

TDS - 11SA

Top Drive Drilling System

800 HP / 500 TON
or
700 HP / 500 TON

Technical
Bulletin

April 1998

Rev. A



TDS-11SA

Top Drive Drilling System

April, 1998

Technical Bulletin

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TDS-11SA Top Drive Drilling System

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Section 1

Introduction

Introduction to the TDS-11SA

Varco Drilling Systems acknowledges the accelerating demand for increased productivity in land drilling operations and has responded to this growing market with the development of the innovative TDS-11SA Top Drive Drilling System.

Varco engineering has made use of the recent advancements in AC technology by designing the TDS-11SA to be powered by two AC drilling motors (either 400 or 350 hp each, depending on the configuration). These 800-hp and 700-hp systems produce 32,500 and 37,500 ft lb of drilling torque respectively. They can provide 47,000 and 55,000 ft lb of make-up/break-out torque respectively.

The TDS-11SA is compact enough to operate safely in a standard 142' mast while providing 500 tons of hoisting capacity. Its highly portable design allows for rig-up and rig-down in just a few hours. It easily integrates into existing rigs at minimal installation cost and minimal rig modification.

Breakthroughs in drilling technology

In today's competitive land and offshore drilling markets, improving productivity by reducing cost per well is a top priority to operators in both horizontal and vertical drilling programs. Low maintenance, quick portability, reduced downtime and low acquisition costs are prime considerations for drilling contractors who strive to reduce the cost per well. Varco has produced a top drive system to meet all of these needs.

Increase productivity and reduce the cost per well

The following TDS-11SA features describe how this drilling system will help you increase productivity and reduce the cost per well:

- ☐ AC motors have no brushes, brush gear, or commutator—reducing maintenance costs. Additionally, AC motors have no arcing devices.
- ☐ The TDS-11SA has an onboard hydraulics system that eliminates the need for a stand-alone hydraulic power unit and fluid service loop—further reducing accessory costs.
- ☐ The two AC motors, the Varco integrated swivel, and the new rig-up and rig-down techniques reduce downtime while providing the most compact and portable drilling package available on the market today.
- ☐ The two motors and the drive train provide a redundant power path, increasing the life expectancy of these components. This also reduces downtime and maintenance costs.
- ☐ The TDS-11SA features a hydraulic link tilt that can tilt the elevator to either side of well center.
- ☐ The TDS-11SA is specifically built for quick portability.
- ☐ The TDS-11SA uses helical gearing to reduce noise.
- ☐ A higher speed (550 rpm max.) TDS-11SA is available.

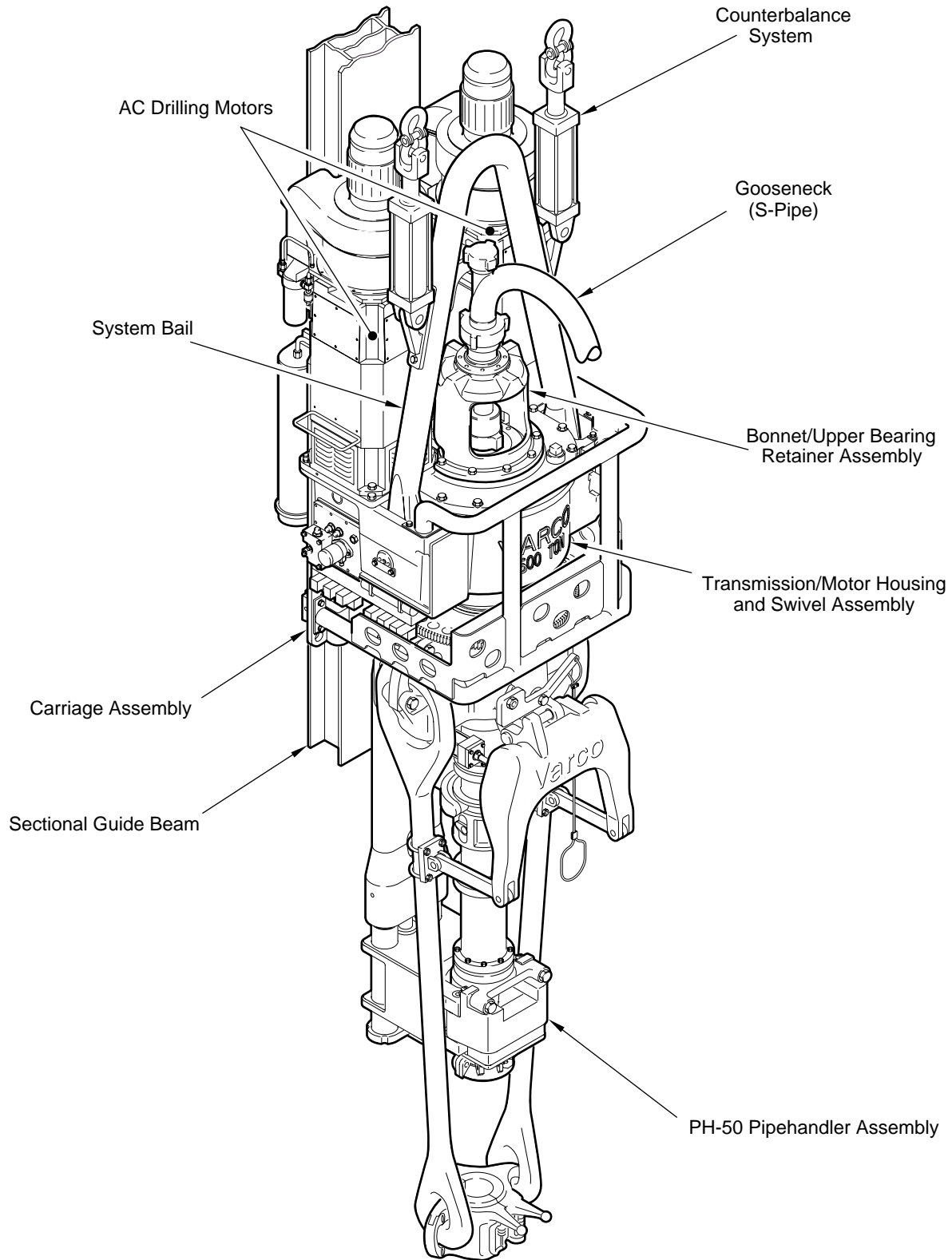
The TDS-11SA has all of the benefits the big top drives have

All of the operational benefits, cost savings and proven time savings realized by utilizing a top drive hold true with this smaller, less expensive unit. The TDS-11SA will provide drilling contractors with all of the benefits of a big top drive:

- ☐ Drilling ahead with 93' stands
- ☐ Eliminating two out of every three connections
- ☐ Back reaming and forward reaming capabilities
- ☐ Full rotation and circulation when tripping out
- ☐ Pulling through tight spots
- ☐ Reducing the incidence of stuck pipe
- ☐ Controlling stand connections
- ☐ Making and breaking connections with the top drive
- ☐ Drilling through bridges and tight spots without picking up a kelly
- ☐ Well control
- ☐ Instant stabbing and well shut-in at any position in the mast when tripping
- ☐ Crew safety
- ☐ Only smooth drill pipe rotating on the rig floor.
- ☐ Operators only need a backup tong
- ☐ Reduced power generation costs by using smaller diesel generator sets; and reduced fuel consumption.

The TDS-11SA, from the innovators at Varco Drilling Systems, incorporates state-of-the art technology in the most important innovation in drilling since the rotary table.

The following product information describes the mechanical, electrical, and hydraulic systems of the TDS-11SA, as well as operational and installation information to help clarify the benefits realized by utilizing the Varco TDS-11SA top drive.



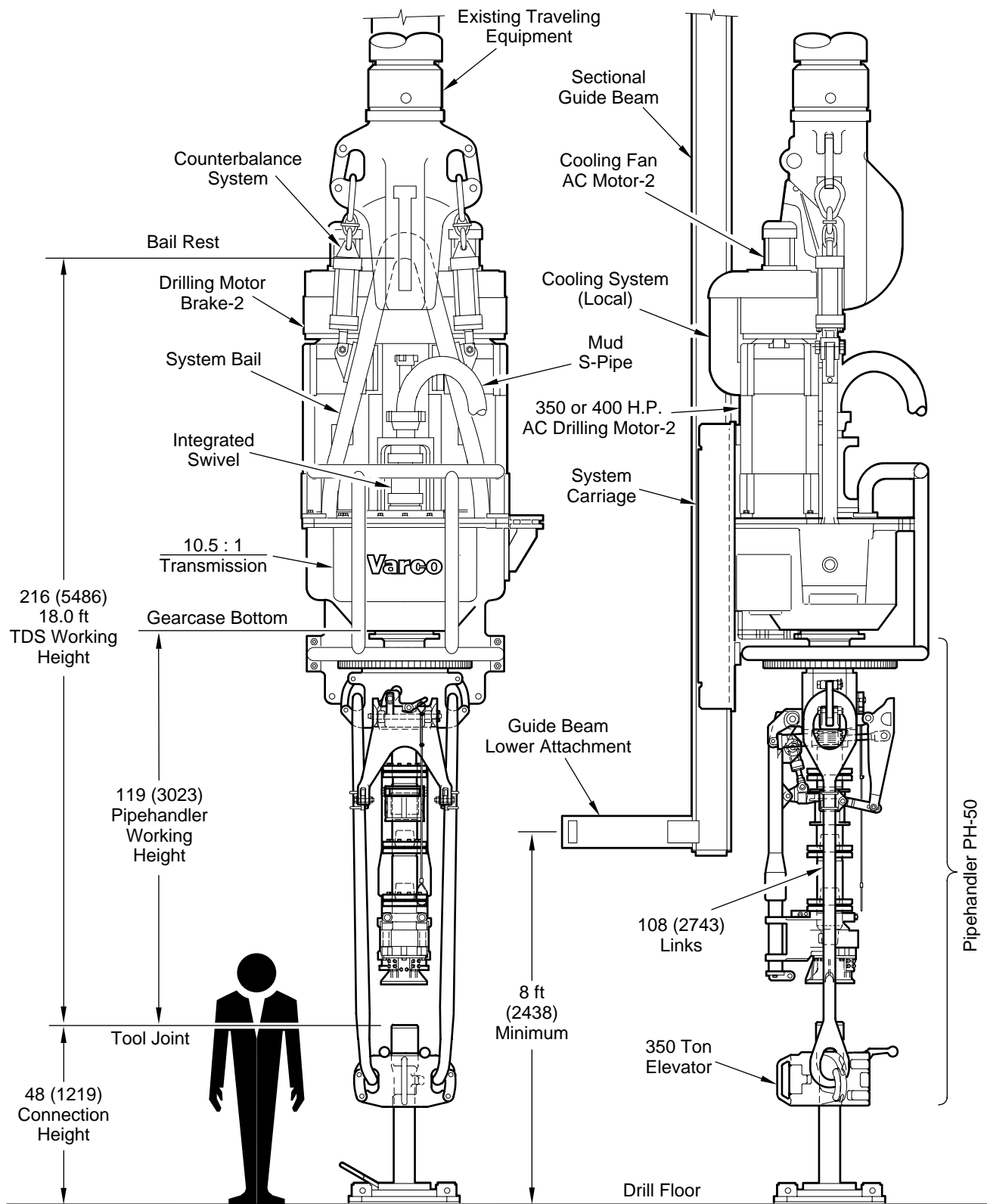
TDS-11SA Top Drive Drilling System

Description

TDS-11SA Major components

The TDS-11SA drilling system includes the following main assemblies and subassemblies:

- ☐ Motor housing and swivel assembly
- ☐ Motor cooling system
- ☐ Carriage and guide beam
- ☐ PH-50 pipehandler
- ☐ Hydraulic control system
- ☐ Counterbalance system
- ☐ AC drilling motors and control system



TDS-11SA General Arrangement

Motor housing and swivel assembly

This assembly is comprised of the following subassemblies:

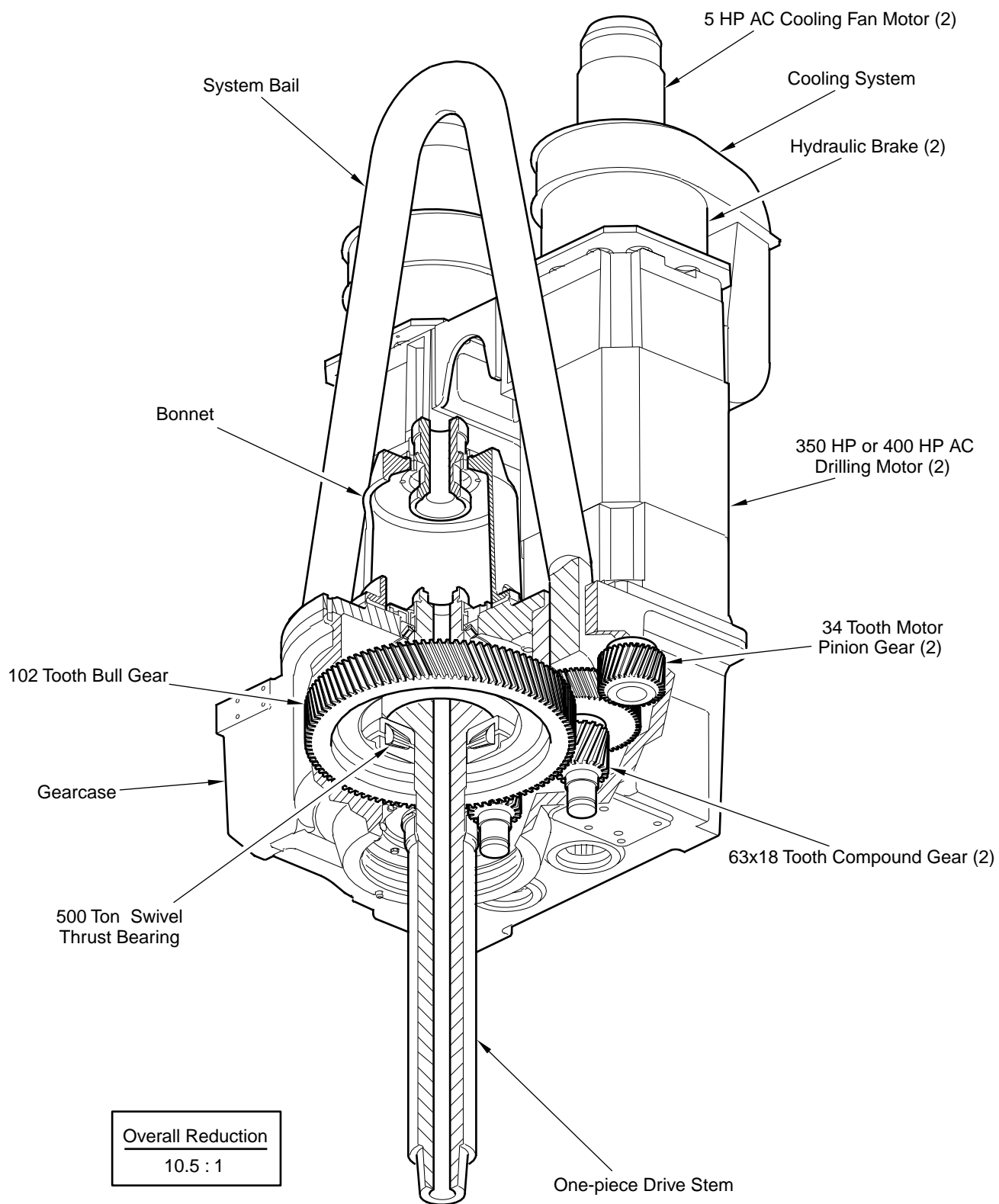
- ☐ Transmission and swivel housing
- ☐ Integrated swivel assembly
- ☐ Drilling motors and brakes

Transmission and swivel housing

The assembly consists of the following components:

- ☐ Bonnet
- ☐ Main body and transmission housing
- ☐ 2 Motor pinions–34T
- ☐ 2 Compound gears–63T/18T
- ☐ Bull gear–102T
- ☐ Main shaft
- ☐ Integrated swivel assembly
- ☐ Lubrication system

The single-speed helical gear transmission with double reduction provides a 10.5:1 ratio from the motors to the main shaft. The main body and gearcase cover house the transmission, the main thrust and radial bearings. The gearcase cover houses the upper take-up bearing and supports the AC motors and bonnet. The bull gear attaches to the load shoulder on the main shaft. All lubrication of the gears and bearing is via a pressurized system integrated into the main body and cover.



TDS-11SA Power train cutaway

Integrated swivel assembly

The main body and transmission housing provide a sealed oil lubrication reservoir for the gears and bearings. An oil pump, integrated into the housing and powered by a hydraulic motor, feeds the bearings and gears. The filtered lubrication oil constantly circulates through the main thrust bearing, upper taper bearing, lower radial and compound gear bearing, and over the gear meshes.

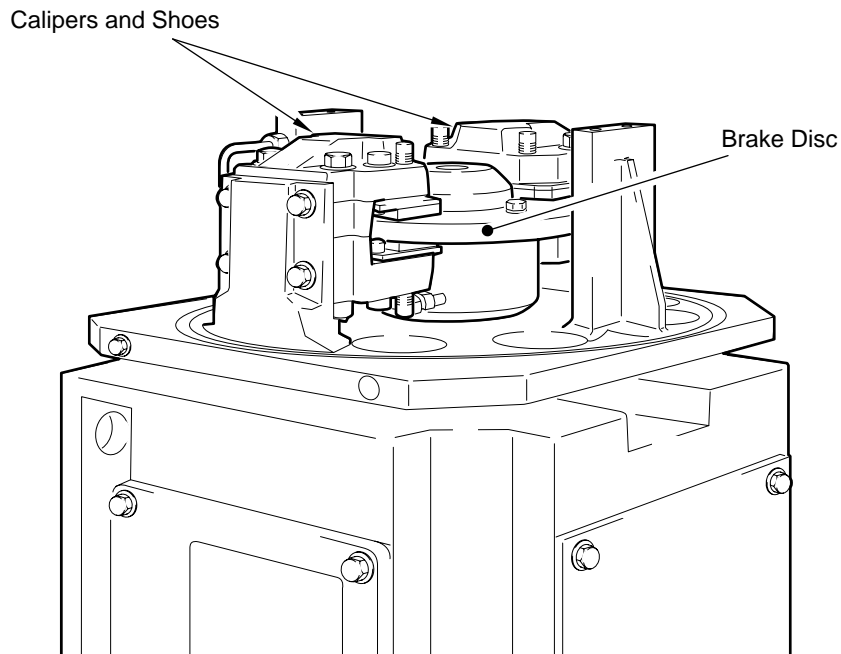
An industry-standard washpipe packing assembly is located between the main shaft and gooseneck, and allows for the rotation of the drill string. The bonnet supports the assembly and attaches to the gearcase to provide lateral support.

A swivel bail of forged alloy steel attaches to the main body with bail pins. It swings forward to attach to standard drilling hooks. The bail is fitted into the main body with grease-lubricated bronze bushings. An extended length is available to allow operator clearance between the gooseneck and hook for wireline packing assemblies.

Drilling motors and brakes

Two 400-hp or two 350-hp AC drilling motors supply power to the TDS-11SA. The motors mount vertically side by side on top of the transmission gearcase cover with a modified “D-face” to avoid shimming or special alignment during installation of the motors.

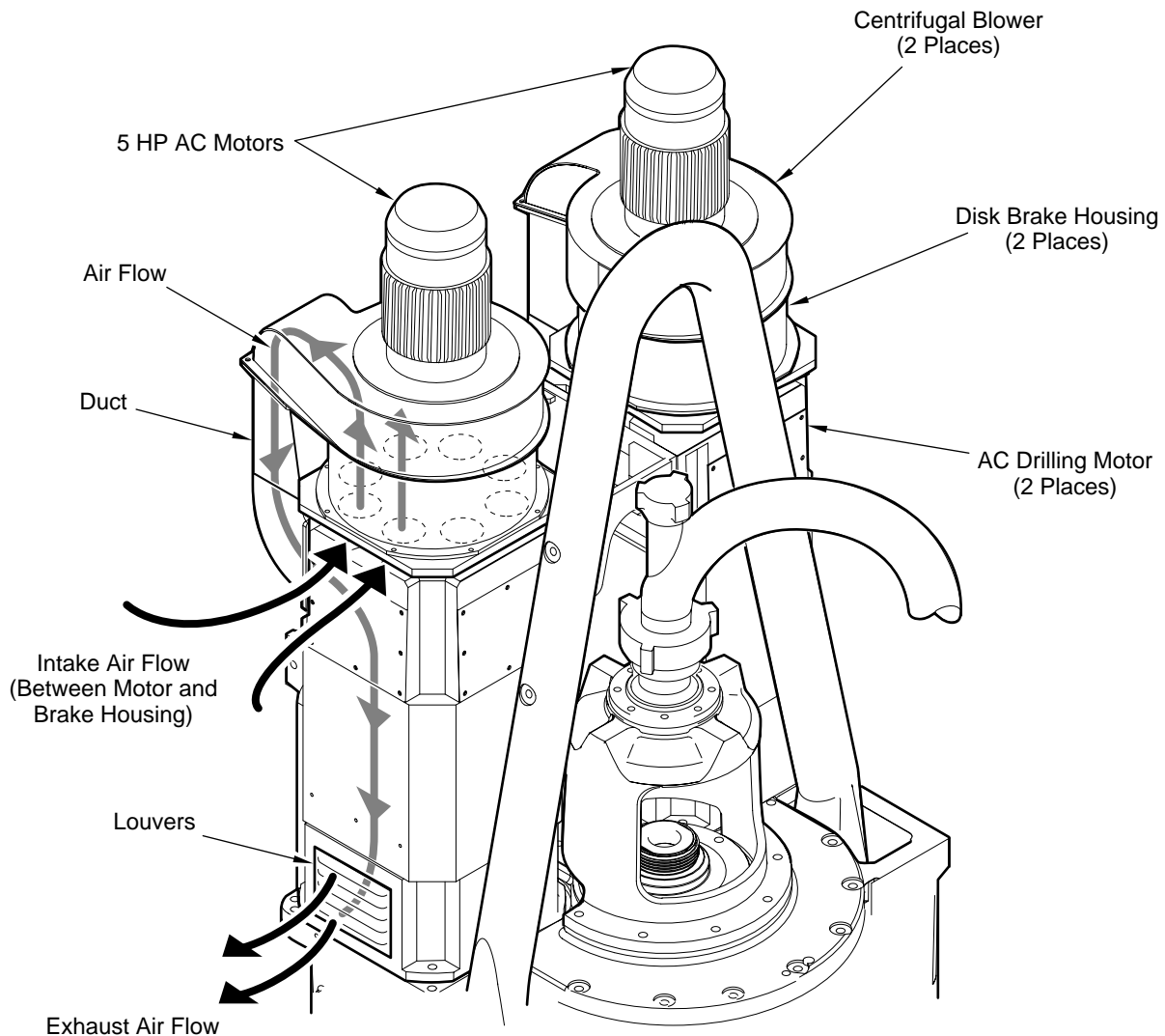
Each motor has a double-ended shaft with a drive pinion mounted on the lower end and a disc brake rotor mounted on the upper end. Two hydraulic caliper disc brakes mount to the top end of each motor, where they can be easily inspected and serviced via the access covers around the brake covers. The caliper disc brakes also assist in drill string positioning when performing directional work. They are remotely operated from the driller’s console.



TDS-11SA Disk Brake

Motor cooling system

The motor cooling system on the TDS-11SA is a local intake centrifugal blower consisting of two 5 hp AC motors mounted on top of each AC drilling motor. The system draws air across the brake and delivers it through rigid ducting to an opening at the top of each motor. The cooling air then passes through the inside of the open-frame type AC drilling motors and exits through the louvered opening near the bottom of the motors. This rugged, simple design provides highly reliable service with positive ventilation.

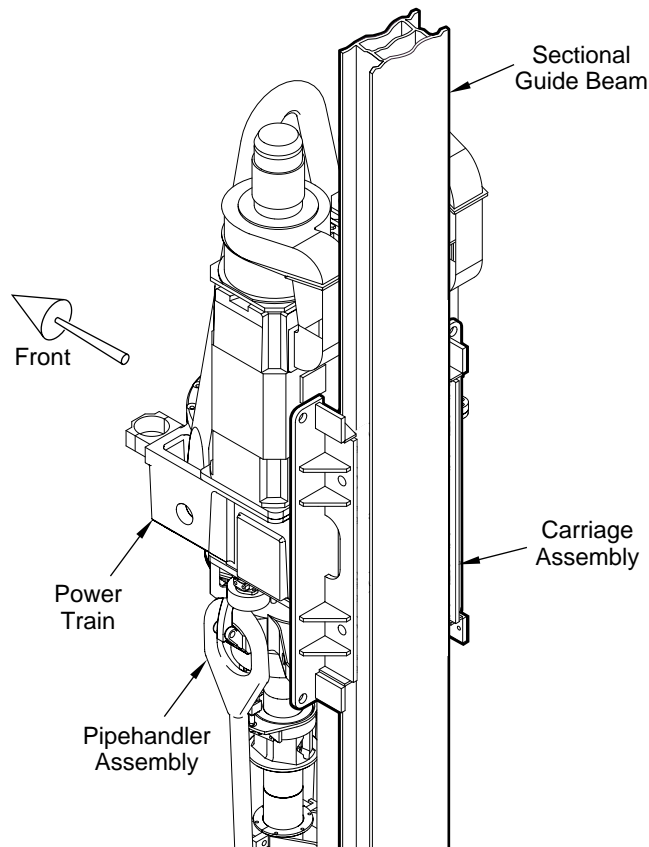


TDS-11SA Motor cooling system

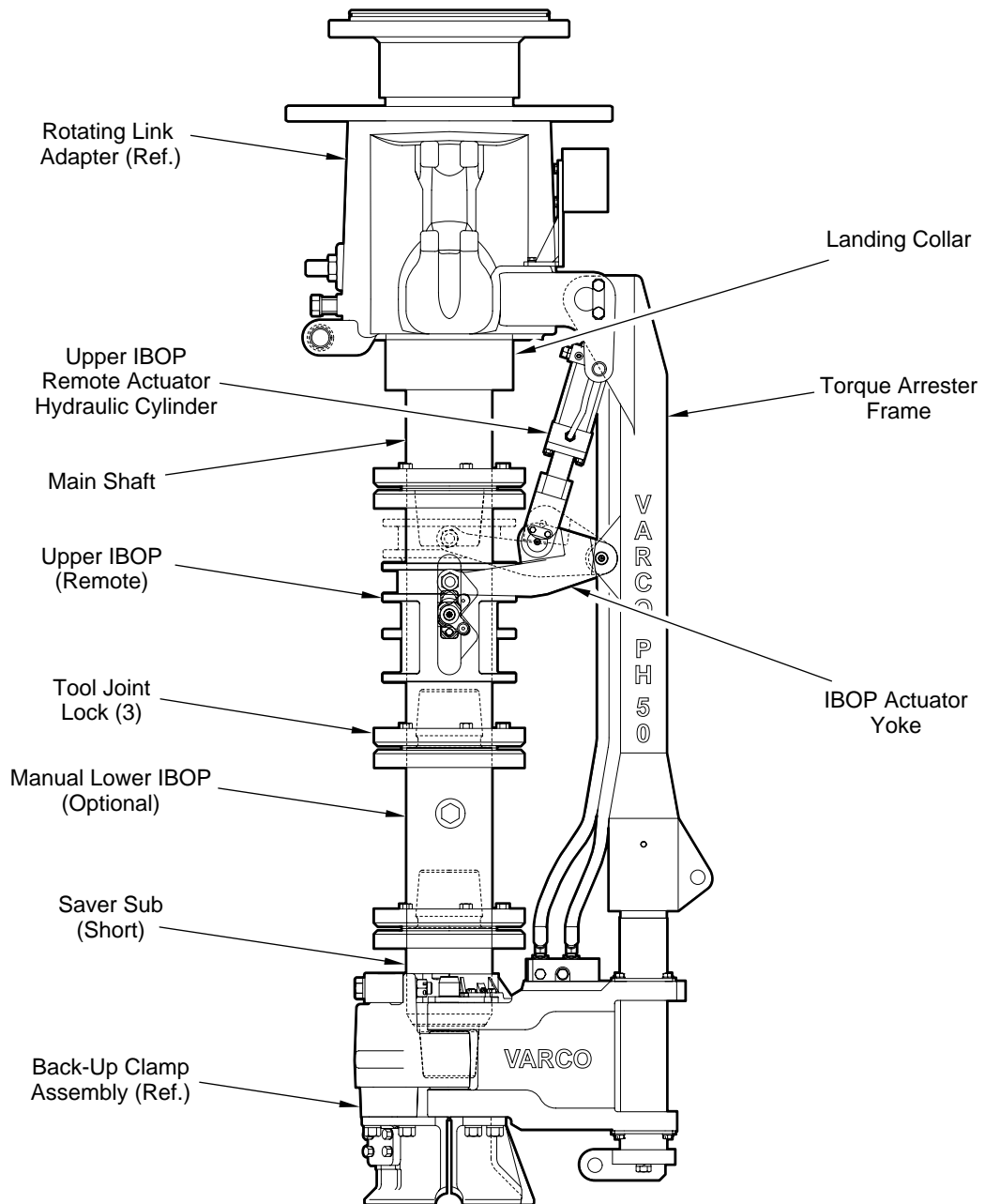
Carriage and guide beam

The TDS-11SA drilling system travels on a hanging guide beam by means of a carriage attached to the gearcase. The guide beam hangs from the crown and extends to within seven feet of the drill floor. There, it attaches to a torque reaction beam mounted across the lower section of the mast or derrick.

The drilling torque is reacted through the carriage and into the guide beam. The guide beam is available in 18' sections (132 lb/ft) and hangs from a pad eye at the crown. The guide beam sections are pinned together in such a way that they hinge to facilitate installation. You can assemble them one section at a time at the drill floor while raising the guide beam to the crown attachment using the drawworks.



Carriage and guide beam



TDS-11SA Drill stem assembly

PH-50 pipehandler

The PH-50 pipehandler consists of the following major components:

- ☐ Powered rotating head/link adapter
- ☐ Bidirectional link tilt
- ☐ Loading collar
- ☐ Remote upper IBOP actuator
- ☐ Torque backup clamp

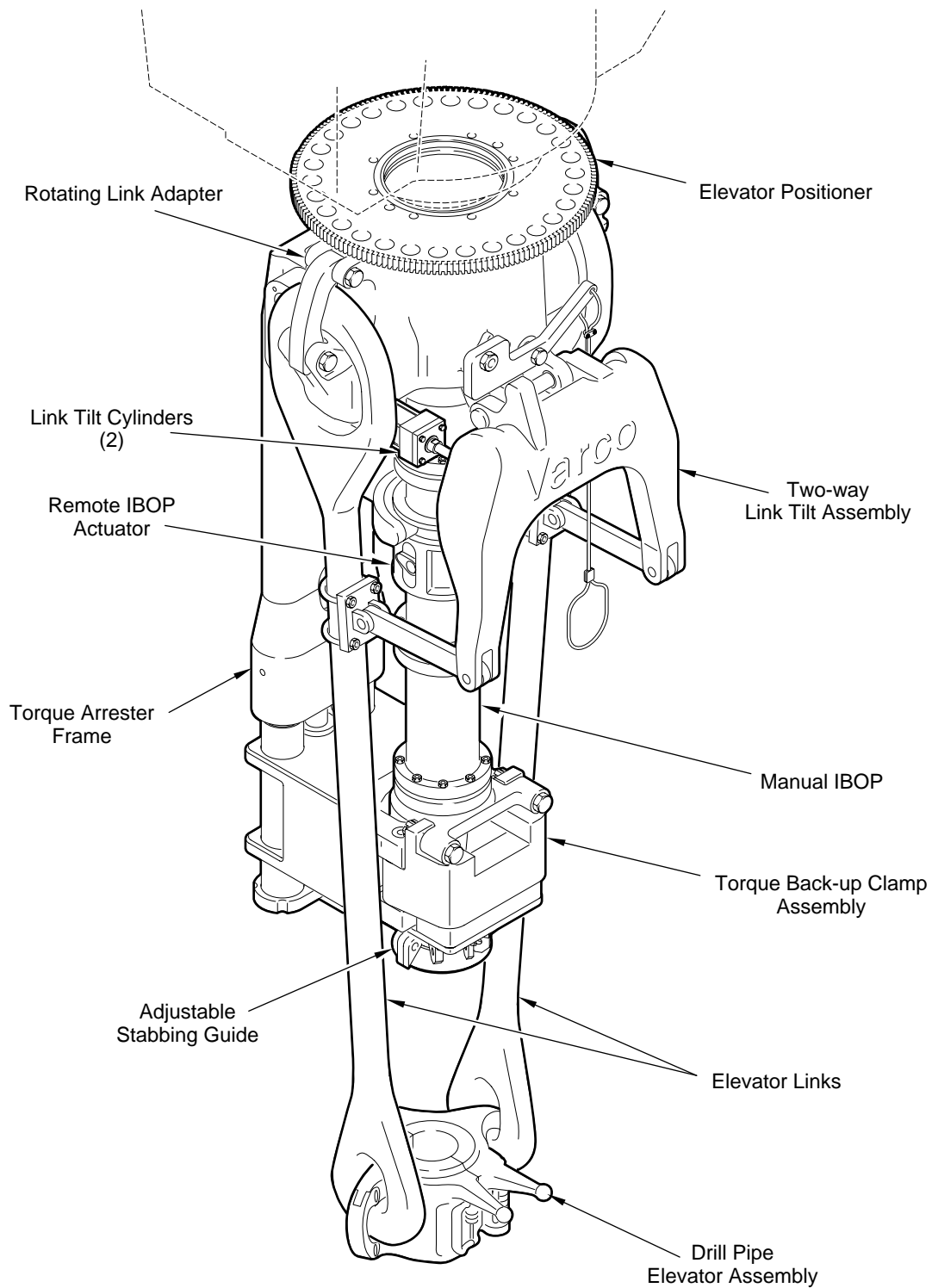
Powered rotating head and rotating link adapter

The powered rotating head/rotating link adapter allow the hydraulic lines to remain connected as the pipehandler rotates with the drill stem components while tripping out or when positioning the link tilt.

The powered rotating head/link adapter has a hydraulic drive motor to rotate it in either direction. An electric solenoid valve, connected to a switch on the driller's console, operates the hydraulic motor. A pinion gear on the hydraulic drive motor rotates the positioning gear that is attached to the top of the rotating link adapter. During make or brake operations the rotating link adapter can be locked into any of 24 index positions by selecting the pipehandler clamp mode and actuating a hydraulically operated shot pin. When the hydraulic drive motor is not powered the link adapter can rotate freely.

The link tilt cylinders and the torque arrestor frame hang from the rotating link adapter.

The link adapter is attached to the stem support. The internal hydraulic fluid passages in the stem connect to the respective fluid passages in the rotating link adapter. Fluid is fed from the main manifold into the stem through the radial passages at the upper end. This fluid is routed from the stem through its grooves to the link adapter and out to all actuators on the pipe handler. While rotating or in any stationary position, fluid flows between the two components.

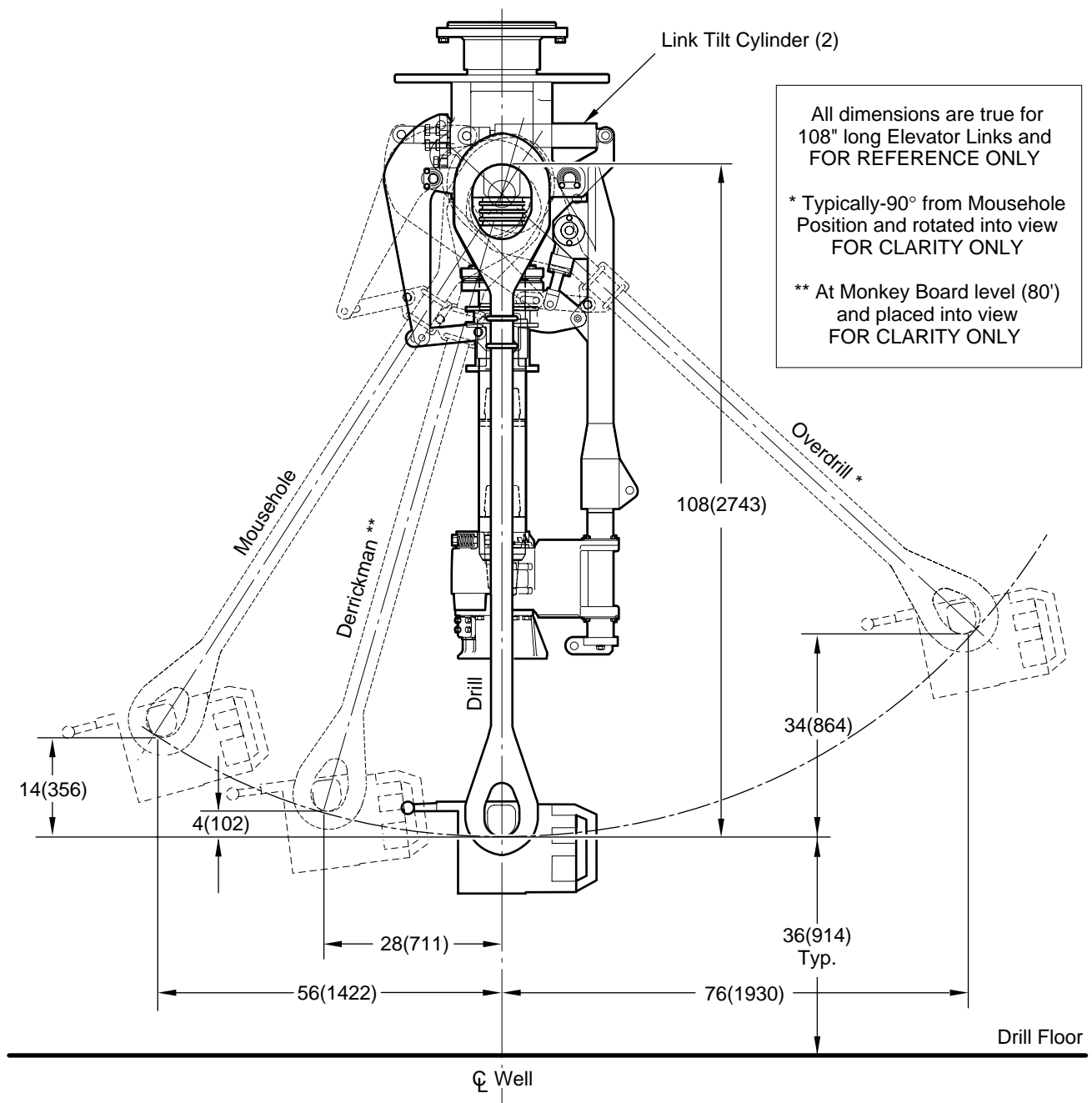


PH-50 Pipehandler with torque backup clamp

Bidirectional link tilt

The link tilt assembly consists of two hydraulic cylinders and clamp assemblies. The link tilt assembly is attached to 350-ton, 108-inch long elevator links with clamp assemblies. The latch on the cylinder assembly limits the travel of the elevator to the derrick man position which is adjustable. Releasing the latch by pulling a cable allows the elevator to travel to the mousehole or overdrill position.

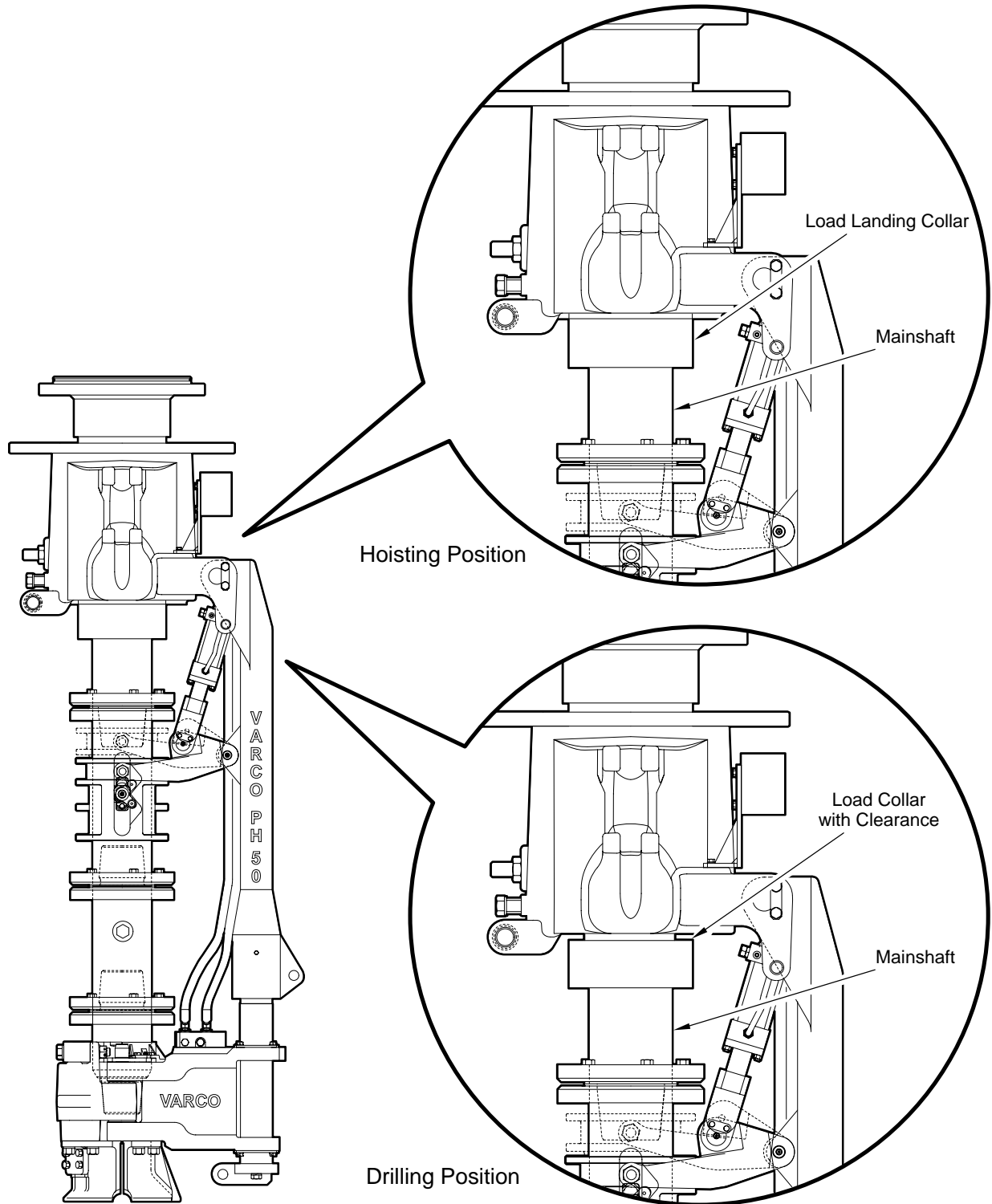
The link tilt operates from a three-position switch located on the driller's console. The TILT position moves the links toward the mousehole or derrickman. The DRILL position tilts the link back to clear the drill pipe and raise the elevator to allow drilling down to the floor. The spring centered position holds the link at any intermediate position. There is a separate float switch which is used to allow the links to hang free. The links may be stopped at any intermediate position. The links float back to the well center when the FLOAT position button on the driller's console is operated.



PH-50 Bidirectional link tilt positions

Loading collar

Elevator hoisting loads are transferred from the elevator links through the elevator into the load collar, mounted on the mainshaft.



Load collar and mainshaft detail

Remote upper IBOP actuator

The two ball type IBOP valves are full size, internal opening safety valves. The remotely operated upper valve and the manually operated lower valve form the well control system. Both valves have 6-5/8" regular R. H. connections and 15,000 psi pressure ratings.

A two-position switch at the driller's console operates the OPEN and CLOSE functions of the upper IBOP valve. When the switch is operated, a hydraulic cylinder through a non-rotating lever arrangement attached to the torque arrestor slides an actuator shell up and down. This lever arrangement drives a small crank arm on each side of the valve which opens and closes the upper IBOP valve.

Torque backup clamp

The backup clamp assembly is located below the lower shoulder of the saver sub. It includes two gripping jaws with die inserts and a clamping cylinder for gripping the box end of the drill string when connected to the saver sub. A torque arrestor frame hanging from the rotating link adapter supports the torque backup clamp cylinder. It attaches to the torque arrestor frame with flexibility for floating up or down to allow for thread engagement/disengagement and reacting backup torque while making and breaking connections.

Hydraulic control system

The hydraulic control system is completely self-contained (onboard) and supplies all hydraulic power. It eliminates the need for an additional service loop. The system consists of reliable, industry-standard components that operate the following assemblies:

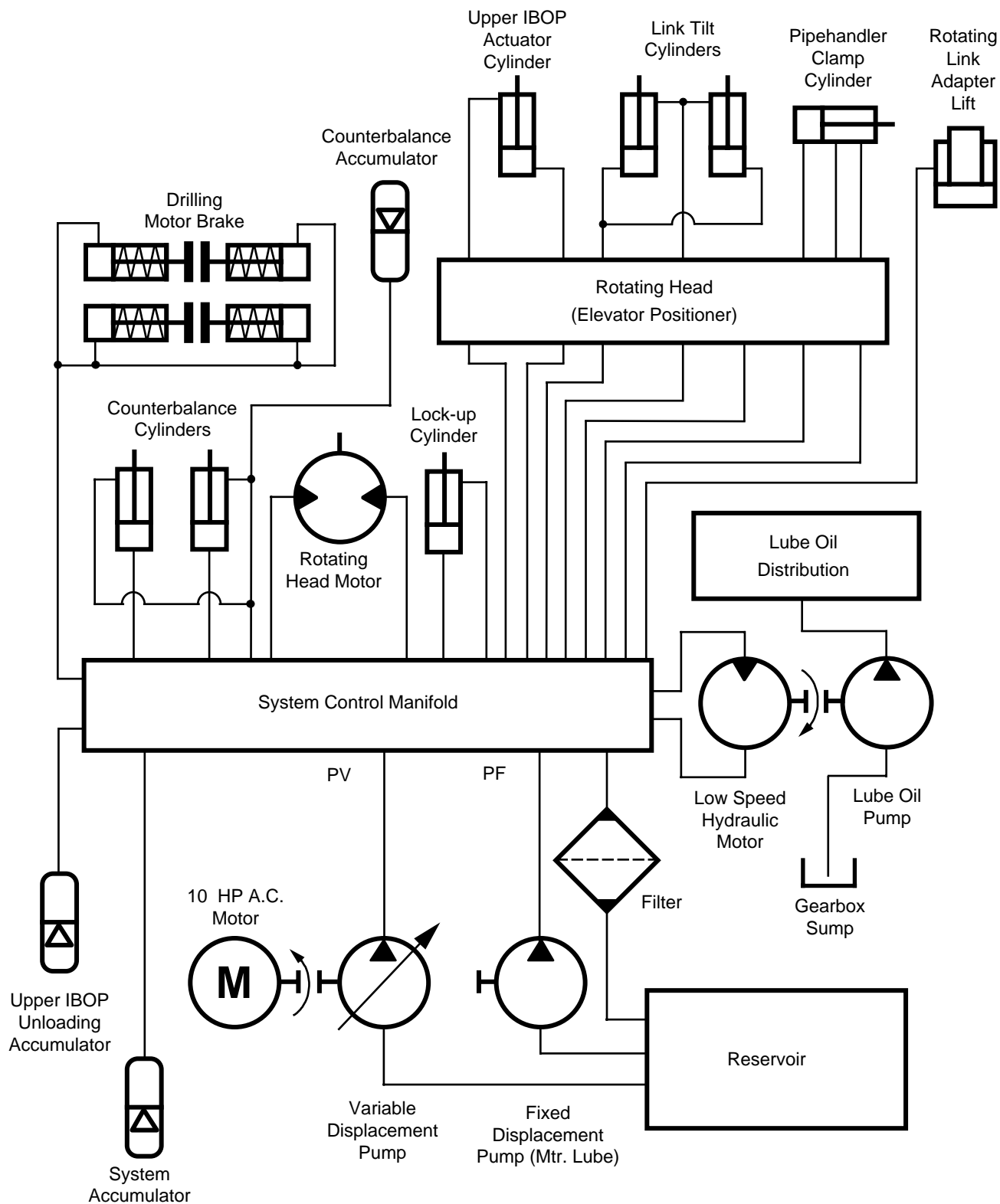
- ☐ Counterbalance system
- ☐ AC motor brakes
- ☐ Lubrication system
- ☐ Powered rotating head
- ☐ Remotely actuated IBOP
- ☐ Torque backup clamp
- ☐ Link tilt

The hydraulic control system is powered by a 10 hp, 1800 rpm AC motor that is direct coupled to drive two hydraulic pumps. A fixed-displacement pump drives the lubricating oil system and a variable displacement pump drives all other functions.

An integral hydraulic manifold mounts to the main body and contains all solenoid, pressure, and flow control valves.

A “sealed” stainless steel reservoir supplies the hydraulic oil. This eliminates the need for draining and refilling during normal rig moves. The reservoir, mounted between the two AC drilling motors, is equipped with strainers and oil level sight gauges.

Hydro-pneumatic accumulators operate the IBOP, pressure control valves, and counterbalance system.



TDS-11SA Hydraulic system

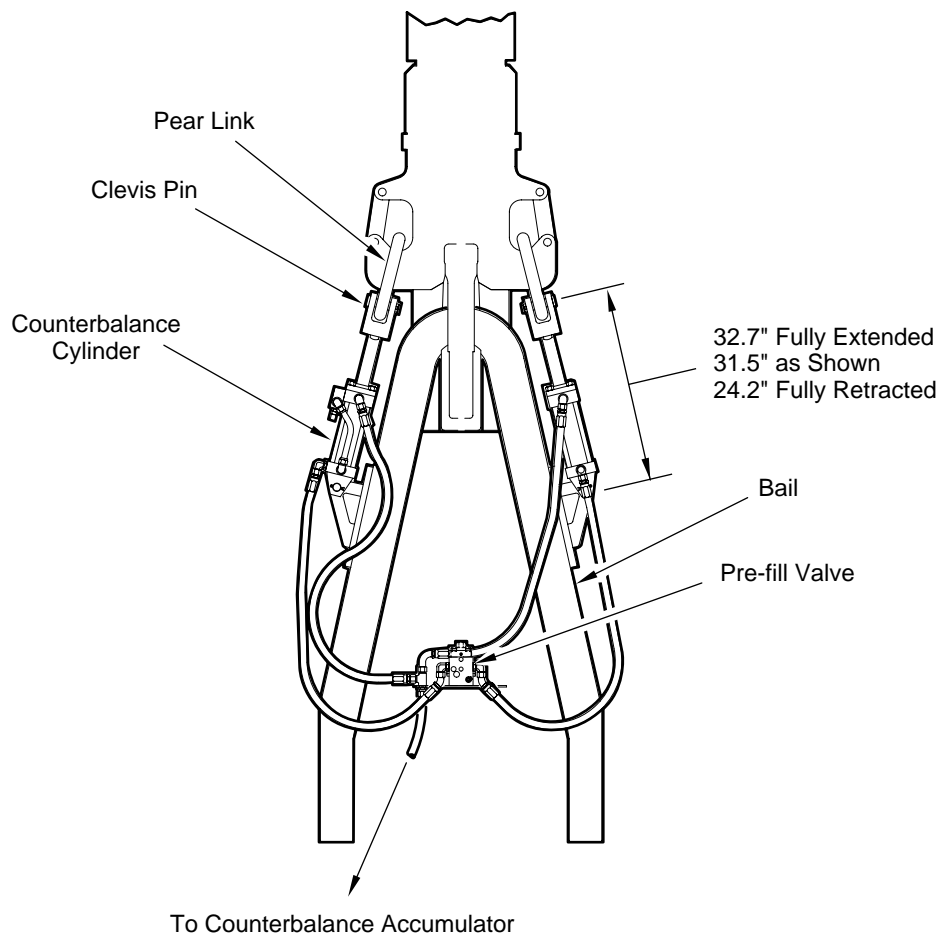
Counterbalance system

The counterbalance system prevents damage to tool joint threads while making or breaking connections with the TDS-11SA. It replaces the function of the hook compensator spring.

The system consists of two hydraulic cylinders and attachment hardware, a hydraulic accumulator, and a hydraulic manifold. The hydraulic cylinders are located between the integrated swivel bail and the ears of the hook. They connect to a hydraulic accumulator. The accumulator is charged with hydraulic fluid and maintained at a predetermined pressure setting by the counterbalance circuit in the main hydraulic control system manifold. A remote valve on the driller's console allows the counterbalance cylinders to extend and retract to aid in rig-up and rig-down operations.

STAND JUMP option

Varco has developed a new feature for the TDS-11SA called STAND JUMP. It consists of a switch at the driller's console allowing you to change the mode of operation of the counterbalance cylinders from DRILL, which is a standard counterbalance condition, to STAND JUMP. The STAND JUMP feature allows the cylinders to lift the weight of the top drive off the drill string while breaking out a connection. This eases the stress on the threads and avoids damage. The cylinders lift the swivel bail off its resting point on the hook.



Counterbalance system

AC motors and control system

The TDS-11SA uses two 400-hp or 350-hp AC motors. They are located on top of the gearcase, which minimizes the distance from the well centerline to the rear of the guide beam.

Varco selected AC drilling motors for use on the TDS-11SA because they provide the following benefits:

- ☐ Reliability
- ☐ Low maintenance
- ☐ Nonpolluting
- ☐ Wide operational range
- ☐ May be stalled indefinitely at full torque
- ☐ 150% overload capability for up to one minute
- ☐ Non-sparking

The AC motors available to power the TDS-11SA are 600 VAC, 3 phase. Input frequencies vary from 0 to 80 Hz. Each motor requires 1100 CFM of cooling air.

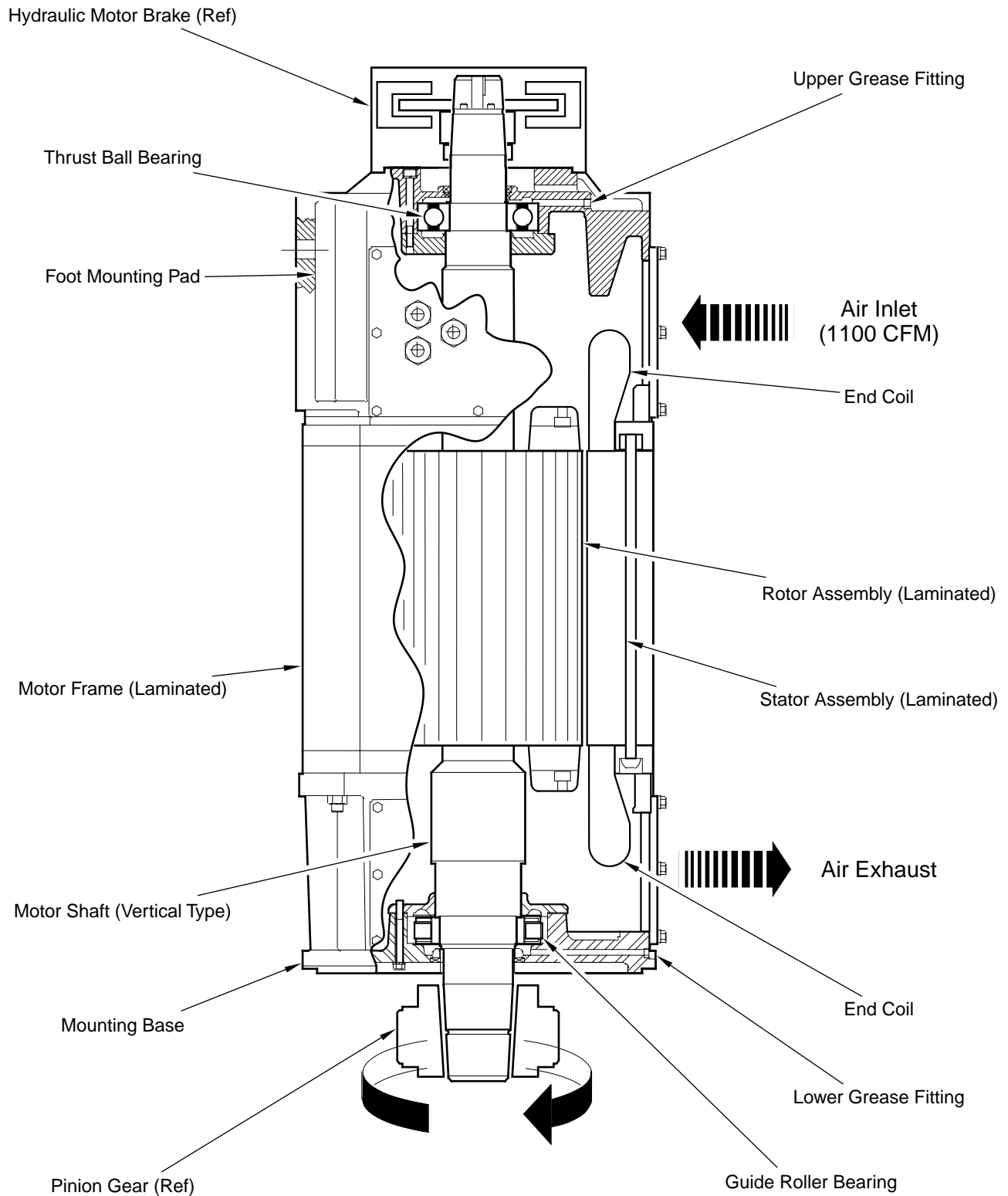
Each motor is rated at 400 hp or 350 hp with a maximum continuous output torque of 1,800 ft lb and 1,550 ft lb per motor respectively. The maximum continuous torque is available from 0 to 1200 motor rpm, with continuous 400 hp or 350 hp from 1200 motor rpm up to the maximum rated motor speed of 2400 rpm.

Combining the two 400 hp AC motors (800 hp total) and utilizing the 10.5:1 gear ratio provides 37,500 ft lb of torque at a drill operating speed range of 0 to 114 rpm. Maintaining the 800 output hp provides 18,250 ft lb of torque at a maximum drill speed of 228 rpm. A graphical display is appears in *Section 6*.

Combining the two 350 hp AC motors (700 hp total) and utilizing the 10.5:1 gear ratio provides 32,500 ft lb of torque at a drill operating speed range of 0 to 114 rpm. Maintaining the 700 output hp provides 15,100 ft lb of torque at a maximum drill speed of 228 rpm. A graphical display is appears in *Section 6*.

The open-frame design of the AC drilling motors allows the cooling air to pass through the inside of the motors, which provides more efficient transfer of rotor and winding heat to the cooling air. The motors are manufactured specifically for top drive applications. They include:

- ☐ Internal temperature sensors
- ☐ Double varnish impregnated windings
- ☐ Upgraded bearing/shaft seals
- ☐ High-capacity bearings
- ☐ Tapered output shafts



Typical AC Drilling motor

Section 3

Operation

Driller's interface and driller's console

The driller's console is manufactured from 300-series stainless steel and it uses full-size, oil-tight switches and indicators. It is designed for purging to meet hazardous area requirements. By request, Varco can supply the console with Pyle-National, U.L., or Ex connectors.

Throttle control

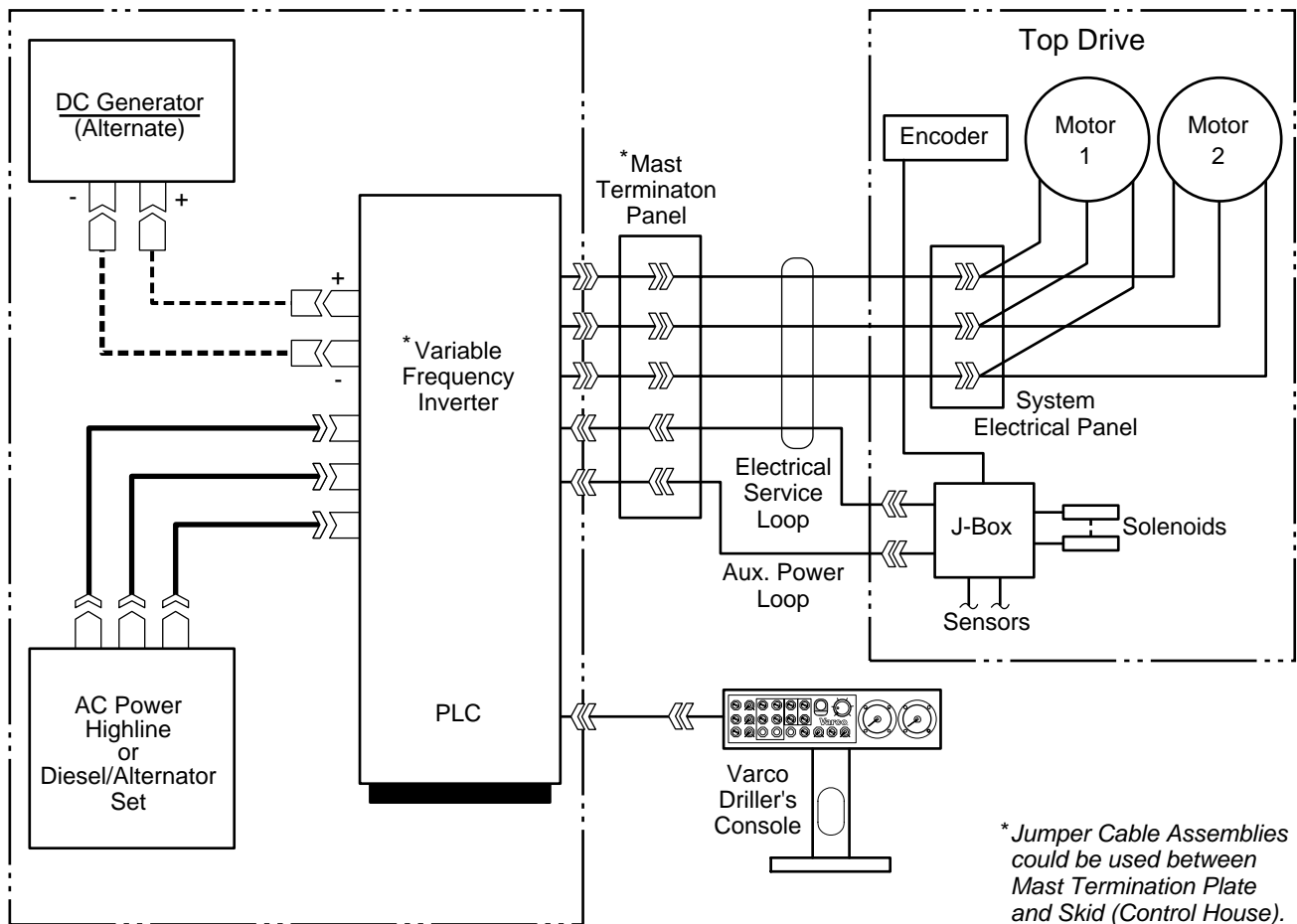
The throttle uses a design similar to the standard throttle control used with SCR systems. The handle is robust and includes integral stops to prevent damage.

Torque control

Two torque limit potentiometers are provided for setting drill and makeup torque limits.

The drill limit control allows the driller to set the maximum torque output of the top drive to match the drill pipe size being used.

The makeup control sets the torque when making up connections using the TDS-11SA drilling motors.



Electrical interface

Switches

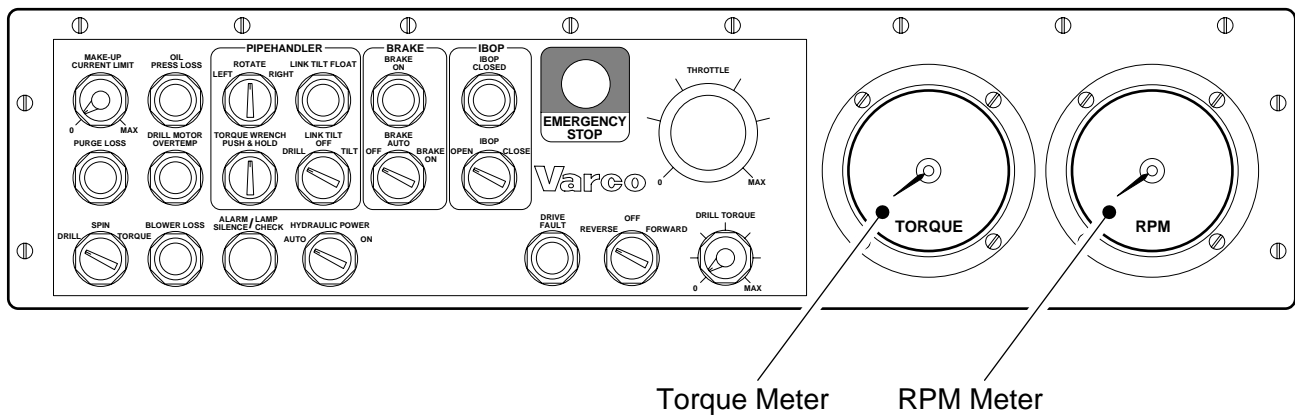
Various switches control the following functions:

- ☐ Drill/Spin/Torque mode select
- ☐ Link tilt
- ☐ Brake
- ☐ Backup clamp
- ☐ Powered rotating head
- ☐ IBOP valve
- ☐ Forward and reverse selection for the drill pipe rotation
- ☐ Emergency stop
- ☐ Stand jump (optional)

Indicators

Various indicators report status/faults to the driller:

- ☐ Oil pressure loss
- ☐ Drill motor over temp
- ☐ Blower loss
- ☐ IBOP closed
- ☐ Brake
- ☐ Drive fault



Varco driller's console (VDC)

Varco control system

The driller's PLC panel is located in the environmentally controlled variable frequency inverter house.

It provides an interface between the driller's console, the variable frequency inverter, and the TDS-11SA. It includes the following components:

- ☐ Control logic for system interlocks
- ☐ Blower and oil pump motor starters
- ☐ Control circuitry for pipehandler functions
- ☐ Power supply for TDS-11SA solenoids and VDC indicators

Inputs to the variable frequency drive is via serial communications that provide speed and torque inputs, and on, reverse and emergency stop inputs. Additionally, any changes to alarm or interlock functions have no effect on the frequency drive. Function changes are implemented with the same programming tools used on the standard Varco top drive systems.

The control system receives input from the operator controls on the driller's console and processes this information through the programmable logic controller (PLC). It controls the responses of the cooling system motor, the solenoid valves, the brakes, IBOP functions, and sensors. The control system reads the status of the sensors and acts as an interlock to prevent inadvertent tool operations. It notifies the driller of the operational status of the TDS-11SA and provides a diagnosis of any inadvertent operational conditions.

Variable frequency inverter

The variable frequency inverter (VFI) consists of the following three major sections:

Rectifier or converter

In this section, the incoming 3-phase AC power is converted to DC for use by the power devices. Alternately, by bypassing the rectifier section, the drive can be powered from a 740 VDC generator.

Power modules

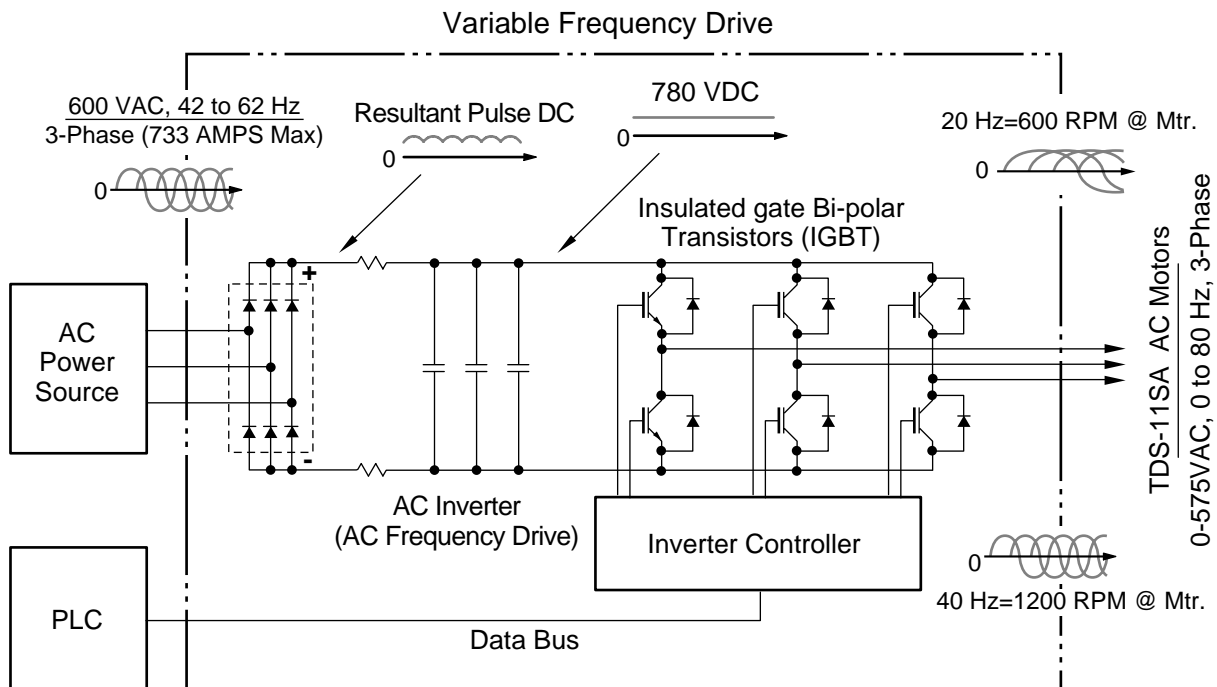
Motor speed control requires, a variable frequency voltage. To do this, DC power is converted to an output waveform that consists of a series of pulses. The duration of each pulse is controlled so that the voltage to the AC motors appears as an AC sine wave. The technique of using pulses to develop a waveform that appears to a motor to be a sine wave is called pulse width modulation or PWM.

Control section

The control section monitors the performance of the drilling motor, accepts throttle and torque limit signals from the TDS-11SA control system, and controls the firing circuits of the power modules.

To vary motor speed, the driller uses a hand throttle. The throttle varies the frequency and voltage to the motor. Because the drilling motor is frequency synchronous, the motor speed is proportional to the frequency (i.e., 20 Hz is 600 motor rpm, 40 Hz is 1200 motor rpm).

One of the greatest advantages of an AC variable frequency drive is the quality of the speed and torque control. It allows you to precisely control drill pipe speed over the full operational range.



AC Power conversion to variable frequency

Service loop

The TDS-11SA has an onboard hydraulic system and, therefore, does not need a fluids service loop. This adds to the cost-effectiveness of the TDS-11SA drilling system and provides a safer work area.

The TDS-11SA service loops consist of power and ground cables, composite cable for all conductors for drilling motors and actuators (solenoid) control, and auxiliary power cables. Cable configurations are available for portable and fixed applications for U.L. and EEx requirements.

Drilling ahead

Drilling ahead with triples

This is the common drilling mode for the TDS-11SA. There are various sources for triples to drill with. On skidding rigs drilling multiple wells, or rigs that can move with racked pipe, the drill pipe can be left racked and used to drill the next well. If triples do not currently exist to drill with, there are two recommended methods of obtaining them. One is to leave some triples racked in the derrick when tripping back in the hole and finish the trip with singles. Enough triples should be left racked to handle anticipated bit life. The second is to make up triples in the mousehole while drilling ahead or during rig idle time. For safety reasons it is best to have a pivoting mousehole so it can be put in a vertical plane to simplify making connections. Note that the connections just need to be spun up as they will be torqued when the top drive motor applies the make-up torque.

Procedure for drilling ahead with triples:

- a. Drill down the existing stand and set the slips.
- b. Breakout the saver sub from the drill pipe using the top drive motor and backup clamp in the pipehandler.
- c. Spinout the connection using the drilling motor.
- d. Lift the top drive.
- e. The derrickman latches the triple in the elevator and the floor crew stabs it in the box.
- f. Lower the top drive, stabbing the pipe into the stabbing guide until the pin of the saver sub enters the box.
- g. Spin-up and torque the connection using the drilling motor (make-up torque must be pre-set). Use a backup tong to react the torque.
- h. Pull the slips, start the mud pumps and drill ahead.

- Set slips on string
- Stop circulation
- Breakout connection using pipehandler and drilling motor (in reverse)

- Raise block
- Tilt link tilt to derrickman

- Pickup stand with elevator
- Stab bottom of stand onto string

- Lower block to stab motor into top of stand
- Spin in motor and stand
- Makeup both connections with motor

- Pull slips
- Start circulation
- Begin drilling



Drilling ahead with triples

Drilling ahead with singles

Typically there are two situations when it is desirable to drill ahead with singles. One is beginning operations on a new well and there are no triples made-up and racked back. The other is when surveys must be made every 30 feet (kicking off using a downhole mud motor). The link tilt feature makes drilling with singles safe and efficient by moving the elevators to the mousehole to pick up the singles.

Procedure for drilling ahead with singles:

- a. Drill down the existing joint and set the slips.
- b. Breakout the saver sub from the drill pipe using the top drive motor and the backup clamp in the pipehandler.
- c. Spin out the connection using the drilling motor.
- d. Lift the top drive until elevators clear box.
- e. Actuate the link tilt to bring the elevator over to the single in the mousehole, lower the top drive and latch the elevator around the single in the mousehole.
- f. Pull the single out of the mousehole and as the pin clears the floor, release the link tilt to allow the single to come to well center.
- g. Stab the connection at the floor and lower the top drive allowing the added single to enter the stabbing guide.
- h. Spin-up and torque the connection using the drilling motor (torque mode). Set a backup tong to react the torque.
- i. Pull the slips, start the mud pumps and drill ahead.

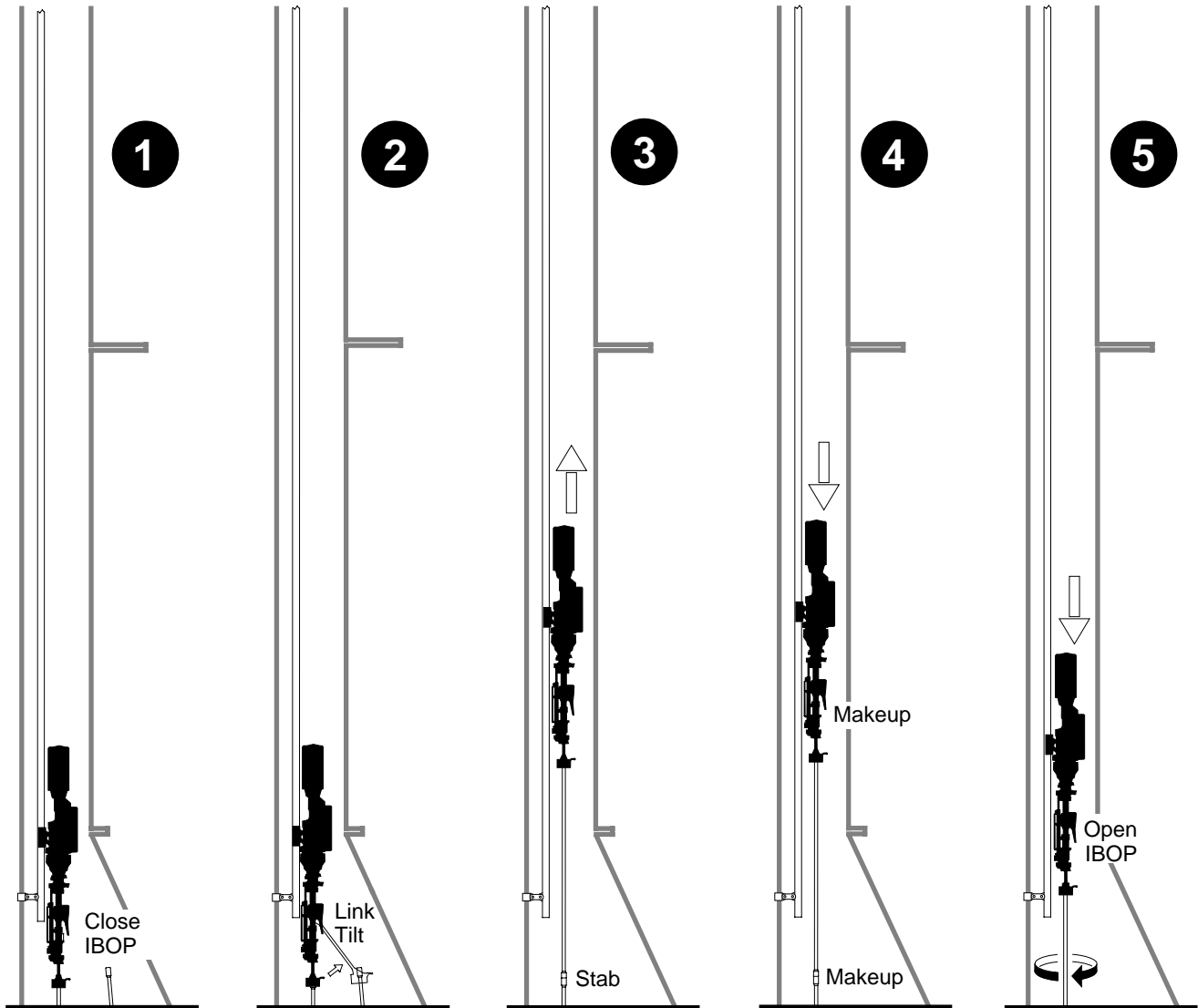
- Set slips on string
- Stop circulation
- Close IBOP
- Breakout connection using pipehandler and drilling motor (in reverse)

- Tilt links to mousehole
- Latch drill pipe elevator around single

- Pickup single with elevator
- Release link tilt
- Stab bottom of single onto string

- Lower block to stab motor into top of single
- Spin in motor and single
- Makeup both connections with motor in torque mode

- Pull slips
- Open IBOP
- Start circulation
- Begin drilling



Drilling ahead with singles

Tripping in and tripping out

Tripping is handled in the conventional manner. The link tilt feature can be used to tilt the elevator to the derrickman, enhancing his ability to latch it around the pipe thus improving trip times.

The link tilt has an intermediate stop which is adjustable to set the elevator at a convenient working distance from the monkey board. The intermediate stop is tilted out of the way to allow the elevator to reach the mousehole.

The elevator may rotate in any direction from frictional or torque forces realized by the drill string.

If a tight spot or key seat is encountered while tripping out of the hole, the drilling motor may be spun into the stand at any height in the derrick and circulation and rotation established immediately to work the pipe through the tight spot.

Back reaming

The TDS-11SA permits reaming out of open hole to prevent pipe sticking and reducing keyseat formation, without affecting racking functions associated with normal tripping; i.e., no singles to contend with. This is provided by the ability of the top drive and backup clamp to breakout 93 foot stand in the derrick/mast.

Procedures for reaming out of the hole:

- a. Hoist the block while circulating and rotating the string until the third connection appears.
- b. Stop circulation and rotation, and set the slips.
- c. Breakout the stand at floor level, and spin out using the drilling motor.
- d. Breakout the drilling motor from the top of the stand using the top drive motor and backup clamp, then spin out with the drilling motor.
- e. Pick up the stand with the drill pipe elevator.
- f. Rack stand back.
- g. Lower the top drive to the floor.
- h. Stab drilling motor into box, spin-up and torque with the drilling motor. With light slip loads, the top drive and backup clamps can be used to torque the connection.
- i. Resume circulation and continue reaming out of the hole.

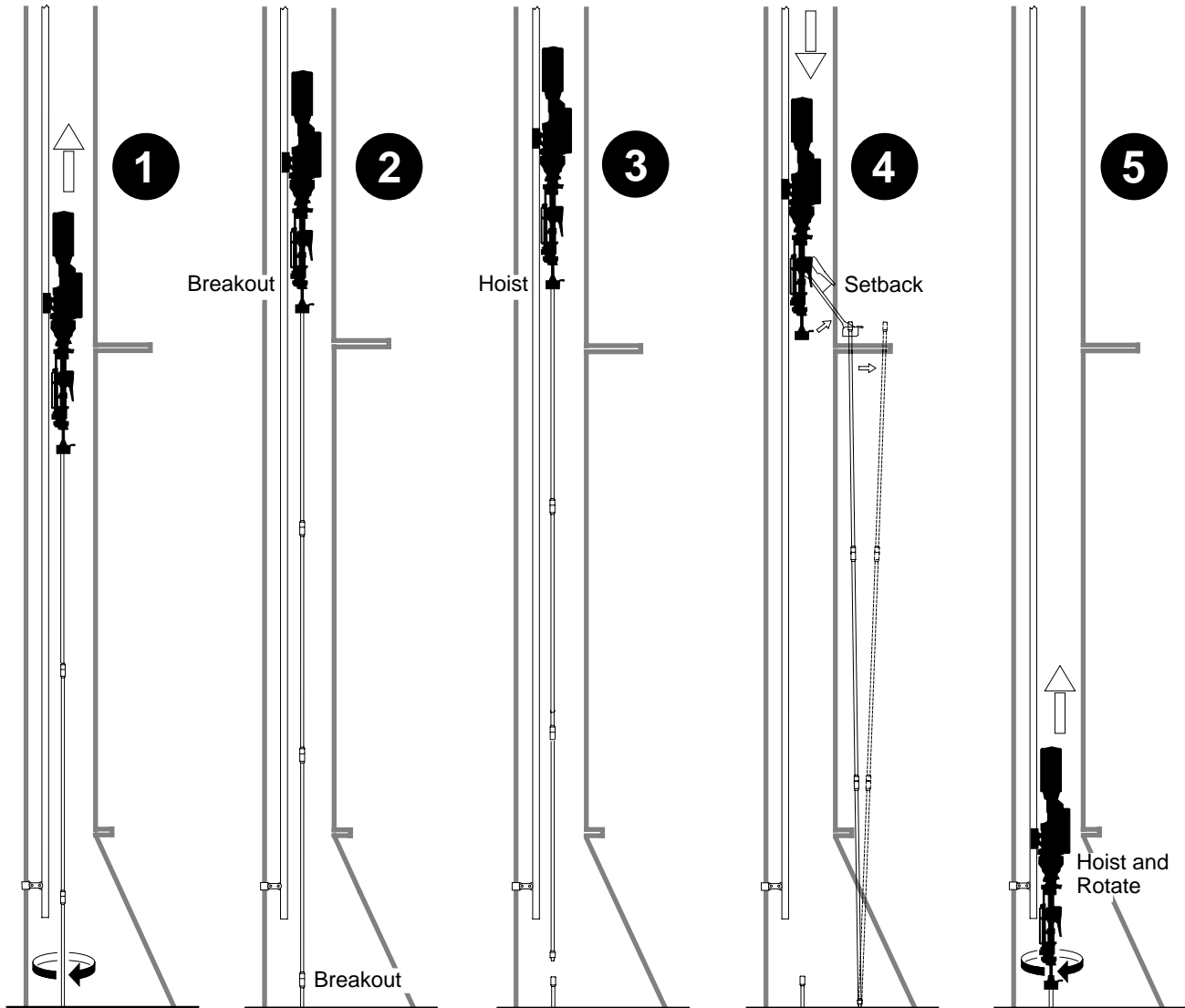
- Hoist while circulating and rotating
- When 3-rd connection surfaces, stop rotation and circulation

- Set slips on string
- Breakout connection using pipehandler and drilling motor (reverse)
- Breakout and spinout stand at floor

- Hoist free stand with elevator

- Setback stand using link tilt

- Lower block, stab motor into string
- Spin in motor and makeup connection with motor
- Start circulation, pull slips, hoist and rotate



Back reaming

Well control procedures

The TDS-11SA can stab into the string at any point in the derrick. While drilling, the remotely controlled upper IBOP valve is always in the string for immediate use as needed.

The lower IBOP valve is the same type as the upper IBOP valve except it must be operated manually with a wrench. Both valves always remain in the string and are therefore always readily available by connecting the TDS-11SA to the drill string.

To attach well control equipment to the drill string the torque arrestor frame assembly can be pulled away from the drill string by opening the clamp cylinder gate.

After removing the lower valve from the upper valve, the lower valve remains connected to the drill string for well control purposes. The TDS-11SA includes crossover subs for connecting the drill stem to the lower valve.

Procedure for well control during tripping operations:

- a. On indication of a kick, set the slips and stab the top drive into the string.
- b. Spin-up and torque connection.
- c. Close remote upper IBOP.

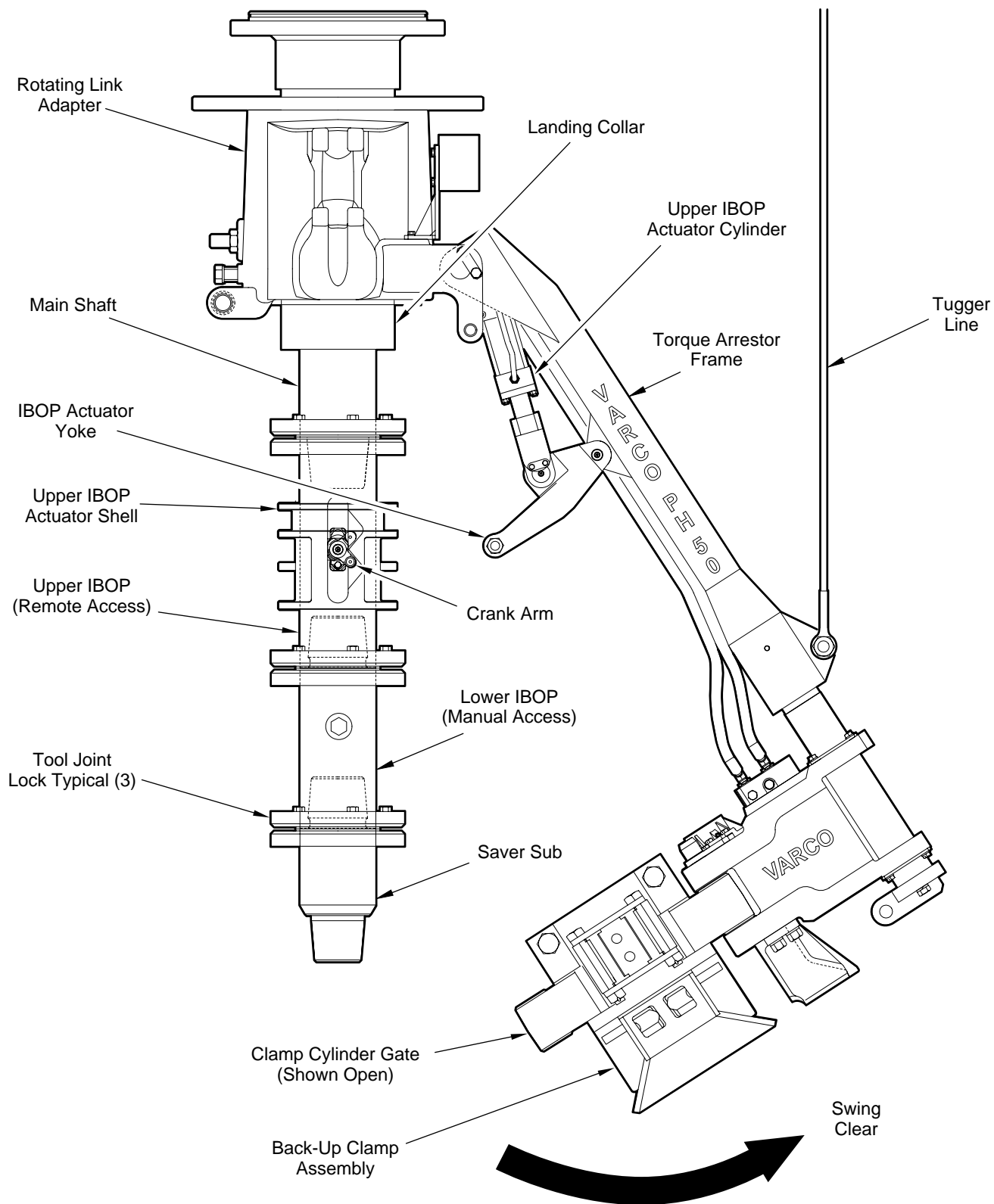
Internal pipe pressure of up to 15,000 psi is now held by the upper IBOP valve. If it becomes necessary to continue tripping in with a dart valve, or another well control accessory, the lower IBOP valve can be used to assist the operation. In this case, the following steps may be followed:

- d. Lower string to the floor and reset the slips.
- e. Manually close the lower IBOP valve.
- f. With the tugger line attached to the back of the unit, swing out the torque arrestor clamp cylinder assembly.
- g. Remove the lower and intermediate tool joint locks.
- h. Breakout lower IBOP and saver sub from upper IBOP using tongs.
- i. Install appropriate crossover sub, check valve or circulation sub on top of lower IBOP valve.
- j. Proceed with normal well control procedures.

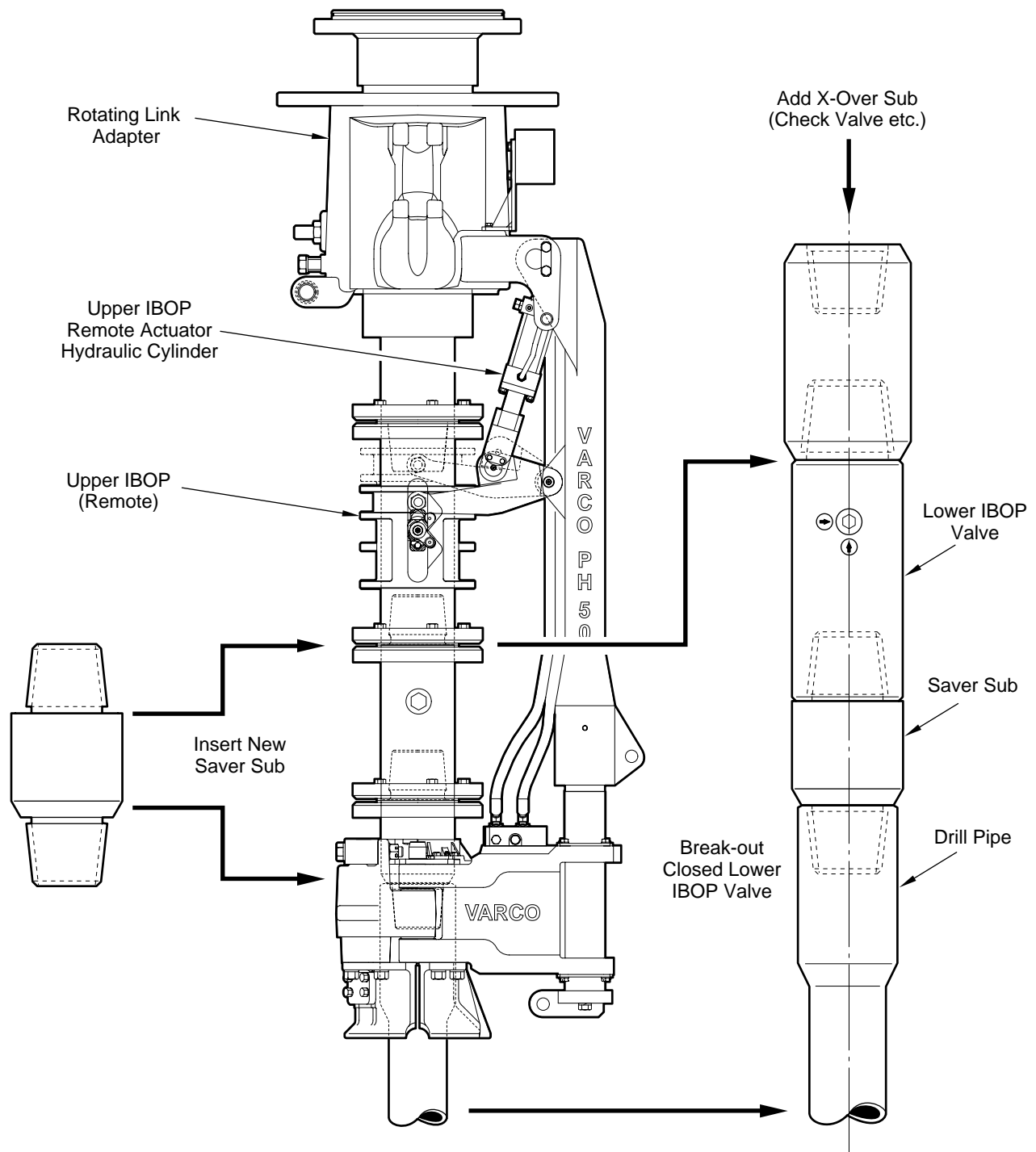
Running casing

For casing operations, longer elevator links (180") must be used to allow clearance for cementing head under the backup clamp in the pipehandler.

Attach a short piece of hose to the saver sub in the pipehandler to fill the casing while lowering. Use the remotely controlled upper IBOP valve to start and stop the fluid flow.



Well control procedures



PH-50 Pipehandler well control procedures

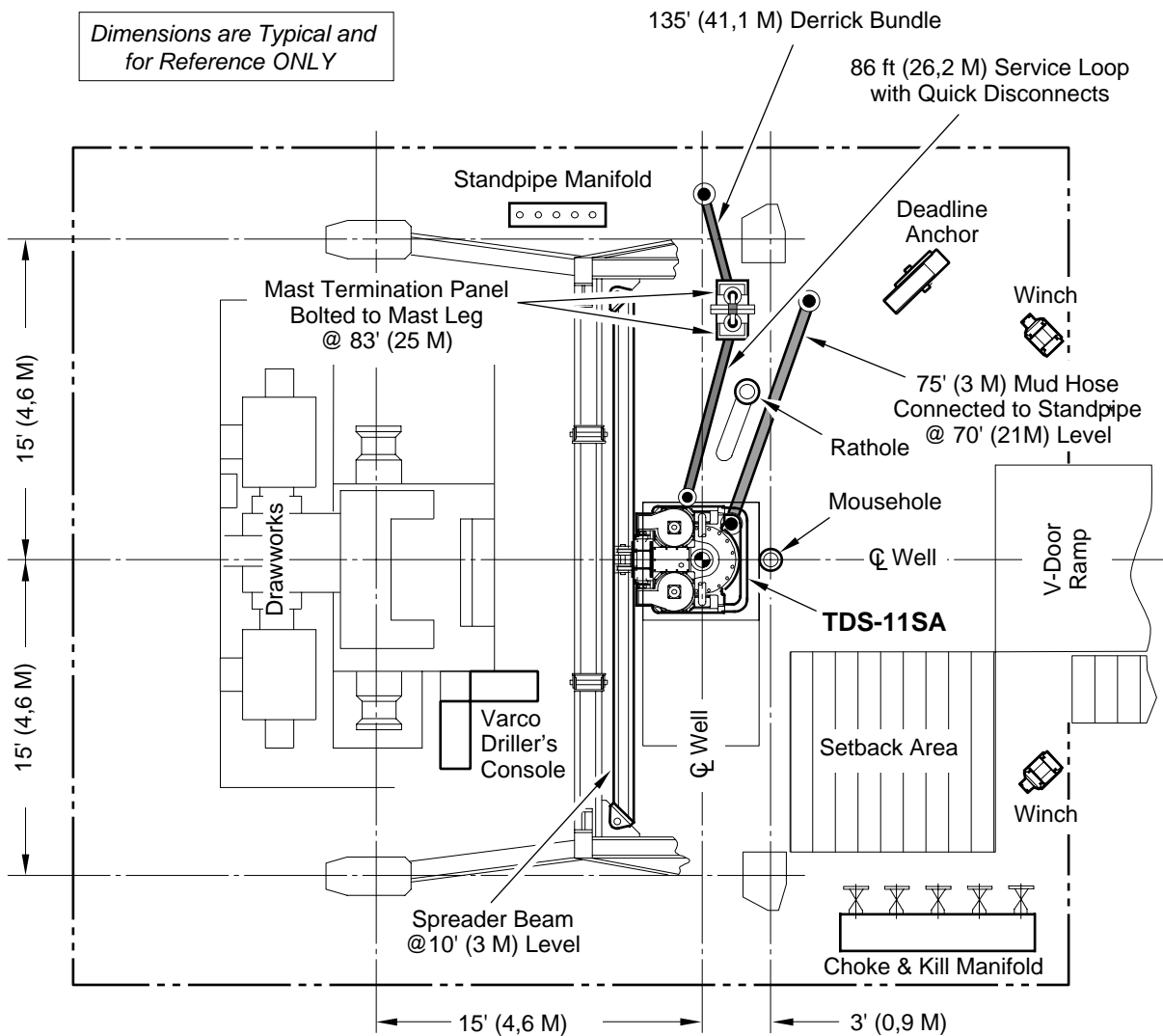
Installation

Installing the TDS-11SA

To install a TDS-11SA on an existing rig there will need to be some electrical and mechanical/ structural modifications. Dependent upon the specific rig characteristics, possible modifications could be:

- ☐ Location of mast termination panel for electrical service loop
- ☐ Extension of standpipe to 73'
- ☐ Replacement of rotary hose (75')
- ☐ Installation of AC drive electrical generator (new or upgrade)
- ☐ Derrick bundle with quick disconnects, or cable tray and cables
- ☐ Tie-back for torque reaction beam
- ☐ Crown pad eye for guide beam
- ☐ Location of tongs, pipe spinner, mud bucket and trigger lines
- ☐ Guide beam clearance to girts and fastline
- ☐ Location of casing stabbing board

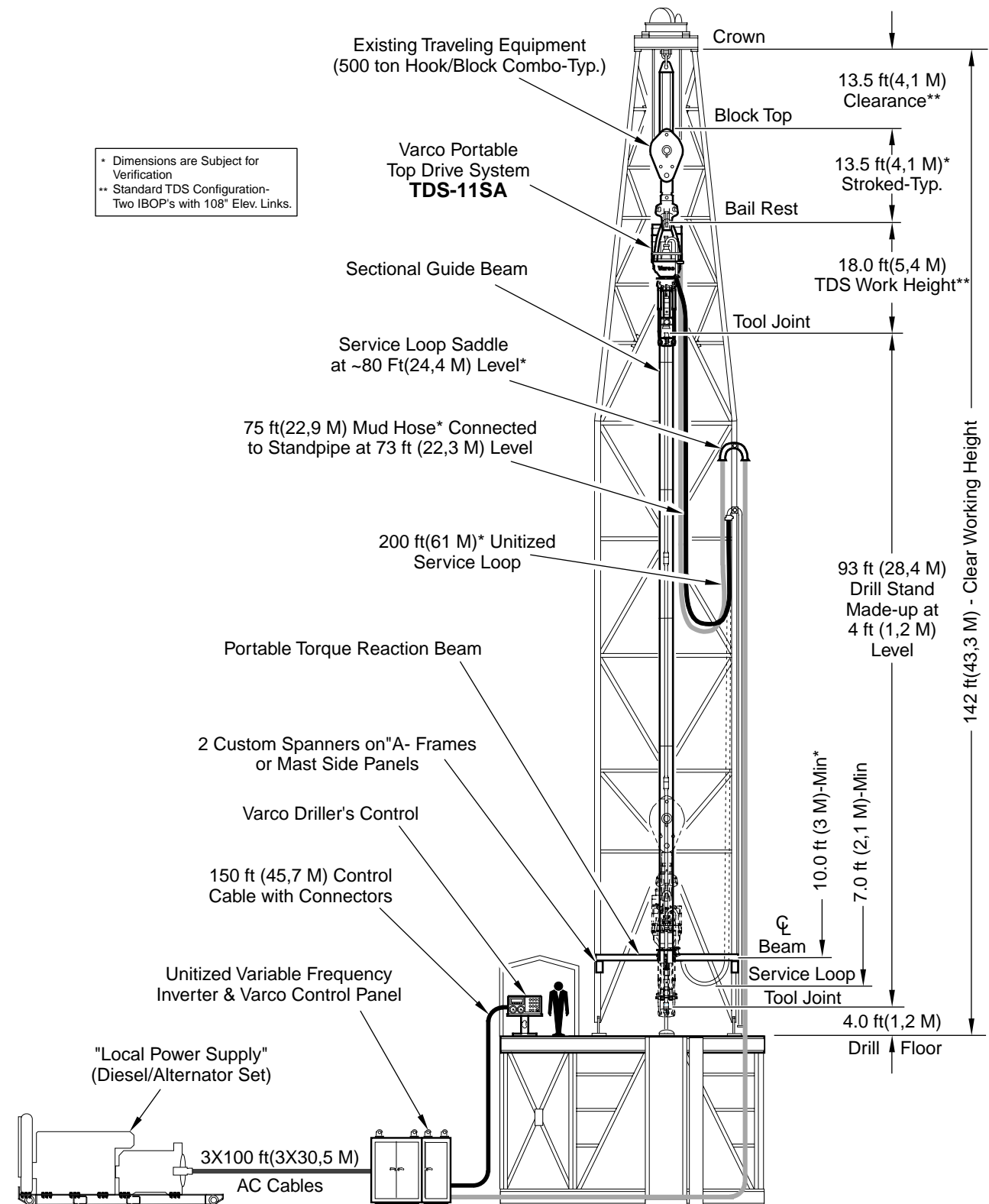
All of the above modifications may not be necessary, but all must be considered as well as the overall rig floor layout in order to ensure that proper installation, time utilization and accurate cost information is made. One of many possible rig floor layouts is depicted below (reference only).



* This Length is for Masts/Derricks with Operating Height 147' and above.

Example TDS-11SA rig floor layout

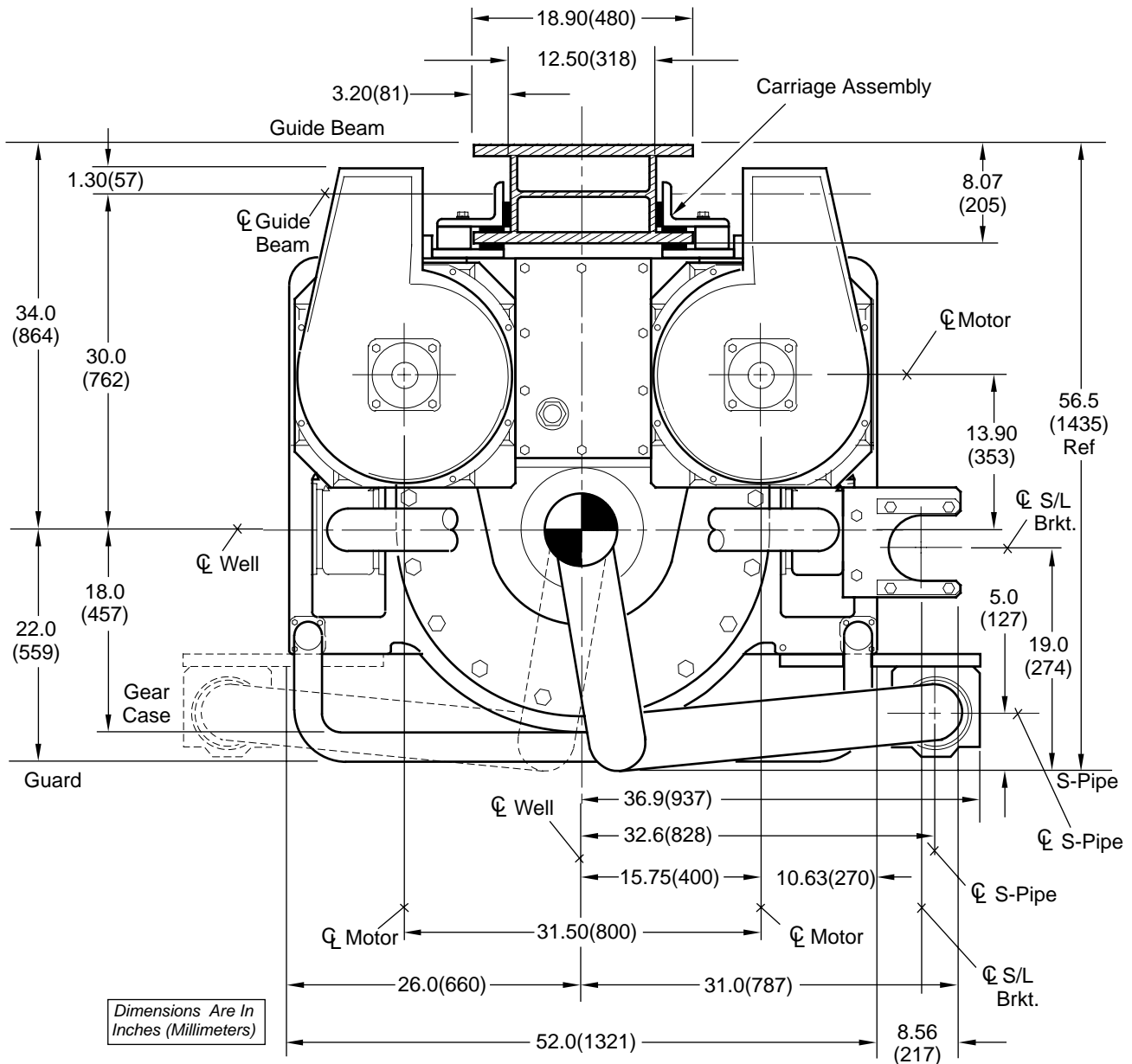
The functional operation of a TDS-11SA has many considerations, a primary consideration is the mast/derrick height. The working height and crown clearance are two primary factors to finalize prior to ordering and installing your TDS-11SA. Working height and Crown clearance can both vary dependent upon hook, block, bail, elevator links, and coupling chosen. A typical TDS-11SA mast interface is provided. A mast/derrick interface requirements and worksheet is provided in *Section 6*.



Typical TDS-11SA mast interface

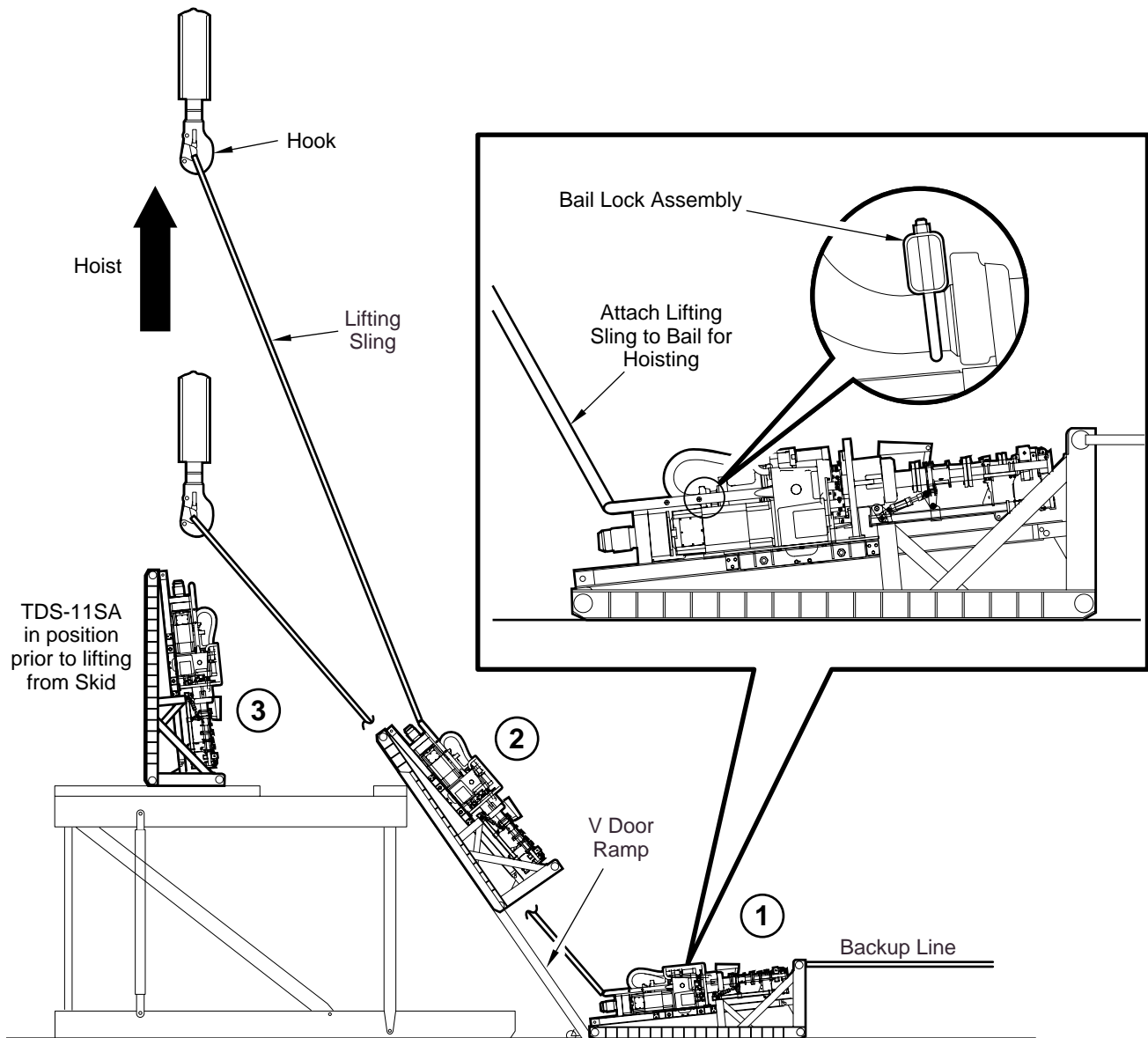
Another key consideration in selecting and successfully operating a top drive is how well the top drive fits inside of the mast/derrick. Given the specific dimensions within the mast/derrick legs, the top drive and its guidance system need to utilize the complete working height.

Provided below is a detailed top view of the TDS-11SA.



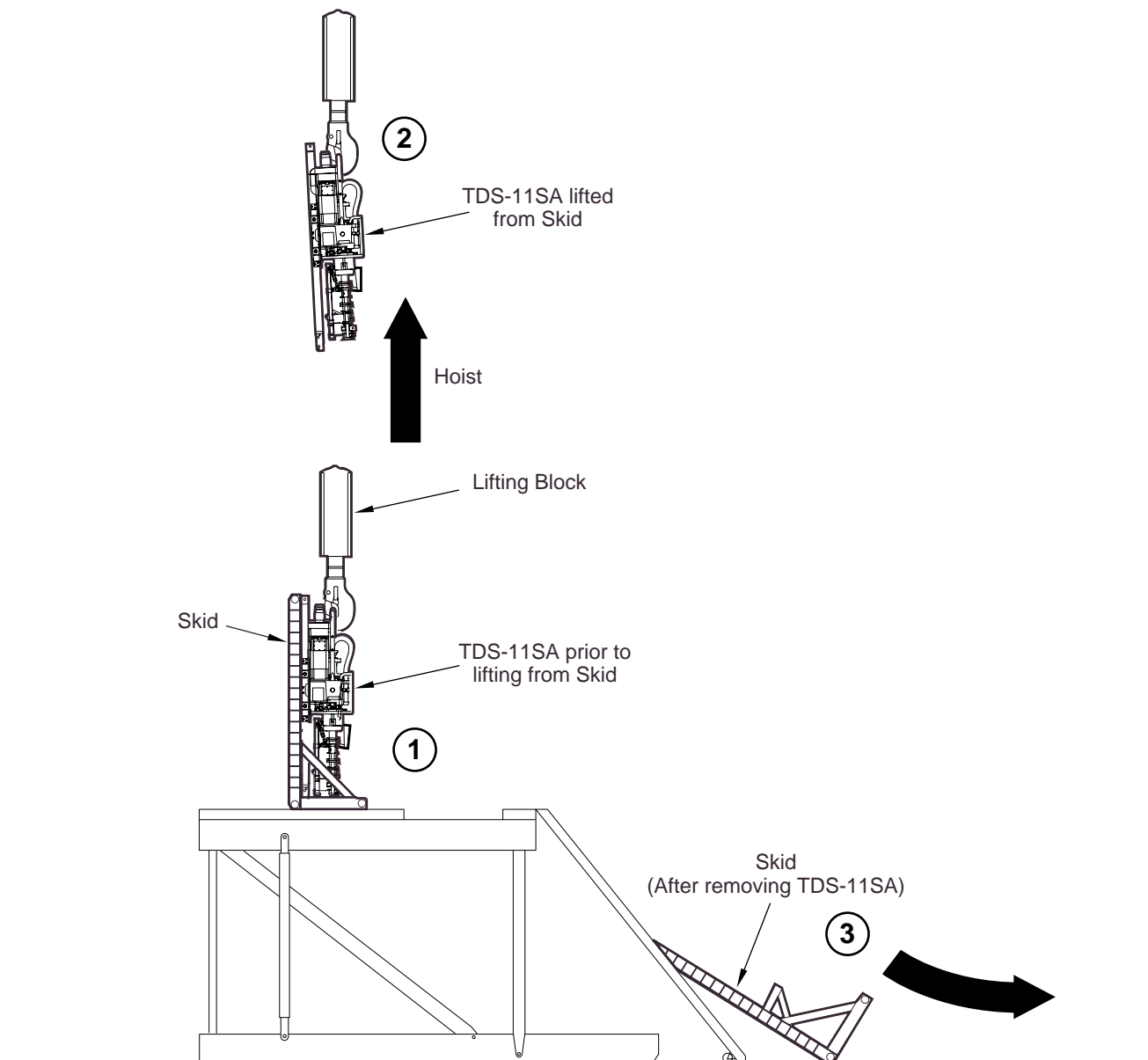
TDS-11SA Envelope/plan view

The TDS-11SA is shipped on a transportation skid with the PH-50 pipehandler connected. In the skid the top drive is attached to the upper section of the guide beam. Using the hook or a crane the TDS-11SA and skid is moved to the rig floor.



Moving the TDS-11SA to the rig floor

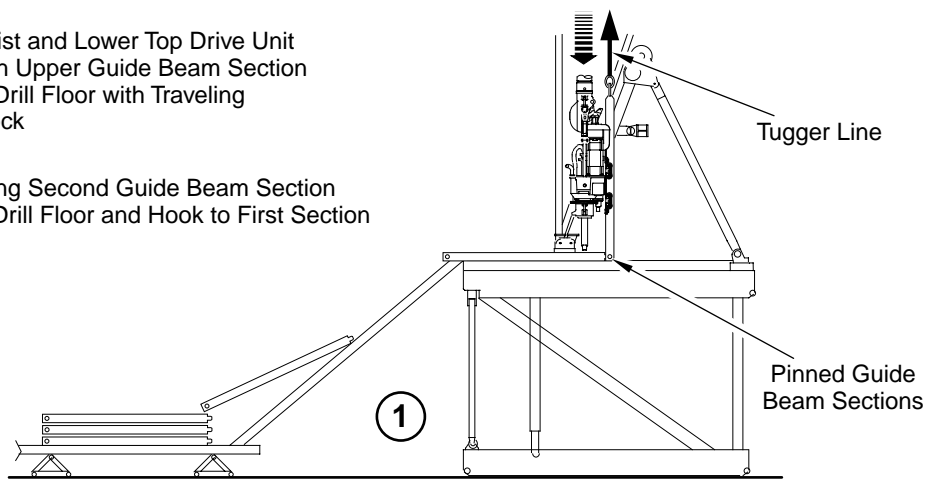
Connecting the hook to the TDS-11SA bail and removing the lock pin allows for the unit to be separated from the transportation skid.



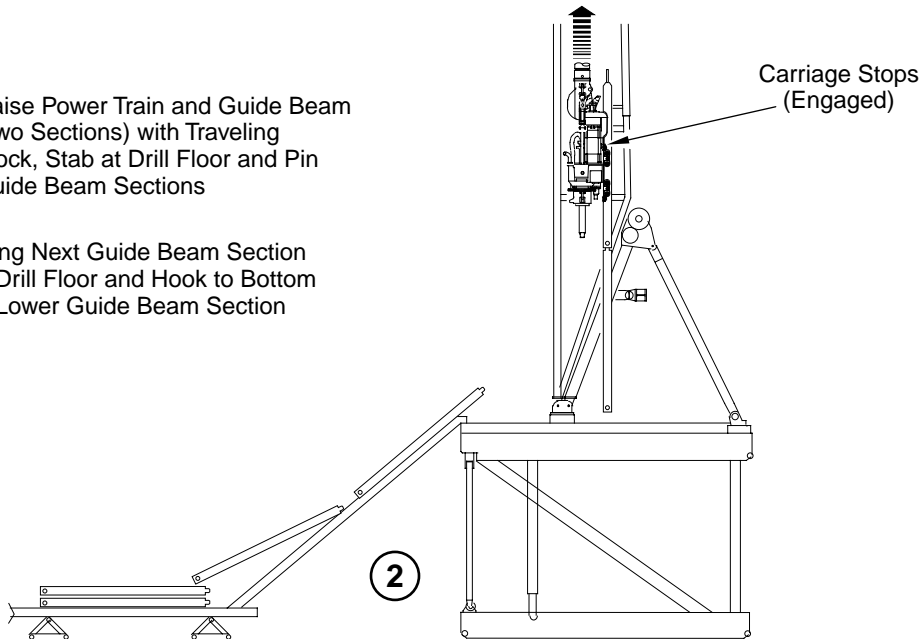
Removing the TDS-11SA from the skid

Following the directions provided in the TDS-11SA service manual allows for easy connection and locking-in of the remainder of the guide beam section and the attachment to the upper support brackets.

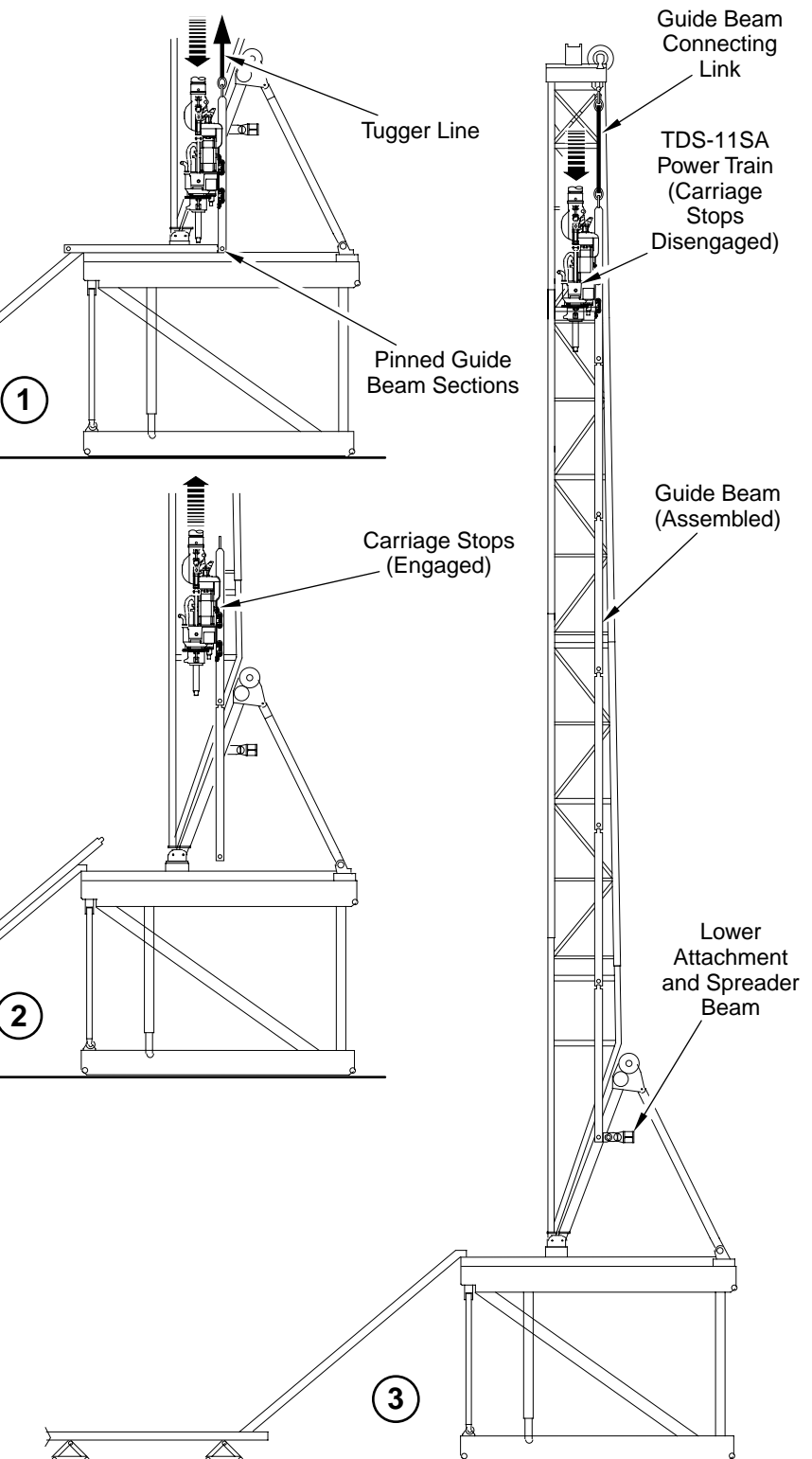
- ☐ Hoist and Lower Top Drive Unit with Upper Guide Beam Section to Drill Floor with Traveling Block
- ☐ Bring Second Guide Beam Section to Drill Floor and Hook to First Section



- ☐ Raise Power Train and Guide Beam (Two Sections) with Traveling Block, Stab at Drill Floor and Pin Guide Beam Sections
- ☐ Bring Next Guide Beam Section to Drill Floor and Hook to Bottom of Lower Guide Beam Section

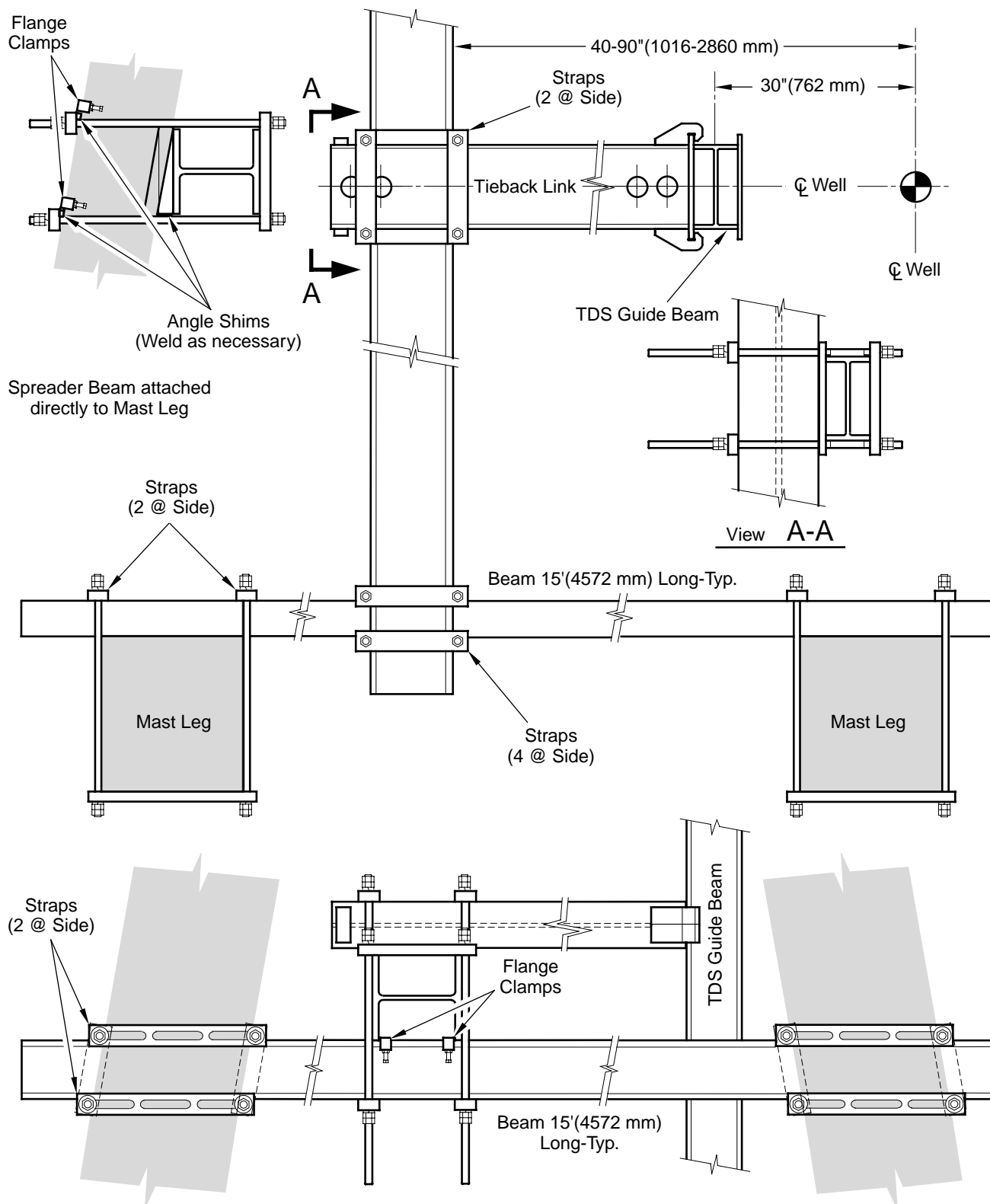


- ☐ Repeat Above Procedures to Complete Guide Beam Assembly
- ☐ Attach Upper Guide Beam Section to Connecting Link
- ☐ Lower Traveling Block Slightly to Disengage Guide Beam Stops
- ☐ Pin Lower Attachment to Spreader Beam



Guide beam rig-up

Once the guide beam is secured at the top, the lower end of the guide beam is attached to the spreader beam and tied back to the mast/derrick. Proper attachment and tieback is vital to the transmission of the system torque to the rig structure.

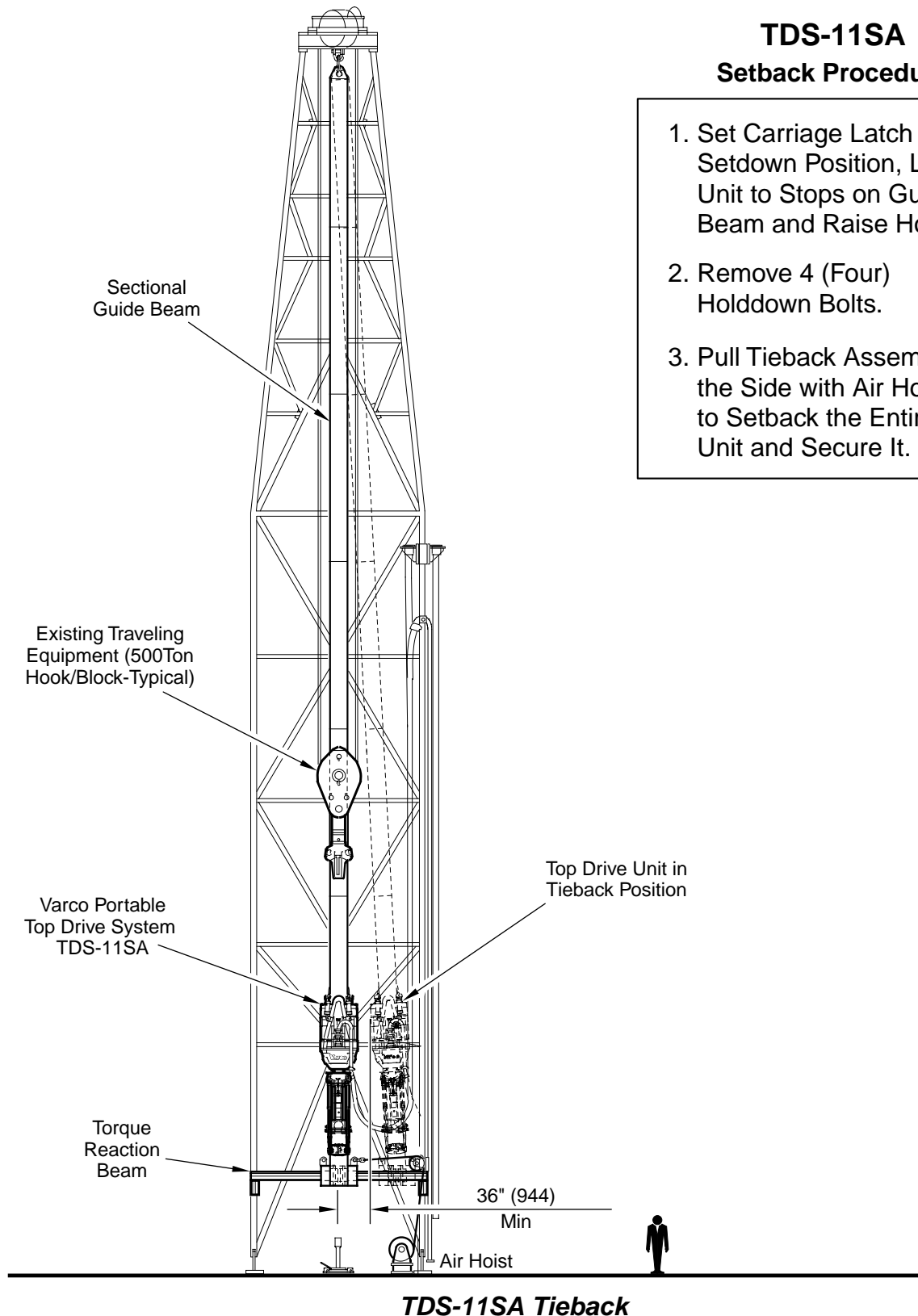


Guide beam lower attachment detail

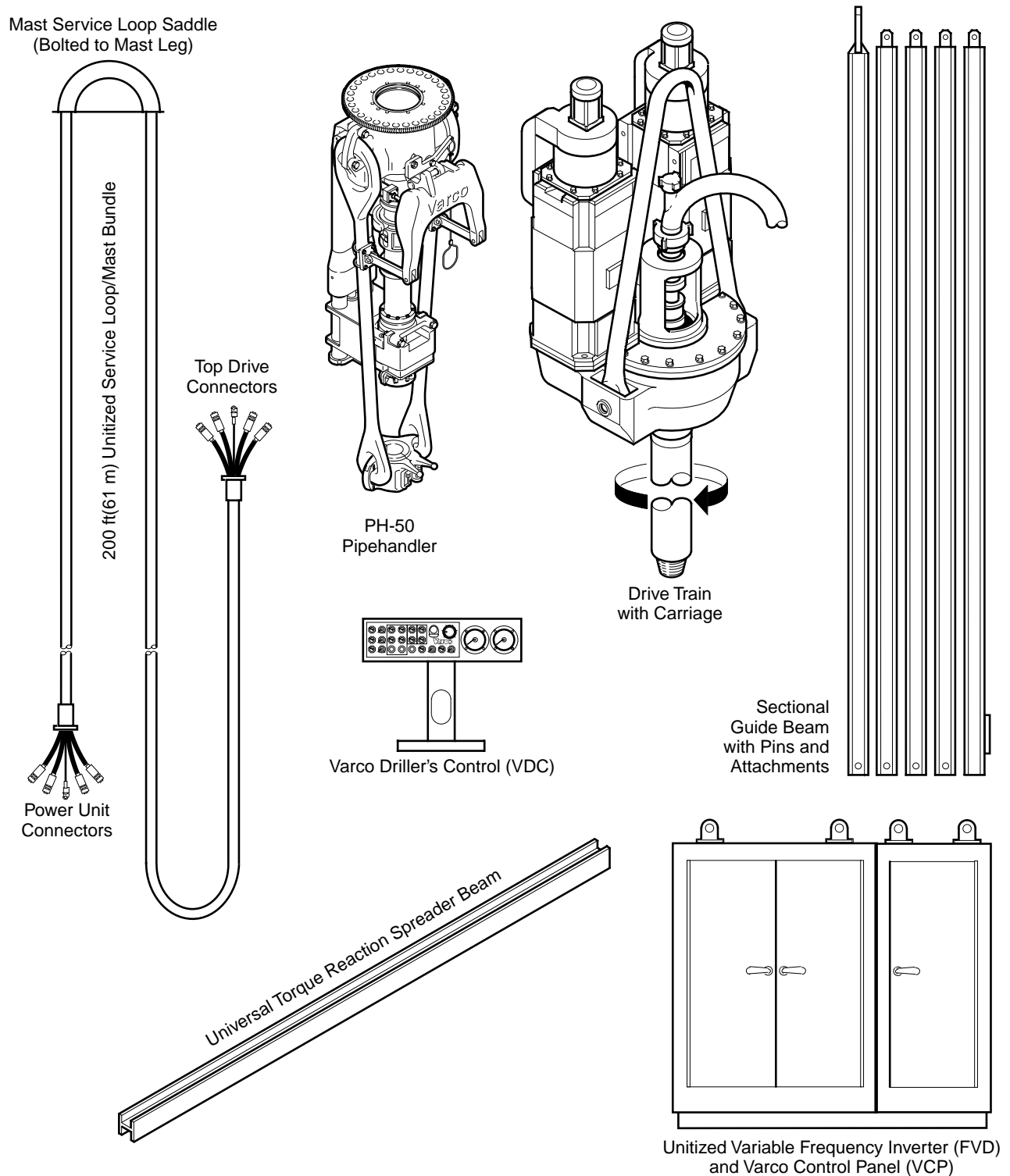
Additionally, if hoisting a load that is greater than the capacity of the top drive is necessary, the tieback is constructed to allow for the top drive and guide beam to be pulled away from well center.

TDS-11SA Setback Procedure

1. Set Carriage Latch in Setdown Position, Lower Unit to Stops on Guide Beam and Raise Hook.
2. Remove 4 (Four) Holddown Bolts.
3. Pull Tieback Assembly to the Side with Air Hoist to Setback the Entire Unit and Secure It.



Additional unit subsystem checkouts and precautions are provided in the TDS-11SA Service Manual—all of which must be followed to ensure proper functionality of the TDS-11SA unit. The illustration below shows a typical standard package for a portable TDS-11SA unit.



Typical TDS-11SA portable package

Section 5

Specifications

General

Transmission	10.5:1 double reduction helical gear
Transmission lube	Constant speed pump, force fed, filtered, and air cooled
Powered rotating head	Infinitely positionable
System Weight	24,000 lb (10886 kg)

Drilling parameters (800 hp)

Drilling speed range	0 to 228 rpm continuous
Drilling torque	37,500 ft lb maximum continuous (50842 N•m)
Drilling horsepower	800 maximum continuous
Static locking brake	39,000 ft lb (52878 N•m)

Drilling parameters (700 hp)

Drilling speed range	0 to 228 rpm continuous
Drilling torque	32,500 ft lb maximum continuous (44050 N•m)
Drilling horsepower	700 maximum continuous
Static locking brake	39,000 ft lb (52878 N•m)

High speed available (800 hp and 700 hp)

Drilling speed range	0 to 500 rpm continuous
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Rated capacities

Hoisting	500 Tons, API-8C, PSL-1, SR-1
Drilling (rotating)	500 Tons, API
Water course (main shaft bore)	5,000 psi CWP (3.0 inch)

Drilling motors (two 400 hp AC motors)

Type Reliance Electric, AC induction, forced air cooled.

Rating	400 hp each (800 hp total)
Rated speed	1,200 rpm
Maximum speed	2,400 rpm
Maximum continuous torque	1,800 ft lb each
Maximum intermittent torque	2,600 ft lb each

Drilling motors (two 350 hp AC motors)

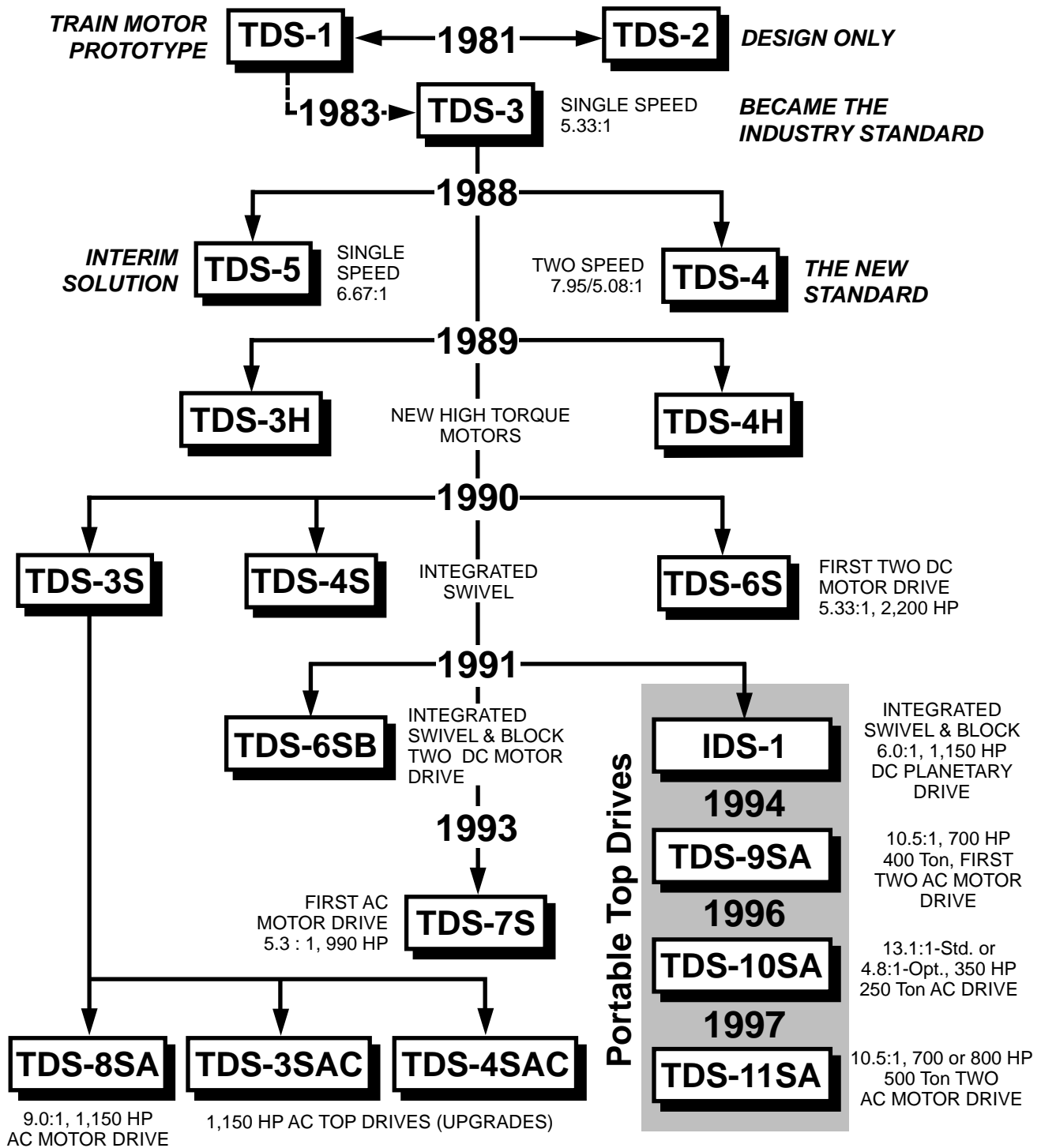
Type Reliance Electric, AC induction, forced air cooled.

Rating	350 hp each (700 hp total)
Rated speed	1,200 rpm
Maximum speed	2,400 rpm
Maximum continuous torque	1,550 ft lb each
Maximum intermittent torque	2,288 ft lb each

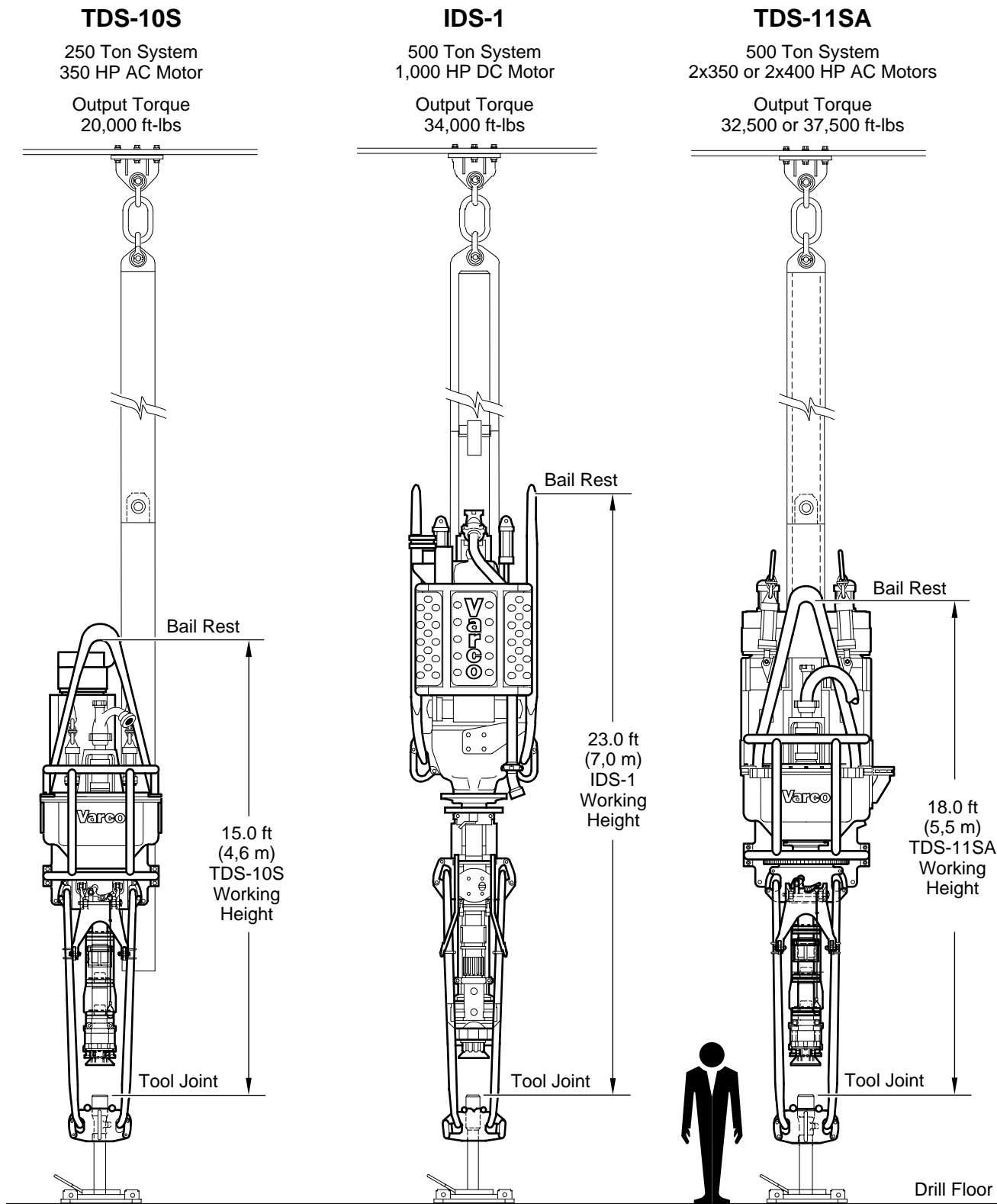
Pipehandler (PH-50)

Torque capacity	55,000 ft lb (67800 N•m) @ 2,000 psi
Drill pipe range (O.D)	3-1/2" through 5" (89 to 127 mm)
Upper IBOP (remote)	6-5/8" API Reg. RH, Box and Pin
Lower IBOP (manual)	6-5/8" API Reg . RH, Box and Pin
IBOP pressure rating	15,000 psi CWP
Elevator links	350 Tons or 500 Tons, API

Appendix

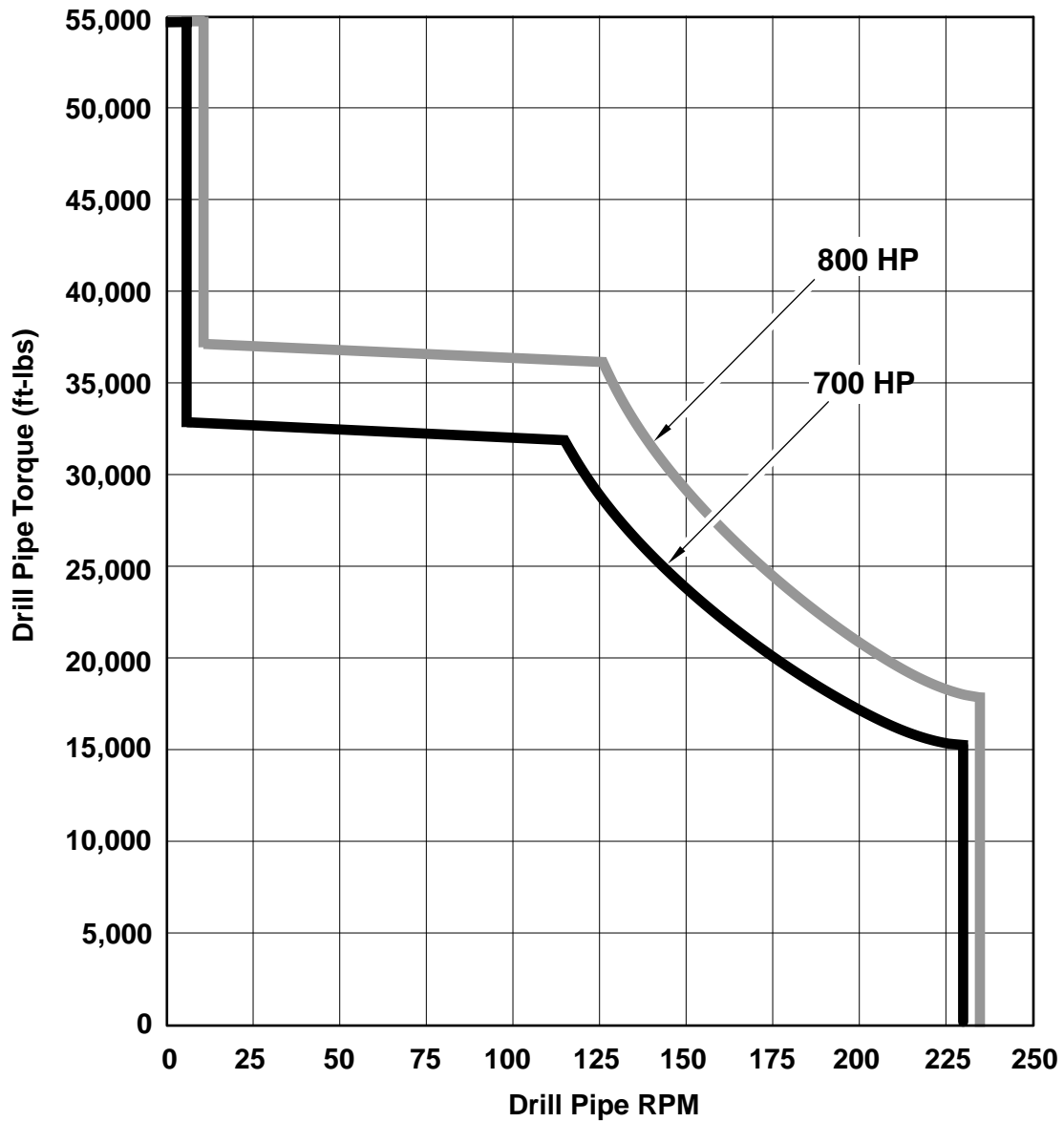


Varco's Top Drive Drilling Systems development

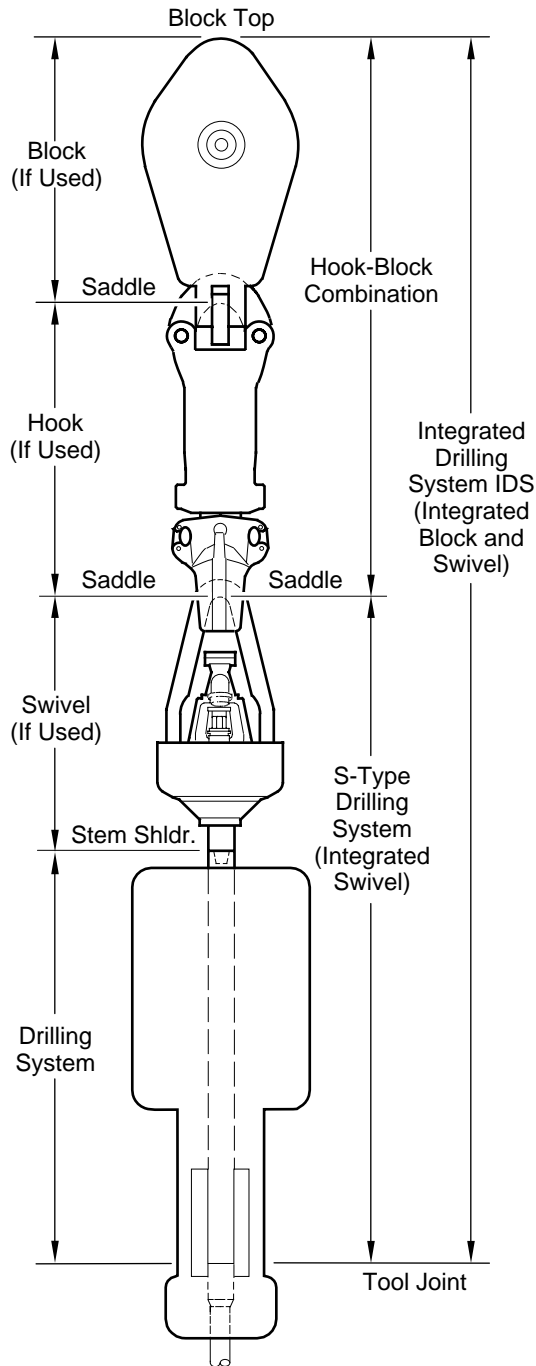


Varco's Top Drive Drilling Systems comparison

Dual AC Motor Top Drive TDS-11SA
2 x 350 = 700 HP or 2 x 400 = 800 HP
500 Ton System, 10.5:1 Transmission



TDS-11SA Output curve



To short-couple a Swivel Bail/Top Drive to a Traveling Block VARCO offers special Adapters with 3 – 4 ft working height

* Includes 750 Ton Hook Adapter

** With 500 Ton 60-in Sheave Varco Integrated Taveling Block

TRAVELING EQUIPMENT	MAKE	MODEL	WORKING HEIGHT			WEIGHT (EST)	
			in	ft	mm	lbs	kg
TRAVELING BLOCKS	DRECO	660B-500	92	7.6	2324	18500	8391
		760B-650	105	8.7	2654	23800	10795
		760B-750	109	9.0	2756	27500	12474
	NATIONAL	650H500	91	7.5	2299	13500	6266
		660H500	109	9.0	2756	18750	8509
		760H650	112	9.3	2832	21800	9888
	OILWELL	H350	77	6.4	1956	9380	4255
		B500	100	8.3	2543	17900	8119
		650	104	8.6	2629	20240	9181
	IDECO	A750	120	10.4	3210	34016	15429
		TB525-6-60	105	8.8	2670	18200	8255
		TB650-6-60	110	9.2	2794	20500	9299
	CECO	TB750-7-60	113	9.4	2873	22100	10024
		RA52-6-500	92	7.7	2337	13250	6010
		RA60-6-650	103	8.6	2621	19158	8690
	McKISSICK	RA60-7-750	110	9.2	2794	22871	10374
		500	91	7.6	2315	21500	9752
		650	109	9.1	2769	22590	10246
HOOK-BLOCK COMBOS (stroked 8")	NATIONAL	500-1195	92	7.7	2340	21546	10000
		650-1090	105	8.7	2664	26932	12500
		500	104	8.7	2648	22000	9979
		650/750	103	8.5	2604	27000	12247
	IDECO	540G250	137	11.4	3480	11600	5262
		545G350	152	12.6	3861	15260	6922
		650G500	169	14.1	4293	21250	9639
HOOKS (stroked 8")	VARCO BJ	660G500	184	15.3	4674	26500	12020
		760G650	192	16.0	4883	31780	14415
		UTB525-6-60	181	15.1	4607	9000	4082
	NATIONAL	5250	104	8.7	2642	5050	2291
		5350	106	8.8	2692	6340	2876
		5500	117	9.8	2981	9950	4513
		5750	138	11.5	3493	18090	8205
	WEB WILS.	51000	158	13.2	4035	32076	14550
		500	97	8.1	2457	6920	3138
		650	103	8.6	2623	8550	3872
	MH	750	113	9.4	2873	9750	4423
		500	120	10.0	3048	8500	3856
SWIVELS	NATIONAL	500	112	9.3	2845	11850	5500
		650/750	138	11.5	3508	18745	8700
	OILWELL	P500	92	7.7	2343	5700	2585
		P650	94	7.8	2375	6900	3130
		P750	116	9.6	2937	11500	5216
	IDECO	PC500	94	7.8	2388	5708	2589
		PC650	96	8.0	2438	7350	3334
	CECO	TL-500	91	7.6	2311	5200	2359
		TL-650	101	8.4	2562	6900	3130
		TL-750	114	9.5	2899	8200	3719
	G.-DENVER	LB500	91	7.6	2311	5947	2698
		LB650	99	8.2	2505	6646	3015
	DRECO	SW550	94	7.8	2381	5700	2585
		S500	98	8.1	2486	5800	2631
		S650	101	8.4	2570	6850	3107
VARCO TOP DRIVES		500	102	8.5	2578	6100	2767
		650	109	9.1	2769	7000	3175
		750	119	9.9	3001	9100	4128
		TDS-3H	214	17.8	5436	32600	14800
		TDS-3S	250	20.8	6350	36750	16685
		TDS-4H	221	18.4	5613	37000	16798
		TDS-4S	250	20.8	6350	38750	17593
		TDS-5H	214	17.8	5436	35200	15981
		TDS-6S *	276	23.0	7010	43750	19826
		TDS-7SA	250	20.8	6350	49000	22742
		TDS-8SA	250	20.8	6350	37750	17520
		TDS-9SA	214	17.8	5425	24000	10886
		TDS-10SA	192	16.0	4877	18000	8164
		IDS-11SA	216	18.0	5486	25250	11453
		IDS-1 **	346	28.8	8788	49000	22742

Top drive worksheet

