Operation and Maintenance Manual

5-C

Mobile Rig

REFERENCE	REFERENCE DESCRIPTION
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03	Updated to electronic format from pdf to ms word in new template
04	Updated Raising Rams with Derrick Standing.
05	Updated and Added Johnson's Manual

TABLE OF CONTENTS

1 APPENDIX

2 INTRODUCTION

This Guide contains general National Oilwell Varco instructions for the operation and maintenance of National Oilwell Varco well servicing or workover rig, and should be given careful consideration and study before operation of the rig. It does not supplant the crew check-out to which the owner of a new rig is entitled under the warranty policy. Failure to operate and maintain the rig in accordance with this Guide may void the warranty covering same. Although it is impossible to anticipate every kind of problem or condition that may be encountered in the field, compliance with the instructions and suggestions set forth herein will materially assist the owner or operator in successfully operating this equipment. However, the information contained in this Guide shall not in any way relieve the owner or operator of the responsibility of exercising reasonable care and prudence in the operation and maintenance of this equipment.

This Guide covers special options available on National Oilwell Varco well servicing and workover rigs and therefore, it may contain information on features not on a specific rig. In such cases, ignore data in this Guide which is not applicable to your rig.

Only parts approved by National Oilwell Varco should be used for repairs or replacements.

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State Of California to cause cancer, birth Defects and other reproductive harm.

Note: The above should be considered as a WARNING in all areas of the world and not just in California.

2.1 General

This operation manual describes the operations in conjunction with the day-to-day running of the National Oilwell Varco 5C Mobile Rig.

This document describes the various control and monitoring facilities. For KECS system overview and description of standard pop-ups etc,.

It is essential that the equipment operators have the required knowledge, education and training before using the system.

2.2 Abbreviations and definitions

F	Fahrenheit
C	Centigrade
Rpm	Revolution per Minute
psi	Pounds per Square Inch
kg/cm^2	Kilograms per Centimetre Squared
ft.	Feet
m	Meters
cfm	Cubic Feet per Minute
m^3/min	Cubic Meters per Minute
gpm	Gallons per Minute
L/min	Liters per Minute
dc	Direct Current
V	Volts
In.	Inches
mm	Millimeters
mph	Miles per Hour
kph	Kilometers per Hour
lbs	Pounds
kg	Kilograms

2.3 Reference documents and drawings

Please refer to Appendix for all drawings.

3 OPERATION INSTRUCTIONS

3.1 Preparation / Configuration

3.2 Orientation (Cab Controls) See page 72.

3.2.1 Roading (See Cab Control page 72.)

Inter-axle Differential Lock: Eliminate differential action between front-rear and rear-rear axles. Use only when road surface is slick and tires spin.

Brake Set Valve: Locks brakes on all wheels. For use when rig is on location – not for driving.

Axle Park Brake Valve: Normal driving position is with valve in "OFF" position. This also serves as emergency brake.

When parking, place valve in "ON" position. This vents brake chamber and applies park brake / emergency brake.

To release axle park brake, push valve in.

Windshield Wiper Control: Pneumatic, variable speed dependent on degree of control knob rotation.

Dimmer Switch: The high-low beam dimmer switch is integral with the steering column. With the light switch on the dash pulled out, turn signal lever on the steering column can be pulled toward the driver to change from high or low beam.

Turn Signal - Emergency Warning Switch: This switch is integral with the steering column. To operate the turn signals, pull the lever down for left turns, up for right turns. To engage the emergency warning flasher, pull the red knob out that is on the side of the column. With the switch in this position all turn signal lights will flash, serving as emergency warning. To release the emergency warning feature, push the red knob in.

Engine Display Unit (EDU): (See Cab Control Page 72.) This unit will display the following: Engine RPM, Vehicle Speed, Engine Warning Signals, Engine Codes, Engine Coolant and Oil Temperature, Engine Oil Pressure, Battery Voltage, and Check and Stop Indicators.

Horn Button: Located in the center of the steering wheel.

Starting Switch: Provides current for instruments and lights, engine electronics, and electric starter circuit. (Always place transmission selector in neutral position to energize starting circuits.)

Electric Start: Starter is energized by full clockwise turn of the starter key. Key should return to intermediate position after engine has started.

Transmission Shifter: Rigs with full torque shifting torque converter/transmission have five or six forward speeds, neutral and reverse. These transmissions may be shifted under load by pushing the shifter up or down. The transmission is in automatic mode when roading and is in manual mode when on the well site. The shifter is located on the right hand side panel of cab and at operator's control at the rear of rig. (See Cab Control Page 72.)

CAUTION: Before shifting drop box selector to either "ROAD" or "WELL" be sure transmission shifters in the cab and at the operators console are both in neutral. If either shifter is not in neutral the transmission will immediately shift into gear when the selector is activated. This will result in immediate machinery rotation resulting in personal injury or equipment damage. See page 77.

Warning System: This rig is equipped with a high water temperature, low oil pressure, and engine derate system. This system will sound a horn if a high water temperature or low oil pressure condition occurs and also will limit the power of the engine.

NOTE: When an engine is not running, and the start switch is on, a low oil pressure signal is produced to sound the horn. The start switch on the cab panel must be placed in the "OFF" position when the engine is not running to shut down the horn.

NOTE: The warning system will limit the power of the engine. To prevent damage to the engine, immediate action should be taken to check for and correct the indicated trouble before restarting the engine.

Engine Kill (Fuel): This control is in the cab. The ignition key switch in the cab can be used for normal engine shut down.

Emergency Engine Kill: This control is in the cab, at the sand drum controls, and at the driller's control console. Its primary function is for EMERGENCY KILL. It will shut off engine intake air and fuel.

CAUTION: Continuous use of this control for routine shut down may cause damage to the engine.

Allison Transmission Converter High Temperature Warning: A horn warning will sound when converter oil temperature reaches 250°F (121°C). If this condition occurs, stop operation, place transmission in neutral, and circulate oil at 1000 rpm engine speed until oil cools.

Transmission Oil Filter: Transmission oil filters have an indicator for a dirty filter condition, which will throttle engine down and downshift the transmission until the filters are changed.

Air Ride Axles: Control valve are on right rear fender.

This axle is supported by two air springs that keep a constant predetermined load on the axles independent of rise or fall of terrain.

Air pressure gauge is provided at the control valve and in the cab instrument panel.

For roading, the pressure regulator should be set at 60 psi (4.2 kg/cm^2). When unit is in position at well site, reduce the pressure to zero psi before erecting derrick. When preparing to road unit again, reset the pressure to 60 psi (4.2 kg/cm^2).

Drive Controls
The primary "road gear" drive control is located in control box on operator's side of engine. It controls power flow to the rear drive axles or drawworks and sand drum. Shift only with transmission in neutral and with engine at idle speed. Be sure to engage fully when shifting. See page 77.

3.2.2 Operation at well

Allison Transmission Shifter: On rigs with full torque shifting converter/transmission, the control is in operator's console at rear of rig (transmission control selector must be in "WELL" (Page 77) position before control console will have air supply). See page 77. (Refer to Operator and Sand Drum Control Panel Manual)

Purge Switch in Engine Control Box on Crane Carrier Chassis

The purge switch is used when the unit has been shut down while on the well site for a long enough time that the rig air pressure is down below 90 psi. Before starting the unit the purge switch should be pushed in (switch lights up) to kill the electric power to the transmission shifter at the rear operator's console and then start the rig. Once the rig air pressure has reached 90psi the purge switch can be turned off and the rear shifter can be used. This allows the purge air system to pressure up the rear console for an explosion proof operation at the rear console.

Purge Switch on NOV Chassis

The purge switch is used when the unit has been shut down while on the well site for a long enough time that the rig air pressure is down below 90psi.Before starting the unit the purge switch should be turned off to kill the electric power to the transmission shifter at the rear operator's console, and the PLC power and then start the rig. Once the rig air pressure has reached 90 psi the purge switch can be turned on the rear shifter and PLC are active. This allows the purge air system to pressure up the rear console for an explosion proof operation at the rear console.

NOTE: Full torque shifting converter/transmissions have lock-up feature that allows greater efficiency. If converter does not go into lock-up before 30' (9.1m) of tubing (1st joint) has passed slips, down shift to next lower gear for increased efficiency.

Drum Clutch/Throttle/Brake Release: To engage drum clutch, start brake release and bring engine throttle up depress the deadman switch on the Joy Stick and move the Joy Stick handle in an upward direction as indicated by the nameplate. This is a modulating control and will increase engine throttle and increase release of the brakes with increasing handle movement. The Joy Stick has a deadman switch on it which must be depressed before it will do anything. All continuous hoisting operations should be done with full handle travel. This Joy Stick is spring loaded to the neutral position which disengages the clutch releases the throttle and sets the service brakes. Releasing the deadman switch will set the service brakes as well as the park brakes. Downward movement of the Joy Stick from the center position with deadman switch depressed releases the brakes only. Side to side movement of the Joy Stick will increase the throttle only.

Drum Brake System: The brake system is a hydraulically actuated caliper disc brake type, consisting of an integrally mounted spring applied hydraulically released cylinder (park brake) and a single acting main cylinder (service brake) for normal brake application and a rotor.

The system is a dual caliper/rotor system with a rotor and caliper mounted to each side of the drum. A pressure gauge is provided in the operator's control console for visible indication of the hydraulic pressure on the service brakes circuits.

The Joy Stick with the deadman switch operates the disc brakes at the operator's console for normal tripping operations. Also provided in the operator's console is a "Park Brake" air control valve. When this valve is set (pushed in) the hydraulic pressure is released on the spring applied cylinder and full braking force is applied to the rotors. This is intended as a park (block not in motion) brake only and should only be used in extreme emergencies during tripping (block in motion) operations. Always place the park brake valve in the set position before shutting off engine, or when the engine is running but the operator is otherwise engaged.

Control Mode:
The control console has a selector switch which has three positions (W.O.B–OFF-Normal). For normal rig operation the switch should be in the Normal position. The OFF position will allow operation without hoist and lowering controls enabled. The W.O.B. is used for very slow movement of the pipe string when lowering into the hole or can be set

for milling operations at a predetermined weight on bit. The push button switch to the right of the selector switch may be pushed to select the weight on bit when the string weight desired is reached while lowering onto the milling surface and the W.O.B. will maintain the selected string weight. On the left hand side of the selector switch is a knob which will increase or decrease the selected W.O.B. for fine adjustment. This knob will also give fine tune control when dropping the string into the hole at slow rates.

Air Slips: An air slips control valve is furnished in the control panel along with the necessary quick couplings in the bottom of the box for connecting to the customer provided air slips. Located inside the control box is regulator and gauge for setting the pressure for retracting slips. See literature provided by the air slips manufacturer for proper pressure setting on slips. Moving the handle on the air slips control valve to retract positions will lift slips from spider when hoisting pipe and moving the handle to the set position will cause slips to seat in spider.

Tong System: The hydraulic power tong system is provided with an energizing control in the operator's console. (Refer to Operator and Sand Drum Control Panel Manual) Refer to Hydraulic System Section also see page 76 and 80.

Utility Winch: The utility winch control (which is a modulating valve) in the control console will hoist when the handle pushed in the raise position and lower the load when placed in the lower position. See page 77 and 81. (Refer to Operator and Sand Drum Control Panel Manual)

AIR SYSTEM

The engine is equipped with a 28 CFM (0,79 m^3/min) air compressor. Air discharge from air compressor is routed thru an air dryer system, then to a wet tank and two dry tanks as well as an isolated spring brake tank. The compressor is equipped with a governor that holds the system pressure between approximately 120 to 140 psi (8.4 to 9.8 kg/cm^2). All air tanks are provided with drain cocks. The wet tank (first air tank in the circuit after the air compressor and air dryer system) is equipped with an automatic drain valve. Remaining tanks should be checked periodically for condensate.

The air dryer is a low maintenance device. It is designed to expel accumulated moisture when the governor reaches the high pressure setting 140 psi (9.8 kg/cm^2). The air dryer element and frequency of change are described in the Preventative Maintenance Section.

Filters are provided in the air supply to the operator's position and to the cab.

When the alcohol antifreeze unit is in use, change alcohol every 36 to 48 hours of operation to avoid air line freeze up problems. Use a commercial methyl alcohol.

HYDRAULIC SYSTEM: 50 GPM 2000 psi (189 liter/min. - 141 kg/cm^2) INTERMITTENT SYSTEM See page 80.

The hydraulic pump is driven from an engine driven power take-off located in the front of the engine. This pump supplies fluid for mast raising, mast extending, leveling legs, utility winch, and power tongs. The system is actuated by closing a bypass valve in the

hydraulic circuitry. The pump is activated by engaging any of the driller's controls for the hydraulic function(s) or by engaging the tong pump control at the hydraulic valve bank.

The utility winch and tong control valves in the operator's control console close the bypass valve that will supply oil from one section of the tandem pump to these functions. The flipper valve, located at the main hydraulic valve bank, closes the same bypass valve as does the utility winch and tongs functions. See pages 76 and 80. (Refer to Operator and Sand Drum Control Panel Manual)

The hydraulic system is an intermittent duty system unless it is provided with oil cooler. Without the oil cooled, it should not be used for power swivel operation or other continuous duty application.

The hydraulic system is designed for normal operation at pressures up to 2000 psi (141 kg/cm^2). Pressures to 2300 psi (162 kg/cm^2) may be used on intermittent non-shock basis for derrick raising or extending only.

CAUTION: Never exceed 2300 psi (162 kg/cm^2) on derrick raising and extending or 2000 psi (141 kg/cm^2) for other operations.

A system relief valve is provided and set to the maximum system pressure. Do not change setting. (See page 62.)

The first section of the triple pump is used for powering the drawworks hydraulic disc brake system. This system uses a variable displacement piston pump that is capable of 40 GPM (151 liter/min) at 2000 psi (141 kg/cm2).

The middle section is for tongs

The second section of the middle pump is used for powering the auxiliary cooling system in the drawworks disc brake system. This system uses a .5 GPM (1.89 liter/min.) gear pump.

The last pump on the triple pump operates the spring brake.

The engine is also equipped with a power steering pump. It may also be provided with filters.

ELECTRIC SYSTEM

Cab instruments and vehicle lights are 12 volt dc; power provided by battery outside of cab. For access to electrical components, remove cover on right hand side of cab and cab front. See page 72.

To minimize electrical system maintenance, the following guidelines should be considered:

Avoid using rig batteries to "Hotshot" other equipment.

Keep battery terminals free of corrosion and covered with grease to exclude moisture.

Do not disconnect the battery to alternator leads or the ground or battery leads when the engine is running and the regulator is in the circuit.

Always open the field circuit before disconnecting battery leads. The field circuit can be disconnected by removing the wiring connector body from the regulator or the field lead from the alternator prior to engine operation.

Do not ground the field circuit other than originally wired.

Do not attempt to polarize the alternator or the regulator.

Be sure that all terminals and connections are kept clean and tight.

Do not interchange (plus) and (minus) battery leads.
Any improper connection can cause instantaneous regulator damage.

Caution: This rig is equipped with electronic components which are susceptible to damage from improper welding techniques. Before doing any welding on the rig, please consult Engine Manufacturer for proper precautions to take.

To disconnect the alternator the following technique is recommended:

- Shut off engine.
- Throw master disconnect switches **(these switches have a lock out feature on it which allows the unit to be shut down and locked out)** to off, or remove wiring connector from body of regulator, as applicable.
- Remove belt.
- Start engine.

Do Not run alternator for long periods of time if it is disconnected from charging circuit.

HYDRAULIC UTILITY WINCH:

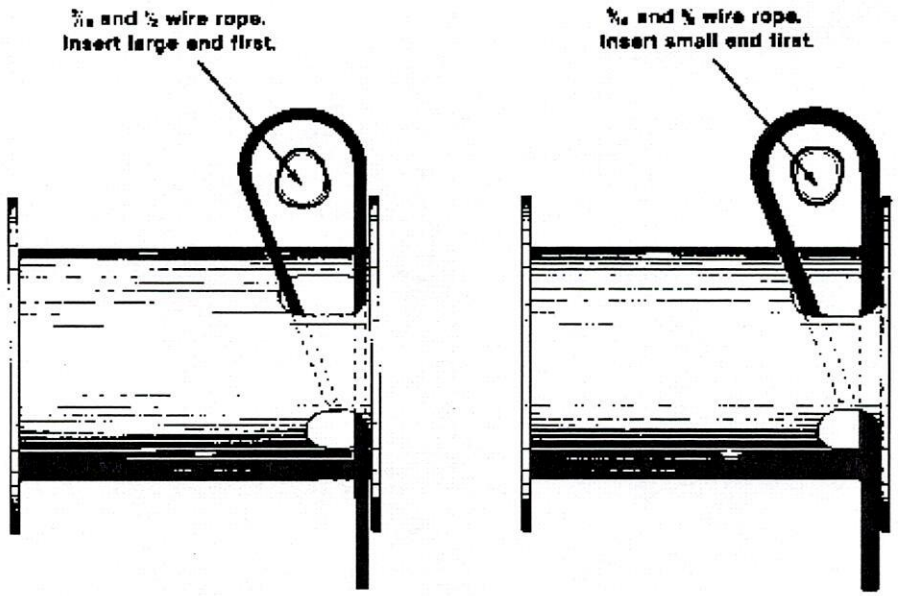
The Utility Winch is mounted on the carrier and uses the rig hydraulic system for power. A directional control valve is located in the operator's control console for convenience of hoisting or lowering operations. See page 77. (Refer to Operator and Sand Drum Control Panel Manual)The winch is internally locked when the directional control valve is in neutral position.

CAUTION: Should be observed that the winch load line is clear from obstruction and that personnel are clear from loads being handled.

Hoisting or lowering speed may be modulated with the directional control valve and throttle at the control console.

CAUTION: Winch must be spooled on counter - clockwise when viewed from motor end. Wrong spooling voids self locking brake.

UTILITY WINCH
Line Anchor Instructions



Series PD-12

Take the free end of the wire rope and insert it through the small opening of the anchor pocket. Loop the wire rope and push the free end about ¾ of the way back through the pocket. Install the wedge, then pull the slack out of the wire rope. The wedge will slip into the pocket and secure the wire rope into the drum. The anchor is designed to accommodate several different sizes of wire rope. You can anchor 7/16" and ½" wire rope by inserting the wedge, large end first. 9/16" and 5/8" wire rope can be anchored by inserting the wedge, small end first.

CAUTION: Always maintain at least 3 wraps of bare drum for hoisting load.

DERRICK LIGHTING

The derrick and carrier is wired in accordance with electrical standards. The following color code is used.

24V	220V
Green - ground	Green - ground
White - neutral leg	White - hot leg
Black - hot leg	Black - hot leg

When making connections to derrick lights from an external power source, be sure to match power source wiring to above coding.

3.3 Starting Procedures

Precheck Before Starting (Roading)

Lubrication

Engine crank case - dipstick.

Hydraulic reservoir - dipstick.

Torque converter - transmission - dipstick.

Control Position

Place transmission dropbox shifter or power divider shifter in "ROAD" position. See page 77.

Transmission must be in neutral to start engine; check by observing indicator light with ignition switch on.

CAUTION: Transmission must be in neutral before starting engine. Place transmission in neutral before stopping engine to insure this action. If transmission is left in gear and the engine is stopped, the shifter or power divider shifter must be manually placed in neutral. If this is not done, driven machinery will start moving as soon as engine starts and may create hazardous conditions. See page 72. (Refer to Operator and Sand Drum Control Panel Manual)

Axle Parking Brake Valve - "pull to park" position.

All hydraulic valves in neutral position and hydraulic pump disengaged at all controls.

All engine shut down valves and engine emergency kills in "OFF" (pulled out) position.

Fuel Level. Check with dipstick.

Air Pressure. Check gauge.

CAUTION: If no pressure exists, be sure wheels are blocked so rig cannot roll.

Radiator Water. Visual check for water level about 1" (25mm) above tubes.

3.3.1 Engine Start Procedure

Transmission must be in neutral to prevent hazardous conditions.

Turn starter switch key full clockwise to engage starter. Anticipate low oil pressure warning to sound prior to engine start. Release key when engine starts.

Some units with pneumatic transmission range indicators and electric starting are equipped with a neutral start override button. This button is only to be used when it is inconvenient to manually place transmission in neutral as outlined in CAUTION (see above).

To start the engine, push the override button while turning the starter switch key full clockwise to engage starter. Release button and key when engine starts.

Check for proper engine running. Check oil pressure, air pressure, and water temperature. (Low oil pressure warning horn should cease when oil pressure is established).

Check converter oil level at converter dipstick.

3.3.2 Cold Weather Start Up

Special engine oils for low temperature operations should be used. Engine preheater should be used for sufficient time to bring engine block coolant temperature and all lube oils up to 0°F (-18°C) or warmer. Disengage drive to rear axles. (Set park brake and block wheels) start engine. Run engine at idle with transmission in neutral until engine oil and transmission main pressure has reached a normal operation level. Run engine at idle speed, transmission in first gear, for minimum of 30 minutes, allowing all gear boxes drive shaft joints and chain drives to run at slow speed while lubricant is stiff. If rig is to be driven, DO NOT exceed 5 mph (8kph) for first mile (1600m) of driving, as lubricant in drive axle differentials is not warmed by above operation.

Drain condensate water that may collect in hydraulic system from hydraulic tank weekly. This is best done after unit has been shut down for several hours. If water is frozen and tank will not drain, thaw and drain or drain at first opportunity.

If alcohol antifreeze unit is provided, change alcohol every 36 to 48 hours of operation to avoid air line freeze up problems. Use a commercial methyl alcohol.

3.3.3 Shut Down Procedure

Shift transmission to neutral position.

Place axle parking brake valve in "PULL TO PARK" position.

Stop engine

NORMAL: If engine has been under load and hot, allow to idle a few minutes to cool, then shut off with normal engine shut down.

EMERGENCY; Shut engine off with emergency kill valve. Use only in case of emergency. Continuous usage may damage engine.

3.4 Normal Operation

3.4.1 Roading Pre-Check

Tire pressure

Air system pressure -100 psi (7kg.cm^2) minimum.

Check engine instruments for normal indication. See page 72.

Drive control – in road position. See page 77.

Power steering -check reservoir level and check ability to turn front wheels.

With hydraulic system air control valve in “OFF” position, manipulate mast raising control valve to "LOWER" to be sure mast is resting on front supports. See page 76 and 80.

Drawworks brake locked on.

Tied down:

Support legs
Mast chained to front support
All loose items properly stowed

Inter-Axle Differential in “UNLOCK” position. See page 72.

Axle Spring brake control – in "RELEASE" position.

Axle Parking brake control – "OFF" position.

CAUTION: For vehicles with front wheel drive, the front wheel drive should only be used in off road applications when maximum traction effort is required. The maximum vehicle speed should be limited to 25mph when front wheel drive is engaged.

Driving Suggestions. Gear selection. First gear is used primarily for moving the rig out slowly, in close places and in rough terrain. Usually third gear is low enough when moving the vehicle from a stop sign, or on a good location, then shifting up to fourth and fifth after the rig is rolling.

The automatic lock-up feature of the transmission will lock in and out while roading as the load requires. An indication of a good gear selection is that the transmission shifts in to lockup, both when roading and on locations. When roading, if it does not lock up and the speed is decreasing, down shift to the next lower gear.

The inter-axle differential lock system should only be used for intermittent periods; in deep ruts, sandy areas or in mud. If the rig is in a bad location where there is a possibility of spinning the wheels or need for more than normal pulling power, engage the inter-axle to "LOCK" so that the power of the engine will be on both rear axles instead of one. When rolling free, shift inter-axle differential to "UNLOCK"

2.4.1.2 Preparing Rig For Roading

In cab, move wheel brake lock to "OFF". See page 72.

Move axle parking brake to "RELEASE".

With transmission control in neutral, shift drive control from "WELL" position to "ROAD" position see page 77.

Check for and tie down any loose equipment.

Check to be sure that support legs are raised and tied up and all wheel chocks removed.

Remove any holddown turnbuckles.

3.4.2 At Well

Location Preparation

Ground Preparation.

Determine soil condition. (See Loading Diagram page 73.)

Mat as required to satisfy load distribution into ground.

Locate guy line anchors if desired per National Oilwell Varco recommended guying diagram. Check for adequate anchor pull capacity. Anchor recommendations are affixed to the mast nameplate and may be found on page 74.

WARNING: Check location for overhead electric power lines or similar obstructions. Be sure mast and guylines will clear any power lines by at least 10' (3m) to avoid hazard of electrocution.

3.4.2.1 Rigging Up

A. Preliminary.

1. Provide supplemental footing on the well site location at the points of concentrated loads shown on the diagram on page 73. This footing must properly distribute the concentrated loads shown to the base material or soil on location so as not to exceed the safe bearing capacity of the base material or soil. Refer to API standards covering mast for various soil bearing capacities.

WARNING: Failure to provide sufficient supplemental footing could cause rig to turn over, major damage to equipment and/or bodily injury.

2. Locate substructure (if applicable) over well site on leveled location. Check for adequate matting and drainage. Attempt to get full support under structure. Set derrick base against substructure. Mat and level as required. Pin to substructure.
Set rig base next to derrick base as shown in Rig-up diagram. Pin to derrick base.
Mat and level as required.

3. Raise and secure substructure work platforms and install handrails in sockets provided on platforms. Provide temporary closures across any openings for safety.

4. Install stairway from ground to substructure floor on off driller's side of structure if applicable.

5. Position the vehicle so the mast screw jacks coincide with the jack bearing pads on the derrick base beam (if used) and all points of concentrated loads align with supplemental footing.

a. Place axle Spring Brake Valve in "SET" position. See page 72.
b. Move control lever from "ROAD" to "WELL" position see page 77.
c. Block rear wheels with wheel chocks to prevent rolling or skidding.
d. Reduce air pressure on air ride axle (if applicable) to zero psi.

6. Using the rear hydraulic legs, jack-up the vehicle 1-2" (25-50mm) to remove load from tires and level laterally and set locknuts. (Do not lift tires clear of ground).

7. Level front of unit, side to side with middle hydraulic legs and set locknuts. Do not raise front wheels off the ground but do relieve weight from the front springs.

8. Oil level in hydraulic fluid tank must be at top gauge line.

9. Check to see that deadline is properly secured to anchor on chassis.

10. Check to see that racking platform is secured to mast at correct elevation for present job.

11. Check that Traveling Block is secured in block cradle.

12. Install and secure turnbuckles located between rear bumper of rig and derrick base.

13. Remove mast tie-down at the rear mast support.

2.4.2.2 To Raise Mast

1. Place pedestals with base plates within the 14" diameter locating rings on the well side of the derrick base (if applicable).

2. With split base down, set derrick leg screws in base plates snug, and tighten up hard.

3. Remove derrick tie down at front derrick support.

4. Unroll load guy lines and wind guy lines.

5. Before each raising cycle, grease derrick hinges at rear support, and pins in each end of raising cylinders. At least weekly prior to raising derrick, grease pivot pins in racking board and rod board and all sheaves pins in racking board and rod board raising system.

6. Place all hydraulic valve handles at hydraulic control position in neutral (centered) position see page 76.

7. Start engine and energize hydraulic pump with flipper switch at operator's side near hydraulic control position see page 76.

8. Energize hydraulic system

9. Open Valve (A). See page 75.

10. Push Derrick raising/lowering valve handle in LOWERING position slowly. DO NOT EXCEED 200 PSI. Circulate at this condition for at least two minutes (minutes on rigs equipped with two raising cylinders). At end of circulating time, while still circulating, open bleed valve (B) and check for entrained air. On rigs with two raising cylinders, check each cylinder, one at a time.

11. If air is seen, close valve (B) and continue to circulate. Repeat step 3 until no air is seen at bleeder (B).

12. After all air is removed, close valves (B) and (A).

13. Raise Mast with mast raising valve. Raise slow and easy. Avoid abrupt stops. Watch all lines and cables to avoid hang-ups see page 76.

CAUTION: Check to be certain that derrick will clear all electric power lines by at least 10' (3m) to avoid hazard of electrocution.

a. Watch all lines to avoid hang-up.

b. As derrick rises, the raising speed will increase due to the load change and geometry. Ease the control lever in to maintain reasonable raising speed.

c. Stop mast at the breakover point. If excessive sponginess is observed, lower the mast and bleed the ram on the pull back side of the rams. See page 75-76.

d. Pull raising valve control handle out slowly to ease derrick over center. To stop mast, move lever back to center position see page 75 and 76.

e. Seat derrick lower section front legs onto split base front legs and secure with two pins and safety pins.

f. Be sure derrick tilt indicator is set to the proper rig up distance as indicated on the tilt indicator plate. If adjustment is required, remove the lock plates securing the derrick tilt screws against the derrick bumper plates or front derrick leg hold down turnbuckles, whichever is provided. Ease the derrick over or back until the tilt indicator bubble is centered. Take care that the tilt screws do not stop the derrick before proper tilt is achieved.

CAUTION: Be certain that matting boards under base plates are level within 1/8" (3mm) on base plate diameter to assure that base plates do not slip on matting.

g. Recheck tilt indicator and bed cross level for proper level. Adjust as required with leg screws.

NOTE: Proper derrick tilt is needed to align block over center of the well.

CAUTION: To avoid bending leg screws, not more than 4-5" (100-125mm) of threads should be exposed when leg screws are tight in working position. Use additional matting under base plates instead of over extending screw.

h. Adjust derrick tilt screws against the derrick bumper plates and lock in position with lock plates, or pin in and tighten derrick hold down turnbuckles, whichever is provided.

2.4.2.3 TO EXTEND TOP SECTION

1. Preparation.
   a. Release main drum brake and remove cable from tie back spool.
   b. Raise blocks and remove block cradle hook. Set Main Drum Brakes.
   c. Release sand drum brake so sand line will slowly spool off as derrick is extended.
   d. Close manual bypass needle valve. See page 76.
   e. Engage hydraulic pump to "IN" position at console or at hydraulic valve group. See page 76 & 80.
   f. Clear all guy wires and lines.
   g. Unspool working line from utility winch as required.
2. Extend derrick by pulling "EXTEND" lever on handle in console. Hydraulic pressure should not exceed 1800 psi (127/cm^2). See page 76.
   a. Pay special attention to all lines to avoid hang-up and keep lines in the clear.
   b. Observe racking board and rod board for proper manipulation.
   c. See that extending ram stabilizers operate properly as derrick upper section passes them so that the rams are stabilized properly.

CAUTION: When extending derrick, operator must see that all extending ram stabilizers; if used, fully grip the ram as the upper section passes them so that the ram is supported horizontally. Otherwise, the ram may buckle causing the derrick upper section to drop.

d. Extend top section of mast until load transfer latches extend automatically. As soon as latches completely extend, stop telescoping immediately because latches will automatically retract and lock when top section is over-telescoped approximately 5" (127mm). If this occurs, lower top section 2' (610mm) completely and latch locks will release. Then repeat telescoping procedure until latches are completely extended.

e. Lower upper section thus lowering top section load transfer latches into working position on load transfer beam in bottom section. After landing top section and mast is secured, one of the crew must ascend the mast and visually inspect the load transfer latches to be sure that they are fully extended and properly seated. A safety lock pin is provided to ensure that the transfer latches remain fully extended and must be installed to make the extended position safe for use.

WARNING: Failure to fully engage all load transfer latches and pin could cause upper section or mast to fail and damage to equipment and/or bodily injury.

f. Open manual by-pass valve on extending hydraulic system. Page 76.

g. Disengage hydraulic pump see page 76.

h. When transfer latches are properly seated on lower section load transfer beam, install mast load guys and pull tight to achieve at 3 to 4 inches (76-102mm) sag in the cables from a straight line, tension required is from 1200# (55o Kg) to 1875# (850Kg).

i. Lower the traveling block and check the position of the elevators over the well center. If the blocks are not aligned within 2 inches (50mm) to either side of the well, check the unit for alignment. Check tail bed level and derrick tilt level. If they are off, rig down and reposition to correct these levels.

j. Check to see that derrick tilt screws (kicker screw) are properly seated against their bumper plates. Then readjust the rear unit support legs so that they are just touching in their base plates. They may be touching but should not be tight. This can be accomplished by relieving the rear unit support leg loads evenly until the "no load" condition is obtained. On hydraulic support leg, the locknuts must be loosened and retightened after support leg adjustment is accomplished. If rear bumper tie down turnbuckles are provided, observe caution to prevent damage when removing load on rear support legs. The turnbuckles should be retightened lightly after the rear support leg adjustment is completed. If derrick leg to derrick base turnbuckles are used, loosen them two (2) turns to allow at least 3/16" slack.

Other Guylines

Set wind guys in accordance with recommended guying diagrams on mast Nameplate see page 55. Use care to avoid pulling derrick crown off well center. Tighten guylines lines to achieve 6 to 10 inches (150-250 mm) of sag. Tension required for 3/4" - 6 x 19 wind guys, from crown to ground for a 180' square pattern is 1550# (700 Kg) to 2600# (1175 Kg).

Set racking platform guys per guying diagram. Be careful not to displace racking board. Tighten to achieve 6 to 10 inches (152-254 mm) of sag. Tension required for 9/16" - 6 x 19 racking platform guys, cross guyed from racking platform to ground for a 180' square pattern is 1200# (550 Kg) to 2000# (900 Kg).

CARE OF MAST WHILE UP

A. Hydraulic raising ram should be coated with light grease or heavy oil while mast is standing with ram extended to prevent corrosion.

B. Check hydraulic jacks frequently and compensate for any uneven settlement that may occur.

C. Lubricate crown block sheaves once each tour through Alemite fittings.

D. Keep ground around mast base beam or jack pedestals well drained to avoid settlement.

2.4.3 Rig Operation On Well

Control Preparation

Check that all control console valves are off or in neutral.

Move transmission control to "WELL" position. These operations provide air to the rear end control console see page 77.

CAUTION: Before shifting selector to either "ROAD" or "WELL" be sure transmission shifters in the cab and at the operators console are both in neutral. If either shifter is not in neutral the transmission will immediately shift into gear when the dropbox selector valve is activated. This will result in immediate machinery rotation resulting in personal injury or equipment damage see page 72 and 77. (Refer to Operator and Sand Drum Control Panel Manual)

Open air supply valve on rear mast support for rod air lift.
If electric shut-off switch is provided, turn to "OFF" position.

2.4.3.1 Main Drum Operation

Engage the main drum clutch/throttle/brake joy stick to hoist the block and load. NOTE: The main drum clutch joy stick is a combination main drum clutch, engine throttle control, and brake control with a deadman switch which must be depressed before the joystick will work. Initial forward movement of the handle sends full air pressure to the main drum clutch, regulated signal to the engine throttle control and begins release of the brake. Further lever movement increases the engine throttle and releases the brakes. The joy stick returns to the neutral position when the operating force is removed. Downward movement of the handle from the neutral position releases the brakes. Side to side movement of the joy stick increases the engine throttle. In case of slippage within pull capacity of clutch, check for low air pressure at clutch inlet indicating either low supply pressure or faulty control valve. If clutch does not release fast and free, check quick release valve on drum clutch for positive operation.

Gear Selection. On rigs with full torque shifting transmission, hoist in a transmission gear that will allow the transmission to go into lock-up within the first joint of pipe pulled. Up shift may be done under full load and full RPM. Down shifting should be done only when engine is at idle speeds and drawworks is rotating slowly.

2.4.3.2 Tong Drive

Move Tongs valve in the operator's control console to the "ON" position.
This will close the bypass valve and direct the oil supply to the tong relief valve.

The tong speed is variable, with hydraulic flow rates running from approximately 11 gpm (41.6 liter/min) at idle to 50 gpm (189 liter/min) at 2100 rpm. Flow rates to the tongs are controlled by the joy stick throttle (side to side movement) located at the operator's position.

Tong pressure may be set at the pressure regulator on the tong relief valve.

When tripping pipe, position the Tongs in "ON" position only while using the tongs to make up or break out joints. All hoisting and running operations should be done with the valve in the "OFF" position.

2.4.3.3 Routine Daily Checklist

Check ground condition under load points and assure that ground is dry or properly drained and matted as required.

Check that front carrier jackscrews are seated firmly into base plates and no settling under load is noticeable. Take up on jackscrews as required to eliminate settling under load whenever such condition is noted.

Check to see that derrick kicker screws are properly seated and rear unit support legs are touching their base plates but not tight.

NOTE: Most of the derrick load will be taken thru the derrick legs to the ground not thru the rear support legs.

With the hydraulic pump NOT engaged move the mast raising and lowering valve to "RAISE" and "LOWER" positions. This is to relieve any pressure build up in the raising cylinders due to thermal change or geometric change. Do the same for mast "EXTEND" and "RETRACT" valve. See page 76.

Check that the manual bypass valve at the hydraulic valve group is open Page 76. This will prevent a build up of pressure by thermal expansion that can cause mast upper section to lift off load latch beam, resulting in a mast incapable of carrying load.

Check traveling block to see that it is still centered with no load over the well center. Realign if necessary.

Check load and wind guy lines for proper tension.

Drain air tanks.

When the alcohol antifreeze unit is in use, change alcohol every 36 to 48 hours of operation to avoid air line freeze up problems. Use a commercial methyl alcohol.

Lubricate as required.

HIGH WIND CONDITION SECURING

The recommended procedure for securing the rig against high winds or storm is to retract the upper mast section into the lower section and then lower the mast to the roading position (resting on the front mast support).

If it is not possible to secure the rig in the roading position, the following steps should be taken:

Tie pipe in the racking board with strong line and tie rods in the rod board. Chain or tie rods against mast near ground.

If possible, tie the block to the well head and pull 20% of the derrick rating against the well for increased stability.

2.4.3.4 Safety

This section lists certain safety items not fitting clearly within this general outline.

Folding mast ladders must be pulled down and out to a fully extended position before climbing. Failure to do this may result in sudden ladder unfolding due to the weight of climber when using ladder which could result in climber falling.

Derrick man should not be in mast when pulling on stuck pipe or packer.

Use eight to ten turns on the main drum before the line reaches the load pickup point. This assures a good friction hold of the line on the drum and minimizes line pocket clamping hazards. National Oilwell Varco-modified line pocket clamps (Consisting of two modified clip bases and two 3/4" x 3" grade five bolts and nuts) should be torqued to a minimum of 150 foot-pounds (203 Nm). Line pocket clamps should be checked weekly or after any unusual shock load is encountered. Failure to properly install and maintain line pocket clamp may result in wire line pulling free of drum. If using double fast line operation, do not pull over 30,000 pounds (13,600kg) with 4-line string up or 40,000 pounds (18,150kg) with 6-line string up to avoid excessive loading on drawworks.

Proper double line tie off practice on the drum involves starting the second layer of line with the Ratigan socket in the pocket provided in the drum end or the line coming through a drum divider. The second layer should be started on top of the first layer allowing the first layer at least a two-wrap lead. The line should be cut to a length that allows at least six turns to be made on the second layer line before the line reaches the pickup point.

On drum type deadline anchors, three complete turns should be made around the drum before clamping or socketing to the horizontal retaining bar. Three clamps should be used. Clamps should be tightened to 150 foot-pounds (203 Nm). Only National Oilwell Varco-modified clamps should be used. If a Ratigan socket is used, a socket pocket is installed as an integral part of the deadline anchor. A 3/8" x 4" grade 8 bolt locks the socket in the pocket. Be sure to use the two 1/2" x 6" retainer bolts to prevent line from jumping the anchor in case a slack line situation develops.

CAUTION: The drum type deadline anchor is not designed to use with the deadline turned around the anchor and clamped back to itself. This causes bending of the anchor and line kinking. The anchor is not designed to operate without the two retainer bolts. Line whip such as may be encountered when a stuck packer pulls loose can throw the line from the drum if these retainer bolts are not used, damaging the anchor and creating a hazard.

Avoid parking vehicles or locating quarters or houses in the sectors represented by 2:00 o'clock to 4:00 o'clock and 8:00 o'clock to l0:00 o'clock on each side of the rig. These are the danger sectors in event of rig overturn.

Always start and stop hoisting operations gradually to avoid jarring rig and creating heavy shock loads.

CAUTION: Always test rig brakes before restarting operation, even after short shut down period.

CAUTION: Derrick must always be guyed in accordance with the guying diagram. Particular attention should be observed that derricks are guyed to prevent pullover toward the drawworks during the following typical operations: See page 74.
1. When swabbing a well.
2. When operation under a double fast line condition (especially with only four lines strung to the block).
3. When spooling new line on the sand drum.

Failure to follow these guidelines may result in the derrick being pulled back over onto the unit. When derrick is standing in the telescoped (half-mast) (Retracted) condition for reasons other than normal rig-up, good judgment should be used to determine the need for guying.

If the rig is equipped with a tong positioner, the safety cable should always be attached to the tongs while they are in operation. The other end of the cable must also always be clamped around the tong positioner post or mast leg. There should just be enough slack between the two cable end attachment points to allow the shackle to be connected to the tongs. Excess cable should be accommodated by loosening one set of clamps, sliding cable through, and reclamping.

CAUTION: Operator should never move traveling block or otherwise change load on the mast when anyone is in the crow's nest at the crown. Sudden movements of the fastline or sway in the crown may cause one to loose balance or get caught in the moving lines or sheaves.

3.5 Rig Down

3.5.1 Preparation

Prior to each rig down, grease rear mast support hinges and derrick raising ram pins, both at derrick end and at vehicle end. At each rig down or at a minimum of one rig down per week, grease pivot pins at racking board raising system.

Unbolt and remove rotary drive propeller shafts when applicable.

Secure traveling block to structure floor lift eyes, remove diagonals and lower structure to roading position. Remove all handrails and fold walkways.

Disconnect air lines and electrical connection between the upper and lower sections of derrick.

Loosen guys at guyline anchors. Pull all guylines clear from the derrick.

Telescoping ram stabilizer arms must be properly gloved around lower portion of telescoping ram at midpoint for stabilization.

3.5.2 Rig Down Operation

Telescoping Derrick

You must climb derrick and remove the locking pin between upper and lower sections before scoping upper section and lower section.

Close manual bypass valve at hydraulic valve group. See page 76.

Engage Tong pump at hydraulic valve group.

CAUTION: Retract both hydraulic catworks cylinder before lowering derrick.

CAUTION: Before any hydraulic pressure is applied to telescope derrick, operator must see that all extending ram stabilizers are fully extended so that the ram is supported vertically. Otherwise, a "buckling" of the ram may occur, dropping the derrick upper section.

Extend upper section approximately 5" (127mm), automatically retracting and locking in transfer latches. NOTE: Watch pressure gauge. If upper section is slow in raising or raises with above normal pressure, indications are air in the extending cylinder. In this event, it may require bleeding. If the upper section raises and retracts the load transfer latches, it is safe to telescope the mast and bleed when the upper section is fully retracted.

Move control valve to "RETRACT" position and telescope the upper section into the lower section. Pay close attention to the following items:

Keep all guylines clear of derrick.

Watch racking platform for proper manipulation.

Take in line on drilling drum as required to keep traveling block above the ground and well head.

Take in line on utility winch as required.

Return upper extend/retract to valve to center position when mast is fully retracted

After telescoping, open manual bypass valve at control valve group. See page 76.

Secure traveling block in block cradle. Position fast line, deadline and utility winch line in their respective turning shoes.

Disengage tong pump.

2.5.3 Lowering Derrick.

Preparation

Make sure block is secured in block cradle. Release drum brakes and put deadline, and fast line behind the tie back spool. Take slack out of the wireline and fix the drum brakes.

Move disc brake park brake valve to "Set" (pushed in) position.

Shut off air supply to operator's control console by turning the main or sanddrum selector switch to off and by placing transmission drop box control selector to "ROAD" position.

Remove tilt screw lock plates and derrick hold down turnbuckles.

Check support legs to see that they are in working position and tight in the base plates.

Check hydraulic rams for external leakage. Repair if necessary before lowering mast.

Oil level should be at middle gauge line before mast is laid down. Any attempt to fill above middle gauge line at this time may result in bursting reservoir if cap is on when rams are lowered with excess oil in system.

Bleed raising rams per procedure see page 75.

Close bleeder valve. See page 75.

Wipe off exposed chromed cylinder sleeve surfaces prior to lowering derrick to avoid pulling dirt into cylinder packing.

Engage tong pump at hydraulic valve group.

Check to determine that hydraulic pressure is available in "RAISE" direction by slight control valve manipulation.

Make sure that the guy lines are sufficiently slacked off before attempting to lower derrick.

CAUTION: Do not exceed 300-500 psi (22-35 kg/cm^2) in this check to avoid damage to structures.

Push in slowly on derrick "LOWER" lever. Build up pressure slowly and pull mast back over center slowly. When derrick breaks center toward the rig, stop. Ease handle on into "LOWER" position and let derrick come down gently. Do not exceed 500 psi (35 kg/cm^2) hydraulic pressure. See page 76.

NOTE: If any external leakage has been observed or if derrick has been standing for a long period of time or for any other suspicion of air in the system, bleed rams prior to this lowering sequence. See page 75.

NOTE: Always keep tong pump engaged when lowering the derrick so that the top side of the raising cylinder pistons can be replenished with hydraulic fluid as derrick lowers.

NOTE: Avoid abrupt control valve movement and control pressure by amount of valve manipulation.

Clear all guylines from derrick to keep them from hanging up. Guylines may be pulled into guyline hooks alongside derrick as derrick is lowering to expedite guyline storage later.

Caution: Watch hydraulic tilt ram cylinders to insure proper retraction sequence during lowering. Top small cylinders must retract first, lower large cylinder last, frozen moisture condensation within ram cylinder during low temperature operation can be one of several causes for improper retraction sequence of the cylinders.

WARNING if ram is allowed to retract improperly it will switch to proper sequence when incorrect stage bottoms and mast will free fall until ram makes up solid which could cause damage to equipment and/or bodily injury.

Keep traveling block in cradle by spooling in fast line as required.

Seat mast on front mast support

Disengage tong pump.

Attach front mast support tie down.

Wrap guylines on guyline hooks and stow loose items.

WITH TONG PUMP DISENGAGED, move hydraulic valve handle to both "RAISE" AND "LOWER" positions. This will relieve any pressures in the raising cylinders.

2.5.4 Care of Raising Mechanism

A. Replenish oil in hydraulic system using an oil recommended in the hydraulic fluid list on page 41-44.

B. Oil tank should be emptied and flushed out thoroughly with solvent every six months, about April and October. The oil filter cap strainer should be removed and cleaned carefully with a fiber brush in solvent to clean the pores of any sediment. Before adding fresh oil, rinse out the cleaner fluid with enough hydraulic oil to just cover the bottom of the tank properly allowing this to drain through the bottom of the tank. NOTE: DO NOT ALLOW HOIST ENGINE TO DRIVE PUMP while cleaning oil tank. The oil system is automatically kept clean by oil filter. Change this filter each 500 hours, or every 60 days.

C. If hydraulic ram is removed from carrier for repairs, FIRST DISCONNECT HOSES AT AUTOMATIC SELF-SEALING COUPLING provided to prevent fluid loss or entrance of dirt in system at these joints. With coupling disconnected, pump can be left running. If rams are to be emptied prior to removal, open bleeder plugs and push in the poppet in hose end of self-sealing coupling.

3.6 Routine inspections

3.6.1 Daily Inspection

A. Check all pins for noticeable wear.

B. Check all pin retainers to make sure that they are sufficiently secured.

It is recommended that periodic inspections and maintenance be established for each machine and that this schedule be carefully followed. Such a procedure will prevent minor defects from becoming progressively more dangerous as well as more costly to repair.

Due to the widely varying conditions under which identical machines may operate, it is impossible for the manufacturer to state exact time intervals at which all inspections and/or maintenance should be performed. All inspections, maintenance and lubrication intervals recommended in any National Oilwell Varco publication represent minimum safe operation intervals for average conditions, since there is no substitute for experience or first hand knowledge of local operating conditions.

Inspections are recommended for two basic purposes at several intervals. They are discussed in the following paragraphs.

To determine that the rig is safe for immediate use. This inspection should be made at the beginning of each tour and include, but not necessarily be limited to the following:

- Be sure that the rig is properly lubricated and that the fuel, lube oil, coolant, hydraulic oil reservoirs and brake water cooling reservoirs are filled to the proper level. When the alcohol antifreeze unit is in use, change alcohol every 36 to 48 hours of operation to avoid air line freeze up problems. Use a commercial methyl alcohol.

- Check rig brakes for proper adjustment and feel before picking up loads. Visually inspect all pins, linkage and control rods. Be sure all cotter keys are in place. Be sure brake system operates freely.

- Check functions of all controls and safety systems.

- Check all guylines for proper tightness.

- Check mast leg and hydraulic jack matting for proper bearing and position. Check ground for sponginess.

- Visually inspect for oil leaks. Tighten fittings as required.

- Visually check for hydraulic fluid leaks.

- Check string up and be sure all sheaves are rotating truly and line is running properly on drum.

- Check that manual bypass valve at hydraulic valve group is open. See page 76.

- With hydraulic pump not running, move mast control valve between "RAISE" and "LOWER" and between "EXTEND" and "RETRACT".

Lubricate as required.

After First Day of Operation on a new rig, check "V" belt tension, all bolts and nuts for tightness table under Weekly Inspection Schedule.

NOTE: Rigs are designed and manufactured with a generous margin of strength in excess of that required to do the job. However, every rig begins to wear on the day it begins to work. This process will continue until, at some future date, the rig is no longer capable of its original work load, UNLESS ALL PARTS SUBJECT TO FAILURE ARE REGULARLY INSPECTED AND REPAIRED OR REPLACED.

The following inspections are intended to determine the need for repair or replacement of parts required to keep the machine in approximately new condition.

NOTE: Under no circumstances should any person attempt any repair for which he is not fully qualified or which he does not thoroughly understand. National Oilwell Varco personnel should be contacted in case of any question.

3.6.2 Weekly

The weekly inspection schedule should include the items listed under daily interval. It should not be limited to the items detailed below, which are considered to be minimum required. Knowledge of local conditions, age and condition of the particular rig, the consequences of failure and the severity of operation will affect the degree of additional inspection required for safe operation under known operating conditions. Inspect the following:

- **Propeller Shaft Flanged Yokes:** (On drilling rigs due to continuous vibration, check every 24 hours). Be sure to use grade 8 bolts or better. All bolts to be full size to fit holes. Bolt length to be such that threaded portion of bolt comes only slightly inside nut and into load bearing area. This is to keep threads out of the torsional bearing area.

SERIES -- WHERE USED	BOLT SIZE	RECOMMENDED TQ
1810 Engine/Trans To PTO	7/16 (11mm)	75 ft-lb (10.4 kg-m)
1880 PTO to Drawworks Input Chain	5/8 (16mm)	225 ft-lb (31 kg-m)
1810 Engine/Transmission to Rear Axles	7/16 (11mm)	75 ft-lb (10.4 kg-m)
1810 Rear Axle Inter-Axle	7/16 (11mm)	75 ft-lb (10.4 kg-m)

- Check brake rotors for surface condition, pad wear and proper adjustment.
- Check all quick release valves for proper operation.
- Lubricate as required.

3.6.3 Monthly

The monthly inspection should include all items listed under the daily interval and weekly interval.

- Check all bolts and nuts for tightness.
- Check all "V" belts for proper tension.
- Visually inspect mast for cracks (and flaking or cracking which may indicate potential failure) bent or missing members. Take whatever corrective action is required. Refer to API RP4G.

- Visually inspect raising cylinder, cylinder supporting structures and cylinder pins. Check for cracking or paint flaking. Check for pin retention and proper pin lubrication. Check for pin retainers.

- Check chain drives for excessive sprocket wear or chain stretch. Check tightness of sprocket bolting to hubs.

- Check tires for cuts, bruises or uneven wear. Check for correct inflation pressures.

- Check air system for leakage and tightness required.

- Check front axle torque rod rubber bushings for tightness.

- Make a thorough inspection of all hydraulic hoses, fittings and tubing. Any deterioration of any system component should be questioned. Look for:

  a. Any evidence of oil leaks on the surfaces of flexible hose or at points at which hoses join the metal end couplings.

  b. Abnormal deformation of the outer covering of hydraulic hose, including any enlargement, local or otherwise.

  c. Leakage at connections which cannot be eliminated by normal tightening.

  d. Evidence of abrasive wear which could reduce the pressure retaining capabilities of hose or tubing affected. The cause of rubbing or abrasion must be immediately eliminated.

3.6.4 Every Six Months

- Remove and inspect all pins in raising systems, brake systems and other control linkages for wear. Pin looseness in retaining holes should be checked. Any pin surfaces where definite wear edges can be seen should be reason for pin replacement. Pin looseness in retaining holes of more than .020" - (.6-.76mm) should be grounds for refitting, repair and replacement. Check all pins for proper anti-rotation means if provided and for proper lubrication.

- Check brake block and rotor condition. Brake blocks should be inspected every six months or sooner if scoring shows up on the brake rotors. The blocks may have bits of metal picked up from the brake rotors that should be picked out.

- Under light load conditions, the brake rotors may become glazed resulting in lower coefficient of friction and loss of braking power. This condition can be corrected by applying fine pumice between the live end blocks and the rotors then lowering the load. This may have to be repeated several times to remove glaze.

CAUTION: Pin replacement should be made with National Oilwell Varco manufactured parts. This assures that proper pin material is used in high strength loading areas so that continued safe operation can be assured.

INSPECTIONS WHEN REQUIRED.

- This final type of inspection concerns individual incidents involving a specific rig. For instance, thorough visual inspection of guying, matting, mast structure, and wire line system should be made after any instance of severe shock loading, whipping or jerking of the mast due to any cause. Inspection should be made prior and following conditions of severe overload to be sure that the rig is in safe condition to accomplish this loading and that no damage results from same.

- Also, inspection should be made prior to roading, rig up and rig down.

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3.7 Main Drum Disc Brake: Refer to D 132 455 14 and 15 Brake Caliper

1. **General Description of Disc Brake Calipers:**
   The brake system consists of hydraulically actuated calipers and two brake rotors integrally mounted to the drum spool. Each caliper has a service cylinder for hydraulically applying the brake during normal braking operation. Also the caliper contains a spring applied hydraulically released cylinder used as a park brake for holding empty blocks and in extreme cases as an emergency brake. Hydraulic back pressure in the service cylinder tends to apply the brake. This tendency of brake drag is eliminated by the hydraulic return cylinder provided on the caliper. To compensate for pad wear the calipers include a slack adjusting feature, providing consistent brake application in both normal service cylinder application and in park brake applications.

   The friction material or pads, consists of non-asbestos brake material bonded to a steel channel. The pads slide over the brake heads and are retained by bolted on steel bar.

2. **Servicing of Brake Calipers: Refers to "Brake Pad Replacement and Snap Ring Resetting".**

Warning: Before servicing brake caliper components, always set pipe or tubing in the slips and tie off the block. Failure to do so may cause the block to fall, causing injury to personnel and damage to equipment.

Pad Replacement:

STEP 1:

The pads should be replaced when worn to a thickness of 1/4" (0.635 cm). To replace the pads, set hookload in slips and tie off block. With hydraulic power supply running, hold the lever on the brake valve (brake lever) down to read 2000 psi (137,9 bar) and place the brake set valve handle in the "release" position. Turn a single retaining nut onto the spring brake stem, hand tighten against the spring brake cylinder end. **Work on only one caliper at a time for added safety.** Shut off the engine. Note: The spring brakes on the calipers not being serviced will set. Use a punch and hammer to loosen the locking nut on the service cylinder. Turn this nut out as far as possible. The nut should be against the shoulder of the adjusting rod.

WARNING: The hydraulic power for the disc brake must not be started while servicing any portion of the service cylinder. The service cylinder is a single acting hydraulic ram with no provision for retaining its piston when not acting against the spring brake cylinder and the tong arms. Hydraulic pressure will cause the piston of the service cylinder to shoot out when not retained as mentioned above.

STEP 2:

Screw the adjusting rod into the service cylinder end until the locking nut is against the cylinder end.

Manually spread the tong arms apart so that the adjusting rod of the service cylinder is free of the socket in the end of the spring brake cylinder rod.

STEP 3:

Swing service cylinder out from between the tong arms as shown in the diagram page.

Remove wire from heads of top bolts in retainer plates holding pads to the brake heads. Remove top bolts and retainer plates. Pull pads off of brake heads and discard. Install new pads in reverse order, replacing retainer bolts, part no. HTC-10, and wire with new ones. Torque retaining bolts to not more than 10 ft-lbf (13,6 N-m).

STEP 4: Resetting Snap Rings

How the Slack Adjuster Works: See Figure 1. As the pads wear, the snap rings are held in place on the service cylinder tube by the spiral retaining ring and spacers. The cylinder end with adjusting rod and the cage tube with snap rings are pushed out by the cylinder piston when hydraulic pressure is applied. When the pads wear the width of one snap ring, the step between the smaller bore and the larger bore of the cage tube passes a snap ring, allowing the snap ring to spring out into the larger bore. The repositioning of the snap ring into the larger bore, effectively increases the collapsed length of the service cylinder, thus compensating for pad wear.

Remove the bolts holding the cylinder end to the cage tube. Pull the cylinder end with the adjusting rod and locking nut out of the cylinder assembly. The bronze sleeve may come out also. If the piston also comes out, the piston seals need to be replaced with new seals. The cylinder will only come out if the seals are leaking badly.

Remove the spiral retaining ring using a thin bladed screw driver, peeling it out of the groove on the cylinder tube. Pull the cage tube off the cylinder bring with it the two 3/16" spacers (0,48 cm) and shim pack with it. Care should be taken not to lose or damage the spacers and shim pack.

Liberally coat all inside surfaces of the cage tube with Lithium based grade NLGI No. 1 or better. To reset the snap rings, remove the first snap ring from the larger bore of the cage tube and install it into the smaller (opposite end) bore of the cage tube. Make sure that this first snap ring is securely seated flat against the snap rings still in the larger bore. This is done to insure the front face of the reset snap rings is flush with the step between the larger and smaller bores of the cage tube. Continue to remove snap rings from the larger bore and reinstall them into the smaller bore, making sure that the snap rings are seated flat against the previously installed snap ring. Also, it is very important to alternate the gaps in the snap rings when installing in such a way as to prevent the gaps from being coincidental between consecutive snap rings. Snap rings pliers are provided with the unit as part of the 109 610 00 Caliper Tool Kit.

Install the cage tube, with its reset snap rings, onto the cylinder assembly, aligning the alignment slot of the cage tube with the alignment head on the cylinder assembly.

Slide one of the 3/16" (0,48 cm) spacers onto the cylinder and inside the cage tube. Next slide all the shims on the cylinder tube and then the second 3/16" spacer. Seat the spiral retaining ring back into its groove on the cylinder tube.

Install the cylinder end with adjusting rod and locking nut to the cage tube, keeping the holes in the cylinder end aligned with the tapped holes in the cage tube. Bolt the cylinder tube to the cage tube; torque bolts to 20 ft-lbf (27,1 N-m)

STEP 5:

To return the service cylinder between the tong arms, rotate service cylinder back between the tong arms. Align adjusting rod on service cylinder with socket in spring brake cylinder rod.

STEP 6:

Turn adjusting rod out until there is no gap between the rotor and the pads. Turn the adjusting back in 1/8 of a turn. Tighten locking nut against the service cylinder end using hammer and punch.

Grease all lubrications points on calipers with Lithium based grade NLGI No. 1 or better.

STEP 7:

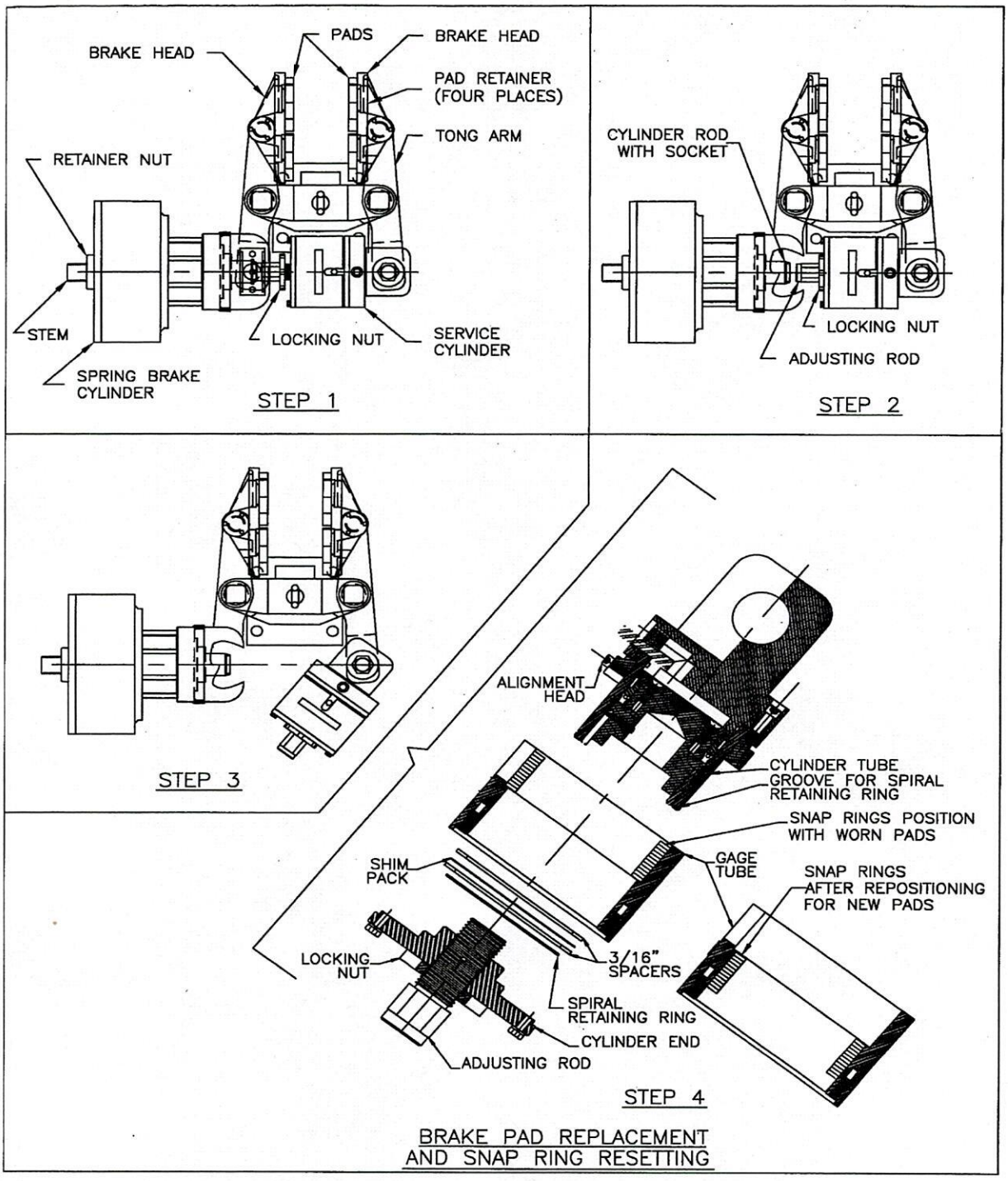
Start Rig, place the lever on the brake set control valve in the release position and apply 2000 psi (137,9 bar) with brake lever. Remove the retaining nut from stem.

With the park brake valve in the release position raise brake lever completely and check to gap between rotor and pads. Repeat step 6 until a gap of 1/16" (0,159 cm) is present between each pad and the rotor.

Repeat steps 1 through 7 for each of the remaining calipers.

Disc Brake Rotor Wear
The rotor is 5.50" wide when new. If it wears down to 5.25" across the width it should be scheduled for replacement.

FIGURE 1



BRAKE PAD REPLACEMENT AND SNAP RING RESETTING

3.8 Lubrication schedule

ENGINE LUBRICATION AND FILTERS – DETROIT DIESEL SERIES 60:

LUBRICATION	RECOMMENDED OIL	CAPACITY	CHECK PERIOD	CHANGE PERIOD
Engine Oil	15W-40	38 Qts. (36 liter) (Check after running 2 Min.)	Each Tour	250 Hours

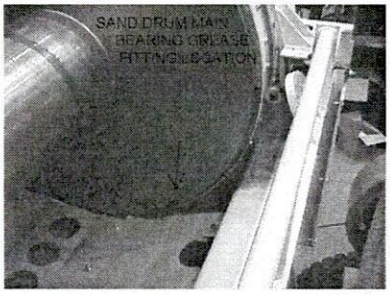
FILTERS	ELEMENT - NUMBER AND MAKE	CHANGE PERIOD
Engine Oil	23527033 (Detroit Diesel)	At Oil Change (250 Hours)
Water	23507189 (Detroit Diesel)	Replace with 23507545 after 250 Hours
Water	23507545 (Detroit Diesel)	Every 250 Hours
FUEL FILTER	**ELEMENT - NUMBER AND MAKE**	**CHANGE PERIOD**
Primary	23518481 (Detroit Diesel)	Wash in Solvent or Fuel every 250 Hours
Secondary	23518482 (Detroit Diesel)	Every 250 hours
Air Cleaner	XLP-18-2008 (Donaldson)	Clean every 250 Hours Change once a year (See Engine Service Manual)

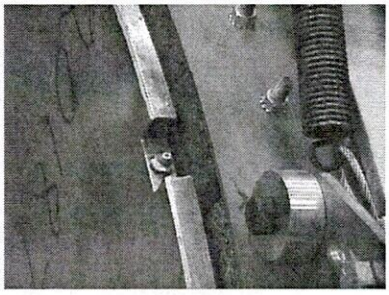
NOTE: Lubrication capacities are approximate and the correct level should be checked by dipstick, gauge, plug or other means provided.

COMPONENT	RECOMMENDED LUBRICANT	CAPACITY	CHECK PERIOD	RECOMMENDED CHANGE PERIOD
Right Angle Gear Box	90 Wt. EP Gear Oil	10 Gal (37.9 liter)	1 Week	6 Months
Drum Drive Chain Case	30 Wt. SAE Motor Oil	12 Gal. (45.4 liter)	1 Week	1 Year
Sand Drum Chain Case	30 Wt. SAE Motor Oil	5 Gal. (19 liter)	1 Week	1 Year
Extending Cylinder Stabilizer Bearings	Lithium Base All Purpose Grease	2 Shots	1 Week	
Hydraulic Reservoir	Hydraulic Oil	220 Gal. (833 liter)	1 Week	1 Year
Air Line Anti-freezer	Methyl Alcohol	1 Quart (1 liter)	Daily	Caution: Before adding alcohol to air line anti-freezer, supply air must be shut off; otherwise air tanks will blow out thru anti-freezer.
Drawworks Grease Manifolds	Lithium Base All Purpose Grease	2 Shots Each Fitting/ On Caliper Brakes, Grease as Noted on Nameplate	Daily/ Caliper Disc Brake follow nameplate instruction	
Hydraulic Pump and Pump Drive Clutch Spider	Lithium Base All Purpose Grease	2 Shots	Daily	
Throttle Actuators	Lithium Base All Purpose Grease	1 Shots Each Fitting	1 Week	
Propeller Shafts and Counter Shafts	Lithium Base All Purpose Grease	2 Shots Each Fitting	1 Week	
Rotary Air Unions	30 Wt. S.A.E. Motor Oil	4 Drops	1 Month	
Raising Cylinder End Pins	Lithium Base All Purpose Grease	2 Shots Each Fitting	1 Month & at Ea. Rig-up & Rig Down	

COMPONENT	RECOMMENDED LUBRICANT	CAPACITY	CHECK PERIOD	RECOMMENDED CHANGE PERIOD
Hinge Point	Lithium Base All Purpose Grease	3 Shots Each Fitting	1 Month	
Crown Block	Lithium Base All Purpose Grease	2 Shots Ea. Fitting	Daily	
Traveling Block	Lithium Base All Purpose Grease	2 Shots Ea. Fitting	Daily	
Racking Board and Rod Board	Lithium Base All Purpose Grease	2 Shots Ea. Fitting	1 Month	
Jackscrew Nuts	Lithium Base All Purpose Grease	3 Shots Ea. Fitting	1 Month	
Extending Cylinder	Clean Off & Coat With Hydraulic Oil		1 Month	
Mast Slides	Lithium Base All Purpose Grease	Swab or Brush On	As Required	
Rear Axle Gear Box	Consult Manufacturers Maintenance Manual	Consult Manufacturers Maintenance Manual		1 Year
All Wheel Bearing	Wheel Bearing Grease			1 Year
Rear Suspension	Lithium Base All Purpose Grease	Show of New Grease	1 Week if Roading	None
Front Steering	Lithium Base All Purpose Grease	Show of New Grease	1 Week If Roading	None
Manual Steering Gear Box	SAW 90 EP Gear Lubricant		6 Months	3 Years
Power Steering	See Hydraulic Reservoir		1 Week	6 Months
Hyd. Utility Winch	SAE 90 EP Gear Lubricant	5 Pints (2.4 liter)	2 Months (See Braden Service Manual)	2 Months First Change 6 Months Thereafter

Sand Drum Main Bearings	Lithium Base All Purpose Grease	2 shots each fitting 1 fitting each side (see photo for location)	Daily	





Hydraulic, Air and Water Filters and Strainers

Filter	Element	Number and Make	Change Period
Hydraulic Filter	911836 K-10	KF3-1K10-PD Schroeder	60 Days
Hydraulic Reservoir Breather Cap			Wash Every 1000 Hours
Air Filters			Clean as Required
Air Dryer	AD2 Cartridge	287313 Bendix-Westinghouse kit	1-3 Year
Power Steering	573082	OFRS 25PO10 Vickers	60 Days

We furnish Chevron AW MV ISO 32 hydraulic oil or its equivalent in our hydraulic tank unless we are advised that the rig will operate in extreme cold weather conditions such as the Alaska or Siberia then we furnish the rig with Mobil Multi purpose ATF fluid.

FILTERS	ELEMENTS	NUMBER AND MAKE	CHANGE PERIOD
Hydraulic Filter	911836 KZ-10	KF3-1K10-PD Schroeder	60 Days
Hydraulic Reservoir Breather Cap			Wash Every 1000 Hours
Air Filters	4438-03	F73G-2AN-AD3	Clean as Required
Air Dryer	AD2 Cartridge	287313 Bendix-Westinghouse kit	1-3Year
Power Steering	573082	OFRS 25PO10 Vickers	60 Days
Disc Brake Pressure Filter	PHV2BVN	Vickers HF3P1SB4LNB2C10	Replace by Indicator
Air Lubricator	4380-030 Repair Kit	L73M-2AP-QDN Norgren	Clean as Required

4 OIL RECOMMENDATIONS

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life.

The following recommendations will assist in the selection of suitable oils for use with Vickers products. Vickers does not publish a recommended oil list by brand name or supplier due to the extremely wide variety of oil types on the market.

In most cases, use of these recommendations will lead to selection of a suitable oil. However, due to the complex nature of oil formulation, the variety of oils available and peculiarities of individual hydraulic applications, there will be rare instances where oil selected on the basis of these recommendations will yield unsatisfactory results. Vickers cannot be responsible for such exceptions. In this respect, the customer is encouraged to consults his Vickers representative when selecting an oil.

4.1 Important Factors in Selecting an Oil

Additives
Hydraulic fluids contain a number of additive agents which materially improve various characteristics of oil for hydraulic systems. These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point.

Viscosity
Viscosity is the measure of fluidity. The oil selected must have proper viscosity to maintain an adequate lubricating film at system operating temperature.

In addition to dynamic lubricating properties, oil must have sufficient body to provide an adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause pump cavitation or sluggish valve action. Optimum operating viscosity of the oil should be between 16 cSt (80 SUS) and 40 cSt (180 SUS).

"Viscosity index" reflects the way viscosity changes with temperature; the smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less then 90. Multiple viscosity oils, such as SAE 10W30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both a temporary and permanent decrease in viscosity due to oil shear encountered in the operating hydraulic system. The actual viscosity can, therefore, be far less in the operating hydraulic system than what is shown in normal oil data. Accordingly, when such oils are selected, it is necessary to use those with high shear stability to ensure that viscosity remains within recommended limits while in service.

Chemical Stability
Oxidative and thermal stability are essential characteristics of oils for Mobile hydraulic systems. The combination of base stacks and additives should be stable during the expected lifetime of the oil when exposed to the environment of these systems.

4.2 Suitable Types of Oil

Crankcase Oil

Crankcase oil having letter designation SC, SD, SE or SF per SAE J183 FEB80. Note that one oil may meet one or more of these designations.

Antiwear Hydraulic Oil

These are produced by all major oil suppliers and should consist of good quality base stocks compounded with antiwear, antioxidation, and antirust additives.

Due to the large number of different antiwear hydraulic oils, it is impossible for Vickers to test its products with all of them and recommend those that are suitable. Because of this, an evaluation procedure was developed for fluid suppliers to establish the suitability of their products for use in Vickers components. Publication M-2952-S, "Pump Test Procedure for Evaluation of Antiwear Hydraulic Fluids for Mobile Systems," which gives the details of this test procedure, is available on request.

Certain Other Types Of Petroleum Oil

Other oils are suitable if they meet the following provisions:

1. Contain the type and content of antiwear additives found in the above designated crankcase oils, and have passed the pump tests as given in M-2952-S.

2. Have sufficient chemical stability for Mobile Hydraulic system service.

3. Meet the viscosity recommendations shown in the following tables.

Oil Viscosity Recommendations

Crankcase Oils-

Hydraulic System Operating Temp. Range*	SAE Viscosity Designation
-23°C to 54°C (-10°F to 130°F)	5W, 5W-20, 5W-30
-18°C to 83°C (0°F to 180°F)	10W
-18°C to 99°C (0°F to 210°F)	10W-30, 10W-40
-10°C to 99°C (50°F to 210°F)	20-20W

Antiwear Hydraulic Oils-

Hydraulic System Operating Temp. Range*	SAE Viscosity Designation
-21°C to 60°C (-5°F to 140°F)	22
-15°C to 77°C (5°F to 170°F)	32
-9°C to 88°C (15°F to 190°F)	46
-1°C to 99°C (30°F to 210°F)	68

*Temperatures shown are cold (ambient) start-up to maximum operating. During cold start-up, avoid high-speed operation of hydraulic components until the system is warmed up to provide adequate lubrication.