensions can be granted only by the President of American Augers and must be signed and enclosed with the certificate consigned at the time of sale. No extension can be granted after sale.

1.9.2 LIMITATIONS OF WARRANTY

The warranty for all the components bought and not produced by American Augers directly are subject to the original warranty of suppliers/manufacturers and therefore defects in materials or workmanship are considered valid only if they are recognized by the same suppliers/manufacturers. In particular the warranty on the Caterpillar engine is supplied by the Caterpillar dealer in the area where the drill is sold.

1.9.3 WARRANTY CERTIFICATE

See Fig. 2.

1.9.4 REQUEST FOR SERVICE SUPPORT

For any request of service support in or out of the warranty period, contact your authorized dealer. Have available model number, serial number of the machine and working hours indicated on the instrument (Fig. 22, HOURS).

1.9.5 WARRANTY AND SERVICE FOR CATERPILLAR ENGINE

The local Caterpillar dealer normally solves problems related to Caterpillar engine. The Caterpillar warranty is valid worldwide. Only Caterpillar dealers are authorized to perform repairs under warranty and supply service and spare parts.

1.10 SERVICE AGREEMENT

Contact the local dealer.

NOTICE

This manual must be kept for the whole lifetime of the machine so that it can be easily found if needed. If the machine is sold, the manual must be provided to the new owner.

1.11 CONVENTIONS

1.11.1 CONVENTIONS OF TERMINOLOGY

As the directional drill is not a conventional construction machine we list some terms normally used in the text with their description. FRONT is the end with the wrenches and foot. LEFT or RIGHT as seen standing behind the machine facing FRONT. The operator's console is on the RIGHT side.

1.11.2 TYPOGRAPHIC CONVENTIONS

In the manual different typographic notes have been used for identifying dangerous conditions. For example:

NOTICE

Notices, cautions and warnings including important information are set apart from the text.

REFER TO: Safety Awareness Program, Paragraph 1.5.1.1.

2.0 DESCRIPTION

2.1 PARTS OF THE MACHINE

The machine consists of the following assemblies (REFER TO: Fig. 40).

2.2 DESCRIPTION OF DIRECTIONAL DRILL

The directional drill contains the following.

2.2.1 THRUST FRAME

Supports the carriage

2.2.2 CARRIAGE

Imparts thrust and pullback force, and rotary motion to the drill pipe

2.2.3 REAR THRUST STABILIZERS (JACKS)

Resist the tendency of the drill to move backward when thrusting

2.2.4 FRONT STABILIZERS (JACKS)

Widen the base of the machine and serve to level the crane

2.2.5 FIXED WRENCH

A hydraulic clamp for holding the pipe during tightening or loosening the joints

2.2.6 BREAKOUT WRENCH

A moveable wrench that applies enough force to loosen pipe joints

2.2.7 MUD

Drilling fluid containing water and usually bentonite and other additives depending on soil conditions.

Refer to the Safety Awareness Program in this manual before attempting to operate this machine.

2.2.8 MUD PUMP

A pump separate from the machine that forces drill fluid through the drill pipe.

2.2.9 TIE DOWN SYSTEM

H-beam stakes which are driven through the front foot to anchor the drill to the earth.

2.2.10 DRILL PIPE

Specially designed pipe threaded on both ends that conducts thrust and pullback forces, and carries drilling fluid to the cutting head.

2.2.11 ES!LOK®

An exit side lockout system that is capable of disabling the rotation and linear movement of the drill pipe.

2.2.12 ZAPALERT®

An instrument that sounds an alarm should the drill become electrically energized.

2.2.13 UNDERCARRIAGE

Tracks and associated parts for support and movement of the machine.

2.2.14 CRANE

Used to lift sections of pipe on and off the machine

2.3 PURPOSE OF THE MACHINE

The directional drill is designed for the production of a bore under the earth with a system more efficient than conventional excavating. The main tool is the cutting head; it may be equipped with a blade or with hard metal teeth and is able to remove soil. The result is a bore with circular section ready for positioning pipe or cable, without the need for back

filling and compacting. The cutting head is advanced by connecting it to sections of drill pipe which are added by the operation of the directional drill. In addition, soil is removed and the bore is lubricated by use of a mixture of water, bentonite and other substances, which is forced into the drill pipe by the mud pump.

The actual bore dimension cannot be guaranteed for each bore. For example: depending on soil conditions and the size of the pipe or cable to be installed, it may be necessary to enlarge the bore by pulling a reamer through it. Operation in hard rock requires additional special accessories which are not supplied and must be ordered separately.

NOTICE

American Augers disclaims any responsibility for differences in dimensions between theoretical and actual bores.

2.4 STRUCTURE

The cutting head (connected to drill pipe held by the machine) is positioned over the desired line of advance of the bore. The entry angle of the cutting head into the soil is determined by the length and depth of the bore, in consideration of the allowable bending of the drill pipe.

The drill is anchored in place using the tie down system and by positioning the rear thrust stabilizers. Drilling fluid is prepared by a mud mixing system (available separately). Operation of the mud pump forces a jet of drilling fluid out orifices in the cutting head.

At the same time, the pipe is advanced by operation of the carriage. It is possible to steer the cutting head as it passes through the soil. By knowing the orientation of the cutting head, the operator can rotate the drill pipe to correct the path of the bore. By continuously rotating the pipe, the cutting head advances without steering. The drill pipe and its joints have been designed to withstand a certain amount of bending.

It is customary and desirable for the drilling fluid to return to the surface at the entry point. This fluid carries all the soil removed in the production of the bore. A pit may be dug adjacent to the entry

point of the cutting head to store the returning drilling fluid.

The operator is seated to permit good visibility of the operation of the drill and various gauges that indicate performance. It is possible to control all the functions by means of electric or hydraulic controls under complete safety conditions for the operator.

2.5 TECHNICAL SPECIFICATIONS

2.5.1 GENERAL FEATURES (DD-240)

Approx. mass: 38.57 Tonnes kg (85,000 lb)

Median pressure on the ground: 0.63 kg/cm², 9 psi

Dimensions in working position, 18° drill angle:

Height: 7.05 m [23 ft 2 inches]

Width: 3.11 m [10 ft 2 inches]

Length: 15.8 m [51 ft 8 inches]

Dimensions in transport position:

Height: 3.6 m [11 ft 8 inches]

Width: 2.5 m [8 ft 2-1/4 inches]

Length: 15.8 m [51 ft 8 inches]

2.5.2 DIESEL ENGINE (DD-240)

Fuel: diesel fuel

Piston displacement: 15.2 L [928 cu. inch]

Power: 391 kW (525 HP)

Fuel tank capacity: 757 L [200 U.S. Gallons]

Hours of operation per tankful: approx. 8 hours at full engine load

REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

2.5.3 ELECTRIC SYSTEM

Voltage: 24 volt DC start and run; 12 volt accessory

2.5.4 HYDRAULIC SYSTEM (DD-240)

Pressures: Rotary (break-out): 345 bar [5000 psi]

Rotary (make-up): 345 bar [5000 psi]

Open loop: 321 bar [4650 psi]

Max. temperature allowed for hydraulic oil is 80°C [175 °F].

2.5.5 PERFORMANCE AS SUPPLIED (DD-240)

Max. carriage speed: 39.6 m/min (130 FPM)
Rotary speed: 0—95 rpm
Drill angle: 10°-18°

2.5.6 VIBRATION

Vibration is an indication of incorrect operation, such as advancing the drill pipe too rapidly.

CAUTION

Stop work in case of vibration, which could compromise the safety of the operator or the integrity of the machine. Modify operational procedure

2.5.7 NOISE

People working near and always inside the minimum safety distance (8 m [25 feet] from the nearest point of the machine) must wear adequate hearing protection suitable to their working position.

DANGER

The noise generated by the machine may cause injury to personnel. Observe the national laws in force about the protection from risks caused by noise.

2.6 RESPONSIBILITY

NOTICE

American Augers disclaims any responsibility for inconvenience, faults or malfunctioning of the machine in circumstances where procedures identified in paragraph 4.18 are not followed.

3.0 STORAGE AND TRANSPORT

3.1 STORAGE

3.1.1 MINIMUM STORAGE SPACE REQUIRED (TRANSPORT POSITION)

DD-240: level 3 x 16 m, height 3.6 m [118 x 630 inches, height 140 inches].

3.1.1.1 PROTECTION WHILE IN STORAGE:

If the machine has been lubricated it can be stored in an exposed area up to 30 days. For storage periods more than 30 days place it in a covered and dry area. Level the storage site so that the tracks are fully supported.

DD-240: The surface must be able to support 38.57 Tonnes kg (85,000 lb).

3.1.2 STORAGE SITE ENVIRONMENT

Temperature allowed: between 0 and +50°C [32°F and 120°F]. For temperatures between 0° and -40°C [32°F and -40°F], consult the Caterpillar manual and follow the instructions for storage of the engine. Verify that there is no water or drilling fluid in the drilling fluid course and no water in the diesel fuel and hydraulic oil tanks.

3.1.3 PROCEDURES OF STORAGE

- Clean all mud and other foreign materials off the machine.
- Position the machine on a level surface. Position the carriage in the center of the thrust frame. Raise the front foot by retracting the thrust frame.
- Switch off electric system by turning the battery switches at the battery box.
- Lubricate the entire machine according to the daily schedule. Coat all exposed hydraulic cylinder rods with oil to protect against corrosion.
- For long periods of storage (more than 30 days) place the machine in a covered and dry site, consult and follow the instructions of storage for Caterpillar engine (mentioned in the relevant maintenance manual), disconnect batteries and store them separately at temperatures above 0°C (32°F).
- Eliminate sediment and water from the tanks (diesel fuel and oil), top up all the gearboxes and the hydraulic oil tank.
- For periods longer than 30 days, disconnect the es!lok® battery charger located inside the storage box. This charger is not affected by the battery switch. If left connected it could discharge the machine batteries.

NOTICE

Before putting the machine back in service reconnect the es!lok® battery charger to either a 12 v DC or 24 v DC supply and recharge the es!lok® batteries. Make sure the es!lok® batteries are charged before attempting to put the machine back into service.

The machine must be kept away from salty or acid environments, from solvents, gas and inflammable liquids and explosives. REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

3.1.3.1 DRAIN OR PROTECT FLUID COURSE

Drain water or bentonite slurry out of fluid course including main mud pump and associated lines. Alternatively, add antifreeze. REFER TO: Paragraph 4.23.4, PROTECTING THE FLUID COURSE FROM FREEZING

3.2 TRANSPORT

WARNING

Transport of the machine must be carried out by trained and authorized personnel only, after learning the information supplied in the manual.

3.2. PRELIMINARY OPERATIONS FOR LOADING THE MACHINE FOR TRANSPORTATION

Clean the machine by using a water spray.

CAUTION

Don't direct water spray inside the muffler, or the air filter, against electric components or control panels.

WARNING

Before loading the machine on a trailer, follow the instructions supplied in this manual carefully.

3.2.2 PROCEDURES OF POSITIONING

Position the thrust frame in order to obtain a minimum overall dimension. Remove the tie-down stakes from the front foot and store them in a safe location. Make sure to retract the thrust frame and raise the rear thrust stabilizers.

Position the carriage as far forward on the thrust frame as possible.

3.2.3 TRANSPORTATION

Considering dimensions, weight and shape of the machine, the transporter is responsible for using the proper method of transport in conformity with local regulations. Detailed information on the machine features are in: Section 1 GENERAL INFORMATION and Section 2 DESCRIPTION paragraph 2.5.1.

3.2.4 LOADING THE MACHINE FOR TRANSPORTATION

WARNING

Make sure that all personnel keep a safe distance while loading the machine for transportation. Start up and handle the machine according to Paragraph 4.7, OPERATION. Use the tethered tramming controls and stay clear of the machine. Always use low speed for loading and move the controls delicately.

WARNING

Do not sit or stand on the machine while tramming. Unexpected movement can cause death or serious injury. Use remote tramming control only, while standing at ground level with good visibility.

Start the engine.

Remove the locking bolt from the thrust frame and the thrust frame support

Operate the Thrust/Pullback control (Fig. 24,) to position the carriage at the Carriage Lock (Fig. 20). Slide the Lock Plate (Fig. 20-A) into the socket on the carriage and engage the pin to hold the Lock Plate in position.

Operate the Thrust/Pullback control (Fig. 24) to position the thrust frame in the transport position.

Raise the front jacks. Retract the front jacks toward the center line of the machine. Gather the control hoses and stow them on the deck of the drill.

Rotate the crane boom towards the rear of the machine and lower the boom onto the crane rest.

Tie off the hook block (Fig. 19).

Remove the handrails from the walkway and store them on the machine (Fig. 21).

Install the hose carrier hold down (Fig. 18).

Tilt the thrust frame of the machine as necessary in order to avoid the front end dragging the ramps or trailer deck while loading or unloading.

Connect the tramming control box (Fig. 27). There are three connections, one on each side and one at the rear, so the operator can have the best possible visibility.

Proceed slowly when passing the edge of the trailer as the machine could swing, when changing the inclination.

After reaching the final position on the trailer, make sure that the front foot is lowered totally.

Lower the rear thrust stabilizers (see Fig. 4/) and make sure the machine is switched off.

3.2.5 TRANSPORT CONDITIONS

Anchor the machine.

Remove the ignition key from the control panel (Fig. 22) and keep it in a safe place.

Switch off the battery switch (Fig. 28).

Tie the machine to the trailer deck and secure the front foot to the trailer deck with chains. REFER TO: Fig. 9.

3.2.6 UNLOADING OPERATIONS

WARNING

Make sure that all personnel keep a safe distance when unloading the machine after transportation. Check that the machine lost no liquids during transport or storage, in particular check if there is the proper amount of hydraulic oil in the tank.

Switch ON the battery master switch (Fig. 28). Insert the ignition key in the control panel (Fig. 22).

Make sure three emergency stop push buttons are UP (Fig. 24, Fig. 25 and Fig. 27). Always use low speed for shifting and move the controls delicately.

Raise the front foot by tilting the thrust frame using the Tilt Lever (Fig. 29).

Raise the rear thrust stabilizers by Using Rear Jack Levers (Fig 29).

Connect the tethered tramming controls (Fig. 27).

Press the RESET button (Fig. 27). Propel the machine using Left and Right Track controls and stay clear of the machine. The tether is long enough for the operator to walk along either side the machine for good visibility. There are three connectors for the tether—one on each side of the drill and one on the back.

WARNING

Do not sit or stand on machine while tramming. Unexpected movement can cause death or serious injury. Use remote tramming control box only while standing at ground level with good visibility.

WARNING

A crushed or damaged tramming control could result in unexpected movement of the machine. Unexpected movement can cause death or serious injury; Always replace the tramming control into its holder.

Angle the thrust frame as necessary in order to make sure that the front foot does not drag on the ground.

Proceed slowly when passing the edge of the trailer as the machine could swing, when changing the inclination.

3.3 LIFTING THE MACHINE

If the machine must be lifted (example: to load on a ship) place the machine on a flat rack with adequate capacity for weight. Position the machine on the flat rack according to paragraph 3.2.4 above.

Switch off the engine.

Use chains to anchor the machine to the flat rack.

Use chains to anchor the machine to the flat rack.

Attach the lifting lines to the flat rack, not to the machine. Use spreader bars to ensure that the lifting lines do not come in contact with the machine (Fig.10).

4.0 USE

4.1 WORKING SITE PHYSICAL FEATURES

4.1.1 MINIMUM SPACE REQUIRED

In working position 3.11 m [10 ft 2 in] width and at least 15.5 m [51 feet] length. Height required for working on flat ground: 7.05 m [23 ft 2 inches] (to allow adding or removing pipe). Additional clear distance must be maintained between the crane and any overhead electric wires. These dimensions do not allow for storage of pipe or tooling nor the set up and operation of a mud plant. In addition, mark off a safety zone 8 m [25 ft] in each direction from the machine and prevent spectators from entering this zone.

4.1.2 GROUND LEVELING

The machine is able to operate on surfaces with a max. lateral inclination of 10°, slope in the running direction up to 15° and to cross steps up to 150mm [6 inches] high. Otherwise level the site using earthmoving equipment.

4.1.3 TYPE OF GROUND

The machine is designed to work on clay, asphalt, cement, rock and normal soil. It is not suitable to work on crumbling, marshy or inconsistent soil, which cannot guarantee traction or support

during work. REFER TO: Paragraph 1.7 USES ALLOWED and Paragraph 1.8 USES NOT ALLOWED.

4.1.4 LIGHTING

There has to be enough light to guarantee good visibility of all the movable parts. It may be necessary to equip the work area with portable lights for night operation.

4.1.5 OPERATING TEMPERATURE: between -15°C and +40°C [+5°F and 105°F].

For temperature lower than 0°C [32°F] use winter fuel for easier starting and in order to avoid the stoppage of filters from deposits of wax. Make sure that all the liquids have suitable features. REFER TO: Section 5 MAINTENANCE. For temperature included between -40°C and -15°C [-40°F and +5°F] REFER TO: Paragraph 4.22 OPERATION UNDER AMBIENT TEMPERATURES BETWEEN -40°C AND -15°C [-40°F AND +5°F].

4.1.6 RELATIVE HUMIDITY ALLOWED

100% allowed when performing work.

4.1.7 MAX. ALTITUDE

2000 m [6500 ft] above sea level.

4.1.8 ATMOSPHERIC CONDITIONS

They must allow adequate visibility within the safety area. It is inadvisable to use the machine during rain where lightning is present.

4.2 FUNCTION OF THE MACHINE

NOTICE

For a detailed description of operation and parts of the machine see Section 2 (DESCRIPTION.)

The directional drill is designed for the production of a bore under the earth with a system more efficient than conventional excavating and restoration of the site. The main tool is the cutting head; it may be equipped with a metal shoe or with hard metal teeth and is able to remove soil. The result is a bore with circular section ready for positioning pipe or cable, without the need for back filling and compacting.

The cutting head is advanced by connecting it to sections of drill pipe which are added by the operation of the directional drill. In addition, soil is removed and the bore is lubricated by use of a mixture of water, bentonite and other substances (drilling fluid, also called mud), which is forced into the drill pipe by the mud pump. The mud circulates through the annulus of the bore and returns to the surface at the entry point.

The actual bore dimension cannot be guaranteed for each bore. For example: depending on soil conditions and the size of the pipe or cable to be installed, it may be necessary to enlarge the bore by pulling a reamer through it. Operation in hard rock requires additional special accessories which are not supplied and must be ordered separately.

4.2.1 NORMAL OPERATION

The operator has manual control over the rotation of drill pipe, the advance and return of the carriage, flow and volume of mud, and operation of the fixed wrench and breakout wrench. The operator also has manual control over the movements of the pipe loader. In addition the operator has manual control over the angle of the thrust frame.

4.3 DANGEROUS ZONES—SAFE DISTANCES

The machine is designed to be operated by one operator, with one additional worker to load and unload pipe baskets as required. This worker may also have the duty to mix and transfer mud to the drill. Other personnel must keep a distance of 8m [25 ft] from the machine. A third worker may be employed along the intended bore path to operate the locating instruments and report their readings to the operator.

Refer to the Safety Awareness Program in this manual before attempting to operate this machine.

After moving into position, the machine remains stationary in operation and has rotating parts, made up by various movable components, therefore each part has to be considered dangerous.

4.3.1 DANGEROUS PARTS AND DESCRIPTION OF THE RISK.

4.3.1.1 TIE DOWN SYSTEM

Consisting of Hbeams that are heavy and present a danger of pinching while being installed.

4.3.1.2 REAR THRUST STABILIZERS

Are extending parts that present a danger of crushing.

4.3.1.3 FRONT STABILIZERS

Are extending parts that present a danger of crushing.

4.3.1.4 CARRIAGE

Has movement forward and backward as well as rotating parts, that present pinch points and a danger of becoming entangled.

4.3.1.5 WRENCH ASSEMBLY

Presents the danger of pinch points

4.3.1.6 CUTTING HEAD

Tools under fast movement and high power. Can emit fluid under high pressure for cutting the earth, also presents a danger of becoming entangled.

4.3.1.7 DRILL PIPE

Heavy objects that must be added or removed from the drill. If handled carelessly, can fall or swing. While being forced into the earth the drill pipe is exposed and may be in rotation, presenting a danger of becoming entangled.

4.3.1.8 MUD SYSTEM

Presents a danger of high pressure fluid spray

4.3.1.9 REAMING TOOLS

Turn fast under high power. While on the surface they present a danger of becoming entangled.

4.3.1.10 DIESEL ENGINE AND MUFFLER

Diesel engine and muffler produce high temperatures. Danger of burns.

Before approaching always wait until:

-the machine is motionless

-the engine is off

-the movable parts are on the ground or in rest position

-the hot parts have cooled.

4.3.1.11 PERSONAL PROTECTIVE EQUIPMENT

Always wear suitable personal protective equipment:

-protection for hearing

-safety shoes

-helmet

-safety glasses

REFER TO: Paragraph 1.5.4

DANGEROUS ZONES—SAFE DISTANCES

WARNING

When using the machine, make sure that all personnel keep a safe distance (8 m [25 ft] in every direction). Use adequate protective equipment for any operation to be done near the machine. See Fig. 5.

4.4 QUALIFICATION OF THE OPERATOR

After delivery of the machine, a technician from the authorized dealer or from American Augers is available for training one or more operators. After training, personnel are qualified for operation and maintenance of the machine.

The operator must know every part of the manual. American Augers is available for any further information or instruction. It is expected that customer personnel will be available and ready for training upon the scheduled arrival of the American Augers trainer.

4.5 POSITION OF THE OPERATOR

During drilling the only position of the operator for operating the machine is at the control console.

Additional workers will assist with loading and unloading the pipe as required. The operator must not ride on the machine while it is moving.

WARNING

Do not sit or stand on machine while tramming. Unexpected movement can cause death or serious injury. Use remote tramming control box only while standing at ground level with good visibility

WARNING

A crushed or damaged tramming control could result in unexpected movement of the machine. Unexpected movement can cause death or serious injury; Always replace the tramming control into its holder.

WARNING

Before leaving the console, make sure that all the controls are in OFF or NEUTRAL position.

4.6 CONTROLS AND INSTRUMENTS

4.6.1 CONTROLS

The drilling functions are controlled by levers and switches mounted on an extendable console. As an option, the controls can be located inside a weatherproof driller's cabin.

One panel is at the rear of the engine. One panel is on the right side of the machine. The operating controls are on a hinged arm at the right front corner of the machine.

4.6.1.1 TRAMMING CONTROL

The control box can be connected at one of three locations. The only function of controls on this box is the positioning of the drill on the job site or for loading and unloading from a transport. This switch box is connected to the drill by a flexible coiled cord, and a container has been provided to hold the switch box when it is not in use. The switch box also contains an emergency stop push button. (Fig. 27).

NOTICE

The switch must be in the TRAVEL position (Fig. 25) to activate the tramming control.

WARNING

A crushed or damaged tramming control could result in unexpected movement of the machine. Unexpected movement can cause death or serious injury. Always replace the tramming control into its holder.

4.6.1.2 EMERGENCY STOP PUSH-BUTTONS

One red emergency stop push-button is positioned on the tramming control switch box, a second is located on the setup panel on the right side. A third is located at the control console. These push-buttons stop the diesel engine and consequently all the functions of the machine.

After an emergency stop, reset it by lifting the push-button before attempting to restart the engine.

NOTICE

It is not possible to restart the engine if any emergency stop push-button is on (down).

4.6.2 INSTRUMENTS AND CONTROLS

(LIST)

4.6.2.1 Fig 22—Engine Panel A

- Service Meter(Hours)
- Engine Start Switch
- Throttle
- Emergency Stop
- 2 Fault Lights

4.6.2.2 Fig.23—Engine Panel B

- Voltmeter
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Fuel Pressure
- Engine Oil Temperature
- Digital Engine Speed (RPM)

4.6.2.3 Fig. 24—Control Console

- Fluid Levels Lights
- Pullback Pressure
- Thrust Pressure
- Makeup Pressure
- Rotating Clamp Pressure
- Fixed Clamp Pressure
- Rotary Pressure
- Work Lights ON/OFF
- Wrench Make/Break
- Fixed Clamp
- Service Filters Warning Lights
- Emergency Stop
- Stop
- Start Engine
- Throttle
- Engine Speed (RPM)
- Rotary Speed Digital Display
- Rotary Brake FREE/LOCK
- Carriage Speed Select
- Rotary Speed Select
- Carriage Push/Pullback
- Wrench MAKEUP/BREAKOUT
- Rotary Clamp GRIP/RELEASE
- Fixed Clamp GRIP/RELEASE
- Rotary MAKEUP/BREAKOUT
- Wrench Travel FORWARD/REVERSE
- Upper Pipe Support RAISE/LOWER
- Lower Pipe Support RAISE/LOWER

4.6.2.4 Fig. 25—Set-up Control Panel

Mode TRAVEL/DRILL
Drill Frame Extend/Retract
Main Fuse
Throttle Down/Up
Start Drill/Engine
Stop Drill/Engine
SIG+ Elec. Jack Guidance Signal (+)
SIG- Elec. Jack Guidance Signal (-)

4.6.2.5 Fig. 26—Crane Pendant Control

Power OFF/ON
Lift Up/Down
Extension In/Out
Winch Up/Down
Rotate Right/Left
Speed Control On/Off
Engine Start/Stop
Air Compressor On/Off
Rotate Right/Left
Speed Control On/Off
Engine Start/Stop
Air Compressor On/Off

4.6.2.6 Fig. 27—Tramming Control

Speed Control
Emergency Stop
Left Track FORWARD/REVERSE
Reset
Right Track FORWARD/REVERSE

4.6.2.7 Fig. 28—Battery Switch and Es!lok

Battery On/Off
Es!lok Reset

WARNING

Make sure all the controls are in the NEUTRAL or OFF position before starting the engine.

WARNING

Replace any malfunctioning signalling instrument immediately.

4.6.3 ES!LOK® LOCKOUT SYSTEM

The exit side crew has to work in contact with drill pipe and down hole tooling. Unexpected movement or rotation of the drill pipe or tooling can cause death or serious injury. The es!lok® exit side lockout system (Fig. 29-1) allows the exit side crew to lock out movement and rotation of the drill pipe and tooling. REFER TO: Attachment 2, ES!LOK® Owner's Manual.

WARNING

Do not attempt to bypass the es!lok® system. Operation of the drill with the es!lok disabled can result in injury or death.

WARNING

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches.

4.6.4 ZAPALERT™

Accidental contact with an underground electrified wire can cause death or serious injury to the drilling crew from electric shock. Crew personnel should wear personal protective equipment. It is essential that the crew is aware if the drill and related equipment become energized. The ZAPALERT® device senses the difference in electric potential (voltage) between the drill rig and earth ground and sounds an alarm. REFER TO: Attachment 3, ZAPALERT™ Manual.

4.7 OPERATION

CAUTION

Read instruction manual before operating (optional) engine preheater. Heater must be preheated up to 30 seconds before engine cranking. Do not operate preheater for more than 3 minutes after engine starts.

⚠ WARNING

Do not use starting fluid (ether). Immediate engine damage and personal injury may result.

⚠ CAUTION

In case unusual noise, abnormal pressure values, or if signal lights appear, stop the engine immediately and carry out necessary repairs.

4.7.1 STARTING THE ENGINE

REFER TO: Fig. 22 thru 28

REFER TO: Attachment 1, Caterpillar 3406 Diesel Engines.

For temperature included between -40°C and -15°C [-40°F and +5°F] REFER TO: Paragraph 4.23, OPERATION UNDER AMBIENT TEMPERATURES BETWEEN -40°C AND -15°C [-40°F AND +5°F].

Make sure that the battery master switch (Fig.28) is turned on.

Read start up instructions on the attached Caterpillar Engine manual.

Make sure that the three emergency stop pushbuttons (Fig. 24, Fig. 25 and Fig. 27) are not pushed in.

Rotate the key (Fig. 22) to the start position. If the engine does not start within 20 seconds, release the key and await the cooling of starter motor (at least 2 minutes).

Release the key as soon as the diesel engine is running.

Engine oil and hydraulic pressures must reach nominal values within 5 seconds. Adjust engine speed with the controls (Fig. 22 or Fig. 24, or Fig. 25) .

Idle the engine for 5 minutes and run with reduced load until the water temperature reaches 60°C [140°F] and the hydraulic oil reaches 40°C[104°F]. The electric system can be damaged seriously, if the engine is started without the batteries connected. The engine must not run with disconnected batteries.

4.7.2 MOVEMENT OF THE MACHINE

Insure that all personnel and objects are clear from the intended path of travel. Place the Mode Switch (Fig. 25) in the TRAVEL mode. Adjust the engine speed to low (Fig. 22 or Fig. 24 or Fig. 25). Remove the tramming control box from the storage box. Connect the cable to one of the three connectors. Press the RESET control (Fig. 27).

While holding the tramming control box, slowly move the controllers FIG. 27: left lever for left track, right lever for right track, away from you for forward, toward you for reverse travel.

⚠ WARNING

Do not sit or stand on machine while tramming. Unexpected movement can cause death or serious injury. Use remote tramming control box only while standing at ground level with good visibility.

⚠ WARNING

A crushed or damaged tramming control could result in unexpected movement of the machine. Unexpected movement can cause death or serious injury; Always replace the tramming control into its holder.

4.8 SET-UP

NOTICE

Efficient set-up requires the driller plus one additional person.

4.8.1 POSITION THE DRILL

Using the tramming controls, move the drill and position it over the intended center line of the bore. Using levers (Fig. 29), position the thrust frame to the desired angle.

4.8.2 REMOVE HOSE CARRIER HOLD DOWN

See Fig. 18.

4.8.3 INSTALL HANDRAILS ON THE WALKWAY

Remove the handrails from the storage area on the drill. Install them in the sockets provided and secure with a bolt and nut.

NOTICE

The handrail sections ARE NOT interchangeable. Each section is marked with a numeral (Fig. 21) so you may fit it into the matching socket (see Fig. 21).

4.8.4 POSITIONING REAR THRUST STABILIZERS (JACKS)

Use the controls (Fig. 29) to lower the rear stabilizers. Use the controls (Fig. 29, Left and Right Rear Jack) lower the stabilizers to contact the ground. The stabilizers are to resist the rearward movement of the drill when making the pilot bore.

Do not use the rear thrust stabilizers to level the drill.

Do not use the rear thrust stabilizers to lift the tracks off the ground.

DANGER

Keep personnel at a safe distance while lowering stabilizers, they present a danger of crushing.

4.8.5 POSITION THE CRANE

Remove the pendant control from the storage box and connect it at the base of the crane. While the driller operates the crane controls, the second person detaches the hook block from its rest. Movement of the right front jack will move the base of the crane, so be sure to unhook the crane from its rest before moving the front jacks.

To activate the crane, connect the remote control cable to the electric socket at the base of the crane.

Set the engine throttle (Fig. 24) to high. Operate the crane using the controls, (Fig. 26).

4.8.6 POSITIONING THE FRONT STABILIZERS (JACKS)

Use the controls (Fig. 29) to position the front stabilizers. Use the controls (Fig. 29, Left and Right Front Jacks) to lower the stabilizers to contact the ground.

4.8.7 THRUST FRAME ANGLE

The thrust frame has two independent movements.

It can be tilted for changing the drilling angle using the Tilt Control (Fig. 29) and can be advanced or retracted (forward or rearward).

4.8.8 THRUST FRAME EXTENSION

To advance or retract the frame, set the switch (Fig. 29, Mode Switch) to DRILL position.

Operate the Thrust/Pullback control (Fig. 24) to position the carriage at the Carriage Lock (Fig. 21). Slide the Lock Plate (Fig. 21) into the socket on the carriage and engage the pin to hold the Lock Plate in position.

In this position, operation of the Thrust/Pullback control (Fig. 24) will extend or retract the thrust frame. Extend the thrust frame until the front foot contacts the ground.

Install the locking bolt through the holes drilled in the thrust frame and the thrust frame support. This will prevent the thrust frame from sliding on the frame support.

Disengage the pin from the Lock Plate.

Slide the lock plate (Fig. 20) away the socket on the carriage. Drilling operations are done with the lock plate away from the carriage.

4.8.9 ANCHOR THE MACHINE

DANGER

MOVING PARTS. Danger of entanglement. Keep body and clothing away.

4.8.9.1 PLACING THE TIE DOWN STAKES

The tie down stakes are intended to prevent the

movement of the drill as it thrusts pipe into the soil, or pulls on a backreamer or the product. Placing the tie down augers requires another person in addition to the drill operator. While the second person holds the stake in position, the driller drives the stake into the ground using a hydraulic stake driver.

As an alternative, the stakes can be pushed into the soil by carefully using the bucket of a backhoe or excavator to exert downward force on the top of the stake.

 **DANGER**

Keep personnel at a safe distance while driving tie down stakes, they present a danger of crushing.

4.8.9.2 OTHER METHODS OF ANCHORING THE DRILL

In especially soft soils or sand, it may be necessary to use an earth anchor in addition to the tie down stakes

In hard or rocky soil it may be necessary to cut openings in the earth to accept the H-beams. Some soils require the use of a pneumatic drill or other equipment.

4.8.9.3 POUR A CONCRETE ANCHOR

In some soils, it will not be possible to install Hbeams.

After selecting the launch point, the driller may use conventional excavating techniques to create a pit which can be filled with concrete. You may consider placing beams or fasteners into the wet concrete and attach the front foot of the drill by fasteners or welding.

4.8.9.4 CONSTRUCT A “DEAD MAN” ANCHOR

Construct a “dead man” anchor by excavating and back filling. One effective method is to use sheet piling and a steel beam. The sheet piling is placed vertically in the excavation in front of the drill. A steel beam is placed horizontally in front of the sheet piling. A heavy chain or cable is attached

between the steel beam and the front foot of the drill. The excavated soil is replaced and compacted over the sheet piling and steel beam. This arrangement prevents the drill from moving backward when thrusting the drill string into the earth. See Fig. 31.

4.8.10 EXCAVATE THE ENTRY PIT

The drill should be anchored to the earth before excavating the entry pit. Use earthmoving equipment to excavate the entry pit in front of the drill. The pit is used to catch and retain drilling fluid that returns from the bore. Many drillers excavate a smaller pit to one side of the entry pit and connect the two pits together with a shallow channel. Fluid returns enter the larger pit and overflow into the smaller pit. During this process many of the solids returning from the bore settle to the bottom of the larger pit and do not have to be handled by the fluid recycling equipment.

4.9 DRILLING PROCESS

Directional drilling is the process of directing a string of small pipe, known as a drill string, under an obstacle, attach a cable or larger pipe line, and pull it back to the starting point. Various factors should be taken into account such as: 1) Hole size, 2) Required curvature, 3) Hole length, 4) Geology, 5) Minimum ground coverage, 6) Survey technique, 7) Magnetic bearing, 8) Drilling fluids, 9) Entrance angle, 10) Exit angle, 11) Drill pipe, 12) Drilling machine, 13) Preplotting chart, and 14) General working area.

There are two categories. The first will be deep crossings, (4.5 m [15 ft] or more). The second category will be shallow crossings (4.5 m [15 ft] or less). In both categories, the basic drilling methods are the same. The differences are in the manner of guidance and locating the drill string head. Consult the manufacturer of the locating system for exact operating instructions.

The directional drill provides the means for rotating, advancing and retracting the drill string. Depending on the specific project, a certain drill string diameter is selected. Selection of drill string diameter or capacity is largely dependent on the

length of the crossing and the anticipated thrust and pullback required for the finished product line.

At the leading end of the drill string, a cutting head is attached (see Fig. 13). The cutting head is usually equipped with nozzles which direct drilling fluid to the soil formation. While the cutting head is being rotated into the ground, drilling fluid is pumped through the drill string and passes through the nozzles in the head to carry cuttings back to the surface. The drilling fluid is also used as a lubricant to reduce friction and heat between the rotating parts and the ground.

4.9.1 DEEP CROSSINGS - THE SETUP

A drilled crossing can be set up in several different ways. One method is to drill in a constant arc or semi circle (see Fig. 37). The other method would be to enter a hole at a downward angle. The drill string is then directed into a horizontal position and advanced for the distance required to clear the obstruction. The drill string would then be directed at an upward angle to the exit point. A crossing is determined by its depth, starting point and finishing point. Once these criteria are determined, a set back distance is calculated for an entering and exiting point to and from the intended line. A general rule of thumb is that a drill string can bend at the rate of 30.5 m of radius per 2.5 cm of drilling pipe diameter. (Example: the minimum bend radius of a pipe 9.85 cm in diameter is approximately 120 m). [In the English system a drill string can bend at the rate of 100 ft of radius per 1 inch of drilling pipe diameter. (Example: the minimum bend radius of a pipe 3-7/8 inches in diameter is approximately 380 ft).]

Once the project is established and the entering and exit points are known, the process can begin. The drill rig is set up and the drill thrust frame is set to the required angle. This is from 10 to 18 degrees, depending on the characteristics of the crossing. The initial pipe section and cutting head are set into the wrench. (Note: While the setup and drilling is proceeding, a second operation should be started to prepare the product line for installation).

The first piece of drill pipe is made out of a nonmagnetic material to eliminate any interference to the survey probe. This first section is setup to mount the cutting head and the survey probe for guidance. Before the drilling process begins, a magnetic bearing is selected for the desired direction of travel. The survey probe is calibrated to this bearing and installed in the first section.

4.9.2 DEEP CROSSINGS - STEERING SYSTEM

While the hole is being drilled, the drill string is rotated along with the cutting head as a single section.

When steering adjustments are required, the drill string is not rotated, however, the cutting head offset is rotated toward the desired direction of travel and the drill string is advanced forward without rotation. The eccentric location of the cutting head relative to the center line of the drill string creates a wedge type effect when pushed without rotation. This causes the drill string to deflect in the desired direction. The locating probe transmits the orientation of the cutter head relative to the face of a clock (Fig. 18). Once the orientation is determined, the driller rotates the drill pipe to the desired location. This is confirmed by the locating instrument. The drill string is then rotated to resume cutting. This process is repeated as many times as necessary to assure proper location of the cutting head as it progresses along the desired path.

4.9.3 DEEP CROSSINGS - DRILLING METHOD

When drilling begins, the drilling fluid (mud) pump is turned on and the cutting head is rotated into the ground. As the first section is being buried, the operator monitors the head location and compares the information to a plotted chart. If there is any deviation from the intended line, the operator makes the steering corrections. Once the first section is buried, the drill section is uncoupled from the drill spindle and another section of drill pipe is added. For each section of drill pipe installed, an additional length of connector wire

is also installed, crimped and insulated to complete the circuit for the survey probe.

The sequence continues until the pilot hole is completed. By the time the pilot hole is completed, the product line should have been prepared to be pulled back. For pulling back a product line or lines, first the cutting head is removed and a backreamer is installed in its place.

⚠ DANGER

**ROTATING PIPE. Danger of entanglement.
Keep body and clothing away.**

⚠ DANGER

MOVING PARTS. Pinch point. Keep body and clothing away.

⚠ WARNING

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches

A backreamer is a cutting head with its cutters facing the drill string. Its purpose is to clear a path for the product line being installed (Fig. 15). Directly behind the backreamer (away from the drill pipe) a bearing swivel is installed. The bearing swivel is to attach to a cap that has been installed on the product line. The purpose of the bearing swivel is to prevent the product line from rotating as the reamer and drill pipe rotate. As the product line is pulled into the hole, the drill string is rotated and drilling fluid is pumped in to maintain the integrity of the hole. A rule of thumb states that the back ream diameter should be at least 1.5x the diameter of the product line. In cases where the product line or bundle of lines are larger than the pilot hole, an oversized backreamer will be required. When backreaming for product line installation, a slightly larger hole than the product line is required so that the drilling fluid can remove the cuttings. The amount of overcut is largely dependent upon soil conditions and the type of crossing or obstacle. In cases where the ground conditions are soft and basically unsupported, use a barrel reamer. This is a tool with radial or coned-shaped ends, which when pulled and rotated through

the ground, compacts the soil in the hole to maintain its integrity. The bearing swivel is installed behind the barrel reamer.

Drilling in hard soil or rock requires a downhole motor (see Fig. 14). Downhole motors are designed and built in various diameters and torque ratings to accommodate most drilling applications.

Downhole motors are used where high cutter bit speed is desired. In most applications the motors are used in combination with the bent sub for steering purposes. Several manufacturers have combination systems for sale or lease.

In cases where the hole must be maintained or blowouts must be prevented, use of a wash pipe is recommended. A wash pipe can be installed when backreaming or directly over the drill string. The use of a wash pipe provides a maintained annular area so the drilling fluid can remove the cuttings and spoil material without increasing downhole mud pressures and the probability of a frac-out (inadvertent return of fluid).

4.9.4 SHALLOW CROSSINGS - THE PROCESS

The DD-240 is not normally used in shallow drilling (4.5 m [15 ft] or less).

⚠ DANGER

**ROTATING PIPE. Danger of entanglement.
Keep body and clothing away.**

⚠ DANGER

MOVING PARTS. Pinch point. Keep body and clothing away.

⚠ WARNING

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches

4.9.5 APPLICATION OF DRILLING FLUID TO HORIZONTAL BORING

When using high productivity drills as large as the DD-240, a fluid recycling system is strongly recommended. Drilling operations might require fluid quantities of 1135 to 2270 L/minute (300 to 600 GPM). Simply mixing fluid in these quantities presents a challenge. A recycling system enables the driller to reclaim most of the drilling fluid for re-use, and minimizes the amount of fresh water required for mixing. The recycling system removes solids from the drilling fluid and usually includes a high pressure pump (mud pump) to send the fluid through the drill pipe into the bore.

Controls for an American Directional Drill recycling system fit in the control console next to the drill controls (see Fig. 24-A). The primary functions of a drilling fluid (mud) in horizontal boring are: 1) to reduce torque associated with sticky soil conditions, 2) to aid removal of solids from the freshly cut hole by a flushing action, and 3) to help stabilize the soil. Water is the major component of drilling fluids used in horizontal boring. Materials added to water to produce a drilling fluid are bentonite and polymer. Factors which are very important to drilling fluid quality are: 1) water quality, 2) formulation of the products and mixing order, and 3) adequate mixing of the products.

4.9.6 DRILLING FLUID - THE PROCESS

Drilling fluid (mud) consists of water or water with additives. Products such as bentonite and polymer can be very helpful for horizontal boring. Optimum delivery of drilling fluid to soil is critical for minimizing operating pressures and torque. There are several key factors which must be considered to maximize your production: 1) hole size, 2) boring rate, and 3) fluid injection rate. These three factors can be used to calculate a fluid-to-soil injection rate in volume of fluid to volume of soil removed. The amount of fluid required to make the soil flow out the hole is dependent on the type and amount of clays in the soil.

4.9.7 CALCULATION OF VOLUME OF FLUID TO VOLUME OF SOIL

The three pieces of information needed to calculate gallons of fluid to gallons of soil at a given boring rate are: 1) hole volume, per unit of length., 2) boring rate, in length/minute, and 3) pump rate in volume/minute. From this information, the volume can be calculated (see Fig. 36). Some soils may require more fluid, others less. If you are at the maximum mud pump output and encounter excess torque, then you can reduce the rate of advance and vary your pump rate to produce minimum torque to optimize progress. Some soils will be easier to drill if polymer is added to the drilling fluid. Bentonite suppliers can offer guidance concerning the use of bentonite and polymer products.

4.9.8 FLUID DISPOSAL

Disposal of drilling fluid wastes should be covered in construction permits. Although drilling fluid additives such as bentonite and polymer are not considered hazardous wastes, local regulations concerning fluid disposal vary. While it is important to apply enough fluid to minimize operating torque, overuse of drilling fluid will increase costs of bentonite and disposal fees.

For instance, reaming a 355 mm diameter hole and using 3.8 litres of fluid per 3.8 litres of soil, above 30.5 m long would require approximately 3028 litres of fluid for 3028 litres of soil excavated. The total waste generated is 6056 litres of a soil and water mixture. Depending on the amount of material displaced from the drilled hole, it could be necessary to dig a pit of an additional 5.6 cubic metres volume just to accommodate the waste from the drilled hole. Using the English system, reaming a 14 inch diameter hole and using 1 gallon of fluid per 1 gallon of soil, a bore 100 feet long would require approximately 800 gallons of fluid for 800 gallons of soil excavated. The total waste generated is 1600 gallons of soil and water. Depending on the amount of material displaced from the drilled hole, it could be necessary to dig a pit of an additional 200 cubic feet volume just to accommodate the waste from the drilled hole.

4.9.9 WATER QUALITY

Hard water (contains calcium and/or magnesium) or salty water is detrimental to bentonite and polymer.

If you notice severe thickening or separation of bentonite or polymer at the bottom of the mixing tank, then you probably have a water quality problem. If your makeup water is salty, replace it with fresh water. If your water source is hard treat with soda ash (sodium carbonate, Na₂CO₃) at a rate from 0.25 kg to 1 kg per 380 litres [0.5 to 2.0 lb per 100 gallons] or adjust the pH to 9.5. Soda ash precipitates out calcium in the make-up water as insoluble calcium carbonate, making it harmless.

4.9.10 MUD MIXING

Adequate mixing is essential for preparing either bentonite or bentonite/polymer slurries. The mixing system must incorporate increased velocity by pipe diameter reduction. Bentonite powder is added through the hopper portion of the jet mixer. Liquid emulsion polymers should be mixed by recirculating through a jet.

4.10 ADDING AND REMOVING PIPE

The crane is intended only for handling pipe and tooling. Do not use the crane for maintenance on other machines (such as tire lifting).

When the crane is not being used, disconnect the control cable and store it in a safe dry location.

The control is not weather proof.

The crane is equipped with an “anti-two block” safety device. Do not disable this device. Do not use the safety device as a shut off when lifting a load. The crane has one power extension section on the boom, and one manual pull out section. When the boom sections are extended, the load on the crane must be reduced according to the load chart (Attachment 4, Crane Owners Manual). Also, as the crane boom approaches horizontal, the load on the crane must be reduced according to the load chart.

DANGER

Do not walk or stand under a suspended load. Retract the boom completely before transporting the drill. Do not allow the crane to contact overhead electric wires.

DANGER

ROTATING PARTS. Danger of entanglement. Keep body and clothing away.

DANGER

MOVING PARTS. Pinch point. Keep body and clothing away.

DANGER

MOVING PARTS. Pinch point. Install the fender beneath the pipe loader. Keep body and clothing away. Do not allow personnel inside the fender while the pipe loader is operating.

4.10.1 ADDING PIPE (FIRST SECTION)

Coat the threads on the rotary spindle with special thread lubricant. Move the carriage to the rear of the thrust frame using Thrust/Pullback control (Fig. 24).

Using the crane and a pipe tongs, lift one section of pipe from storage and place it over the thrust frame.

Raise the pipe supports using the Pipe Support controls (Fig. 24). Lower the pipe into the pipe supports.

Using Thrust/Pullback control, advance the carriage until its threads contact the box of the pipe section. Using Makeup/Breakout control, rotate the spindle until the threads tighten. Be sure to coat the pipe threads (pin end) with thread joint compound. Advancing the carriage, slide the first section of pipe through the wrenches for installation of the sonde housing and cutter head.

Lower the pipe supports, using the Pipe Support controls (Fig. 24)

Following manufacturer’s instructions, resupply the locating sonde with fresh batteries and calibrate the locating receiver. Put the sonde into a sonde

housing and hand fit it to a cutting head. Hand-fit the sonde housing and cutting head to the threads. Be sure to coat the pipe threads with thread joint compound. If the sonde and cutting head is very long, it may be necessary to tilt the thrust frame or excavate a pit in front of the drill.

Tighten pipe joints to the pipe manufacturer's specifications. You can set a limit on the rotary torque at the spindle by observing the pressure on the Rotary torque gauge (Fig. 24) and using the chart to convert the pressure to rotary torque. Turn the Rotary Pressure controls (Fig. 24) to adjust the maximum pressure on the gauge. Avoid over-tightening the pipe threads to reduce problems when loosening the threads.

Using suitable tools, tighten the cutting head and sonde housing to the pipe.

DANGER

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches

4.10.2 USING A MUD MOTOR

A mud motor will be longer than the combination of the sonde housing and cutting head. The mud motor also normally requires the use of a non-magnetic pipe section which fits between the mud motor and the first section of drill pipe. The locating sonde or other instrument is located inside this non-magnetic section.

The use of a mud motor will normally require excavation of a pit in front of the drill. The pit should allow the cutting bit to enter the far vertical wall of the pit. Mud motors vary somewhat in design. Follow the manufacturer's instructions with respect to installation of the cutting bit, and adjustment of the mud motor and non-magnetic section to calibrate the locating instrument.

4.10.2.1 THE ROTARY BRAKE

The operation of a mud motor induces an unwanted backward rotation into the drill string. The rotary brake is used to lock the rotary spindle and prevent it from turning backward. Using the Rotary

Brake Free/Lock control (Fig. 24). Unlock the rotary brake before attempting to steer the mud motor.

4.10.3 INSTALLING A WIRELINE GUIDANCE INSTRUMENT

Several suppliers sell and lease a magnetic survey system which provide information to the drill operator such as drill head rotation, drill head angle and magnetic bearing. This information is relayed to the operator by means of probe installed directly behind the cutting head in the first section of the drill pipe. The data is usually transmitted to the surface via a single conductor wire. Most of the units are provided with a surface processor for computing the information.

The wireline guidance instrument is housed in a special section of drill pipe. Some housings are made of a non-magnetic alloy. It is necessary to calibrate the guidance instrument and "time" it to the drill string to get accurate readings. Follow the manufacturer's instructions.

4.10.4 ADDING PIPE (ADDITIONAL SECTIONS)

Drill the first section of pipe, sonde housing and cutter head into the earth until the spindle is just about to enter the breakout wrench. The box end of the pipe should be located between the jaws of the fixed wrench.

Grip the first section of pipe tightly in the fixed wrench, using the Fixed Clamp control (Fig. 24). Loosen the threads on the spindle by rotating spindle using the Makeup/Breakout control (Fig. 24). Break out the joint, leaving the first section of pipe secure in the fixed wrench.

Coat the spindle threads with thread joint compound.

Move the carriage to the rear of the thrust frame using Carriage Thrust/Pullback control.

Bring another section of pipe into position over the thrust frame, following the instructions above.

Make up the joint between the spindle threads and the new section of pipe. Rotate the spindle slowly using Makeup/Breakout control and ad

vance the carriage toward the pipe, making sure the spindle and pipe box are aligned.

Coat the pipe threads with lubricant. Rotate the spindle slowly using Makeup/Breakout control and engage the new pipe threads with the previous section. As the threads begin to tighten, apply pressure to the end of the pipe with the carriage spindle.

Use the carriage to push the section of pipe until its pin end engages the box of the previous section of pipe. Rotate the spindle slowly using Makeup/Breakout control and engage the new pipe threads with the previous section of pipe. Using the Fixed Clamp control (Fig. 24) release the jaws of the fixed wrench.

Add additional sections of pipe to the drill string repeating the instructions above.

Continue to add sections of pipe to complete the pilot bore. Make steering corrections as necessary.

4.10.5 REMOVING PIPE

Using movement of the carriage (Carriage Thrust/Pullback control), pull pipe back from the hole until the joint between the spindle and the pipe is aligned in the jaws of the wrench. The lower section of pipe should be held by the fixed clamp, Fixed Clamp control (Fig 24). Make sure the carriage is pulled back so that the sliding rotary box has moved forward. The sliding rotary box must have room to move rearward as the pipe threads disengage.

NOTICE

Because Range 2 pipe sections can vary in length, the wrenches on the DD-240 are adjustable to align the wrenches with the tool joints. Position the wrenches forward and rearward along the thrust frame, using the Wrench Forward control (Fig. 24).

Position the spindle in the breakout wrench. Close the jaws using Fixed Clamp control. Loosen the threaded joint at the spindle by moving the Wrench control, activating the breakout wrench. Then return the breakout wrench to its original position.

Rotate the spindle in the breakout direction and loosen the upper threaded joint to the spindle by operating Makeup/Breakout control. This will require only 2 to 3 revolutions.

With the spindle threads loose but still engaged, move the carriage toward the rear of the thrust frame. Observe the mechanical pointer fixed to the thrust frame near the wrenches. Move the carriage toward the rear of the thrust frame until the shoulder of the pipe pin is aligned with the pointer. This is the proper position to remove the pipe with the loader arm.

Using the Thrust/Pullback control, move the carriage toward the wrenches. Pause and apply thread joint compound to the spindle threads. Move the spindle threads into the box of the pipe still held in the fixed wrench. Make sure the sliding rotary box has moved to the rear of the carriage.

Use Makeup/Breakout control to rotate the spindle in the makeup direction until the threads have completely engaged. Observe the pressure on the

Rotary Pressure gauge (Fig. 24). Compare the pressure reading to the conversion chart (Fig. 34) to find makeup torque. Avoid overtightening the threads, which can shorten pipe life and make breakout difficult. Correct makeup torque values are supplied by the pipe manufacturer.

DANGER

**Do not walk or stand under a suspended load.
Do not allow the lifting mechanism to contact overhead electric wires.**

Place the pipe sections in an area where they will not interfere with the movements of the drilling crew.

4.10.6 CALCULATING ROTARY TORQUE FORCE

Rotary torque force can be learned by comparing the reading on the Rotary Pressure gauge (Fig. 24) to the table (Fig. 34). Example: 2,550 psi indicated on the DD-240 gauge provides a torque of 7,299 ft-lb (High range) or 20860 ft-lb (Low range).

4.10.6.1 LIMITING ROTARY TORQUE

The maximum rotary torque force can be set by turning the Rotary Pressure Makeup/Breakout knobs (Fig. 24). This can prevent applying too much force and damaging the pipe threads.

4.10.7 CALCULATING THRUST AND PULL BACK FORCE

Thrust and pullback force can be calculated by comparing the reading on the Carriage Pressure gauge (Fig. 24) to the table (Fig. 33 and 34). Example: 1,400 psi indicated on the DD-240 gauge provides a thrust/pullback force of 17,928 lb (High range) or 57,365 lb (Low range).

4.10.7.1 LIMITING THRUST AND PULLBACK FORCE

The maximum thrust and pullback force can be set by turning the Carriage Pressure knobs (Fig. 24). This can prevent applying too much force and damaging a down hole motor. It can also help the drill operator regulate the rate of advance of the cutter head or the retraction of a back reamer.

4.11 START OF THE DRILLING OPERATION

Confirm that the machine is in the drilling position, otherwise find this position and move the machine. The drill pipe should be positioned longitudinally along the intended bore path.

Anchor the machine.

Connect the mud mixing equipment (sold separately) to the drilling rig by means of a flexible hose. The connection is alongside the thrust frame. Following manufacturer's instructions, operate the transfer pump on the mud recycling system to ensure an adequate supply of drilling fluid to the mud pump on the DD-240. It is normal for drilling fluid to escape from the cutting head even if the mud pump is not operating.

With the drill properly positioned along the intended bore path, and with the front foot anchored securely, activate the mud pump. A strong jet of

drilling fluid will escape from the cutting head.

Control mud flow with controls on mud system.

DANGER

Drilling fluid under pressure can cause personal injury. Stay away from the jet.

Using the Rotary Makeup/Breakout control lever (Fig. 24), advance the carriage to thrust the cutting head into the earth.

Depending on the desired bore path, it is the driller's decision whether to advance the head with or without rotation.

When the length of pipe has been nearly thrust through the fixed wrench, align the joints in the pipe between the wrench and the breakout wrench.

Operation of the breakout wrench will loosen the threads, assisted by rotation of the spindle in the clockwise direction.

When the spindle has come loose from the length of pipe, apply thread joint compound to the spindle.

Retract the carriage to the rear of the thrust frame.

Operate the crane to position another section of pipe between the spindle and the female thread (the box) of the previous pipe.

Apply thread lubricant to the pin of the new pipe.

Slowly advance the spindle into the box of the new pipe, then allow the pipe to slide over the pipe supports until the pin of the new pipe contacts the box of the previous pipe. Slowly rotate the spindle and advance the carriage until the threads of the two pipes engage and tighten. Tightening must be done with rotation of the spindle. The breakout wrench on the DD-240 is not designed to tighten.

Release the jaws of the fixed wrench and advance the pipe into the bore path as before.

Repeat this sequence to complete the pilot bore.

Steering corrections depend on the type of cutting head in use.

DANGER

Keep personnel away from the rotating parts.

4.12 END OF DRILLING OPERATIONS

Maintain good verbal contact with the personnel at the exit point. Make sure everyone is clear of the exiting pipe. Notify the driller and activate the es!lok® system. Using suitable tools, remove the cutter head and sonde housing. Separate the cutter head from the sonde housing.

DANGER

Drilling operations may require construction of an exit-side pit. The pit must be constructed following Federal and local laws. Unsafe pit construction may cause death or serious injury.

DANGER

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches.

Completely clean the cutter head. Remove the sonde instrument from the housing. Remove the batteries and store the sonde in a safe container.

4.13 START OF THE PULLBACK OPERATIONS

After the completion of the pilot bore, the operator must decide whether to enlarge the bore by reaming. Factors include the soil conditions, length of the bore, and the flexibility of the pipe or cable being installed.

If reaming is required, remove the cutting head from the drill pipe using suitable tools.

DANGER

Unexpected movement or rotation of the drill string can cause death or serious injury. American Directional Drills come equipped with the es!lok® exit side lockout system. Use the es!lok® system to disable the drill while changing tooling. Instructions for operating the es!lok® system are found in a separate manual REFER TO: Attachment 2, Es!lok® Operator's Manual.

WARNING

Do not attempt to bypass the es!lok® system. Operation of the drill with the es!lok disabled can result in injury or death.

WARNING

A wrench on rotating drill pipe can seriously injure or kill. Do not break out tool joints with pipe wrenches.

To pre-ream the pilot bore, install the reamer in place of the cutting head. When all personnel are clear, re-enable the es!lok® system, and rotate the drill string. Use of drilling fluid with the cutting head will remove soil debris and will lubricate and cool the reamer.

Continue to withdraw sections of pipe from the pilot bore until the reamer has reached the entry point.

Some drillers add sections of drill pipe behind the reamer as it passes through the pilot bore. This ensures that the driller will have access to the pilot bore even in case of some collapse of the surrounding soil. The operator may be able to complete reaming and pullback in a single operation. In that case, a heavy duty swivel is connected to the far side of the swivel. A suitable pulling eye is connected both to the swivel and to the pipe or cable to be installed.

4.14 END OF PULLBACK OPERATIONS

The pullback operation is complete when the pipe or cable has been installed and pulled back to the entry opening.

Using suitable tools, remove the swivel, reamer, and pulling eye. Leave the pipe or cable exposed according to the requirements of the installation.

4.14.1 REMOVING THE TIE DOWN STAKES

Remove the tie down stakes from the front foot. Do not attempt to remove the tie down stakes by raising the machine's front foot. Remove the tie down stakes from the work area and store them.

⚠ DANGER

MOVING PARTS. Pinch point. Keep body and clothing away.

4.14.2 CLEAN UP

Position the carriage at the midpoint of the thrust frame as an aid to balance the machine. Remove the mud supply hose from the mud pump. Put the Mode switch (Fig 25) in the TRAVEL position. Retract the rear thrust stabilizers. Remove all tools and loose objects from the area and put them into storage. Before tramming away from the entry point, position the thrust frame into the travel position (see Paragraph 3.2.2). Using the tramming control box, slowly back the machine away from the entry point. before transporting it. Wash mud, drilling fluid and soil off the machine before transporting it.

⚠ WARNING

Do not sit or stand on machine while tramming. Unexpected movement can cause death or serious injury. Use remote tramming control box only while standing at ground level with good visibility.

⚠ WARNING

A crushed or damaged tramming control could result in unexpected movement of the machine. Unexpected movement can cause death or serious injury; Always replace the tramming control into its holder.

4.15 SWITCHING OFF THE ENGINE

Position all the controls in the OFF or NEUTRAL position.

Reduce the engine rpm to minimum (Fig. 24,) using Engine Throttle control.

Wait 5 minutes for the engine to cool.

Switch off the engine by pushing the Emergency Stop button (Fig. 24).

4.16 EMERGENCY STOP

Using the EMERGENCY STOP push-buttons (red) it is possible to stop every function of the machine immediately by switching off the diesel engine.

Location of the 3 emergency stop push-buttons:

-On the set-up control panel on the right side of the machine (Fig. 25).

-On the tramming control switch box (Fig. 27) accessible from the ground.

-On the main control console (Fig. 24).

When one of emergency stop push-button is pushed, the diesel engine switches off immediately.

4.17 START AFTER AN EMERGENCY STOP

To re-start the machine after an emergency stop, find and remove the reason for the emergency. Then use the following procedure: Rotate the ignition key to switch the OFF position (Fig. 22). Position all the controls in the OFF or NEUTRAL position.

Identify the emergency push-button used for the stop and lift it.

Start up the machine with the normal procedure. REFER TO: Paragraph 4.7.1. STARTING THE ENGINE.

4.18 CHECKS DURING OPERATION

During drilling, it is absolutely necessary to monitor instruments and functions regularly. In case of anomaly, act immediately, by modifying the adjustments or stopping operation.

A priority list of instruments can be the following:

-Engine rpm (Fig. 24)

-Engine Throttle (Fig. 24)

-Carriage pressure (Fig. 24)

-Carriage pressure (Fig. 24)

-Rotary hydraulic pressure (Fig. 24)

-Hydraulic oil filter lights (Fig. 24)

The driller should also make periodic inspections of the engine instruments (Fig. 23):

-Voltmeter

-Engine water temperature

-Engine oil pressure

4.19 NORMAL OPERATING RANGES OF INSTRUMENTS

-Engine oil pressure normal value is 2.8 bar [40 psi]

-Engine coolant temperature normal range is 71°C to 96°C [160°F to 205°F] maximum 88°C [190°F]

-Hydraulic oil temperature normal range is 38°C to 60°C at an ambient temperature of 5°C to 27°C [100°F to 140°F at an ambient temperature from 40°F to 80°F]

-Volt meter 12.8 to 13.5 volts

-Engine rpm (Fig. 24). Do not exceed 2600 rpm-Rotary speed (Fig. 24) according to soil conditions, normal range (DD-240: 0-95 rpm)

The correct operation of the battery charging circuit is indicated by the voltmeter with the indicator between 12.8 and 13.5 volts. When the engine is running, if the indicator is below 12.8v it indicates an anomaly. Check the system.

Hydraulic oil red alarm lights indicate a need for maintenance when the system is at normal operating pressure and at normal temperature. In case these these lights remain on when 40°C [104°F] temperature is reached, replace the filters.

CAUTION

It is the operator's responsibility to stop the machine for any abnormal value indicated by the instruments.

4.20 ES!LOK® LOCKOUT

WARNING

Read and understand the instructions in the es!lok® operator's manual, Attachment 3).

WARNING

Do not attempt to bypass the es!lok® system. Operation of the drill with the es!lok disabled can result in injury or death.

The es!lok® exit side lockout must be manually engaged by the drill operator and by the Competent

Person on the exit side crew. The drill operator pushes the reset switch on the receiver box mounted near the control console (Fig. 28). The Competent Person enables operation by pressing the start button on the es!lok® unit worn on the belt. The normal indication is a green light on the receiverbox and a flashing green light on the unit worn on the belt. In case of any fault, the thrust and rotation functions of the drill will stop, and will not operate until both persons have reset their respective devices.

4.20.1 START AFTER USE OF ES!LOK®

The normal use of the es!lok® is to provide safety to the exit side crew while they are in contact with the drill pipe and tooling. After notifying the drill operator by radio or other signal, the Competent Person presses the red STOP button on the belt unit. A red light will be seen on the receiver box, reminding the drill operator that a lockout is underway. Only when it is safe to do so, the Competent Person will notify the drill operator to reset the receiver. The Competent Person also resets the belt unit by pressing the START button. Normal functions are restored to the drill.

4.21 USE OF ZAPALERT®

WARNING

Read and understand the ZAPALERT® operator's manual (Attachment 3).

Read and follow the test and set up instructions in the ZAPALERT® operator's manual (Attachment 3). The ZAPALERT® is intended to warn the crew if the drill and associated equipment become energized. It is critical to take proper action after striking a buried cable. Taking the wrong action can cause death or severe injury.

4.21.1 START AFTER USE OF ZAPALERT®

Make sure that the drill and associated equipment are no longer energized. Retest and set up the ZAPALERT® as before.

4.22 OPERATION BETWEEN TEMPERATURES -40°C AND -15°C [-40°F TO +5°F]

Only the machines especially arranged at the factory can work under ambient temperatures between -40°C and -15°C [-40°F to +5°F]. This is due to a particular choice of materials (rubber, gaskets, oils, grease) so that the components do not suffer from the cold and do not age quickly. Some machines are equipped with a preheater device to keep the minimum temperature needed for starting the diesel engine.

It is necessary to carefully follow the specifications of oils and cooling liquids for the diesel engine, that must guarantee suitable protection at the minimum temperature. REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

WARNING

Make sure all the controls are in the NEUTRAL or OFF position before starting the engine.

CAUTION

Failure to observe starting instructions can cause damage to the hydraulic circuit and to the diesel engine.

4.22.1 PRE-HEATING DEVICES

During normal operation, the machine is able to keep the temperatures of the oils within the limits allowed. In case of stop it is necessary to supply power for keeping the temperatures inside the diesel engine. This is made by connecting the relevant plug of the pre-heating device to an electric supply rated at 1 kW at 110/220V 50/60Hz monophase. The customer must specify which voltage range the heater will be connected to. In this way it is possible to start the diesel engine even at ambient temperatures between -40 and -15°C [-40°F to +5°F], it is advisable to use pre-heaters in case it goes under 0°C [32°F]. Connect the cable of preheater to the electric supply.

WARNING

Pre-heating device operates on high voltage (110 volts or 220 volts AC). Connect to a circuit equipped with a ground fault interrupter (GFI). Protect the electric cables from contact with water or other liquids.

4.22.2 STARTING THE ENGINE (with the machine kept warm through pre-heaters)

REFER TO: Attachment 1 Caterpillar 3406 Diesel Engines.

Idle the engine.

Wait until the engine has reached the operating temperature before moving. Wait for the hydraulic oil to reach the temperature of +30°C [86°F] before operating the controls.

Check that the filter pilot lights filters are switched off before movement.

Disconnect the cable of preheaters from the electric supply before putting the machine to work.

4.22.3 STARTING THE ENGINE (in case the preheaters are not connected while stopped)

In case of long stops with ambient temperatures between -40°C and -15°C [-40°F to +5°F] without the preheaters connected, before starting the engine.

Idle the engine.

Wait until the engine has reached operating temperature before moving.

Wait until the hydraulic oil has reached the temperature of +30°C [86°F] before moving the controls.

4.22.4 PROTECTING THE FLUID COURSE FROM FREEZING

Whenever drilling is stopped and the ambient temperature is expected to reach 0°C [32°F] or below, it is necessary to protect the fluid course (path of mud flow) from freezing.

4.22.4.1 DRAIN THE FLUID COURSE

The fluid course on the DD-240 can be drained by breaking the tool joint nearest the wrenches and by opening the small valve behind the hammer union where the mud supply hose is connected.

CAUTION

Freezing water can do severe damage to the mud pump and other parts of the fluid course. Do not use engine antifreeze fluid in the mud pump due to concerns about spills. Use special antifreeze fluid which is classified as “non-toxic.”

5,0 MAINTENANCE

5.1 DANGEROUS ZONES—SAFE DISTANCES

WARNING

Carry out maintenance when the machine is off. Before operating, clean the machine and lock movable parts. For maintenance to be carried out with running machine, follow instructions in Section 4 USE.

Hydraulic oil, gearboxes oil, diesel engine oil, pins and bearings grease, diesel engine cooling liquid, batteries liquid, fuel: handle with care.

Engines, muffler, gearboxes and hydraulic system, can reach very high temperature. Do not attempt maintenance immediately after stopping the work until after the parts are cool.

WARNING

Do not carry out welding near the tanks and inflammable liquids.

DANGER

Make sure that personnel keep a safe distance during maintenance and control operations.

5.2 ORDINARY, PERIODICAL AND PREVENTIVE MAINTENANCE

This section includes all the necessary operations for maintenance by drill operator (example: greasing, adding oil, etc).

5.2.1 QUALIFICATION OF THE TECHNICIAN

The technician in charge must be trained to know the operation and handling of the machine, to verify that there are no functioning faults, to carry out maintenance with suitable equipment and protection, and to inform the responsible qualified personnel about special repairs that cannot be made by himself (example: adjustment of Caterpillar engine, welding, etc).

NOTICE

For any operation which is not described in this manual or for extra information please contact AMERICAN AUGERS or the nearest dealer directly.

5.2.2 FREQUENCY OF INSPECTIONS

Periodical inspections give the operator a simple identification and solution of the problems. It is advisable to carry out the inspections more frequently when working in difficult soil conditions. At every inspection/maintenance schedule all previous inspections must be carried out. For example, at 250 working hours, also perform the items listed in daily and weekly schedules.

5.3 SCHEDULED INSPECTION AND MAINTENANCE

Every day before use and at least every 10 hours, inspect and perform maintenance on the machine according to the procedures indicated in Section 5.

NOTICE

Refer to the table (Fig. 45) for approved replacement fluids

5.3.1 MAINTENANCE SCHEDULES OF DIRECTIONAL DRILL MODEL DD-240.

NOTICE

The procedures must be carried out as indicated in the maintenance section of the manual for the operator. For maintenance on the diesel engine REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.3.1.1 Daily (or 10 hours)

Engine crankcase lube oil level.

Engine coolant level.

Hydraulic tank oil sight glass level (3/4 full).

Fuel level.

Rotary box lube level sight glass (3/4 full).

Look around rig and mud system for signs of fuel, coolant, hydraulic leaks.

Check hydraulic fittings visually.

Grease carriage cam followers.

Grease wrench and die holder slides.

Grease hinge pin bosses.

Check crane pins and retainers.

Check track tension.

5.3.1.2 Weekly (or 50 hours)

Perform daily maintenance items, plus:

Carriage planetary gearbox lube levels. Remove “level check” plug. Fill to lower edge of opening.

Pump drive gearbox. Remove dipstick. Add oil to mark shown on dipstick.

Track drive gearbox. Remove “level check” plug. Fill to lower edge of opening.

5.3.1.3 Monthly (or 250 hours)

Perform daily and weekly maintenance items, plus: Drain and replace engine lube oil and crankcase filter.

Check battery water level.

Clean or change primary air filter element.

Inspect engine coolant level.

5.3.1.4 Six Months (or 500 hours)

Perform daily, weekly and monthly maintenance items, plus:

Change air filter elements. Change engine fuel filters.

Change all hydraulic filter elements or when indicated by red lights.

Remove and replace all gearbox oil, or submit sample for analysis. Includes:

-Rotary gearbox

-Carriage drive gearboxes

-Track drive gearboxes (2)

-Hydraulic pump drive gearbox

Change hydraulic system oil, or submit sample for analysis.

5.3.1.5 Yearly (or 1000 hours)

Perform daily, weekly, monthly and six month maintenance items, plus:

Replace engine coolant or submit sample for analysis.

5.3.1.6 After Each Job

Thoroughly wash and drain mud system of all cuttings and packed bentonite.

Check track adjustment. Tighten if needed, see manual.

NOTICE

At every inspection all the inspections with previous schedules must be carried out.

5.3.2 EMERGENCY STOP

Verify that the 3 emergency stop push-buttons of the machine are operating.

5.3.3 GREASING

The points listed below must be lubricated daily (where not otherwise specified, 2 grease pumps are enough). Use Shell Retinax LC, which is suitable for most temperatures. When working in very high or low temperature consult the factory.

5.3.3.1 GREASE POINTS (LIST)

NOTICE

Grease fittings must be kept clean so that contamination is not forced inside. Replace damaged fittings.

5.3.4 ENGINE OIL

Consult the CATERPILLAR operating and maintenance manual. Check that the engine oil is at the maximum level and that there is nocontamination, which could lead to change, filter and oil prematurely. Typical contamination is: oil discoloration, water or engine coolant in the oil, etc.

WARNING

Before changing oil wait for the engine to cool.

5.3.5 ENGINE COOLANT

WARNING

Before checking or changing coolant wait for the engine to cool.

Check that the level of the radiator coolant is at maximum and that there is no contamination. Add coolant if the level is low. Consult Attachment 1, Caterpillar C-15 and C-16 Industrial Engines for the specifications about coolant and cooling system.

5.3.6 AIR FILTERS

Do not clean the air cleaner unless the instrument shows a need for service. At each inspection of the air cleaner also inspect the rubber evacuator valve (Fig. 35-1). Check that in the air cleaner pipes there are no deposits, if so clean them. The primary filter can be cleaned and reused up to 6 times. The secondary filter must not be used again. A stoppage indicator (Fig. 35-2) signals the need to clean or replace the filter. In extremely dusty conditions, the maintenance of engine air filter should be increased. Use the procedures indicated in Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.3.7 FUEL

Use only clean fuel of the proper grade.
After every refuelling, lock the tank.

Discharge water and deposits from the fuel tanks.

For temperatures lower than 0°C [32°F] use winter fuel in order to avoid the stoppage of filters for deposits of wax.

WARNING

Before changing fuel filters wait for the engine to cool.

Replace the diesel fuel filters every 500 hours or earlier if necessary.

Use the procedures indicated in Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.3.8 HYDRAULIC OIL CIRCUIT

NOTICE

Very small amounts of contamination of hydraulic oil can damage the system.

WARNING

Hydraulic oil may be under high pressure. Release pressure before opening the system.

Check the level in the tank using the transparent gauge mounted on it. If the level is too low, add oil as far as the mark indicates the level.

The level must be checked when the oil is cold, with all cylinders retracted.

After refilling, lock the tank cap.

Check the condition of the pipes and hoses and replace damaged ones.

Identify and eliminate the losses immediately: Losses of hydraulic system under pressure get always worse.

5.3.8.1 PROCEDURE FOR REPLACEMENT OF FILTERS (500 HOURS or when indicated by lights)

WARNING

Support the thrust frame with a strong support before draining the hydraulic filters. Do not start up the engine until personnel have moved away from the area.

CAUTION

Hydraulic circuit can be damaged irreparably if start up procedure is not followed correctly

To replace oil filters:

1. Place a container under the filters to catch the oil. Oil from nearby hoses will also drain out.
2. Use a wrench to loosen and remove the outer container.
3. Remove and replace the filter element.
4. Replace the outer container.
5. Run the engine at low speed and operate the rotary.
6. Confirm proper oil level in the tank.
7. Run the engine at high speed for 5 minutes.
8. Shut off the engine and inspect for leaks.

5.3.8.2 PROCEDURE FOR THE REPLACEMENT OF HYDRAULIC OIL (every 500 hours)

Drain hydraulic oil from the tank in a container suitable for transport or elimination.

All parts must be cleaned.

Remove the hydraulic tank inspection cover and remove any deposit of old gaskets.

Keep all the bolts together. Remove the suction filter in the tank.

Clean suction filter, breather pipe, and magnetic cap with a lint free cloth and clean oil.

WARNING

Do not use inflammable solvents, near fire, sparks or other ignition sources.

Wipe the inner part of the tank with lint free cloths.

Reassemble the suction filter.

Put silicone on inspection cover and reassemble. Tighten bolts of the cover.

Refill with hydraulic oil (REFER TO: Fig. 38, Approved Replacement Fluids). Do not mix hydraulic oils produced by different companies due to the possibility of reactions among the oils. A transparent gauge is mounted on the tank in order to allow quick checks of oil levels. The oil level in the tank can vary considerably according to the effect of temperature (hot oil increases the volume) and to the position of hydraulic cylinders.

Overfilling can cause oil to come out of the tank.

CAUTION

Check levels only when gearboxes are cold.

5.3.9 GEARBOXES AND PUMP DRIVE

Inspect the gearbox in order to discover leaks. In case of a small loss, fill the gearbox to the correct level.

Replace the oil in the gearboxes and in the pump drive every 500 hours and whenever contamination occurs. After unscrewing a level plug, a small quantity of oil will escape. As soon as this happens inspect the oil in order to verify that there is no contamination which requires an unscheduled replacement.

5.3.9.1 PUMP DRIVE, LEVEL CHECK

For controlling the oil level in the pump drive use the dipstick (rod) accessible from the engine door. The correct level must be between the two lines marked on the rod.

5.3.9.2 HYDRAULIC PUMP DRIVE, FILLING PROCEDURE

For filling use the elbows where breather pipe is positioned

Remove the breather pipes

Top up with suitable oil until it comes out the level hole. For draining the oil remove the plug in the bottom of the gearbox. Catch the oil in a suitable container.

Dispose of used oil in a lawful manner.

5.3.9.3 CARRIAGE ROTARY GEARBOX

Inspect the gearbox in order to discover leaks. In case of a small loss, fill the gearbox to the correct level.

Replace the oil in the gearboxes and in the pump drive every 500 hours and whenever contamination occurs.

5.3.9.4 CARRIAGE ROTARY GEAR BOX, LEVEL CHECK

After unscrewing a level plug , a small quantity of oil will escape. As soon as this happens inspect the oil in order to verify that there is no contamination which requires an unscheduled replacement.

5.3.9.5 CARRIAGE ROTARY GEAR BOX, FILLING PROCEDURE

Top up with suitable oil until it comes out the level hole.

For draining the oil remove the plug in the bottom of the gearbox. Catch the oil in a suitable container. Dispose of old oil in a lawful manner.

CAUTION

Failure to observe starting instructions can cause damage to the hydraulic circuit and to the diesel engine.

5.3.9.6 CARRIAGE ROTARY GEAR BOX FILLING PROCEDURE

Inspect the gearbox in order to discover leaks. In case of small leaks, fill the gearbox to the correct level.

Replace the oil in the gearboxes and in the pump drive every 500 hours and whenever contamination occurs.

5.3.9.7 TRACK DRIVE GEARBOXES, LEVEL CHECK

There are two check plugs on each track drive gearbox. Move the machine to position the level plugs. One plug must be at 12:00 o'clock. The other

plug will be positioned counterclockwise at the 10:00 o'clock position. Remove the plug at the 10:00 position After unscrewing the level plug , a small quantity of oil will escape. As soon as this happens inspect the oil in order to verify that there is no contamination which requires an unscheduled replacement

5.3.9.8 TRACK DRIVE GEARBOXES, FILLING PROCEDURE

Position the level plugs as described in 5.3.9.7, above. Remove both plugs.

Dispose of old oil in a lawful manner.

Top up with suitable oil until it comes out the level hole at the 10:00 clock position.

For draining the oil remove the plug in the bottom of the gearbox. Catch the oil in a suitable container.

5.3.10 TRACK TENSION

Track tension is maintained by adding grease through a special fitting, one on each track.

5.3.11 WELDING

CAUTION

Failure to follow welding procedure can cause damage to electric and mechanical components. Damage to components due to improper procedures is not covered under warranty.

CAUTION

Disconnect all wires to battery equalizer before welding on machine. Failure to do so may result in damage to battery equalizer and batteries. Disconnect ground terminal first. Reconnect ground terminal last.

Welding must be done with the battery switch (Fig. 28) in OFF position (switched off).

The ground wire must be connected directly to the component where the welding is made. Failure to follow the above instructions could damage electric and hydraulic components, cylinders, gears and bearings, due to internal arcing.

5.3.12 RADIATOR

This category includes the engine radiator and hydraulic oil radiator. Check that there are no obstructions. Clean the obstructions in order to allow the correct air flow and cooling. Cooling capacity of heat exchangers of the machine is greatly reduced by deposit of foreign material such as dust layers, oil layers, leaves, grass and other material which can obstruct air flow. Correct any problem immediately.

5.3.13 HYDRAULIC PISTON RODS

Check that the rods are not damaged, and that they do not have losses of oil. Clean if necessary. If this is not done, the shaft seals can fail.

5.3.14 CLEANING

Clean all the marking plates as well as all lighting devices installed. Do not direct spray of water inside the muffler, or the air filter, against electric components and control panels, on caps and opentanks. Do not use acid or abrasive solutions. For the control panels use only a damp cloth or compressed air (max. 2 bar [30 psi]).

5.4 OTHER CHECKS AND MAINTENANCE (50 HOURS)

At the beginning of every week or after every 50 operating hours, inspect the following items, in addition to any scheduled maintenance.

5.4.1 BOLTS AND NUTS

Inspect for any loose or missing bolts and nuts. Tighten loose bolts and nuts. Replace missing bolts and nuts.

5.4.2 PIPES AND HOSES

Inspect pipes for leaks. Replace leaking pipes. Inspect hoses for leaks and for damage to the outside surface due to abrasion.

5.4.3 LEAKS

Inspect the machine for leaks of gear oil, hydraulic oil, engine coolant and fuel. Big leaks should be repaired. Small leaks should be wiped clean and the relevant part watched closely for oil level. Note that allowing oil or other fluids to leak into the environment might be unlawful.

5.4.4 GAUGES AND INSTRUMENTS

Wipe the faces of gauges with a cloth moistened with water. Replace cracked or missing glass.

Fluid-filled (shock resistant) gauges should be replaced if the glass is cracked.

5.4.5 BATTERIES

WARNING

Machine batteries contain acid. Use proper precautions and follow the instructions listed above.

Check the level of the electrolyte and add liquid if the level is too low. Check the battery cables and verify that there are no abrasions or indentations; if volts. necessary, replace the battery cables. Check that the battery terminals are not corroded, otherwise clean and replace them. The voltage of the battery is 12

Do not start the engine without batteries or disconnect them with the engine running. This can damage the electric system.

The batteries contain sulfuric acid. Protect eyes, face and hands during maintenance work. Do not pour battery acid on clothes, skin or eyes. If the acid reaches the skin, flood with water. If the acid reaches the eyes, wash with water plentifully and go to the doctor immediately. In case of ingestion drink water or milk and go to the doctor immediately.

Batteries can produce explosive gas. Do not smoke near a battery: keep away inflammable source, sparks or flames. Charge the batteries only in well ventilated areas.

Clean corrosion marks on battery terminals, if any. A paste made of sodium bicarbonate and water is normally enough to clean terminals and battery

box. After cleaning, rinse thoroughly with clean water. Coat the terminals with grease in order to prevent future corrosion.

5.4.6 UNDERCARRIAGE

DANGER

Remove pipe and pipe basket from the machine before performing maintenance.

The max. weight of the machine on the undercarriage system can be in excess of 38.57 Tonnes [85,000 lb]. Before starting any maintenance on the undercarriage, the machine must be properly supported vertically. The vertical support must include a locking system that cannot be inadvertently released allowing the machine to fall down. Failure to use this procedure could cause serious injury or death of the operators.

5.5 OTHER INSPECTIONS AND MAINTENANCE (EVERY 500 HOURS)

Check and/or effect the maintenance of the machine every 250 hours of engine operation as follows: (this control must be carried out together with the daily and weekly controls mentioned previously).

5.5.1 MOTOR MOUNTS AND RADIATORS

Check the rubber for wear. If the rubber parts are worn replace them.

5.5.2 UNDERCARRIAGE ROLLERS

Replace the rollers in case of damage, flat spots, etc.

5.5.3 BREATHER PIPES

WARNING

Do not use inflammable solvents, near fire, sparks or other inflammable sources. Before starting the operation wait until all the machine units (engine, etc.) are cool.

Check that there are no obstructions or deposits accumulated. Clean the breather pipes in case of obstructions. We recommend using an oil solvent (diesel fuel is OK).

Flywheel gearbox (1)

Hydraulic tank (1)

Fuel tank (1)

5.5.4 TRACK TENSION

Track tension is maintained by adding grease through a special fitting on each track.

5.6 OTHER INSPECTION AND MAINTENANCE (EVERY 500 HOURS)

5.6.1 ENGINE BELTS

WARNING

Wait for the engine to cool.

Check that belts have the right tension. If they have loosened, put them under tension. Replace belts if they are worn over the limits. REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.6.2 COOLING SYSTEM

WARNING

Wait for the engine to cool.

Fill the cooling system with antifreeze. REFER TO: Attachment 1, Caterpillar 3406 Diesel Engines.

5.6.3 ENGINE OIL BREATHER PIPE

WARNING

Wait for the engine to cool.

Every 600 hours clean the engine breather pipe. Clean it more often when operating in dusty conditions. REFER TO: Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.6.4 ELECTRIC SYSTEM

Inspect all the cables and wires for cracks, broken connections and loosened attachments. Repair or replace damaged parts.

5.7 OTHER CHECKS (EVERY 1000 HOURS OR EVERY YEAR)

5.7.1 ENGINE FUEL FILTERS REFER TO Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.7.2 ENGINE COOLING SYSTEM

WARNING

Wait for the engine to cool.

Add rust inhibitor to the engine cooling system every 600 hours or 12 months. REFER TO Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

5.7.3 EMERGENCY STOP

Verify the correct operation of both emergency stop controls.

5.8 INSPECTIONS AND MAINTENANCE EVERY 24 MONTHS

5.8.1 ENGINE COOLING SYSTEM

WARNING

Wait for the engine to cool.

Replace the coolant at 1200 hours or 24 months. Follow carefully the instructions indicated in Attachment 1, Caterpillar C-15 and C-16 Industrial Engines.

6.0 DIAGNOSTIC

6.1 OPERATING FAULTS

6.1.1 CLOGGED AIR FILTER

Visibility of the red marker (Fig. 34-2) indicates that the air filter is clogged with dust. This causes a high decrease of engine efficiency and can cause serious damage to inner mechanical parts. Clean or replace filter elements.

6.1.2 ENGINE OIL PRESSURE ALARM

In case of low engine oil pressure an automatic device stops the engine. Check for low oil level or other fault. If necessary, contact American Augers technical assistance service.

6.1.3 ENGINE COOLANT TEMPERATURE ALARM

In case of high temperature an automatic device stops the engine. Once suitable operating temperature has been reached again, the engine can be started. If necessary, contact American Augers technical assistance service.

6.1.4 ROTARY AND CARRIAGE DO NOT OPERATE

Activation of the es!lok® belt unit by the Competent Person or loss of signal will lock out the rotary and carriage function. REFER TO: Attachment 3 ES!LOK® Operation and Maintenance Instruction Manual.

6.1.5 CLOGGED OIL FILTER

Switching on of one or more lights (Fig. 24, LT1) indicates the restriction of the filters. Under conditions of extreme cold it is possible that these lights switch on when the machine is started and then switch off by increasing of hydraulic oil temperature.

This is normal, but do not operate the machine with one of these lights on in order to avoid serious damage to the hydraulic system.

7.0 DEMOLITION

7.1 MACHINE DEACTIVATION

For demolition of the machine, apply to authorized centers only. The elimination of waste materials must be carried out in conformity with the laws in force in the country of destination. Place the machine in a site having the features described in Paragraph 3.1 STORAGE. The site must be inaccessible to non-authorized personnel.

The movable parts must be positioned in the same way followed for transport (REFER TO: Section 3. STORAGE AND TRANSPORT).

Place oils and fuel not used in sealed containers.

Remove the batteries and place them in a dry and inaccessible site.

Normally the same centers which sell batteries also collect old batteries.

For oils, apply to the suppliers. Furthermore in Italy there is the “Association of Used Oils” which has been established for law. It is always available for the elimination of oils not used.

For the elimination, material of different nature must be separated and sent to authorized collecting sites.

NOTICE

Take used liquids to an authorized recycling center.

NOTICE

American Augers declines any responsibility in case of recycling or reusing of parts of the machine.

7.2 RESIDUAL RISKS

Corners of sharp steel parts are dangerous. Keep the machine in a site inaccessible to people except those in charge with dismantling.

NOTICE

The machine is made with some nonbiodegradable materials. Take the machine to an authorized place for elimination of these materials.

Figure 1 Declaration of EC Conformity

Not required in North America

Figure 2 Warranty Certificate

WARRANTY

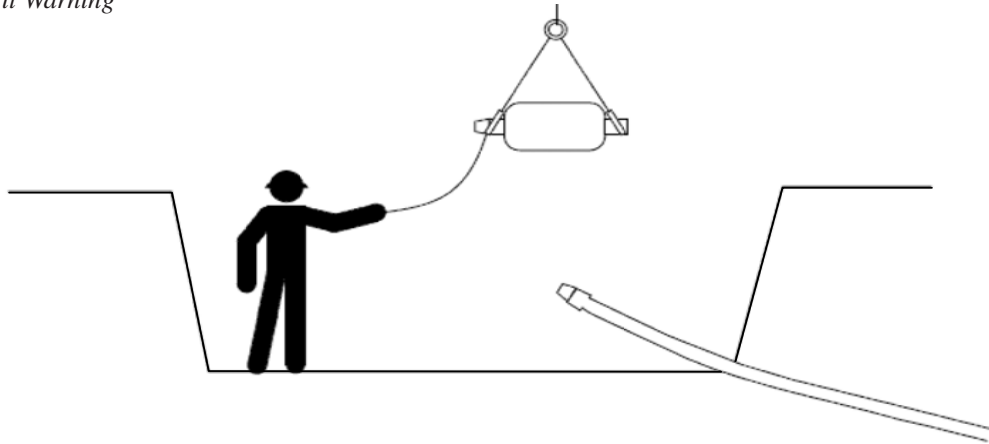
The Manufacturer warrants its products to be free from defects in material and workmanship for a period of **six months** from the date of shipment from the factory. The Manufacturer shall not be responsible for any damage resulting to or caused by its products by reason of installation, improper storage, unauthorized service, alteration of products, neglect or abuse or the use of the product in a manner inconsistent with its design. This warranty does not extend to any component parts not manufactured by Manufacturer; however, Manufacturer's warranty herein shall not limit any warranties made by manufacturers of component parts which may extend to Buyer.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES AND NO REPRESENTATIONS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, (INCLUDING, BUT NOT LIMITED TO, A WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE,) ARE MADE BY MANUFACTURER IN CONNECTION WITH THE MANUFACTURE OR SALE OF ITS PRODUCTS. NO EMPLOYEE, DISTRIBUTOR, OR REPRESENTATIVE IS AUTHORIZED TO CHANGE THIS WARRANTY IN ANY WAY OR GRANT ANY OTHER WARRANTY ON BEHALF OF THE MANUFACTURER.

Claims for defects in material and workmanship shall be made in writing to Manufacturer within ten days of discovery of defect. Manufacturer may either send a service representative or have the product returned to its factory at Buyer's expense for inspection. If judged by Manufacturer to be defective in material or workmanship, the product will be replaced or repaired at the option of the Manufacturer, free from all charges except authorized transportation.

THE REMEDIES OF BUYER SET FORTH HEREIN ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER REMEDIES. THE LIABILITY OF MANUFACTURER WHETHER IN CONTRACT, TORT, UNDER ANY WARRANTY, OR OTHERWISE SHALL NOT EXTEND BEYOND ITS OBLIGATION TO REPAIR OR REPLACE, AT ITS OPTION, ANY PRODUCT OR PART FOUND BY MANUFACTURER TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP. MANUFACTURER SHALL NOT BE LIABLE FOR COST OF INSTALLATION AND/OR REMOVAL OR BE RESPONSIBLE FOR DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE. UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE FOR LOSS OF ANTICIPATED PROFITS.

Figure 3 Exit Pit Warning

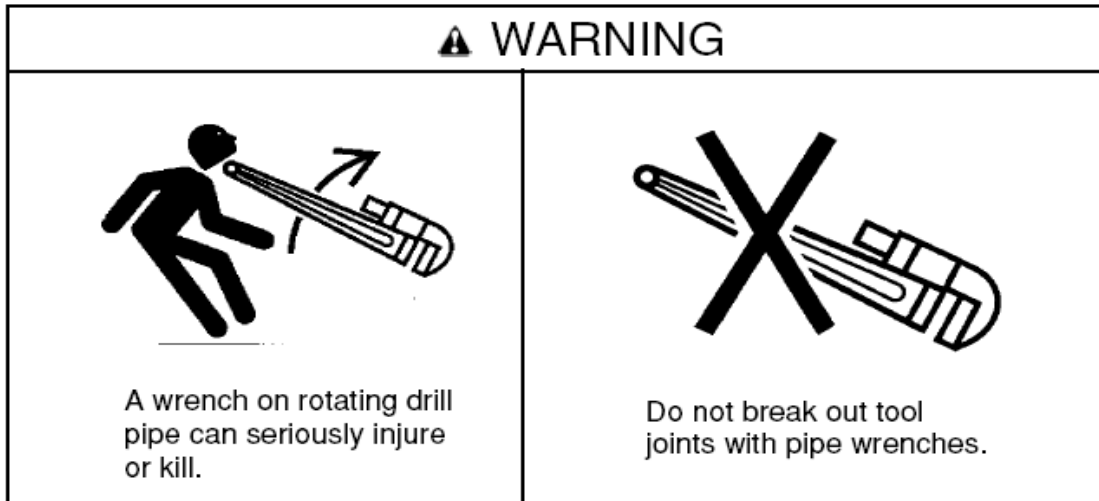


Drilling operations may require construction of a pit to receive the cutter or mud motor on the exit side of the crossing. It is the responsibility of the owner to make a safe pit that is in accordance with the rules set forth in the (OSHA) Code of Federal Regulations 29. There are specific requirements for pit

construction, protection, barricades, traffic control, installation and type of ladders used in the pit and personal safety equipment. American Augers recommends that the owner become familiar with the requirements of 29CFR1910. Information can be obtained from your Regional Department of Labor Office.

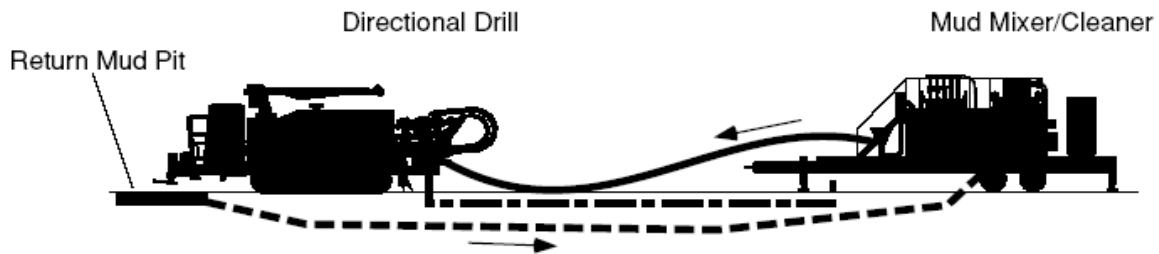
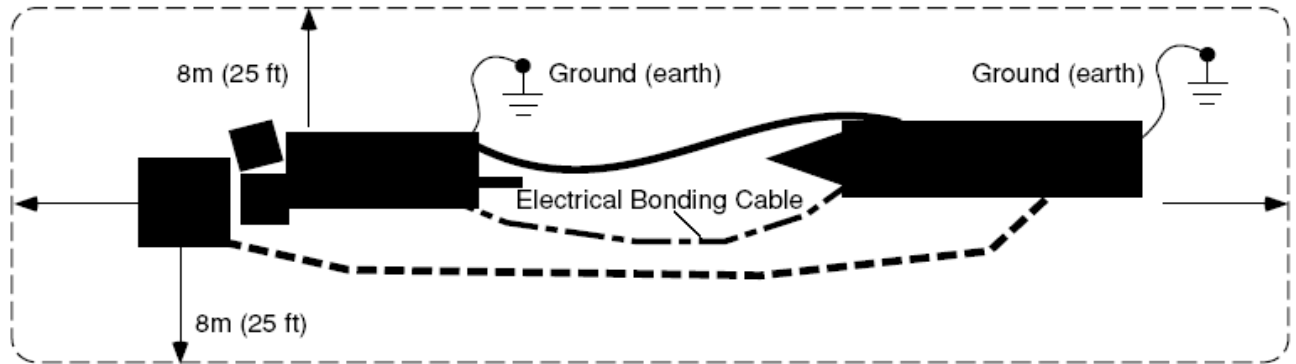
Use the es!lok® exit side lockout system to prevent inadvertent movement or rotation of the drill pipe and tooling.

Figure 4 Pipe Wrench Warning



Use only suitable equipment to break out tool joints.

Figure 5 Electrical Hazard Warning



⚠ WARNING
Electrical Hazard

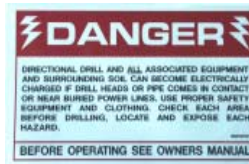
Erect safety barrier 8m (25 ft) beyond machine.
Make sure grounding stake is properly installed.
Keep spectators away.

Electrical Bonding Cable (not supplied) electrically bonds mud mixer/cleaner to drill (to maintain equal electrical potential in event of an electric strike.)

Figure 6 Machine Labels



15GB7113



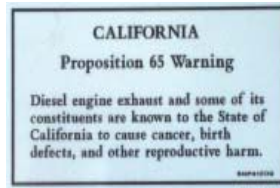
8NP41101



8NP41102



8NP41204



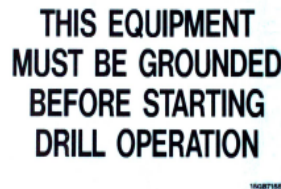
8NP41209



8NP41389



15GB7118



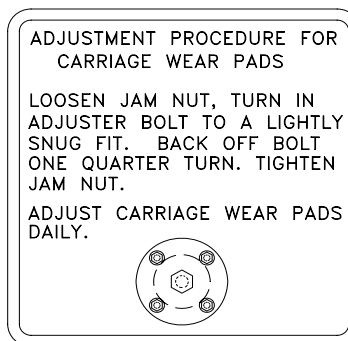
15GB7155



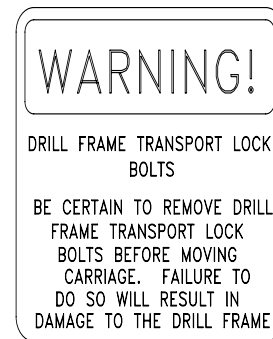
15GB7119



15GB7116



8NP41336



8NP41341

Figure 7 Machine Label Placement



8NP41209
15GB7118
8NP41204
8NP41341
15GB7155
8NP41101



15GB7113



8NP41336



8NP41336
8NP41341

Figure 8 Machine Label Placement



8NP41102



15GB7113

15GB7116



8NP41101



15GB7116

Figure 9 Machine Transport



Figure 10 Machine Lifting

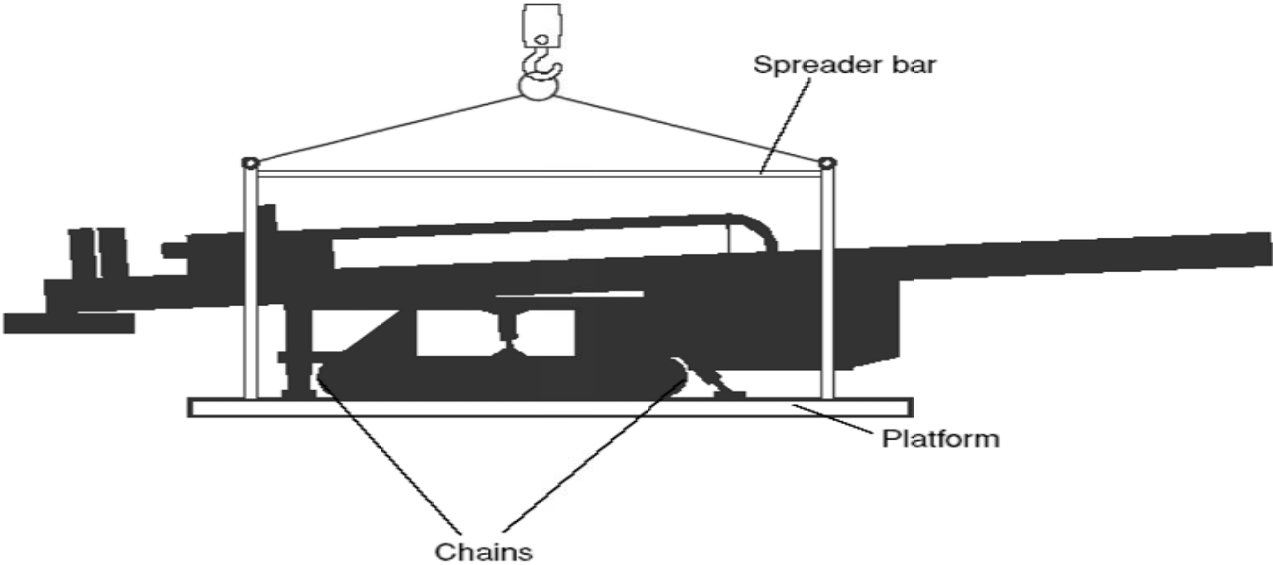


Figure 11 Machine Dimensions

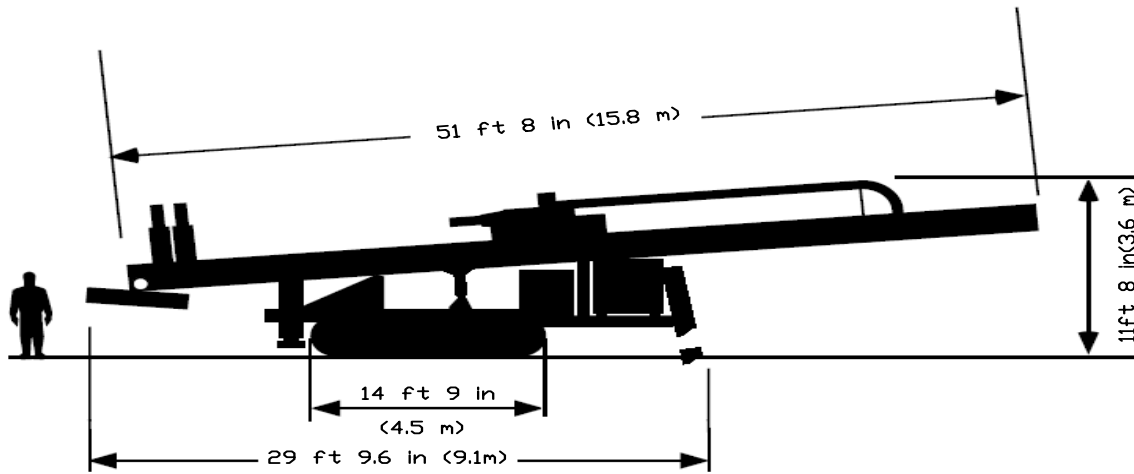


Figure 12 Maximum Height and Angle

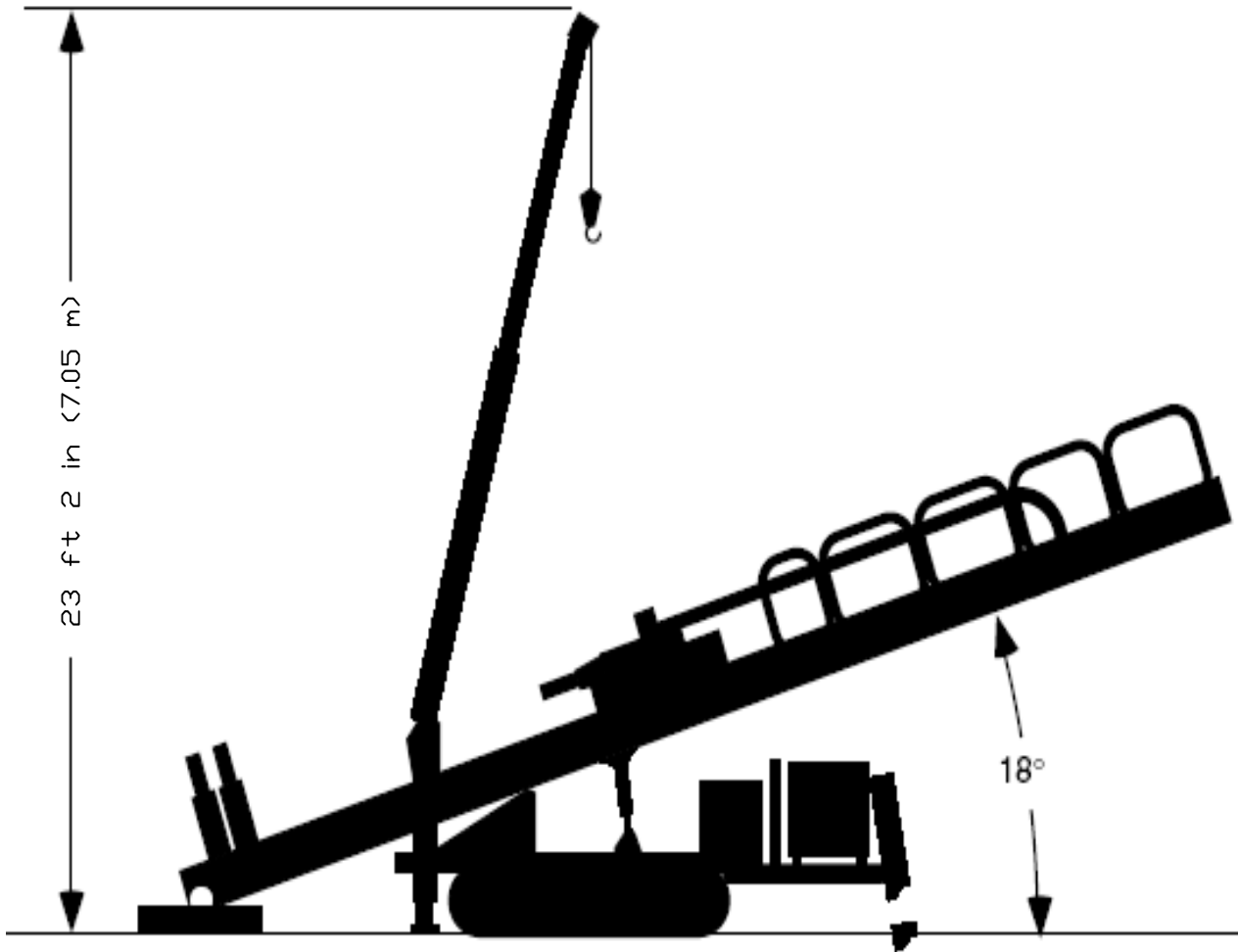


Figure 13 Tooling

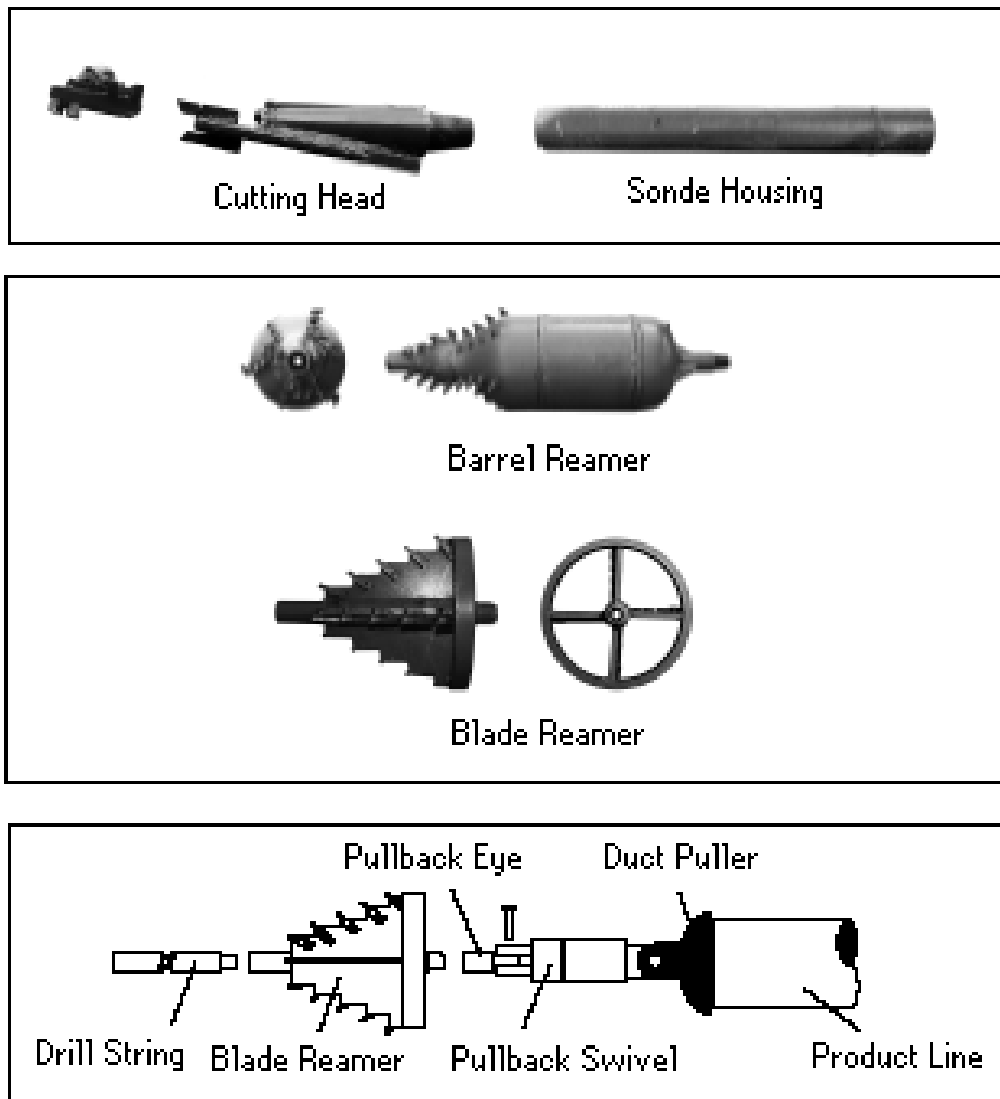


Figure 14 Down Hole (Mud) Motor

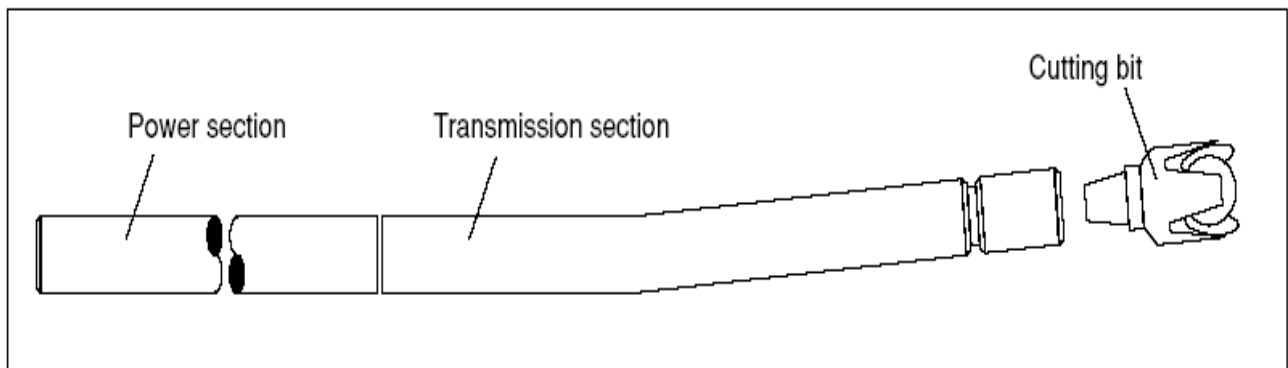


Figure 15 Steering

With cutter head positioned as shown, and thrust without rotation, bore moves in direction of arrow. Clock face will be represented on locating receiver.

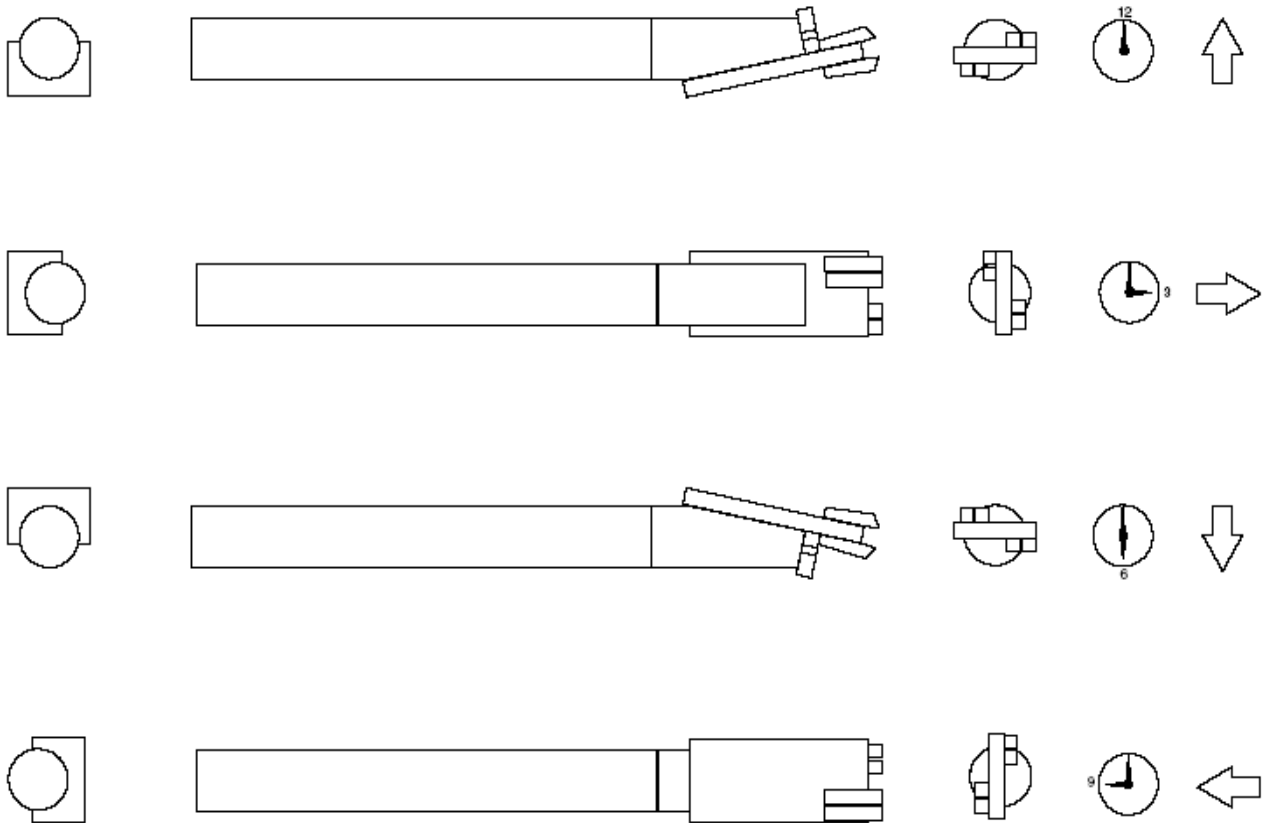


Figure 16 Clock face display on three brands of receivers

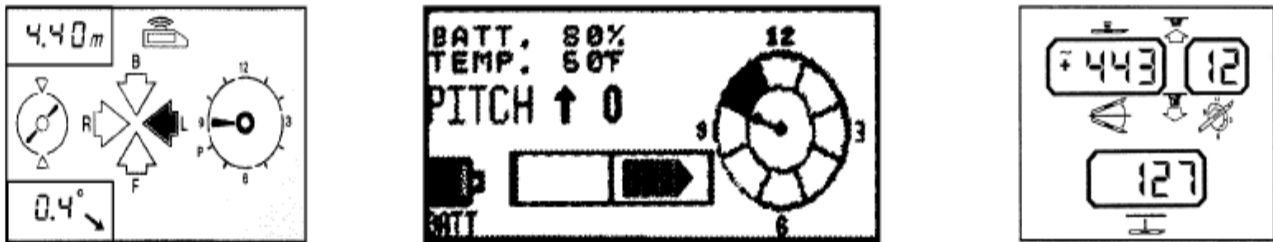


Figure 17 Trimming

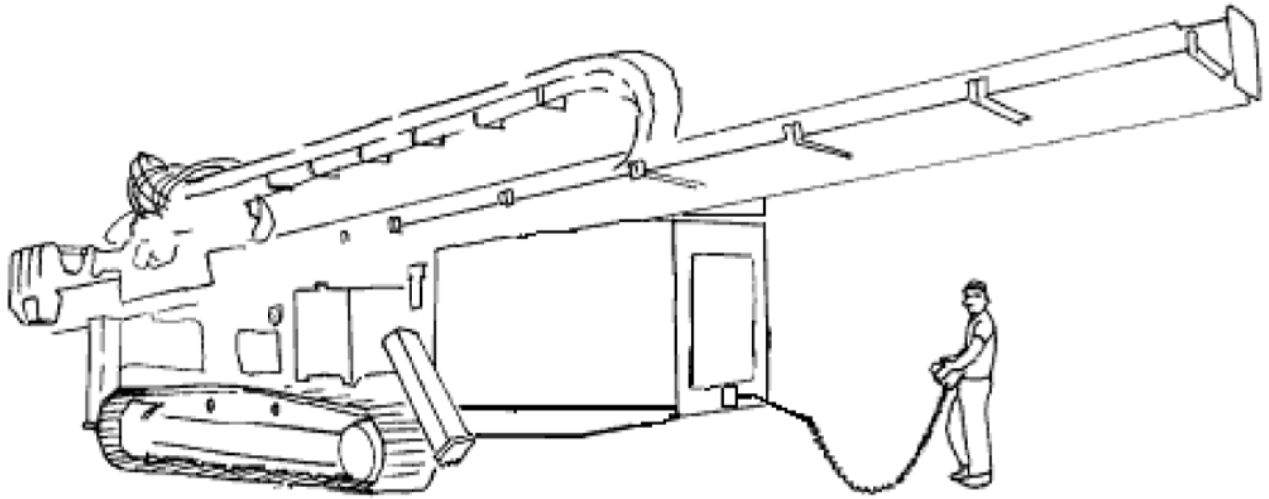


Figure 18 Hose Carrier Hold-Down

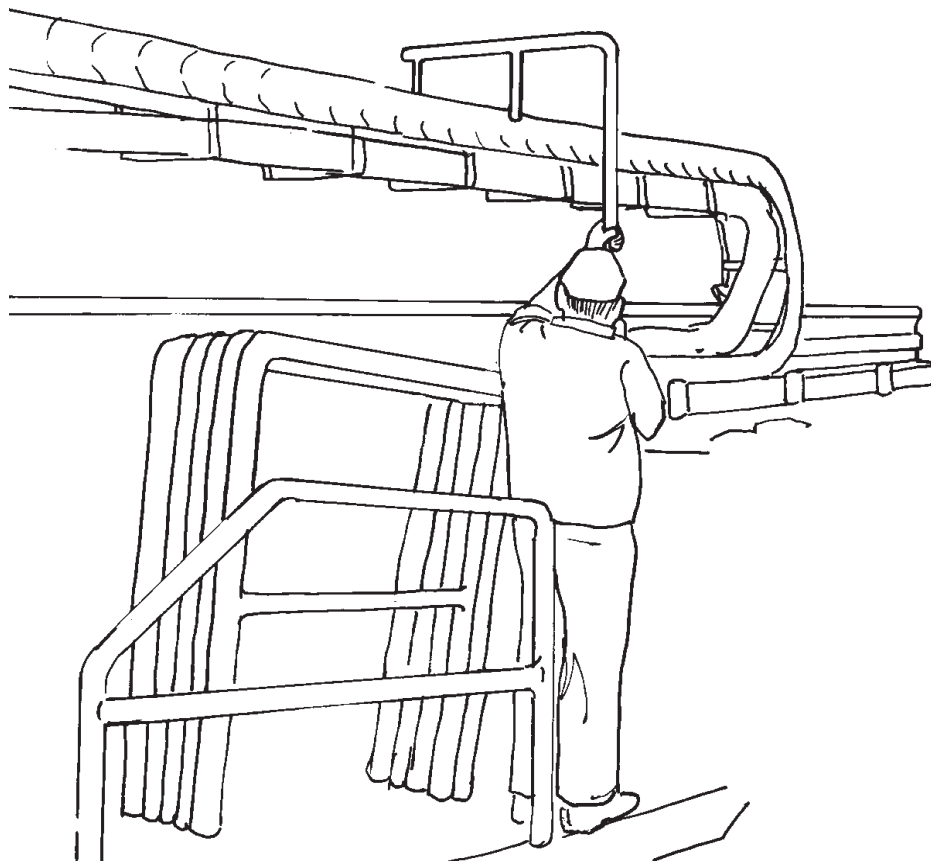


Figure 19 Positioning the Crane

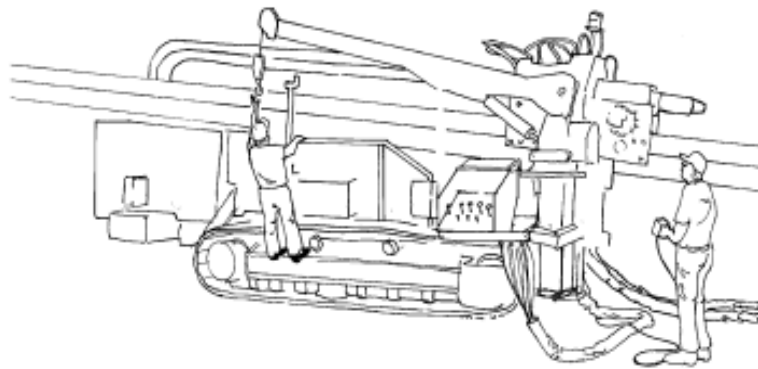


Figure 20 Carriage Lock Plate



Figure 21 Handrails

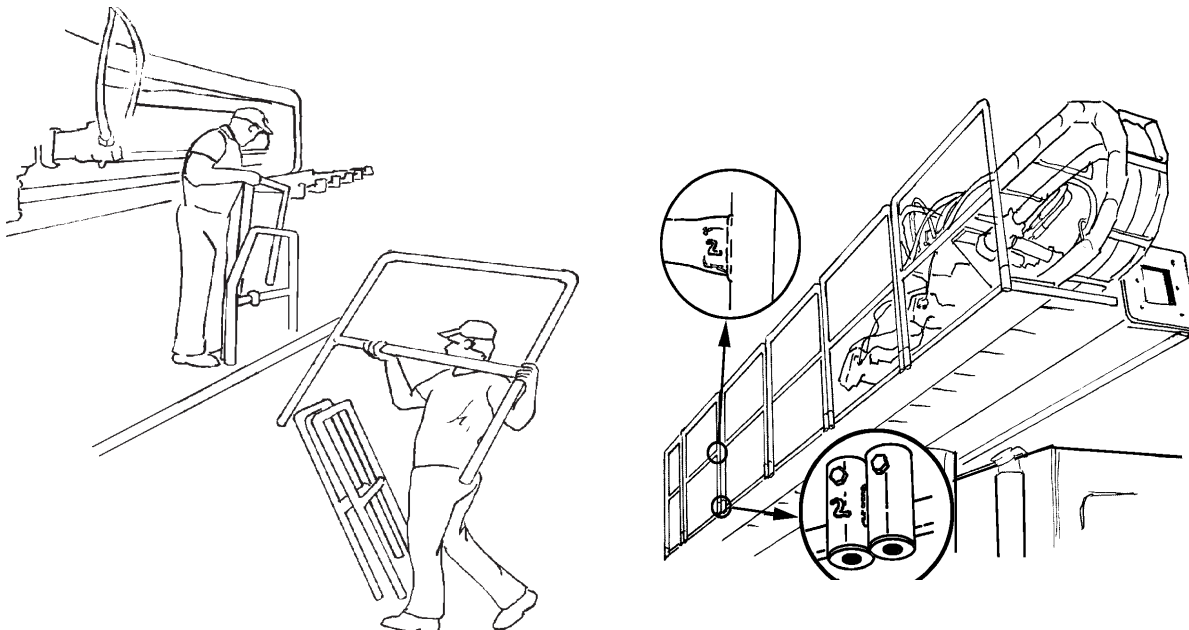


Figure 22 Engine Controls



Figure 23 Engine Instruments



Figure 24-A Mud Pump Control Panel



Figure 25 Set-up Panel

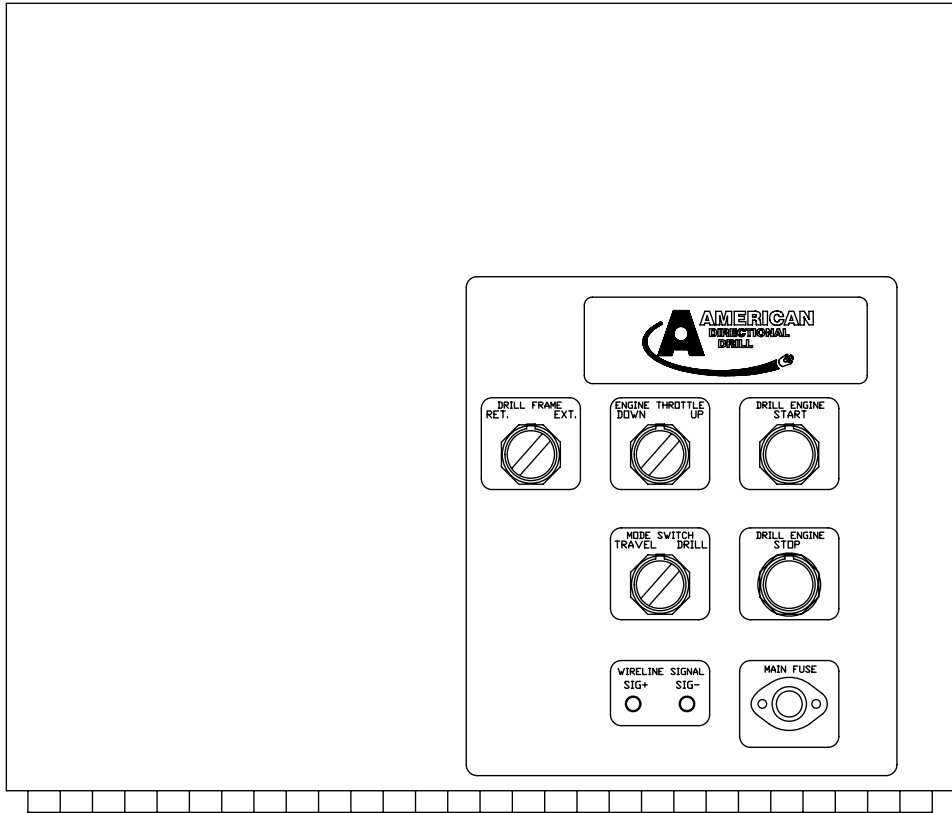


Figure 26 Crane Controls



Figure 27 Tramming Controls

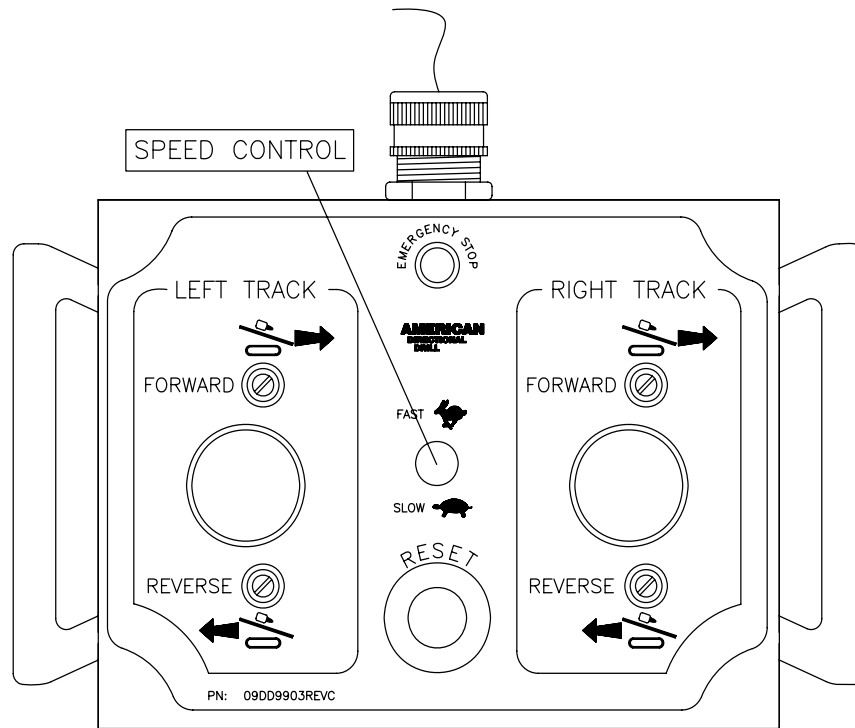


Figure 28 Battery Switch and es!lok

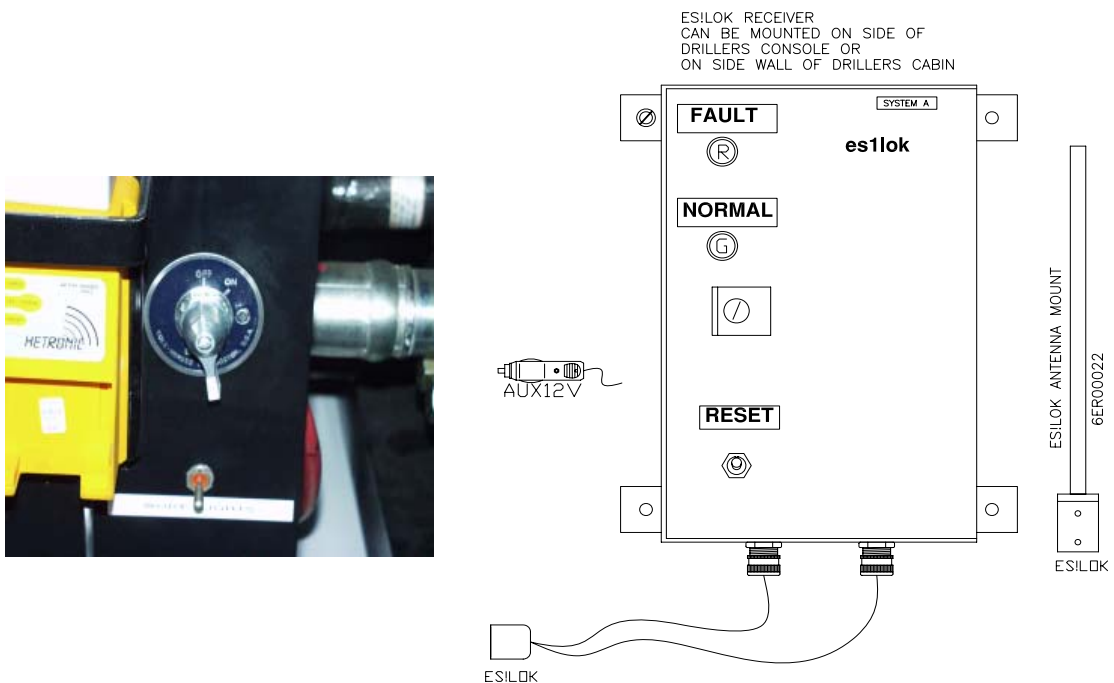


Figure 29 Tilt and Jacks Controls

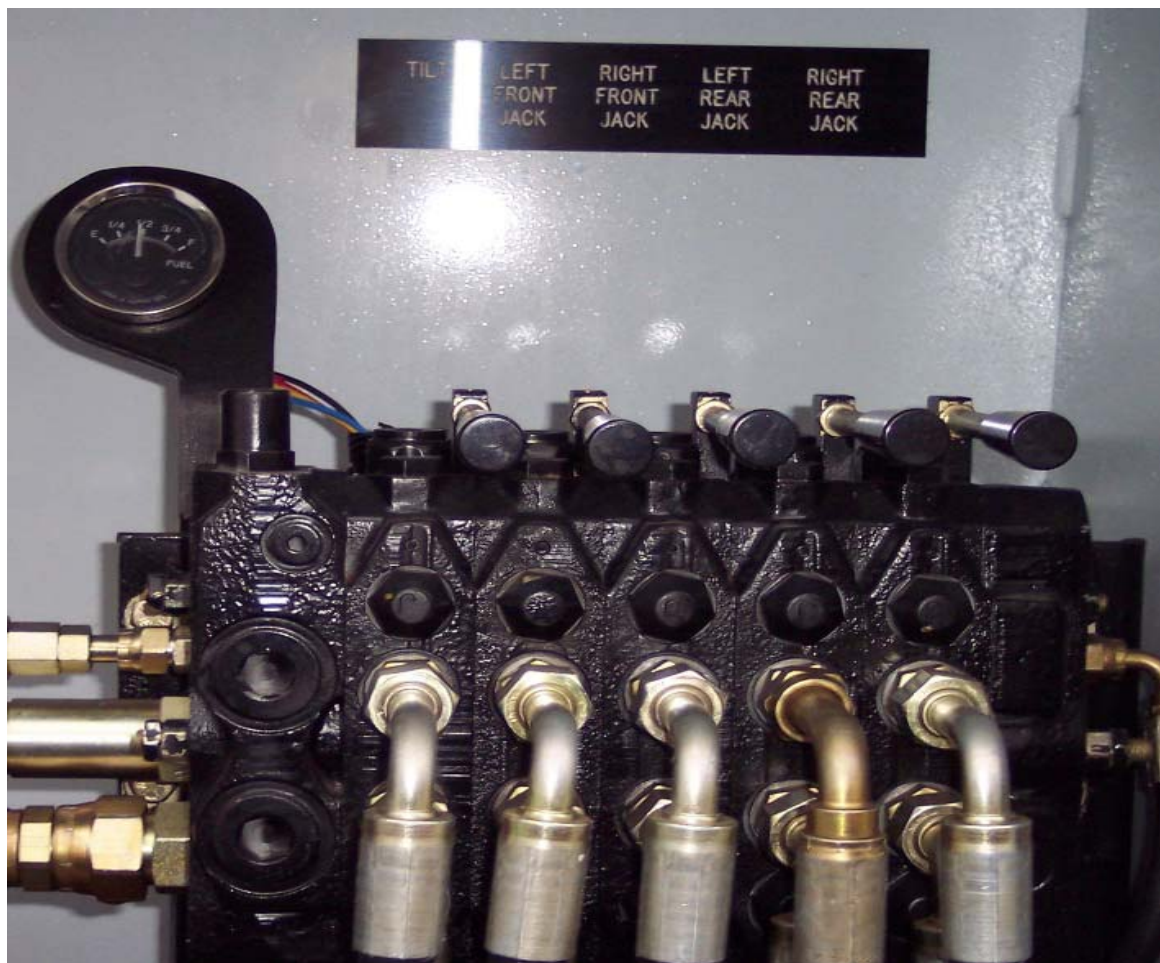


Figure 30 Pipe Supports

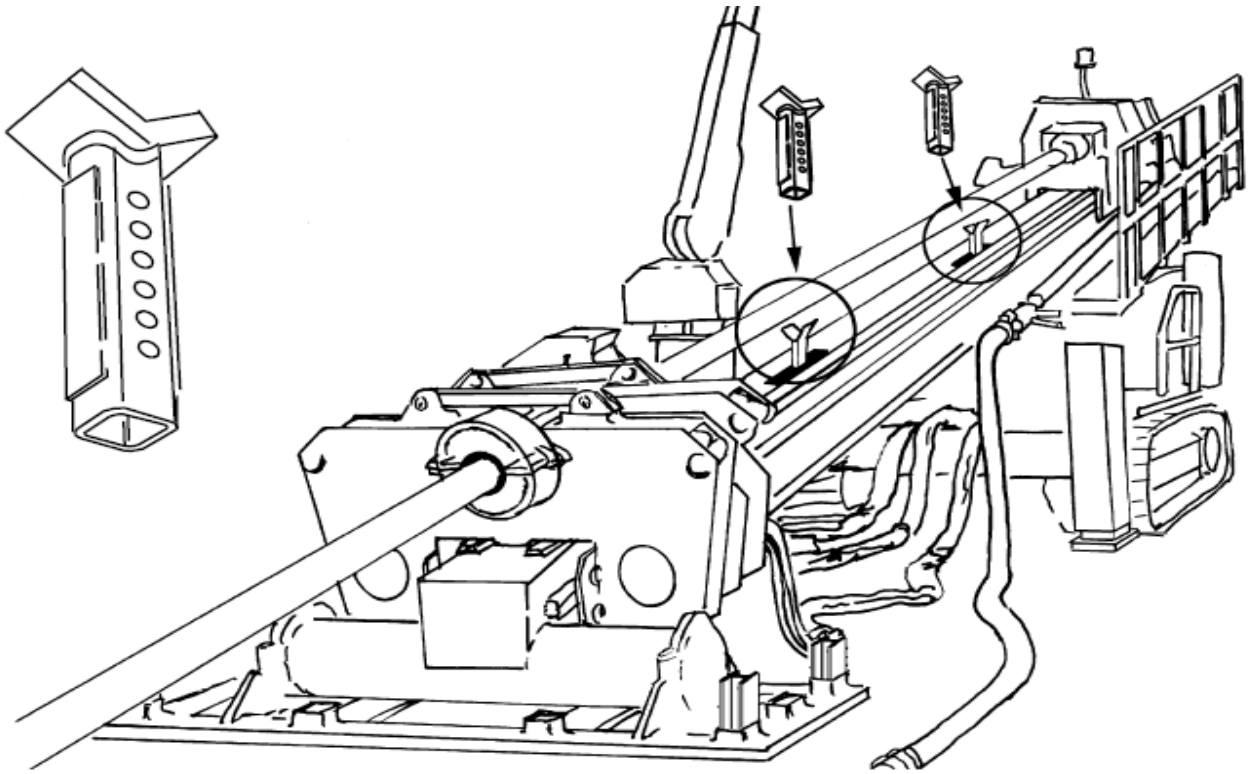


Figure 31 Tie Down stakes

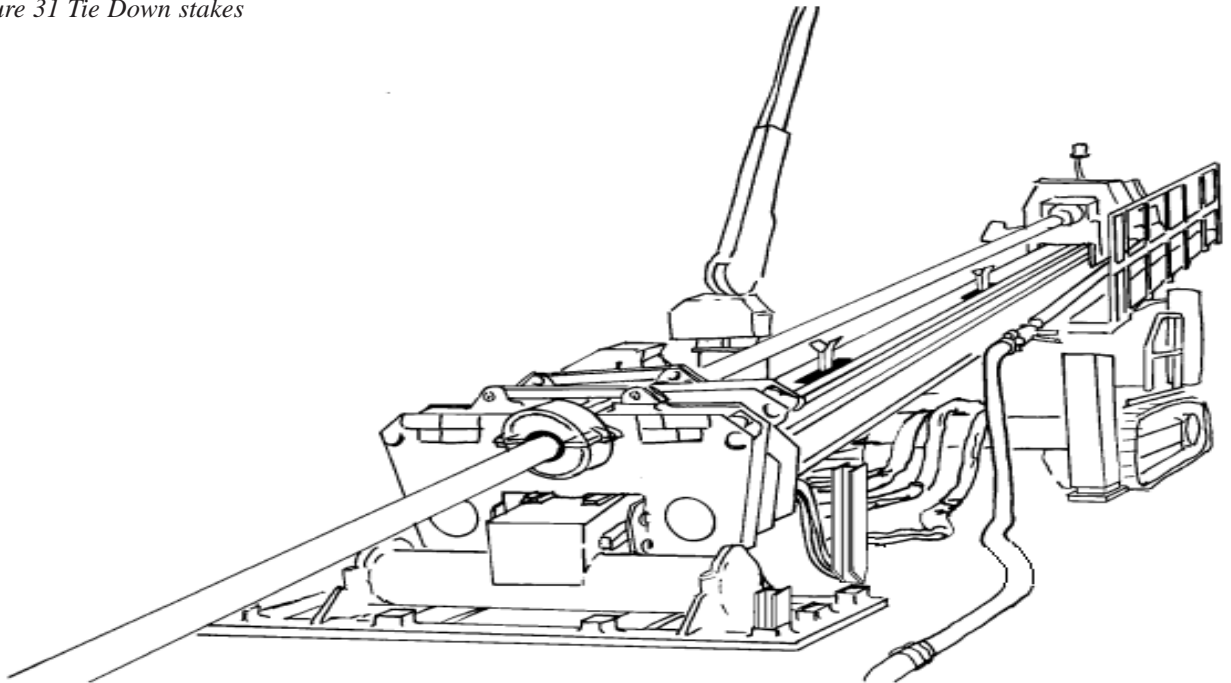


Figure 32 Buried Anchor

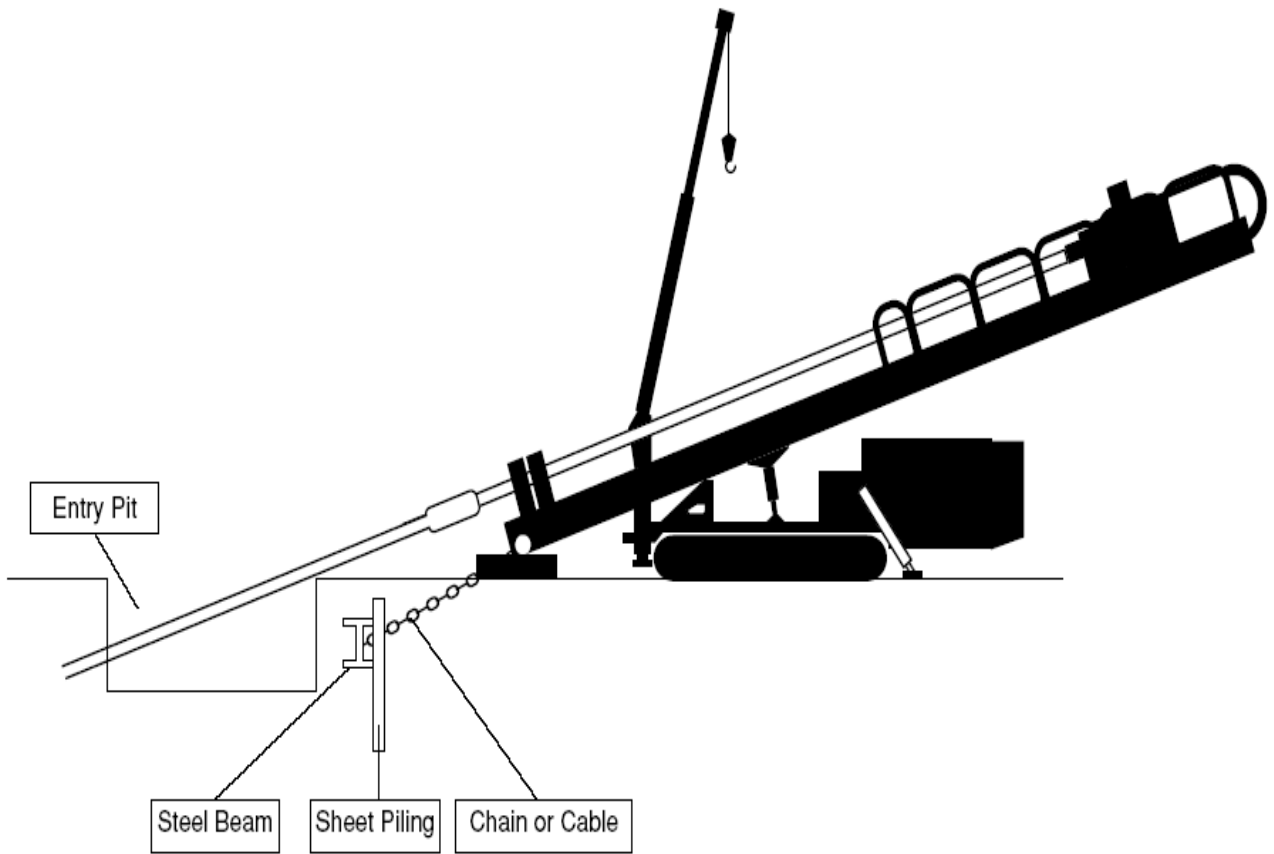


Figure 33 Carriage Pressure

GAUGE PRESSURE PSI	FORCE (LBS) 1ST GEAR	FORCE (LBS) 2ND GEAR	FORCE (LBS) 3RD GEAR
900	28682	14450	8964
1000	34419	17340	10757
1100	40155	20230	12549
1200	45892	23120	14342
1300	51682	26010	16135
1400	57365	28900	17928
1500	63101	31790	19720
1600	68838	34680	21513
1700	74574	37570	23306
1800	80311	40460	25099
1900	86047	43350	26891
2000	91784	46240	28684
2100	97520	49130	30477
2200	103257	52020	32270
2300	108993	54910	34062
2400	114730	57800	35855
2500	120466	60690	37648
2600	126203	63580	39441
2700	131939	66470	41234
2800	137676	69360	43026
2900	143412	72250	44819
3000	149149	75140	46612
3100	154885	78030	48405
3200	160622	80920	50197
3300	166358	83810	51990
3400	172095	86700	53783
3500	177831	89590	55576
3600	183568	92480	57368
3700	189304	95370	59161
3800	195041	98259	60954
3900	200777	101149	62747
4000	206514	104039	64539
4100	212250	106929	66332
4200	217987	109819	68125
4300	223723	112709	69918
4400	229460	115599	71710
4500	235196	118489	73503
4600	240933	121379	75296
4700	246669	124269	77089

Figure 34 Rotary Gauge Pressure

HYDRAULIC GAUGE PRESSURE PSI	ROTARY TORQUE LOW RANGE ,LBS FT	ROTARY TORQUE MID RANGE ,LBS FT	ROTARY TORQUE HIGH RANGE ,LBS FT
550	993	670	348
650	1987	1341	695
750	2980	2011	1043
850	3973	2682	1390
950	4967	3352	1738
1050	5960	4023	2085
1150	6953	4693	2433
1250	7947	5364	2781
1350	8940	6034	3128
1450	9933	6705	3476
1550	10927	7375	3823
1650	11920	8045	4171
1750	12913	8716	4518
1850	13907	9386	4866
1950	14900	10057	5214
2050	15893	10727	5561
2150	16887	11398	5909
2250	17880	12068	6256
2350	18873	12739	6604
2450	19867	13409	6951
2550	20860	14080	7299
2650	21853	14750	7647
2750	22847	15420	7994
2850	23840	16091	8342
2950	24833	16761	8689
3050	25827	17432	9037
3150	26820	18102	9384
3250	27813	18773	9732
3350	28807	19443	10080
3450	29800	20114	10427
3550	30793	20784	10775
3650	31787	21454	11122
3750	32780	22125	11470
3850	33773	22795	11817
3950	34767	23466	12165
4050	35760	24136	12513
4150	36753	24807	12860
4250	37747	25477	13208
4350	38740	26148	13555
4450	39733	26818	13903
4550	40727	27489	14251
4650	41720	28159	14598
4750	42713	28829	14946
4850	43707	28500	15293
4950	44700	30170	15641
5050	45693	30841	15988

Figure 35 Air Cleaner

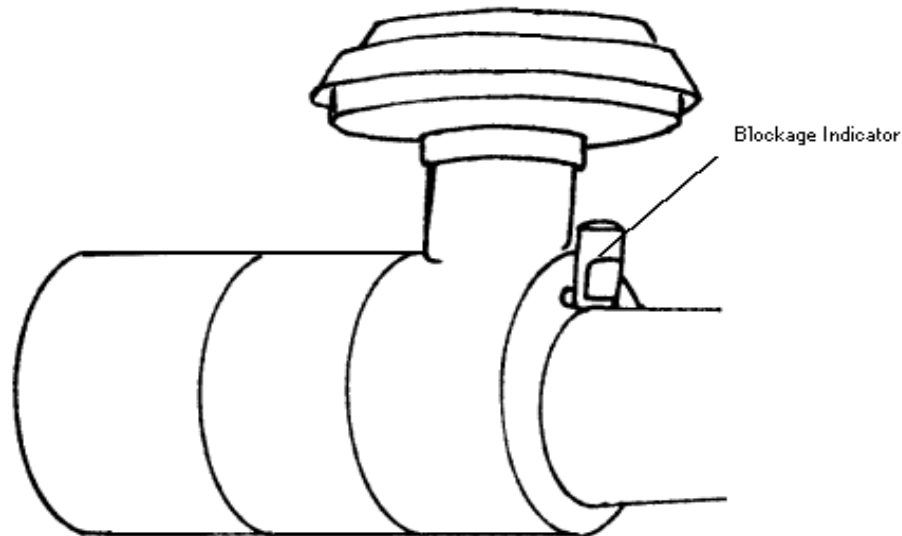


Figure 36 Volume of Soil Formula

$$\frac{\text{Gallons Water}}{\text{Gallons Soil}} = \frac{\text{Flow Rate, Gal/Minute}}{\left(\frac{\text{Hole Dia. (inches}^2\text{), Gal/ft}}{24.5} \right) \times \text{Bore rate, Ft/min}}$$

Use this formula to calculate a fluid-to-soil injection rate, to make soil fluid enough to flow out of the bore. As much as two gallons of fluid per gallon of soil could be required to minimize torque. Example: backreaming a 14-inch diameter hole= 8 gallons of soil per foot of bore. Progressing at 0.8 ft/min=6.4 gallons of soil per minute. Depending on soil type you might have to pump 6 gallons of fluid per minute. Therefore, one hundred feet of bore would generate approximately

800 gallons of soil plus an additional 800 gallons of fluid or a total of 1600 gallons per 100 feet of bore. This volume would require a returns pit of approx. 6x6x6 feet. If you have reached maximum mud pump rate and still need to reduce torque, reduce the bore rate (in feet/minute).

Figure 37 Steering Radius

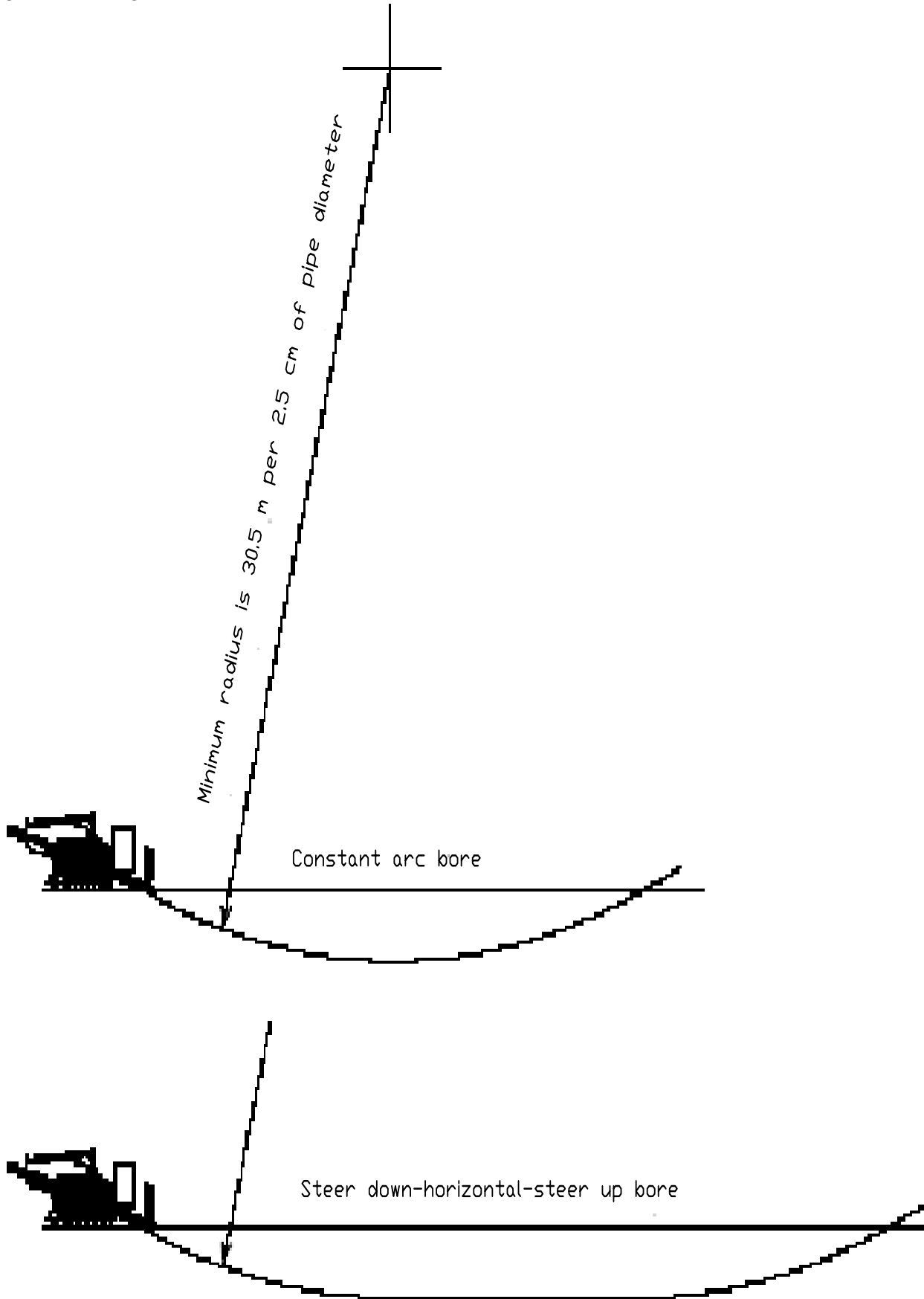


Figure 38 Approved Replacement Fluids

(Ambient temperature = -18Deg C to 44Deg C[0Deg F to 110Deg F])
 Consult factory for specifications at low temperature

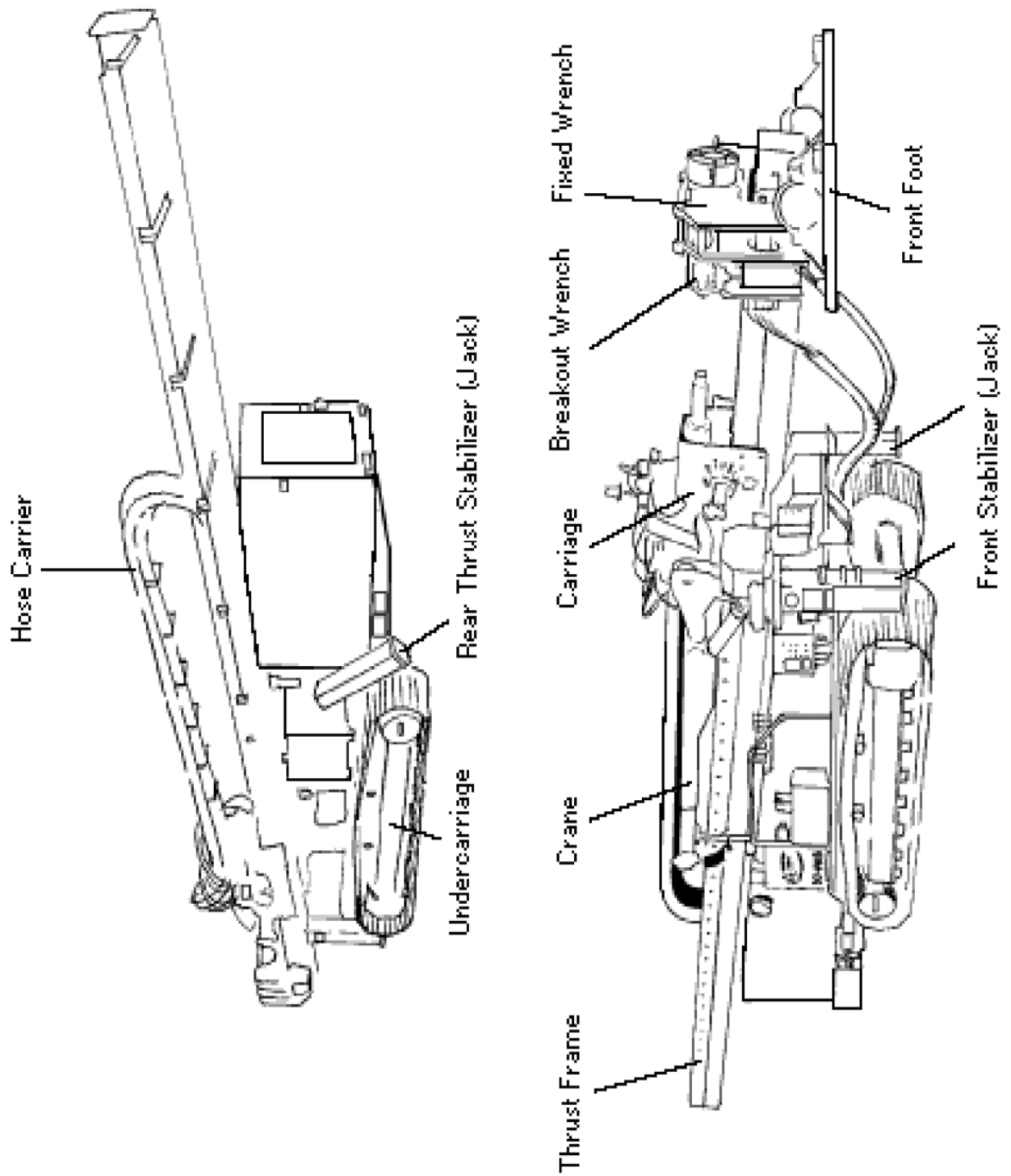
Engine Oil.....	Shell Rotella™ T	AA Spec 401
Hydraulic Oil	Shell Tellus™ T46	AA Spec 202
Pump Drive Oil	Shell Spirax S™ 80W140	AA Spec 102
Rotary Drive Oil	Shell Spirax S™ 80W140	AA Spec 102
Rotary Gearbox	Shell Spirax S™ 80W140	AA Spec 102
Carriage Drive Oil.....	Shell Spirax S™ 80W140	AA Spec 102
Track Drive Oil	Shell Spirax S™ 80W140	AA Spec 102
Grease	Shell Retinax™ LC-2	AA Spec 301
Mud Swivel Grease	Shell Retinax™ LC-2	AA Spec 301
Slip Sub Grease	Jet Lube Kopr Kote.....	AA Spec 302
Engine Antifreeze	Shellzone™ 60%, Water 40%.....	AA Spec 601
WaterCourse Antifreeze	Pitt-Penn RV Antifreeze	AA Spec 603

To order fluids from other suppliers, consult the AA Lubrication Specifications

Figure 39 Maintenance Schedule

	Daily or 10 hrs	Weekly or 50 hrs	Monthly or 250 hrs	6 Months or 500 hrs	Yearly or 1000 hrs
Engine crankcase oil	X	X	X	X	X
Engine coolant level	X	X	X	X	X
Hydraulic oil level	X	X	X	X	X
Fuel level	X	X	X	X	X
Rotary box oil level	X	X	X	X	X
Inspect for leaks	X	X	X	X	X
Grease	X	X	X	X	X
Check track tension	X	X	X	X	X
Carriage planetary gear box oil		X	X	X	X
Hydraulic pump gearbox		X	X	X	X
Track drive gearboxes		X	X	X	X
Replace engine oil & filter			X	X	X
Battery water level			X	X	X
Clean or replace air filter			X	X	X
Test engine coolant			X	X	X
Change engine fuel filters				X	X
Change hydraulic oil filters				X	X
Change oil all gearboxes				X	X
Change hydraulic oil				X	X
Replace engine coolant					X
Check track tension					X

Figure 40 Machine Nomenclature



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