Maintenance Guide

HMIS Top Drive System

250TON HMIS 475HP

Tesco Corporation ("TESCO") has made every effort to ensure that this document contains accurate and current information for the TESCO top drive, however, **the document is intended to be used in conjunction with a complete training program and on-site supervision** and TESCO does not warrant or guarantee that the information contained herein is either complete or accurate in every respect, and the reader hereby protects, indemnifies and holds harmless Tesco Corporation together with its directors, officers, employees and agents from and against all liability for personal injury, death or property damage to any person arising directly or indirectly from the use by the reader of the information contained in the document.

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Revision Information

Version	Date	Description of Changes
Rev A	June 2004	HMI model; general engineering review with updates and additions for 2004.
Rev B	March 2005	All models; updated the Service Checklist Appendix to reflect information in the Maintenance and Service Schedules chapter; updated the Mudsaver Valve and Actuator Inspection chapter.
Rev C	June 2005	All models; added information about how to adjust the preload when the top drive is installed in the derrick. HMI model; added information on how to perform three separate preload checks for the HMI top drive units; separated non-destructive testing images from text to conform with Tesco technical documentation standards.
Rev D	May 2006	HMI model; updated non-destructive testing and inspection schedules as per ICD HLR-020.
Rev 4	February 2007	Added note about checking gauges and fluid levels to Maintenance and Service Schedules chapter as per ECN-133-0001. Updated version numbering from alphabetic to numeric.
Rev 5	March 2007	Updated Non-Destructive Testing and Inspection Schedules chapter as per ECN-122-0017.
Rev 6	June 2007	Updated Non-Destructive Testing and Inspection Shedules chapter as per ECN-122-0025 (added sentence about accordance with API 8C/ISO 13535.
Rev 7	October 2007	Added caution symbols to all Warning, Caution, and Danger notes. Added more safety warnings.
Rev 8	November 2007	New revision to remove CE-ATEX standards from manual.

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CHAPTER 1: ABOUT THIS DOCUMENT

This document contains information on how to service and maintain your HMIS Top Drive System.

Table 1-1: Where to find more information

For information on	Refer to
system components	System Description
• installing the top drive • rig up procedure • commissioning • pre-operational checklists • rig out procedure	Installation Guide
• setting torque and speed • driller's panel function and operating descriptions • making connections • drilling ahead • tripping • stuck pipe	Operations Guide
TESCO manufactured parts and part numbers	Parts List
• electrical schematics • hydraulic schematics • cooling schematics • gearbox lubrication schematics	System schematics
available options and spares	TESCO Representative

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CHAPTER 2: MAINTENANCE AND SERVICE SCHEDULES

Note: To ensure the equipment operates properly and to prevent downtime, check the pressure and temperature gauges, all fluid levels, and flow meters daily.

TOP DRIVE SERVICE REQUIREMENTS

Daily Top Drive Service Requirements

Inspection

Perform the following visual inspection *at least once every operating day*. More frequent inspections might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Gearbox oil level	correct gearbox oil level (halfway up sight glass)
Hydraulic hoses and connections at the top drive	leaks
Grabber dies	excessive wear
Mudsaver valve (lower ball)	manually operate the valve to check function
Saver sub threads	excessive wear
Swivel oil level (see Figure 2-1 on page 4)	correct level
Grabber	check and reset grabber height; see “How to Reset the Grabber Height” on page 37.

Figure 2-1: HMI swivel oil level

Lubrication

The following lubrication should be performed *at least once every operating day*. More frequent lubrication might be required if you are operating the top drive in harsh or demanding drilling environments.

Lubricate	With	# Shots
Grease nipples on the EXTEND cylinder (4)	EP2 multi-purpose grease	2 each
Lower bearing retainer of gearbox grease ports (2)	EP2 multi-purpose grease	2 each
Upper bearing retainer of gearbox grease ports (2)	EP2 multi-purpose grease	2 each
LINK TILT cylinders (4 per side - 8 total)	EP2 multi-purpose grease	2 each
Grease ports on the elevator (3)	EP2 multi-purpose grease	3 each
Mudsaver valve actuator (3)	Mystik J76 - TESCO Part #4409, or, Metalon EP1.5 -TESCO Part #2996	Fill grease reservoir

Swivel Lubrication Requirements

The following lubrication should be performed *at least once every operating day* if the top drive is equipped with the optional swivel. More frequent lubrication might be required if you are operating the top drive in harsh or demanding drilling environments.

Lubricate	With
Ports on the swivel link hinge points (2)	EP2 multi-purpose grease
Wash pipe port (1)	EP2 multi-purpose grease
Swivel yoke hinge pins (2)	EP2 multi-purpose grease
Upper bearing retainer (1)	EP2 multi-purpose grease
Lower bearing retainer (2)	EP2 multi-purpose grease

Weekly Top Drive Service

The following visual checks should be performed *at least once every operating week*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All fasteners (nuts, bolts and lock wires)	correct location, tightness
Connection locking clamps	correct location, tightness
Counter-balance system	correct installation and function
Load collar	adequate load ride height on the spring; load ride height should be 3/8 to 1/2 in.; if it is not, contact TESCO's Maintenance and Service Group
Safety chain on the grabber leg	broken components, loose wires

Swivel Inspection Requirements

The following inspection should be performed *at least once every operating week* if the top drive is equipped with the optional swivel. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Hammer unions	damage/decay and tightness

Monthly (Periodic) Top Drive Service

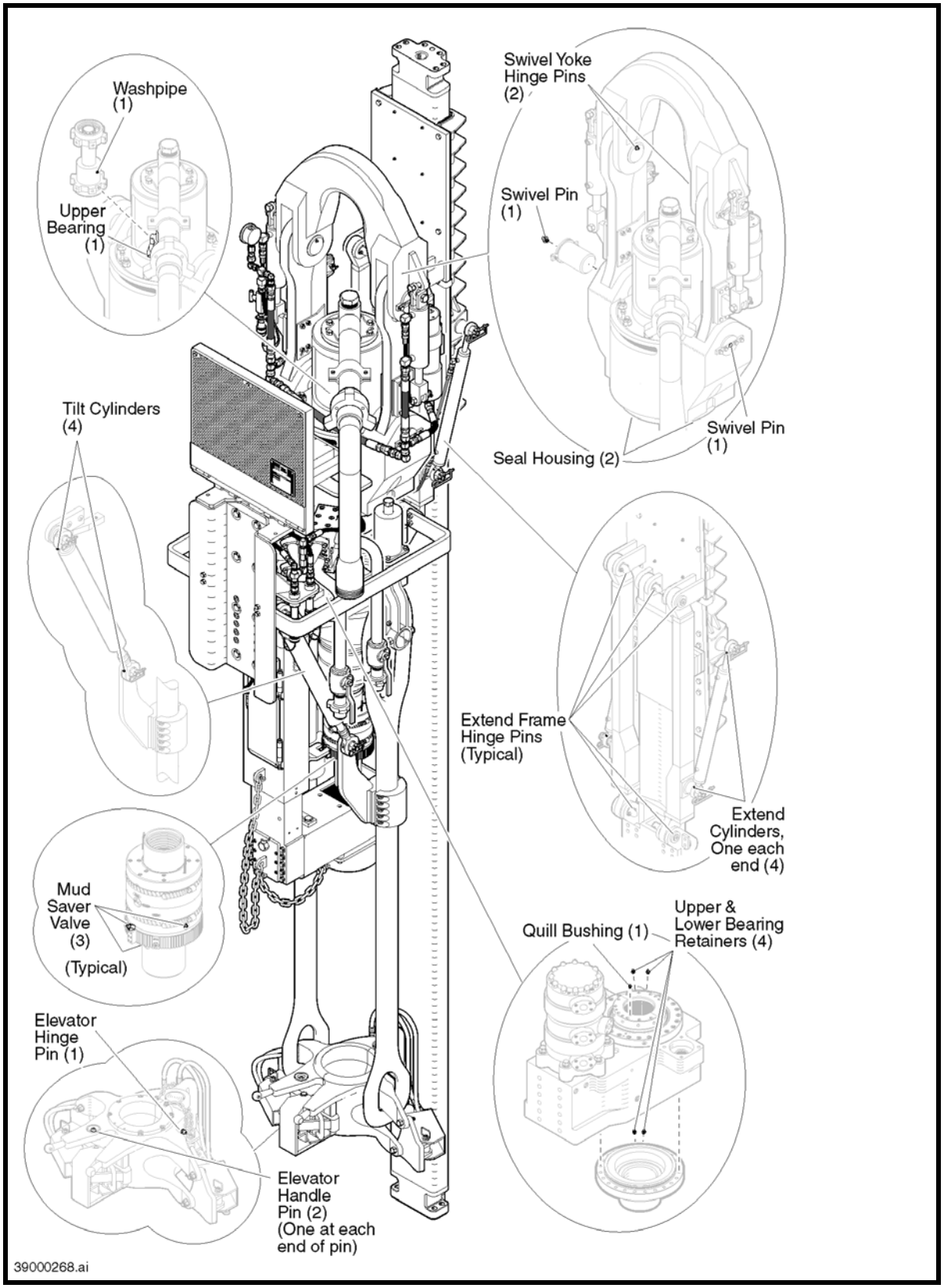
The following visual checks should be performed *at least once every operating month* or as indicated in the following table. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Gearbox oil	abnormalities (take samples to test for water, metal particles, etc.; every 900 operating hours)
Hydraulic fittings	tightness
Roto-actuator sleeve	general condition; disassemble, clean, grease, coat with corrosion inhibitor and reinstall (see “How to Disassemble and Service the Roto-Actuator” on page 33)
Counter-balance system	correct cushion height (see “How to Set the Counter-Balance Cushion Height” on page 35)
Sensor panel	moisture; tightness of wire terminations
Quill hub preload	correct preload (see “How to Check and Adjust Preload” on page 40)

The following lubrication should be performed *at least once every operating month*. More frequent lubrication might be required if you are operating the top drive in harsh or demanding drilling environments.

Lubricate	With
Hinge pins and extend frame (if applicable)	spray with penetrating oil (WD 40, or spray lithium)

Figure 2-2: Lubrication points for the Top Drive



SERVICE LOOP SERVICE REQUIREMENTS

Weekly Service Loop Service Requirements

The following visual checks should be performed *at least once every operating week*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All service loop components	damage, excessive wear
Urethane capture blocks (at top drive and roller saddle)	hose placement, tightness
Fluid quick couplers (auxiliary hydraulics)	damage or decay, tightness

Monthly (Periodic) Service Loop Service Requirements

The following visual checks should be performed *at least once every operating month*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Wire terminals in the driller's panel	tightness
All hoses	leaks, damage
Threads, isolation valves	damage, loose parts

TORQUE ARREST SYSTEM SERVICE REQUIREMENTS

Daily Torque Arrest System Service Requirements

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All connections	damage or decay
All overhead equipment (T-bar, torque beam, torque track, torque bushing)	damage or decay

Weekly Torque Arrest System Service Requirements

The following visual checks should be performed *at least once every operating week.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All bolts and threaded rods	damage or decay, tightness
Torque track hanging assembly	damage; close visual inspection is required
Torque bushing liner or torque arrest beam liners	wear (the bushing liner must be replaced before the liner mounting bolts come in contact with the torque tube)
Torque bushing clearance	amount of clearance (it might be necessary to remove a torque bushing shim if there is more than 1/4 in. clearance between the torque bushing and the torque tube, or if there is excessive torque bushing movement)
Torque track stabilization components	cracks or loose fasteners; close visual inspection is required

POWER UNIT: PRIME MOVER SERVICE REQUIREMENTS

Daily Prime Mover Service

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All hose connections and belts	leaks, tightness
Exhaust system	routing, loose clamps and bolts; check visually
Oil level	low idle oil level; check for leaks
Coolant level	correct level
Oil pressure	correct operating range; consult the manufacturer's service and maintenance documentation for your prime mover module
Operating fuel pressure	adequate pressure; consult the manufacturer's service and maintenance documentation for your prime mover module
Air filter restriction indicator	consult the manufacturer's service and maintenance documentation for your prime mover module
Rig saver	confirm correct position (open)

Weekly Prime Mover Service

The following visual checks should be performed *at least once every operating week*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Battery (if applicable)	correct electrolyte level; evidence of corrosion
Water pump/seal drain	evidence of leaks
Weep hole plugs	correct placement, evidence of leaks
Fan hub	correct lubrication; see the appropriate Engineering Memo document for lubrication specifications
Universal joint on the drive shaft	correct lubrication; grease if required (do not over-lubricate or this can damage the seals)

Monthly (Periodic) Prime Mover Service

The following visual checks or procedures should be performed *at least every operating month, or according to the schedule below.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Electrical control panels	dirt, moisture; replace desiccant packs
Radiator cap	damage or corrosion
Drive belts	correct tension, cracks and erosion
Air starter filter	cleanliness, clean as required
Crankcase oil and filter (use recommended OEM filters; refer to the prime mover manual for frequency)	cleanliness; these filters should be changed every 300 operating hours (refer to the equipment service manual for the correct oil) a complete oil analysis should be conducted every third oil change (900 operating hours) Note: It is best to change the oil immediately after equipment operation, when the current oil is warm.
Radiator and heat exchanger	cleanliness; inspect and clean every 300 operating hours **Caution**: Never use high pressure spray to clean the radiator. Pressure can bend and damage the cooling fins. Never spray a hot radiator with cold water. Always stop the engine before cleaning the radiator.
Hydraulic fittings	tightness

Inspect	For
Fuel filters (primary and secondary; use recommended OEM filters)	cleanliness; inspect periodically, replace according to manufacturer's specifications. Note: More frequent replacement might be required where the fuel supply quality is poor.
Exhaust system	carbon build-up; also, use rig up or operational downtime to inspect bolts and flanges
Centrifugal oil filter (if equipped)	cleanliness; service every 900 operating hours, or according to manufacturer's specifications.
Cooling system filter	cleanliness; replace every 900 operating hours
Coolant	perform a coolant analysis every 900 operating hours, replace as required

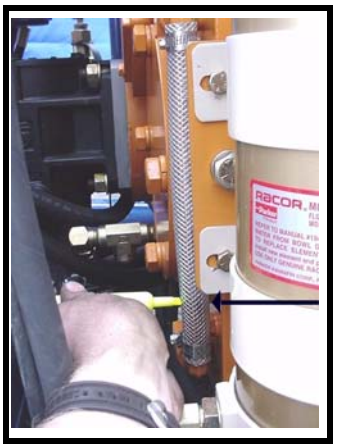
POWER UNIT: PUMP DRIVE SERVICE REQUIREMENTS

Daily Pump Drive Service

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Oil level	adequate oil level; fill if required
Oil system	leaks
Cooling system	excessive dirt, general condition; check the heat exchanger
Pump drive lubrication system	correct lubrication of the pump splines (check at the oil filler cap)
Hydraulic hoses and connections	leaks, tightness

Figure 2-3: D2P oil level–engine not running



Weekly Pump Drive Service

The following visual checks should be performed *at least once every operating week*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Breather filter cap	cleanliness
Mating bolts (mounting to prime mover)	tightness

Monthly (Periodic) Pump Drive Service

The following visual checks should be performed *at least once every operating month*. More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Pump shaft splines and adapters	wear, correct lubrication • refer to TESCO's fluid specifications for hydraulic units (EM000039, EM000041, EM000042)
Pump drive oil	cleanliness; change as required • do not over-fill; excess oil causes heat build-up • refer to TESCO's fluid specifications for hydraulic units (EM000039, EM000041, EM000042) • it is best to change the oil immediately after equipment operation, when the oil is warm
Hydraulic fittings	tightness

POWER UNIT: FILTER MANIFOLD SERVICE REQUIREMENTS

Daily Filter Manifold Service

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Filter housing and manifold	leaks
Charge pressure differential (one gauge on the inlet and one gauge on the outlet of the charge pressure manifold)	correct differential pressure • maximum differential is 100 psi; if differential is greater than 100 psi, replace the filter elements • use the manufacturer's recommended filter element
Hydraulic hoses and connections	leaks, tightness

Monthly (Periodic) Filter Manifold Service

The following visual checks should be performed *at least once every operating month.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Oil filters (closed loop)	cleanliness • oil filters should be replaced as indicated by oil analysis, or every 4,000 operating hours • use the manufacturer's recommended filter
Oil filters (tank)	cleanliness • oil filters should be replaced every 900 operating hours or as indicated by the canister dirt alarms • use the manufacturer's recommended filter
Hydraulic fittings	tightness

POWER UNIT: OIL RESERVOIR SERVICE REQUIREMENTS

Daily Oil Reservoir Service

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Reservoir and area	leaks
Return oil tank filters	dirt; inspect the dirt alarm and replace the filter if required
Low oil level shutoff equipment	correct connection; inspect visually
Tank oil (see Figure 2-4)	correct operating level
Hydraulic hoses and connections	leaks, tightness

Figure 2-4: Oil tank level

Monthly (Periodic) Oil Reservoir Service

The following visual checks should be performed *at least once every operating month.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Return oil tank filter	correct connections; inspect visually
Filter canister	correct bolt; correct torque
Tank (all sides, including underneath)	leaks
Hydraulic fittings	tightness

Annual Oil Reservoir Service

Replace the tank screen filters *at least once every operating year.*

POWER UNIT: COOLING SYSTEM SERVICE REQUIREMENTS

Daily Cooling System Service

The following visual checks should be performed *at least once every operating day.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
Air/oil cooler	• leaks • correct fan operation Note: Set the fan switch to manual before you check operation. • fan cleanliness • correct hot oil shuttle flow Note: if the unit is operating, check the flow meter on the opposite side of the electrical panel.
Water/oil cooler (if installed)	leaks or damage; check visually
All sides, including under	leaks; complete visual inspection
Cooler core	debris, blockages
Hydraulic hoses and connections	leaks, tightness

Monthly (Periodic) Cooling System Service

The following visual checks should be performed *at least once every operating month.* More frequent inspection might be required if you are operating the top drive in harsh or demanding drilling environments.

Inspect	For
All mounting bolts and fittings	tightness

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CHAPTER 3: NON-DESTRUCTIVE TESTING AND INSPECTION SCHEDULES

TOP DRIVE OWNER'S GUIDELINES

The integrity, performance, and safe operation of TESCO's top drives depend on sound maintenance and inspection of all load path, torque arrest system, and critical components. This chapter describes TESCO's **minimum** recommended inspection schedule, including the following:

- recommended reporting format for third party inspections
- recommended minimum inspection frequency for each load path, torque arrest system or critical component
- specific areas of concern for each component

Caution: In addition to the schedule suggested here, all load path, torque arrest system, and critical components must be inspected following rough drilling, excessive jarring, or any other exceptional circumstance that might increase fatigue failure.

When you receive inspection reports, file them in accordance with procedures in your operating area.

It is critical that you maintain complete inspection and service records for all load path, torque arrest system, and other critical components.

Caution: This guide addresses MPI and WFMPI testing only. This information must be used in conjunction with a regular inspection and maintenance program as defined in "Chapter 2: Maintenance and Service Schedules".

TESCO will not assume responsibility or liability for any component, product or material that has been repaired, rebuilt, welded, or heat treated outside of TESCO facilities.

GUIDELINES FOR COMPONENT INSPECTORS

Only qualified personnel can inspect load path, torque arrest system, and critical components. Inspectors must use only fully operational, regularly maintained testing equipment. To ensure accurate test results, each component must be thoroughly cleaned before inspection. In some cases removal of paint is required.

Visual and magnetic particle inspection shall be conducted in accordance with API 8C/ISO 13535.

If you are inspecting a TESCO load path, torque arrest system, or critical component, you must provide the top drive owner with the following information.

General information for each component tested:

- type of test or inspection performed (MPI, WFMPI, etc.)
- type of equipment used to perform the testing
- operating conditions
- name and type of inspecting company
- name and signature of the inspector
- date of inspection

Inspection results for each component tested:

- part description (name, size, etc.)
- serial number of the inspected part
- exact location of all points of damage (measured from a recognizable point of reference) including the following:
  - cracks
  - excessive wear
  - deformation
  - corrosion
  - erosion
- all dimensions for all cracks (length, depth, width)
- a photograph or illustration indicating all cracks or damage points
- confirmation that all indicated inspection areas have been checked

LOAD PATH COMPONENTS AND INSPECTION INFORMATION

This chapter contains illustrations of all components in the top drive load path. Each illustration indicates the inspection points for the specific component. It also describes any special considerations that must be addressed when inspecting the component.

It is critical that all components of the load path be subjected to periodic magnetic particle inspection (MPI) by a qualified inspector. Each piece should be inspected for surface defects according to the schedules that follow.

> **Note:** Any part of an operating day should be considered one day. Removal of paint might be required for inspection.

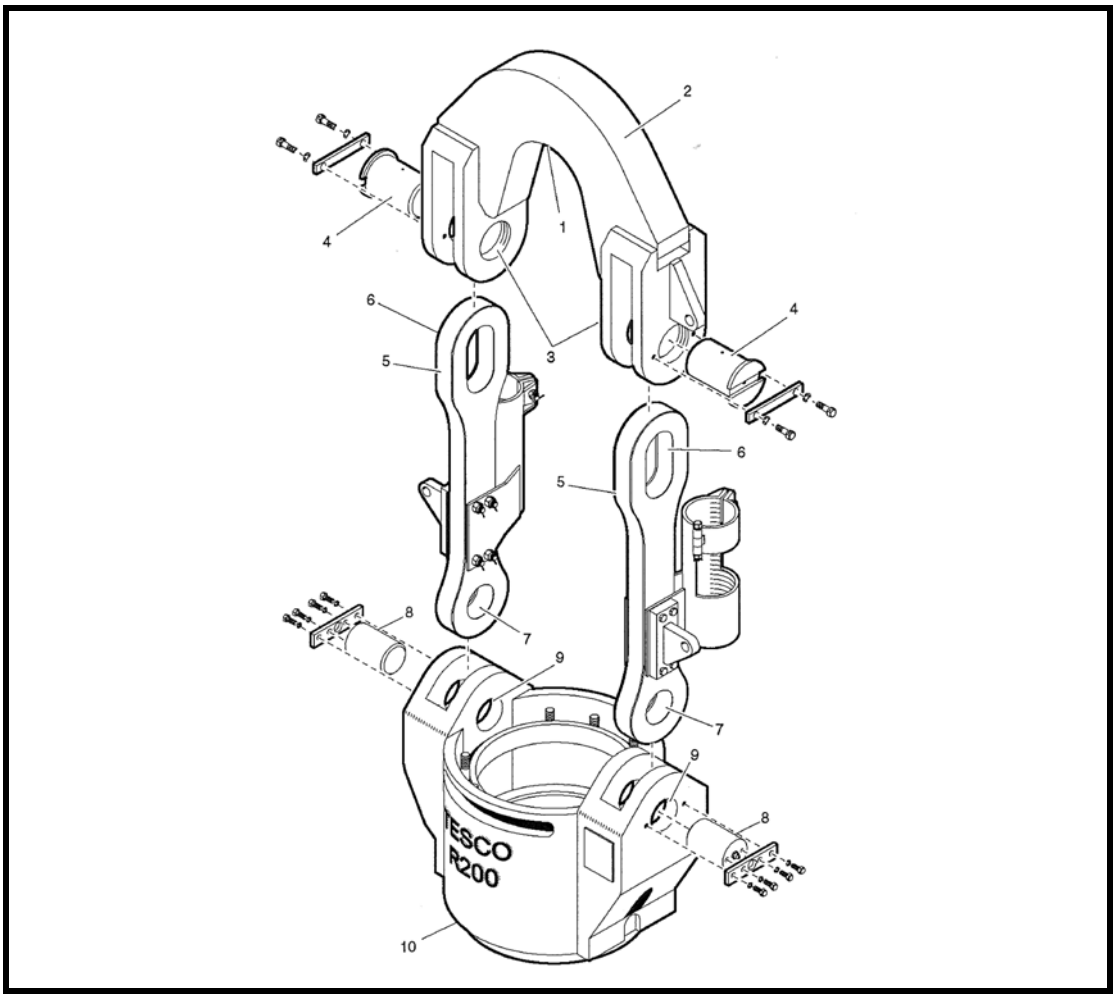
Inspection Types

The three inspection types are outlined in Table 3-1.

Table 3-1: Inspection types

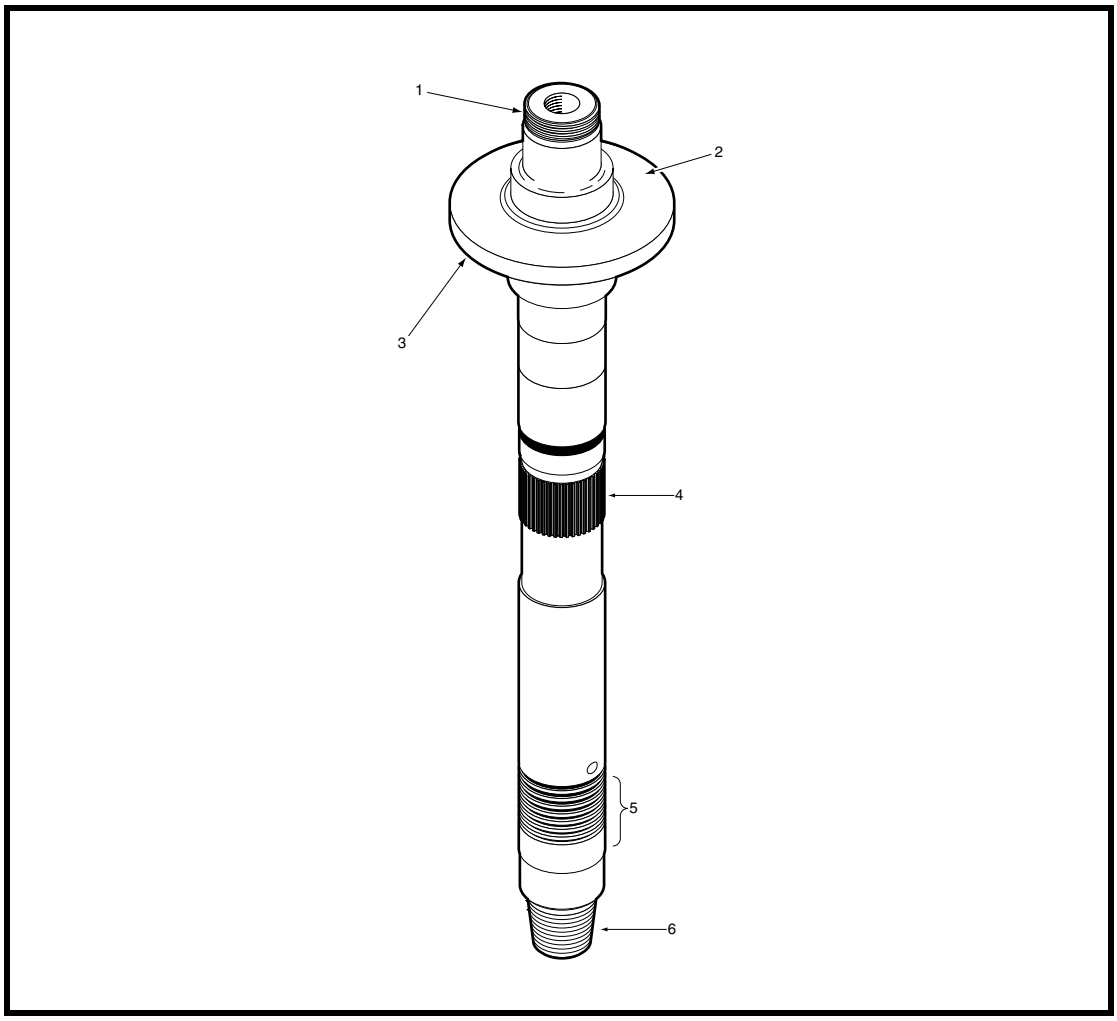
Inspection Type	Description
A	Visually inspect for: • wear • deformation • cracks • corrosion • galling • heat damage • other irregularities If a crack is suspected, perform local paint strip and MPI inspection. All cracked components should be referred to TESCO Engineering for disposition.
B	Perform MPI or WFMPI for cracks. All cracked components should be referred to TESCO Engineering for disposition.
C	Return to a TESCO authorized service centre for complete dimensional, visual, WFMPI/MPI inspection for recertification. Upon completion of Type C inspection, the inspection schedule starts at zero operating days.

Figure 3-1: Swivel (HMI)



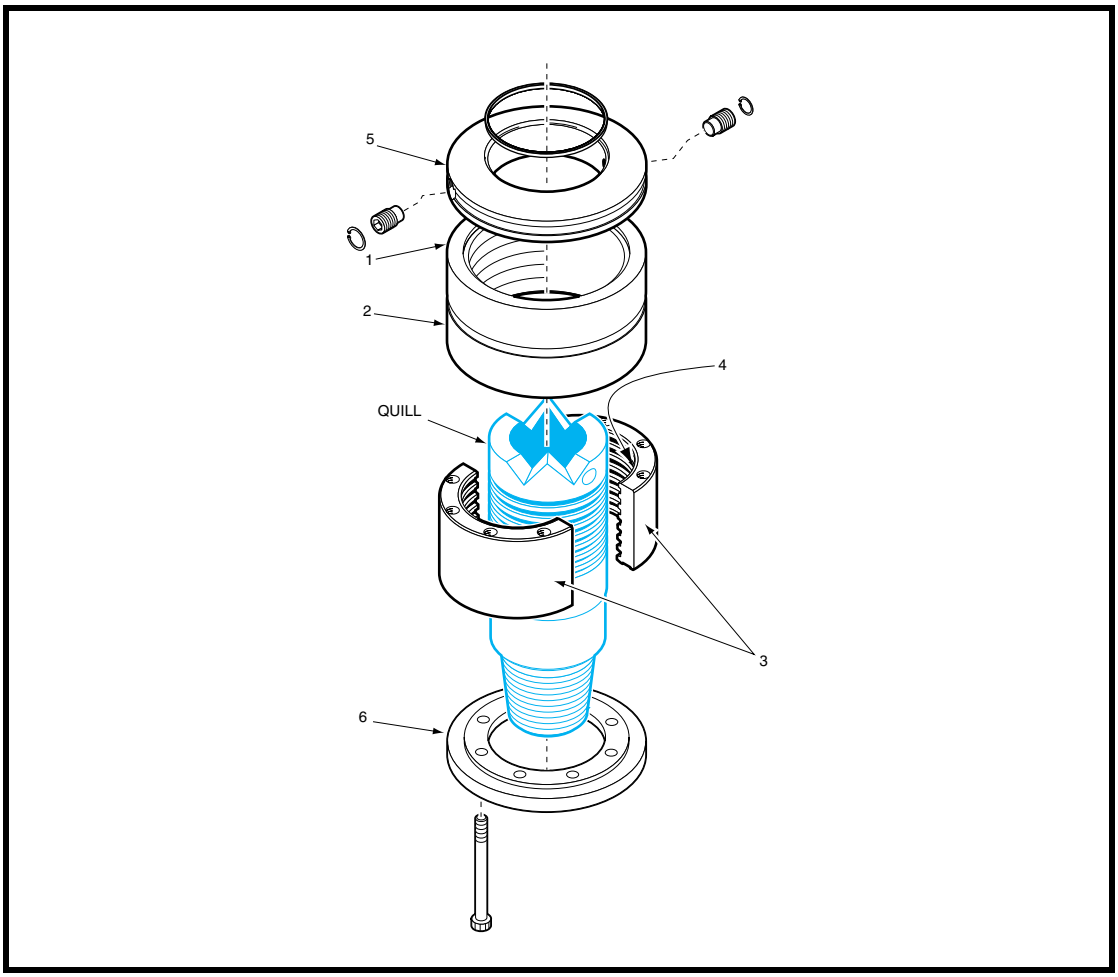
Point	Name	Frequency (Operating Days) and Inspection Type*			
		At 250	At 500	At 750	At 1000
1	Hook contact point	A, B	A, B	A, B	C
2	Swivel yoke	A	A	A	C
3	Swivel yoke pin holes	A, B	A, B	A, B	C
4	Yoke pins	A, B	A, B	A, B	C
5	Swivel links	A	A	A	C
6	Swivel link, yoke pin holes	A, B	A, B	A, B	C
7	Swivel link, swivel pin holes	A, B	A, B	A, B	C
8	Swivel pins	A, B	A, B	A, B	C
9	Swivel body pin holes	A, B	A, B	A, B	C
10	Swivel body	A	A	A	C
***Refer to Table 3-1 on page 19 for inspection type details**					

Figure 3-2: Quill (HMI)



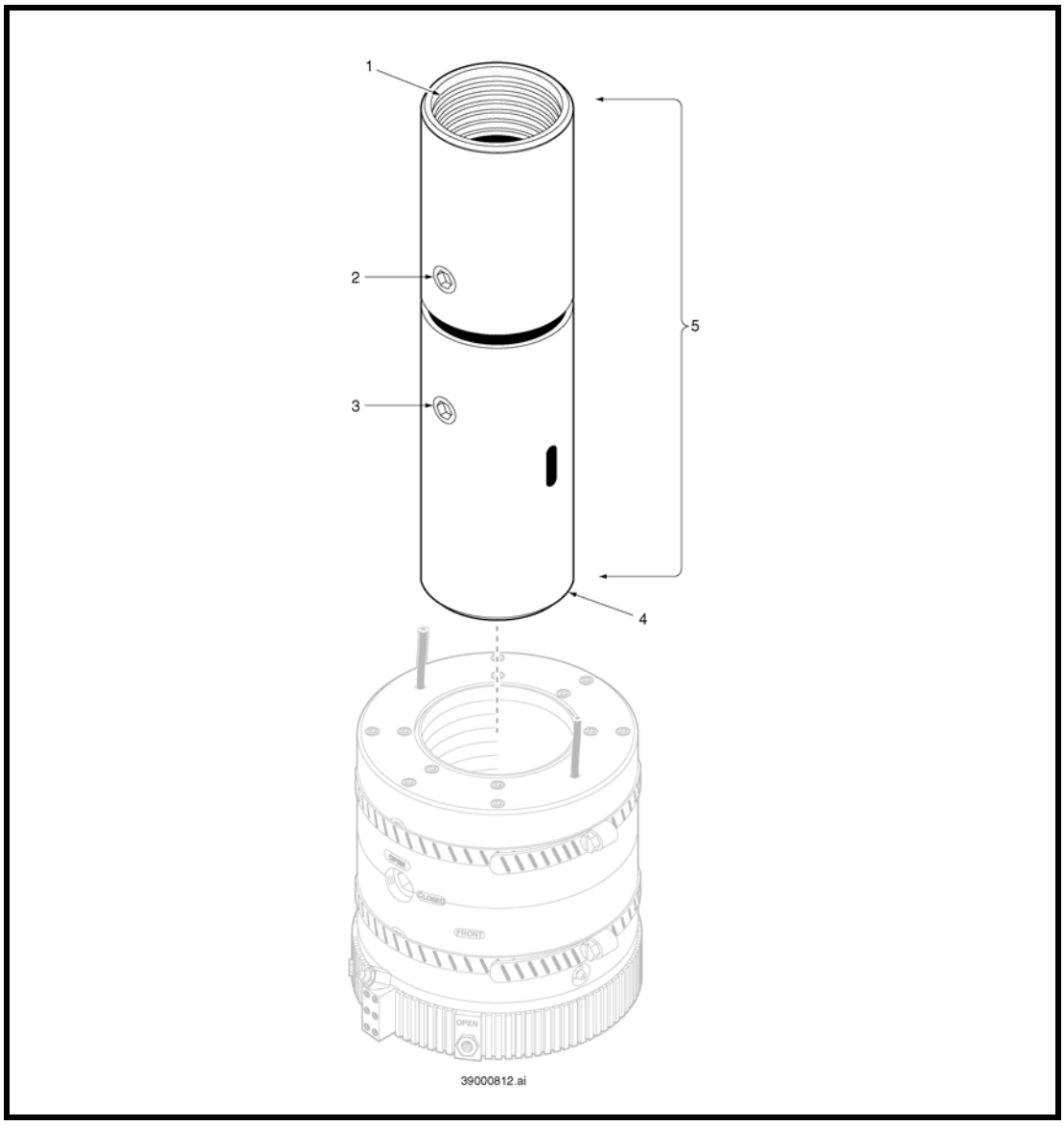
Point	Name	Frequency (Operating Days) and Inspection Type*				
		Every 60	At 250	At 500	At 750	At 1000
1	Threads and bore	—	A	A	A	C
2	Upper thrust surface	—	—	—	—	C
3	Lower thrust surface	—	—	—	—	C
4	Splines	—	—	—	—	C
5	Load nut grooves	—	A,B	A,B	A,B	C
6	Quill pin end (also refer to "Threaded Connections" on page 28)	A,B	—	—	—	C
***Refer to Table 3-1 on page 19 for inspection type details**						

Figure 3-3: Load nut retainer and split collar (HMI)



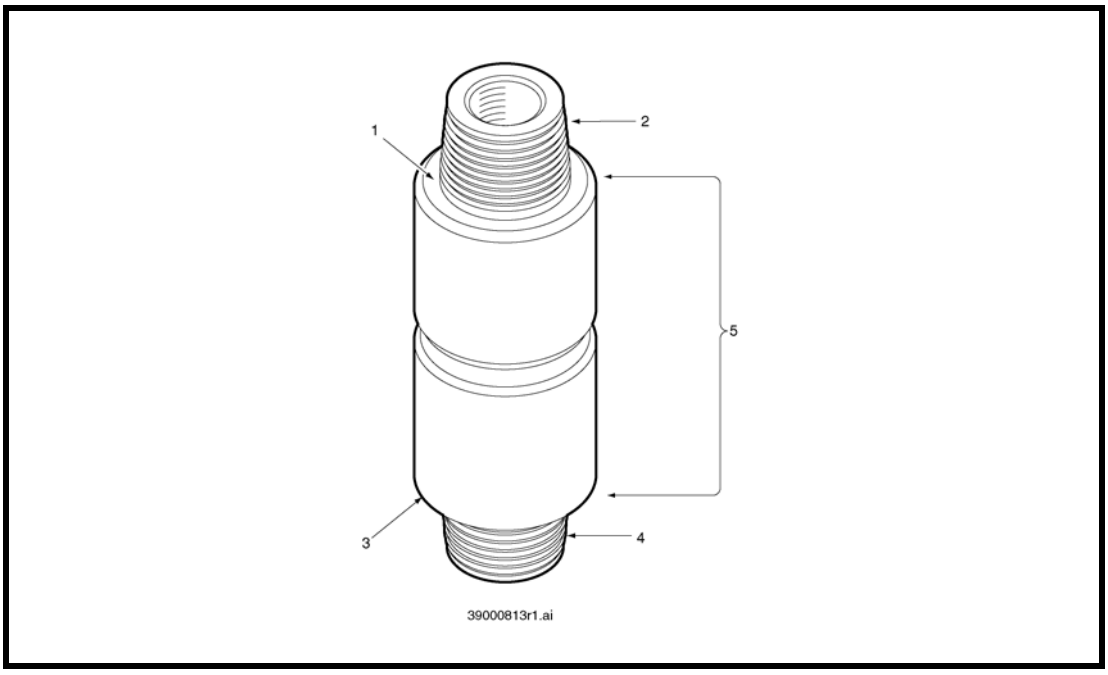
Point	Name	Frequency (Operating Days) and Inspection Type*				
		Every 60	At 250	At 500	At 750	At 1000
1	Load nut retainer shoulder	—	A,B	A,B	A,B	C
2	Entire load nut retainer	—	A,B	A,B	A,B	C
3	Split collar	—	A,B	A,B	A,B	C
4	Split collar grooves	—	A,B	A,B	A,B	C
5	Top plate	—	A,B	A,B	A,B	C
6	Bottom plate (not a load area)	—	A	A	A	C
*Refer to Table 3-1 on page 19 for inspection type details						

Figure 3-4: Mudsaver valve and actuator (HMI)



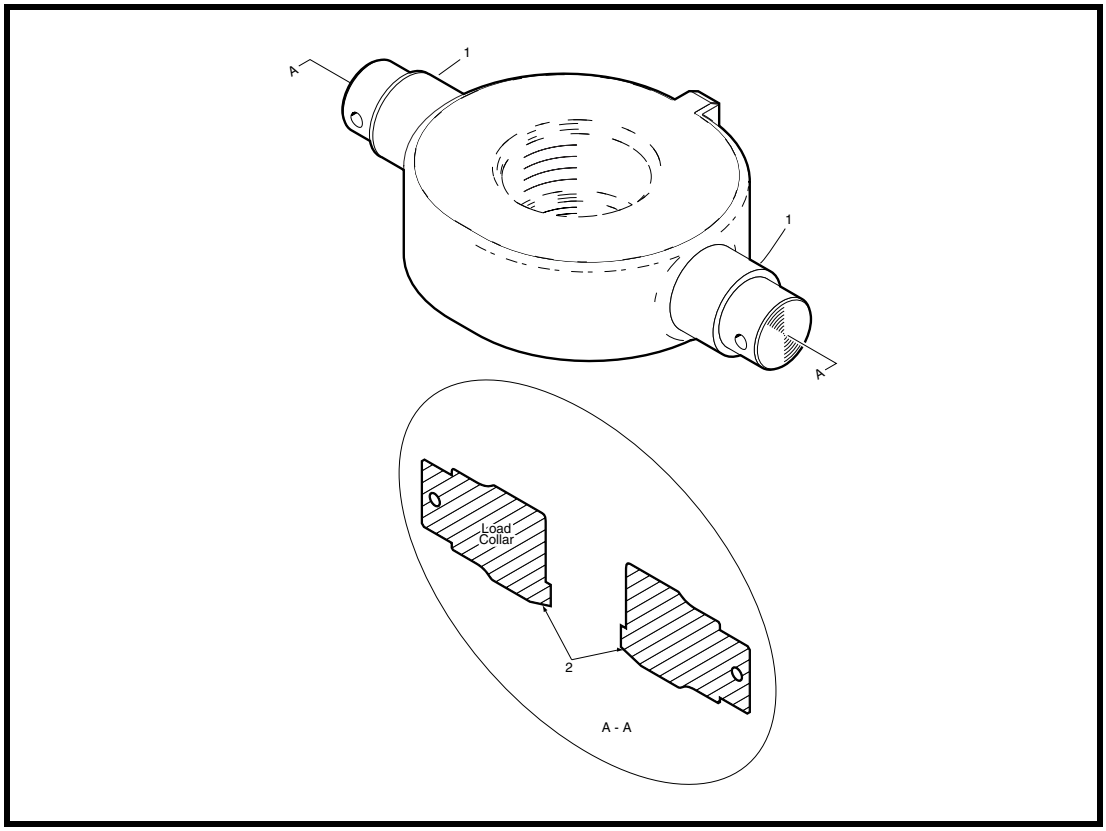
Point	Name	Frequency (Operating Days) and Inspection Type*				
		Every 60	At 250	At 500	At 750	At 1000
1	Top box connection	A,B	—	—	—	C
2	Upper valve stem hole	A,B	—	—	—	C
3	Lower valve stem hole	A,B	—	—	—	C
4	Lower box connection	A,B	—	—	—	C
5	Length of valve body	A,B	—	—	—	C
***Refer to Table 3-1 on page 19 for inspection type details**						

Figure 3-5: Saver sub (HMI)



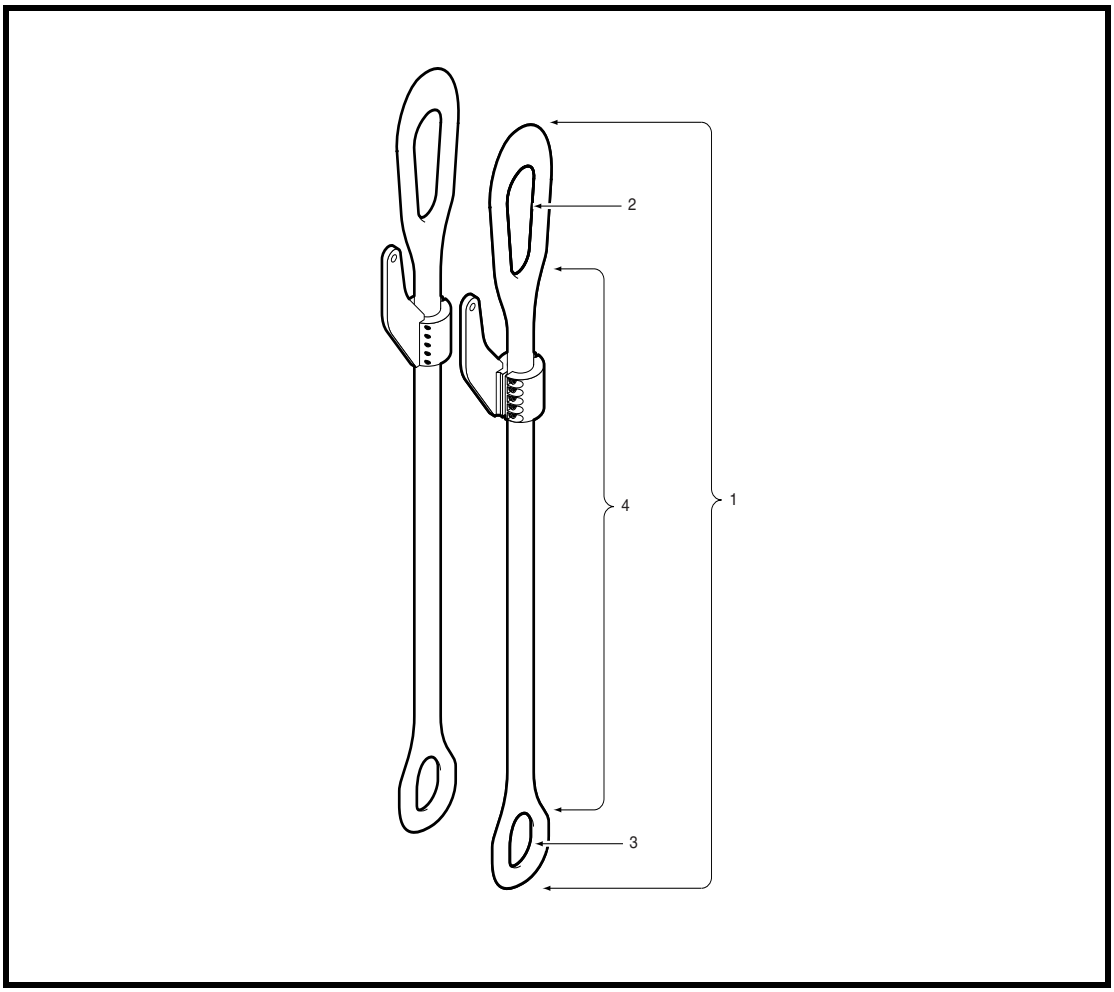
Point	Name	Frequency (Operating Days) and Inspection Type*				
		Every 60	At 250	At 500	At 750	At 1000
1	Upper seal face	A,B	—	—	—	C
2	Upper threads	A,B	—	—	—	C
3	Lower seal face	A,B	—	—	—	C
4	Lower threads	A,B	—	—	—	C
5	Entire length of body	A,B	—	—	—	C
***Refer to Table 3-1 on page 19 for inspection type details**						

Figure 3-6: Load collar (HMI)



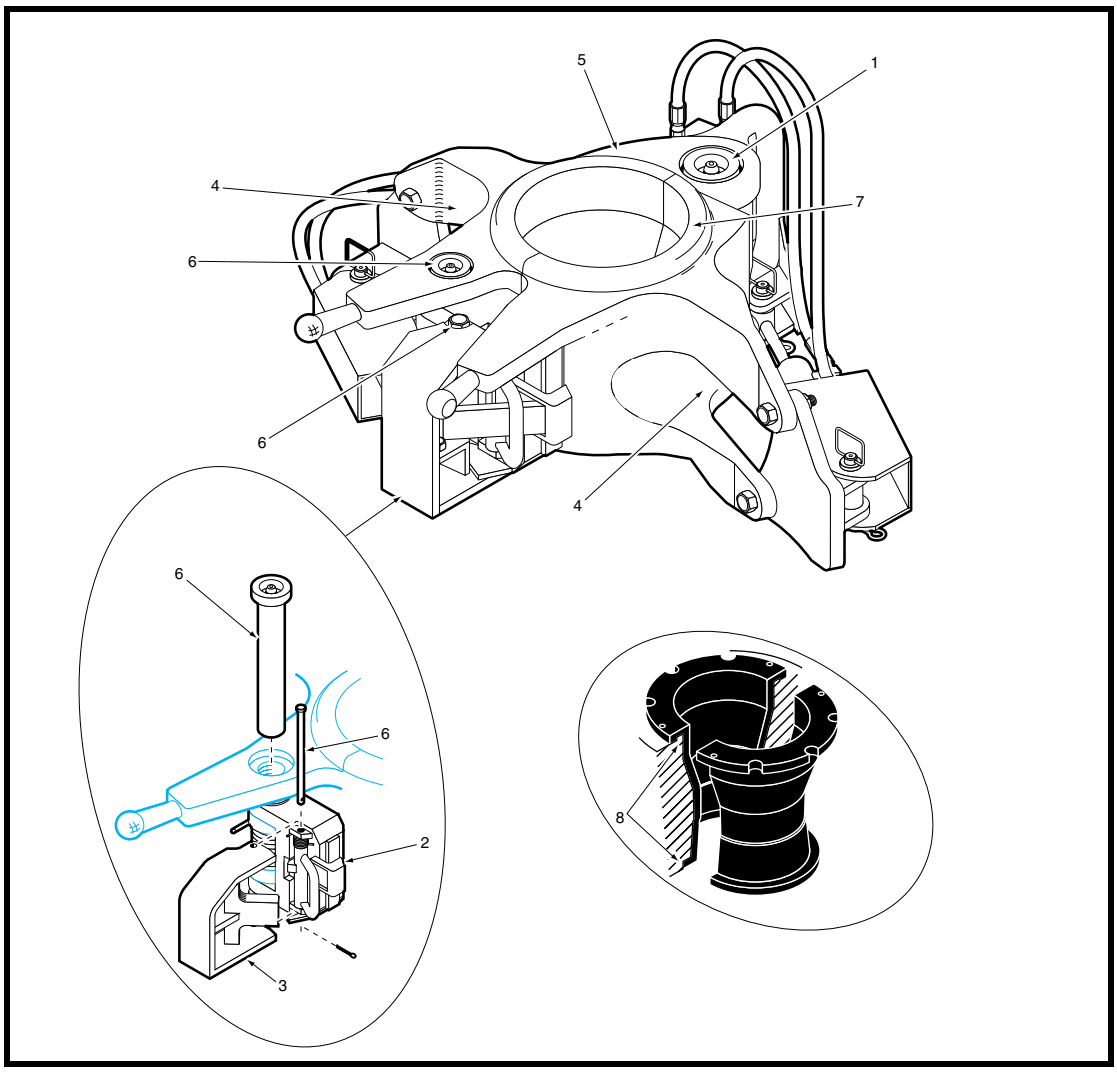
Point	Name	Frequency (Operating Days) and Inspection Type*				
		Every 60	At 250	At 500	At 750	At 1000
1	Load collar ears	A	A,B	A,B	A,B	C
2	Load shoulder (check for cracks, galling and heat damage)	—	A,B	A,B	A,B	C
3	Complete load collar	A	—	—	—	C
***Refer to Table 3-1 on page 19 for inspection type details**						

Figure 3-7: Elevator links (bails) (HMI)



Point	Name	Frequency (Operating Days) and Inspection Type*	
		Every 250	At 1000
1	Entire length of link	A,B**	C
2	Top eye (load collar eye)	A,B**	C
3	Bottom eye (elevator eye)	A,B**	C
4	Length between the eyes	A,B**	C
***Refer to Table 3-1 on page 19 for inspection type details ** As recommended by equipment manufacturer**			

Figure 3-8: Elevators (HMI)



Point	Name	Frequency (Operating Days) and Inspection Type*
		At 250
1	Main hinge pin	C**
2	Primary latch	C**
3	Secondary latch	C**
4	Elevator link ears	C**
5	Elevator body	C**
6	Latch pins	C**
7	Elevator inserts	C**
8	Insert grooves (top and bottom) (Ensure the insert does not fall out)	C**

***Refer to Table 3-1 on page 19 for inspection type details**
**** As recommended by equipment manufacturer**

THREADED CONNECTIONS

All threaded connections listed in the following table must be subjected periodically to wet fluorescent magnetic particle inspection (WFMPI) by a qualified inspector. Each piece should be inspected for surface defects. Also, an inspection of threads should be conducted in accordance with the following schedule.

Note: Any part of an operating day should be considered one day.

Caution: All inspections listed in the following table should be performed following any episode of rough drilling, excessive jarring or any other exceptional circumstance that might increase fatigue failure. Operator discretion is critical in determining when this testing should occur.

Threaded Connection Inspection Frequency (HMI)

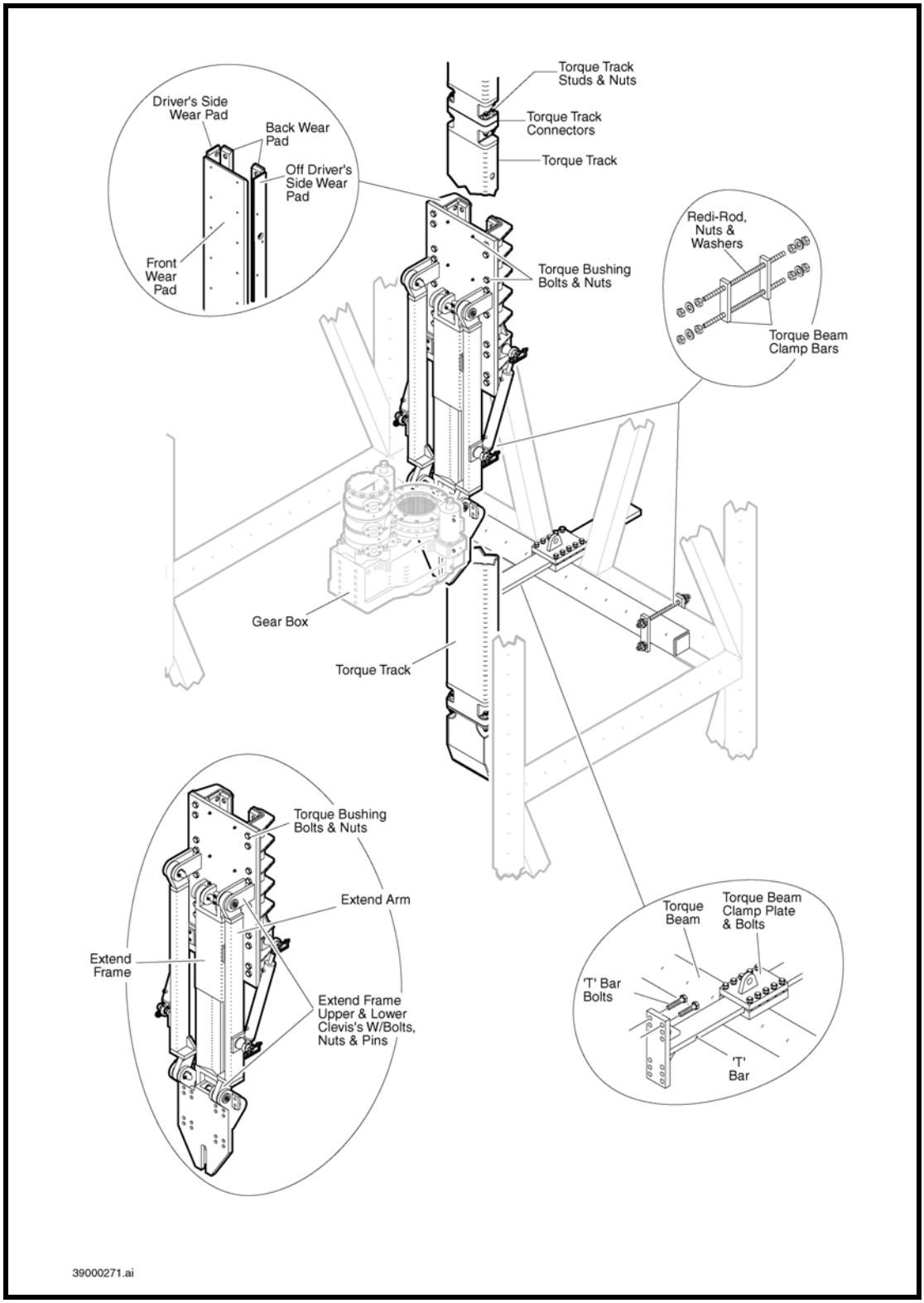
Description	Minimum Frequency*	Inspection Type
Mud saver/stabbing valve (box X box, connections)	60 operating days	WFMPI
Saver sub (pin X pin, connections)	60 operating days (lower threads and seal face require daily visual inspection)	WFMPI
***Frequency = the number of operating days**		

TORQUE ARREST SYSTEM

All components of the torque arrest system must be subjected to periodic magnetic particle inspection (MPI) by a qualified inspector. Each piece should be inspected for surface defects according to the following schedule.

Any part of an operating day should be considered one day. Removal of paint may be required for inspection.

Figure 3-9: Non-destructive testing for the standard torque arrest system (HMI)

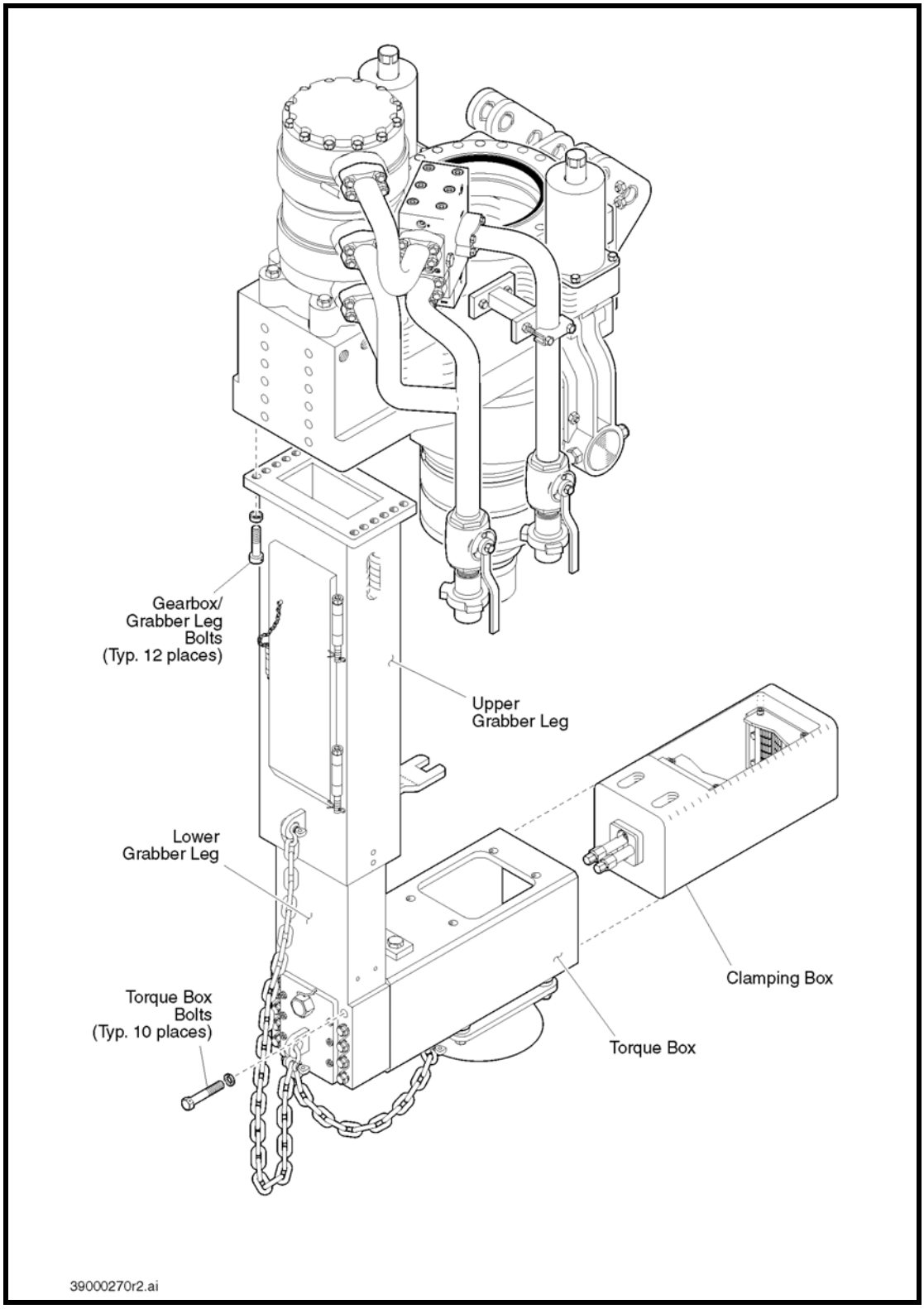


Torque Arrest System Inspection Frequency (HMI)

Name	Frequency (Operating Days) and Inspection Type*			
	At 250	At 500	At 750	At 1000
Bolts-gearbox to extend frame mount	A	A	A	Replace
Complete extend frame mounts	A	A	A	C
Extend frame	A	A	A	C
Extend arms	A	A,B	A	C
Torque bushing front plate	A	A	A	C
Torque bushing side plates	A	A	A	C
Torque bushing bolts/nuts	A	A	A	Replace
Torque track connectors	A	A	A	C
Torque track mounting plate on bottom section; include all bolt holes	A	A,B	A	C
Torque track studs/nuts	A	A	A	Replace
T-bar	A	A,B	A	C
T-bar/clamp bolts	A	A	A	Replace
T-bar extension	A	A	A	C
T-bar clamp plate	A	A	A	C
Torque beam	A	A	A	C
Torque beam clamp bar	A	A	A	C
Redi-rod nuts (torque arrest system)	A	A	A	C
Connection to the derrick leg	A	A	A	C
Torque track	A	A	A	C
***Refer to Table 3-1 on page 19 for inspection type details**				

PIPE HANDLER ROTATION SYSTEM INSPECTION FREQUENCY

Figure 3-10: Other non-destructive testing (HMI)



Name	Frequency (Operating Days) and Inspection Type*				
	Every 60	At 250	At 500	At 750	At 1000
Torque box	—	A	A	A	C
Clamping box	—	A	A	A	C
Torque box bolts	—	A	A	A	Replace
Grabber bolts	—	A	A	A	Replace
Gearbox/grabber leg bolts	—	—	—	—	Replace
Upper grabber leg	—	A	A	A	C
Lower grabber leg	—	A	A	A	C
***Refer to Table 3-1 on page 19 for inspection type details**					

CHAPTER 4: SERVICE PROCEDURES

INTRODUCTION

The service procedures described in this chapter are an extension of the service activities discussed in Maintenance and Service Schedules.

HOW TO DISASSEMBLE AND SERVICE THE ROTO-ACTUATOR

This procedure is performed as part of monthly top drive maintenance.

This procedure explains how to clean the internal bore of the actuator and the outer diameter of the mud valve body. If you need to replace a seal, or if any other type of service is required, refer to the manufacturer's service manual.

1. Remove the hydraulic lines for the mud valve-open/valve-close circuit.
2. Plug and cap the hydraulic line terminations to prevent dirt accumulation.
3. Remove the actuator stop bracket.
4. Remove the internal snap rings on the hex drive shaft.
5. Remove the hex drives (2).
   Note: The strip kit contains a slide hammer for this purpose.
6. Loosen the upper and lower hose clamps.
   Note: It is easier to loosen them until they can be repositioned above the locator pins than to try to remove them entirely.
7. Loosen all setscrews except 2 by 1/2 turn.
   Note: Leave two opposing screws tight to hold the actuator in place until you are ready to remove it.
8. Remove the connection-locking clamp for the saver sub.
9. Remove the saver sub.
10. Visually inspect the lower portion of the valve body for raised die marks.
    Note: Any raised spots will impede the removal of the actuator. Buff them smooth to ensure smooth removal.
11. Place wooden blocks on top of the grabber.
    Note: These blocks will support the actuator during the next part of this procedure.
12. Raise the grabber to support the weight of the actuator.

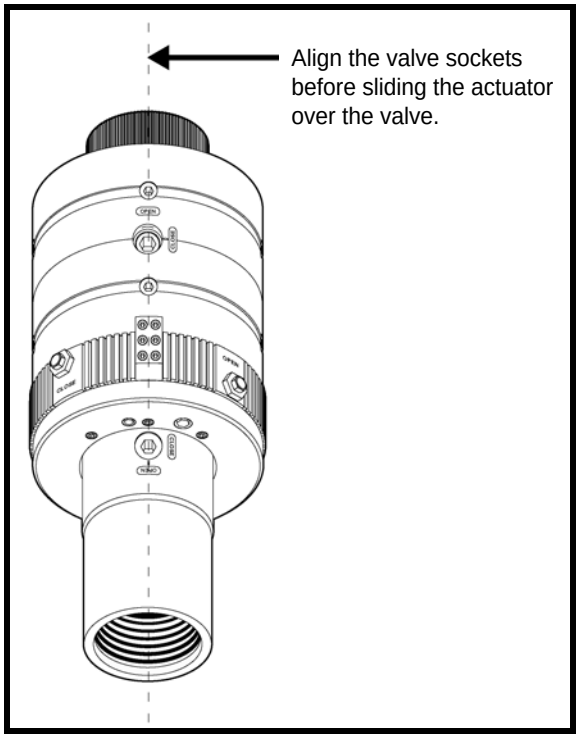
13. Remove all setscrews (8) and springs (8).
14. Remove the locator pins (8) using the slide hammer, if required.
    Note: The actuator is now separated from the double ball valve.
15. Before you continue, note the orientation of the actuator in relation to the double ball valve.
16. Lower the grabber.
17. Remove the actuator from the double ball valve.
    Note: The strip kit includes two lifting handles for moving the actuator. These handles screw into any of the locking pin locations.
18. Clean the internal bore of the actuator and the outer diameter of the mud valve body.

Re-assembly

1. Lightly grease the internal bore of the actuator and the outer diameter of the mud valve body.
2. Position the actuator on top of the wooden blocks, on the grabber.
3. Ensure that the actuator and valve are either both open, or both closed.
4. Ensure that the actuator and valve are oriented in the same way as they were when removed. See Figure 4-1.

Danger! If the orientation is not correct, the valve will not open when required. This causes a serious safety hazard.

Figure 4-1: Actuator/valve orientation



5. Slowly raise the grabber to move the actuator to the correct position. The actuator should slide smoothly onto the double ball valve.
6. Install four brass shims (0.010 in.) or a 0.010 in. feeler gauge between the body of the mud valve and the actuator.
   Note: The shims help to align the valve and actuator concentrically during assembly.
7. Coat all locking pins and setscrews with a thin coat of anti-seize compound.
8. Install the locking pins, springs and setscrews as follows:
   a. Put all locking pins, spring and setscrews in place.
   b. Turn the setscrews until they meet the springs, but do not tighten them.
   c. Start the locking pins.
9. Install the hex drives (2).
10. Install the snap rings into snap ring grooves.
11. Tighten all setscrews, evenly, to 100 ft-lb.
12. Install a hose clamp over the locking pins.
13. Remove the brass centering shims.
14. Lower the grabber.
15. Remove the wooden blocks.
16. Rotate the quill with the top drive to position the locking mechanism to accept the stop bracket of the actuator.
17. Install the stop bracket.
18. Connect the hydraulic lines for the mud valve-open/valve-close circuit.
19. Test the actuator to confirm that it is working correctly.

HOW TO SET THE COUNTER-BALANCE CUSHION HEIGHT

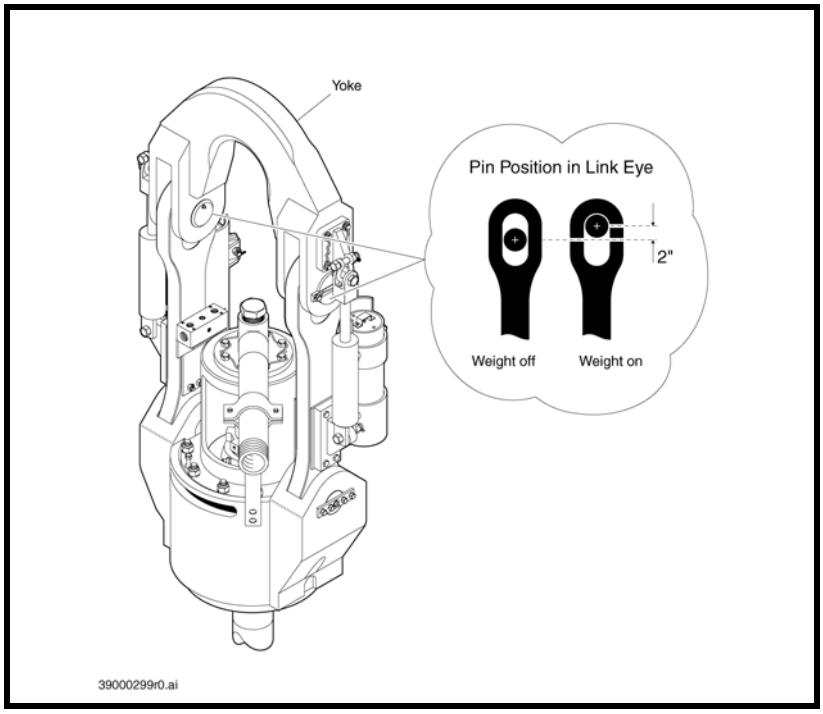
Perform this procedure as part of monthly top drive maintenance. Ensure the top drive is positioned at the racking platform before you start this procedure.

1. Connect the hose quick-coupler for the elevator to the charge fitting for the counter-balance system.
2. Shut off the auxiliary pump.
3. Set the ELEVATOR switch (at the driller's panel) to CLOSE.
4. Open the needle valve on the counter-balance manifold.
   Note: This relieves all pressure on the counter-balance system.
5. Check the nitrogen pressure, and adjust if required.
   Note: The nitrogen pressure must be 800 psi
6. Ensure the counter-balance relief valve is set at 1200 psi.
7. Close the needle valve on the counter-balance manifold.
8. Start the auxiliary pump.

9. Set the ELEVATOR switch (driller's panel) to OPEN, and push and hold the ELEVATOR SAFTEY–OPEN button.
   Note: This will send 1500 psi hydraulic pressure to the needle valve on the counter-balance manifold.
10. Slowly open the needle valve and allow the hydraulic oil to charge the counter-balance system.
11. Monitor the counter-balance cushion by watching the gap that develops between the swivel bail and the block hook.
12. Continue to charge the system until the gap is 1-1/2 to 2 in. (the yoke pin should now be located in the center of the slotted eye of the link).
13. Close the needle valve.
14. Shut off the auxiliary pump.
    Note: This will allow the oil pressure in the auxiliary system to decrease.
15. Set the ELEVATOR switch to OPEN, then to CLOSE. This will relieve any pressure in the system.
16. Remove the elevator hydraulic hose from the counter-balance manifold.

Caution: If you disconnect a quick coupler while there is pressure in the system, it will be extremely difficult to reconnect the coupler.

Figure 4-2: Counter-balance cushion height

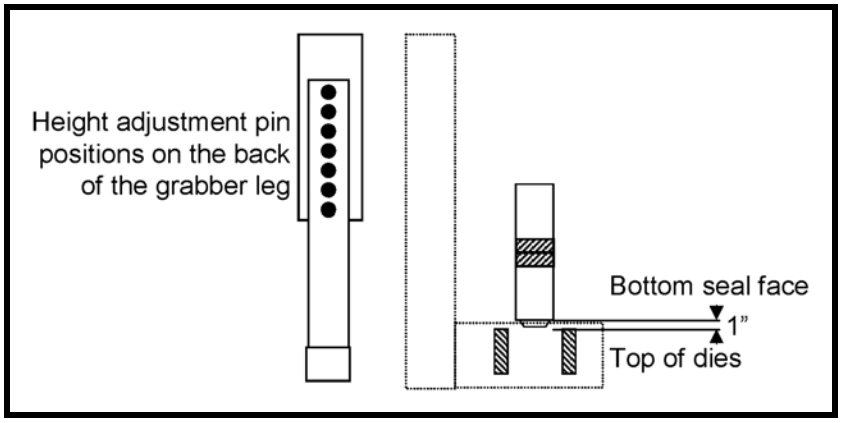


HOW TO RESET THE GRABBER HEIGHT

Use this procedure to reset the grabber height. Perform this procedure as part of monthly top drive maintenance.

Use a pin located on the back side of the grabber leg to adjust the height. You can use one of several pin locators to position the grabber leg.

Figure 4-3: Grabber position



Before You Start

Measure the distance from the top of the grabber die to the lower seal face of the saver sub.

Note: This measurement should be 1 in. If the distance is not 1 in., adjust the grabber height by changing the pin locations as follows.

1. Open the hinged pin retainer on the upper grabber leg.
2. Lower the top drive until the grabber is resting on the floor.
3. Adjust the height of the top drive so that the weight of the grabber leg is removed from the height adjustment pin.
4. Remove the height adjustment pin.
5. Lower or raise the top drive to obtain the required 1in. dimension (see Figure 4-3).
6. Find the closest aligned holes between the grabber leg spring and the grabber leg . If no holes align, raise the top drive slightly until two holes align.
7. Insert the height adjustment pin.
8. When the height adjustment pin is in place, raise the top drive to transfer weight back onto the grabber leg spring.
9. Push up and down on the grabber leg.
   Note: This ensures the leg floats on the spring and comes to rest in the proper position.
10. Measure the die/sub distance again.
    Note: If the distance is not 1 in., repeat this procedure to adjust the grabber height.
11. When the correct distance is achieved, install all safety devices.

HOW TO SET THE PRESSURE RELIEF VALVE FOR THE AUXILIARY SYSTEM

Perform this procedure as part of monthly power unit maintenance. The pressure relief valve for the auxiliary system is located on the hydraulic oil cooler.

1. Set the AUX PUMP switch (at the driller's panel) to ON.
2. Set the GRABBER switch to OPEN.
3. Loosen the lock nut on the adjustment screw of the relief valve.
4. Unscrew the lock nut a few turns, but do not remove it.
5. Adjust the set screw on the relief valve until the pressure gauge (near the relief valve) reads 1900 psi (min.)–2000 psi (max.).

Figure 4-4: Auxiliary relief valve

Note: Some Tesco top drives are equipped with a secondary auxiliary relief at the auxiliary manifold. This is used to warm the oil in the lines for cold climate applications. If your top drive is equipped with this secondary relief valve, set the main tank relief valve to 150-200 psi higher than the top drive relief valve. The top drive relief valve should be set to 2,000 psi (±50).

6. Tighten the lock nut.
7. Set the GRABBER switch to neutral.
8. Set the AUX PUMP switch to OFF.

HOW TO SET THE FUNCTION LIGHT PRESSURE SWITCH FOR THE AUXILIARY SYSTEM

Perform this procedure as part of monthly power unit maintenance.

Note: The function light pressure switch for the auxiliary system should be set to 800 psi. It is easier if two people perform this procedure.

1. Set the AUX PUMP switch to ON.
2. Set the GRABBER switch to OPEN.
   Note: Leave the switch in the OPEN position. This allows system pressure to build.
3. Use the relief valve setscrew to reduce the auxiliary pressure relief setting to 800 psi.
4. Use the adjustment wheel on the pressure switch to adjust the pressure switch until the AUX PUMP 'ON' indicator light on the driller's panel illuminates.
   Note: You might have to have someone stand at the driller's panel to monitor the light. If no assistance is available, use a digital multi-meter as follows:
   a. Disconnect the wires at the junction box for the pressure switch.
   b. Attach a digital multi-meter (DMM), in Ω (ohm) range, to the wires from the switch.
   c. Adjust the wheel on the switch until the switch closes.
      Note: The DMM will switch from O.L.(overload) to 000.1(±0.2) which indicates a short circuit.
   d. Ensure the auxiliary system is at 800 psi.
   e. Re-install the wires.
   f. Close the junction box.
5. Reset the auxiliary relief valve to the operating setting.
   Note: See "How to Set the Pressure Relief Valve for the Auxiliary System" on page 38 for more information.
6. Operate any hydraulic function to confirm that the indicator light is operating correctly.

HOW TO CHECK AND ADJUST PRELOAD

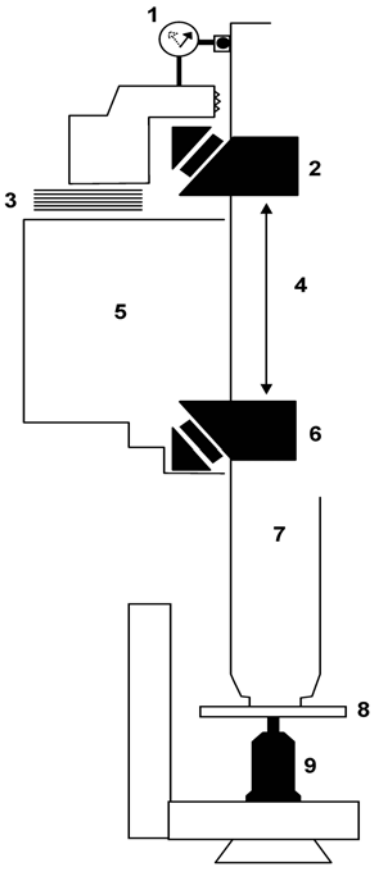
When the top drive is manufactured, TESCO adjusts the preload for the quill upper bearing by placing a shim pack between the top bearing retainer and the gearbox.

When the retainer bolts on the top bearing are torqued, this exerts a clamping force on the quill upper bearing and thrust bearing. This force prevents the quill from exhibiting end play during operation of the top drive. Preload is measured in 0.000 of an inch. The ideal preload is 0.008–0.010 in.

Over time, bearing and component wear will reduce the preload. If the preload is reduced too much, quill end play will result. Even the smallest amount of end play will result in damage to the bearings and mating components.

For this reason, quill end play should be checked every month, or after any severe operating events such as jarring or rough drilling.

Figure 4-5: Description of preload



1. Dial gauge
2. Upper quill hub bearing
3. Shim pack
4. Preload: Preload is the amount of compression between the upper and lower quill hub bearings.
   - To *increase* the preload, remove shims.
   - To *decrease* the preload, add shims.
5. Gearbox
6. Lower quill hub bearing
7. Quill
8. Protective block
9. Bottle jack or grabber

How to Check for Quill Hub End Play When the Top Drive is Installed in the Derrick

This procedure describes only one method for checking the quill endplay when the top drive is in the derrick. If you are not sure if your method will be effective, contact a qualified TESCO representative.

1. Secure the top drive in the mast.
   - Pin the torque bushing to the track, or
   - support the top drive mainframe directly in the mast with slings, tugger line, hoists, come-a-longs or other supports.

   Note: Whichever method you use to secure the top drive in the mast, make sure the travelling blocks and the counter-balance are not supporting any weight from the top drive. When the top drive is secure, the weight of the swivel and quill should be supported by the top drive gearbox and should rest on the lower bearing in the gearbox.

Caution: It is critical that all top drive weight is off the quill and the top drive is *not* supported by the counter-balance system. Disconnect the counter-balance system, or lower the travelling equipment enough so that the counter-balance system is slack.

2. Mount a dial indicator gauge on the quill, with the stem contacting a point on the bottom face of the lower bearing retainer.
3. Select a bottle jack that is appropriate for the combined swivel and quill weight of the top drive.
   - If combined quill and swivel weight is less than 5000 lb, then a 5 ton bottle jack is recommended.
   - If combined quill and swivel weight exceeds 5000 lb, then a 7-1/2 ton bottle jack is recommended.

Caution: Ensure the bottle jack is rated appropriately for the load.

4. Insert the bottle jack between the grabber box and the end of the quill.

Caution: Use blocking and suitable protection to prevent damage to the connection and grabber.

Note: For an HMI top drive, where the grabber is supported by a spring, insert blocking between the top of the elevators and the underside of the grabber so that you can apply load to the quill.

5. Use the bottle jack to hoist the quill. Monitor the dial gauge for movement.
6. Hoist the quill several times to confirm endplay readings.
7. Remove shims as required to eliminate endplay.

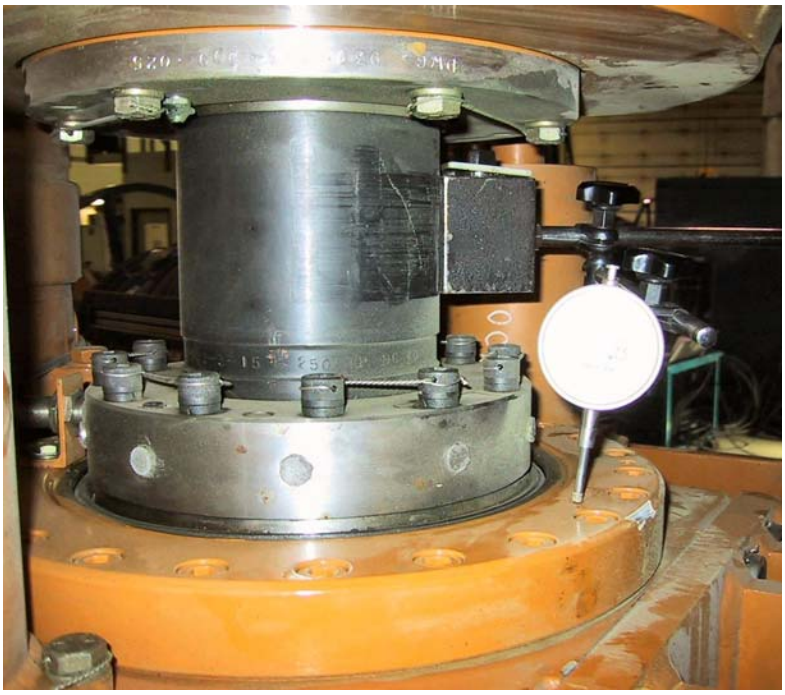
How to Check and Adjust HMI Specific Preloads

There are three preload checks that must be performed for HMI top drive units:

- gearbox bearing preload
- swivel bearing preload
- quill to quill-gear-drive-bushing/spacer preload

Check the Gearbox Bearing Endplay

1. Install a magnetic-base dial gauge on the quill.
   Note: Put the magnetic end on the quill and the needle on the bearing retainer.



2. Install a soft sling in the bonnet of the top drive.
3. Use overhead equipment to gently hoist and lower the top drive.
4. Monitor the dial gauge for movement. Values on the dial gauge should be within acceptable preload parameters:
   - new bearings: 0.008 to 0.010 in.
   - used bearings: 0.000 to 0.005 in.
5. If the dial gauge indicates movement outside acceptable parameters, test the quill to quill gear drive bushing endplay first to isolate the actual endplay location. See “Check the Quill to Quill Gear Drive Bushing/Drive Spacer Endplay” on page 44.
6. If the test for quill-to-quill-gear-drive-bushing preload indicates no endplay, then adjust the gearbox preload.
   a. Unbolt the bearing retainer.
   b. Remove the required number of shims that are located under the upper bearing retainer. See “Sample Calculation” on page 45.
   c. Reinstall the bearing retainer.

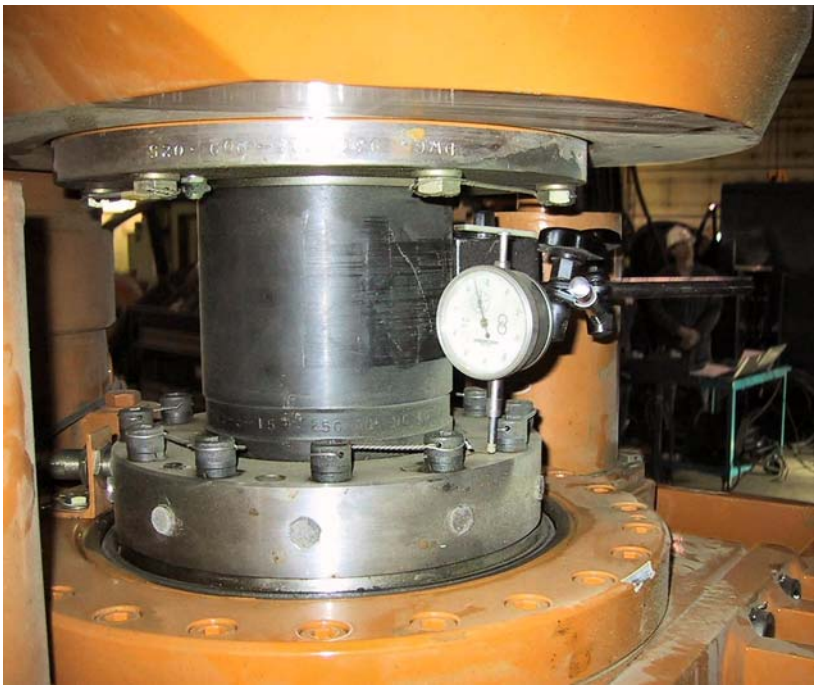
Check the Swivel Bearing Preload

1. Remove the wash pipe from the bonnet.
2. Install a magnetic-base dial gauge.
   Note: Attach the magnetic base to the bonnet so that the needle rests on the quill.

3. Install a soft sling in the bonnet of the top drive.
4. Use overhead equipment to gently hoist and lower the top drive.
5. Monitor the dial gauge for movement. Values on the dial gauge should be within acceptable preload parameters:
   • new bearings: 0.003 in.
   • used bearings: 0.001 to 0.003 in.
6. If the values are outside acceptable preload parameters, adjust the preload.
   a. Remove the bolts that attach the bonnet/upper bearing retainer to the swivel housing.
   b. Remove the required number of shims. See “Sample Calculation” on page 45.
   c. Reattach the bonnet/upper bearing retainer to the swivel housing.

Check the Quill to Quill Gear Drive Bushing/Drive Spacer Endplay

1. Check that the quill-drive-hub-to-quill-hub bolts are tight.
2. Install a dial gauge on the quill between the swivel and the gearbox.
   Note: Attach the magnetic base to the quill such that the needle rests on the quill gear drive bushing.



3. Install a soft sling in the bonnet of the top drive.
4. Use overhead equipment to gently hoist and lower the top drive.
5. Monitor the dial gauge for movement. There should be no movement.
6. If there is movement, this indicates that the spacer is not the correct size. Contact Tesco, as the spacer will have to be removed and resized.

How to Calculate the Preload Adjustment

If the previous procedure reveals *any* amount of quill end play, the quill preload must be adjusted. To decrease end play in the quill (increase the preload), you must remove shims from the shim pack. Use the following calculation to determine how many shims to remove.

observed quill end play (in 0.000 in.) + 0.010 in. = the thickness of shims to be removed

Sample Calculation

If the quill end play is 0.019 in., then 0.019 in. + 0.010 in. = 0.029 in. (±0.002)

Between 0.027 to 0.031 in. of shims must be removed to adjust the preload to the correct force.

HOW TO PERFORM A HYDRAULIC OIL ANALYSIS

Hydraulic oil analysis is part of periodic power unit maintenance.

Note: Test ports for the hydraulic oil are located at the closed-loop filter manifold.

1. Ensure that the oil is warm and recently circulated.
   Note: If the oil is cold or has been static, particulate will settle to the bottom of the tank and you will not get an accurate sample.
2. Ensure that you have a small, clean sample bottle ready.
   Note: If the oil sample is contaminated with debris or grime, the analysis will be inaccurate.
3. Shut off the power unit.
4. Install a tee and valve at the filter manifold, at the driller's gauge port.
5. Start the power unit.
6. Set the PUMPS–REV/FWD switch to FWD, and use a low flow rate.
7. Open the valve at the filter manifold and allow the oil to flow for several seconds.
8. Collect a sample from the running stream of oil.
   Note: Ensure that you do not allow outside dirt or contaminants into the sample bottle.
9. Submit for analysis according to laboratory instructions.
   Note: When submitting oil for analysis, include any information that may assist the lab in conducting the analysis. For example, list any recent component changes or equipment problems.

If you have any questions regarding the results or would like assistance, contact Tesco's technical support.

HOW TO SERVICE THE CENTRIFUGAL OIL FILTER (ENGINE)

This procedure is performed as part of periodic power unit maintenance.

1. Shut off the engine and wait until the centrifuge in the oil filter stops spinning.
2. Remove the filter cover.
3. Lift the centrifuge turbine assembly slightly and hold.
4. Allow oil to drain out of the hoses.
5. Loosen the bowl nut until the face of the nut extends beyond the bushing face.
6. Strike the face of the nut to separate the centrifuge bowl from the turbine base.
   Note: Do not strike the nut with any hard object; the palm of your hand will work.
7. Remove the bowl nut completely.
8. Remove the bowl and baffle screen.
9. Remove the accumulated dirt from the centrifuge bowl.
   Note: Use an implement that will not damage the bowl. Wipe the bowl with solvent after you remove the debris.
10. Clean the baffle and turbine base.
11. Check the bowl seal and replace it if necessary.
12. Remove the cover and cover seal.
13. Clean the mating surface and replace the cover seal, if required.
14. Reassemble the filter, and ensure that all moving parts rotate freely.
15. Start the engine and monitor the filter connections and joints for leaks.

HOW TO PERFORM A COOLANT ANALYSIS (ENGINE)

1. Ensure that you have a coolant test kit available.
   Note: These are available from the equipment manufacturer.
2. Ensure that your test area is clean and free of contaminants.
3. Using the test kit and supplied instructions, evaluate the coolant fluid for the following:
   - Nitrite concentration: If nitrite concentration is inadequate, system corrosion can occur.
   - Glycol concentration: If glycol concentration is inadequate, freezing or boil-over can occur.

Caution: Consult the manufacturer's documentation before you use any inhibitor or anti-freeze additives. Never introduce unapproved additives (sealer additives, for example) into the coolant system.

HOW TO CHECK THE SPLINES ON THE PUMP SHAFT

Note: This procedure takes several hours to perform. Pump shaft splines can *only* be inspected when an extended period of downtime is anticipated.

Caution: Always perform correct lock-out procedures as recommended by your Safety or Loss Prevention Department before you attempt this procedure.

1. Close the isolation valves to isolate the hydraulic lines that go to the pump drive.
2. Shut off the suction valve(s) to the pump(s).
3. If you must remove the hydraulic hoses from the pumps, ensure the ends of the hoses are protected from dirt and grime.
4. Loosen the hold-down nuts/studs for the pump.
5. Using a soft sling, create a basket sling for the pump.
6. Attach the sling to an overhead lifting device.
7. Hoist the sling until the weight of the pump is supported with the lifting device.
   Note: *Do not lift the pump.* Hoist it only enough to support the pump weight.
8. Pull the pump backwards to disengage the pump/spline connection.
   Note: Move the pump back far enough to get a good view of the splines and internal components.
9. Remove and inspect the pump adaptor plate. Replace it if necessary.
10. Ensure that there is residual oil between the pump and the pump adapter.

Caution: If these areas are dry, inspect the lubrication hoses/pump until the problem is located. Inadequate lubrication will cause severe equipment damage.

11. Check all load areas for spline deterioration.

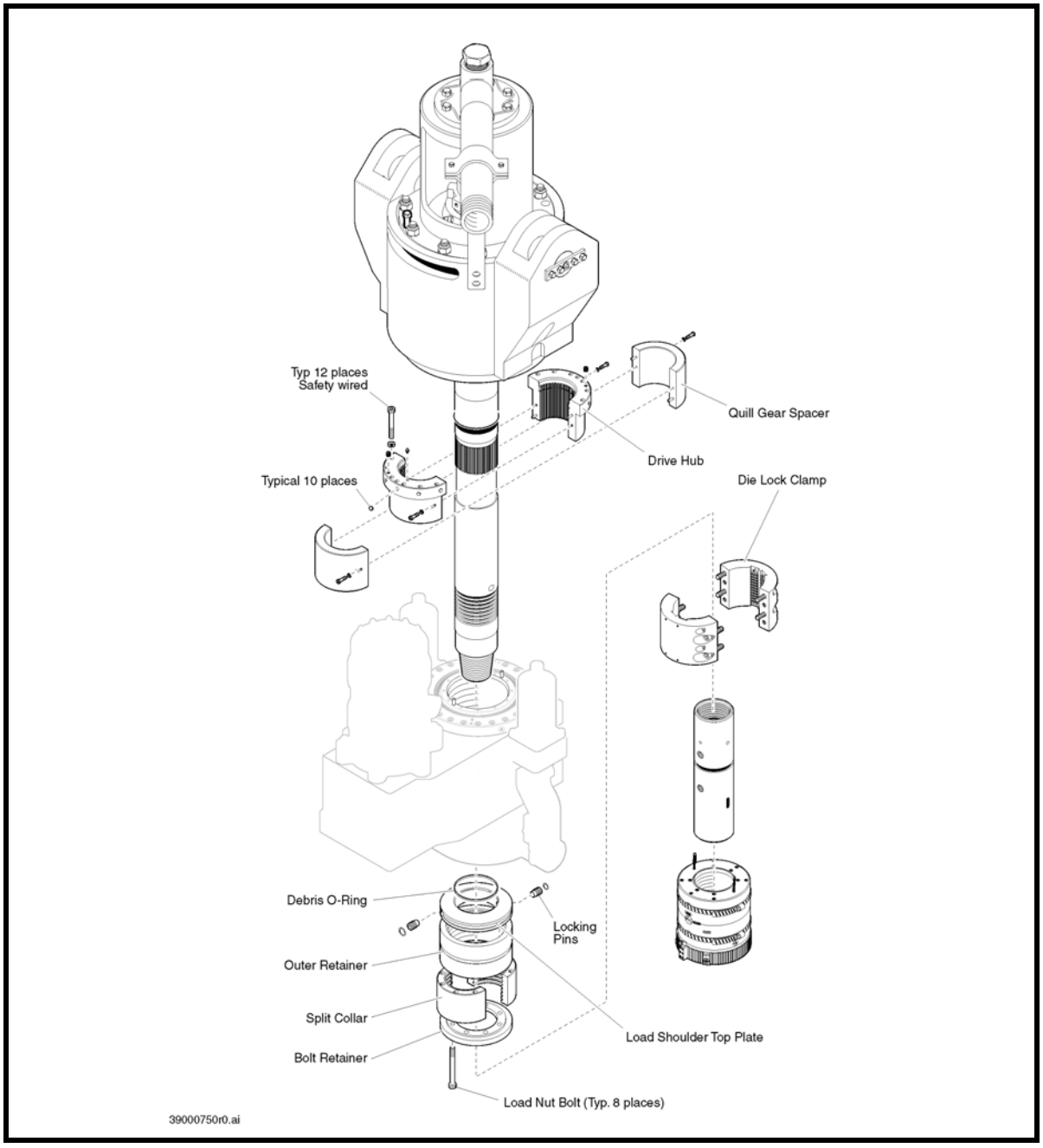
12. When inspection is complete, reinstall the pumps in their original position.
13. Torque all hold-down bolts to 350 ft-lb.

When you restart the unit, check the oil supply to each pump drive as follows:

14. Start the pump drive.
15. Allow the lubrication pump to circulate for one minute.
16. Slightly loosen the lubrication line to each pump adapter plate.
17. Ensure that each line has adequate oil flow.
    Note: The volume of flow should be low but continuous. If a line does not exhibit correct flow, shut down and completely remove the line. Inspect the line for clogs, pump failure, or filter problems (if a filter is present).

CHAPTER 5: DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

Figure 5-1: Load path components



HOW TO DISASSEMBLE THE LOAD PATH

Use the following procedures to disassemble the load path:

- Break Out the Load Path
- Remove the Load Nut
- Remove the Quill and Swivel Body

Break Out the Load Path

Perform the following steps *before* you disconnect the service loop hoses and cables from the top drive. The top drive must be fully functional for you to disassemble the load path.

1. Put the top drive into its shipping stand.
2. Move the top drive to a firm, level location where you have the following:
   - overhead hoisting equipment
   - enough overhead clearance so that you can remove the quill.
3. If you want to remove the saver sub, loosen and remove it now.
4. Loosen and remove the mudsaver/quill die lock clamp.
5. Remove the hydraulic hoses for the open and close circuits for the mudsaver valve.
6. Position the grabber so that it will close on the mudsaver valve.
   Note: Use the pin set on the back of the grabber leg to change the position of the grabber.
7. Place blocks between the valve actuator and the grabber.
8. When the grabber is in position on the mudsaver valve, set the GRABBER switch to CLOSE.
9. Clear all tools from the quill area.
10. Set the MODE switch to CONN.
11. Set the PUMPS–REV/FWD switch to REV.
12. With the grabber closed on the mudsaver valve, press and hold the BREAKOUT button.
13. Break out the mudsaver valve and allow the quill to unscrew the connection.
14. When the connection is unscrewed, lower the grabber and the mudsaver valve.
15. Verify that the blocks that you installed earlier will support the weight of the mudsaver valve.
16. Open the grabber to release the mudsaver valve.
17. Install a valve-handling nubbin and remove the mudsaver valve.
18. Refer to the Rig Out Procedures as described in the Installation Guide for your unit.

Remove the Load Nut

1. Remove the snap rings from the locking pin(s) on the load nut.
2. Remove the locking pins.
3. Pry the top debris o-ring out of its groove in the load nut and slide it up the quill.
4. Remove the lock wires from the load nut bolts (8).
5. Remove all the bolts on the load nut.
6. Slide the bolt retainer off the bottom of the quill.
7. Gently tap the outer retainer to expose the inner split collars.
8. Remove the inner split collars from the quill.
   Note: This exposes the groove profile of the quill.
9. Slide the top plate of the load shoulder off the quill.
   Note: The locking pins on the top plate prevent the load nut from rotating on the quill.

Remove the Quill and Swivel Body

The quill and swivel body cannot be removed until the quill collars and the load nut have been removed. The quill must be connected to a lifting apparatus.

1. Remove the lockwires from the bolts on the quill drive hub.
   Note: These bolts, combined with the drive hub, hold the quill in the quill gear.
2. Remove the socket head bolts (12).
   Note: The quill is now free.
3. Secure the quill and swivel body by running a sling through the yoke of the swivel.
   Note: If you removed the yoke and links, wrap a soft sling around the bail pins in the side of the swivel.
4. Hoist the swivel body and quill out of the gearbox.

Caution: The lifting apparatus must be rated for 6,000 lb. If the drive bushing of the quill will not separate from the drive hub, use the jacking screws (2) on the top of the drive hub to separate them.

HOW TO ASSEMBLE THE LOAD PATH

Use the following procedures to assemble the load path:

- Install the Quill
- Install the Load Nut
- Connect the Mudsaver Valve

Install the Quill

Inspect, clean and deburr the following components before you reassemble the load path:

- quill threads
- load nut profiles
- drive bushing and drive spacer
- bolts
- load nut components

1. Ensure all required maintenance for the gearbox and swivel body is completed before you perform this procedure.
2. Ensure the quill is clean.
3. Ensure the lower quill connection is properly protected (use a lifting nubbin or other suitable protection).
4. Lightly grease the quill splines and drive bushing areas.
5. Ensure the dowel pins are installed in the drive hub of the gearbox.
6. Ensure the load collar is in place.
7. Install the gear drive bushing and spacers onto the quill.
8. Ensure that the radial location bushing for the quill gear is properly installed and that it uses a spiral lock retaining ring.
   Note: These are located at the bottom of the drive hub.
9. Hoist the swivel and quill gear above the gearbox.
   Note: Use a lifting device rated for at least 6,000 lb.
10. Ensure the top drive stand is on a solid and level surface.
11. Slowly lower the quill through the quill drive gear.
12. When the quill drive gear is close to the top of the drive hub, rotate the drive gear to align it with the dowel pins.
13. Lower the quill until the dowels are visible at the top of the drive hub.
14. If required, reset the jacking set screws (2). These are located on top of the drive bushing hub.
15. Put a drop of blue Loctite thread fastener in each hole and install ‘socket head’ cap screws.
    Note: Torque bolts in a cross pattern, gradually increasing the torque on all bolts to 140 ft-lb.
16. Secure all bolts in place with lock wire.

Install the Load Nut

The swivel body and quill must be in place before you can perform this procedure.

1. Raise the top plate of the load shoulder into position with the bevel side facing up.
2. Loosely install the locking pins. This will hold the top plate in position.
3. Ensure the quill profile is clean.

4. Coat the quill profile area with a light coat of anti-seize compound or rust inhibitor oil.
5. Ensure the inner segments of the split collar are clean.
6. Install the inner segments of the split collar on the quill.
   Note: Tap the segments with a non-marking hammer to seat them.
7. Ensure the outer retainer is clean and coated with a light film of rust inhibitor oil or anti-seize compound.
8. Slide the outer retainer onto the split collar segments.
9. Slide the bottom plate into position.
10. Use the first bolt to line up the bottom retainer plate with the outer retainer and top plate.
11. Insert the remaining bolts.
    Note: Torque the bolts in a cross pattern, gradually increasing the torque on all bolts to 140 ft-lb.
12. Secure all bolts with lockwire.

Install the Mudsaver Valve

Before you can perform this procedure, the quill must be fully installed as per previous procedures.

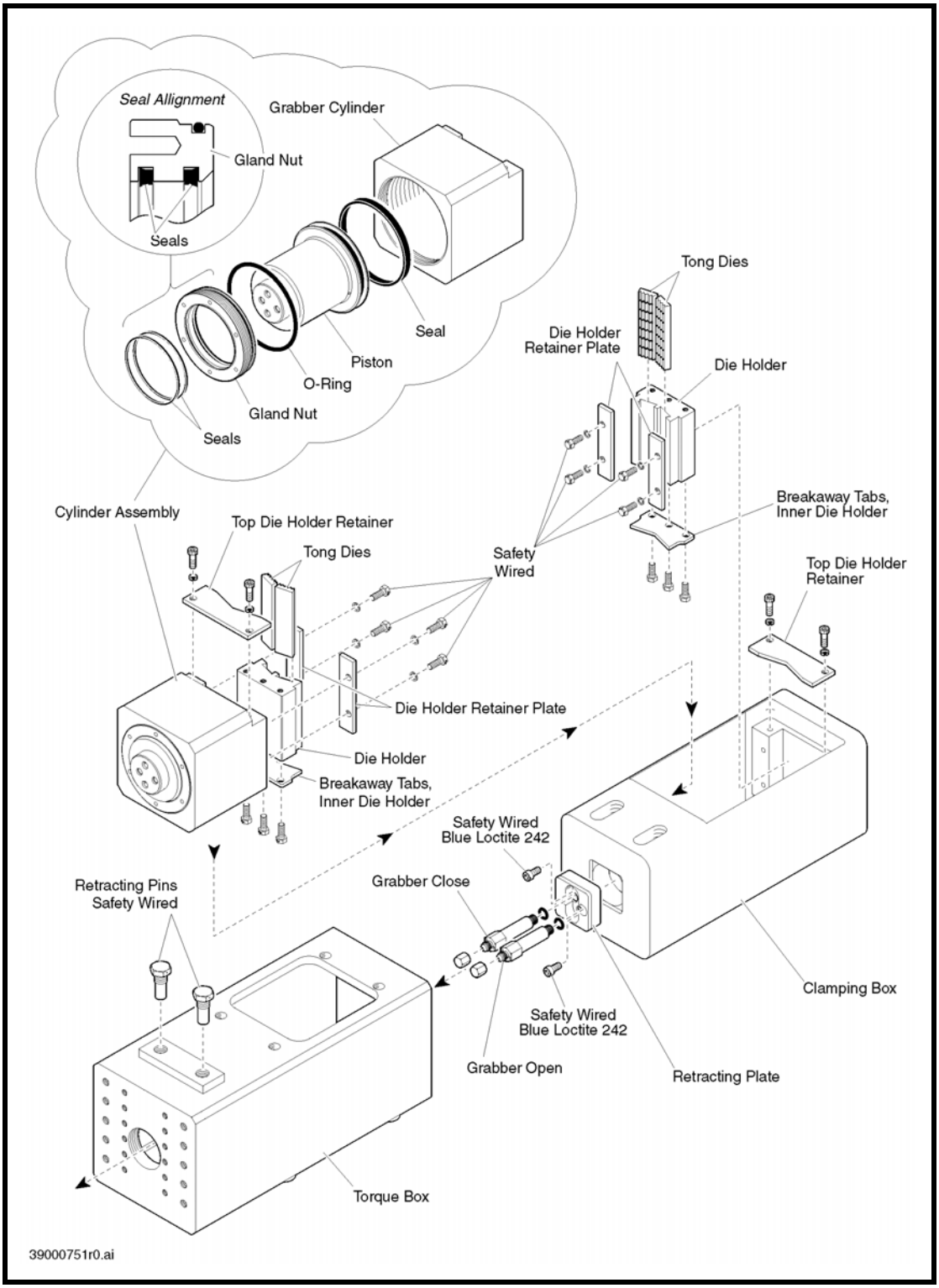
1. Reduce SET and MAX TORQUE values to levels much lower than what is required for normal operations.
2. Apply thread dope to the mudsaver valve and the quill pin.
3. Lift the mudsaver valve and start the mudsaver/quill connection by hand.
4. Screw the mudsaver/quill connection together by hand.

Caution: Do not use the top drive to make the connection; this can damage the valve threads.

5. Manually reset the grabber height so that it closes on the mudsaver valve.
6. At the driller's panel, set the GRABBER switch to CLOSE; it should close on the mudsaver valve.
7. Set the MODE switch to CONN, and set the PUMPS–REV/FWD switch to FWD.
8. Push and hold the MAX TORQUE button.
   Note: Use the Bosch control valve on the filter manifold of the power unit to increase MAX TORQUE to the desired make up torque.
9. Release the MAX TORQUE button when desired torque is achieved.
10. Open and lower the grabber.
11. Install the mudsaver, die lock clamp and retainer ring.
12. Use a die lock clamp to install the saver sub into the mudsaver valve.
    Note: For more information refer to the Operations Guide for your unit.

HOW TO DISASSEMBLE AND ASSEMBLE THE GRABBER

Figure 5-2: HMI grabber box components



Introduction

This section contains the procedures that explain how to disassemble and assemble the grabber components:

- How to Change the Grabber Dies
- How to Remove, Service and Reinstall the Grabber Actuating Piston
- How to Remove and Reinstall the Grabber Leg

The grabber might require disassembly and repair if the following problems occur:

- The grabber will not open or close even though electrical and hydraulic circuits are operating normally.
- The grabber will not hold the required pressure.
- A hydraulic oil leak is detected.

How to Change the Grabber Dies

It is easiest to perform this procedure if the drill pipe is disconnected and the saver sub is removed, however, grabber dies can be changed with the drill pipe connected to the saver sub, if required.

Caution: This procedure requires the removal and replacement of small parts. If possible, use the EXTEND function to move the bottom of the grabber away from hole center. Cover all exposed areas around well center to prevent parts from falling through the table.

Caution: It is easier to access the grabber dies and bolts if the grabber is partially closed. Do not allow the grabber to close fully.

1. Remove the lower die keeper plates (2) and the retaining bolts (2 per plate).
2. Use a long pin punch or similar tool to tap the dies downward and out of the die holder blocks.
3. Remove spacers, if used.
4. Use a film of grease or pipe dope to lubricate the new dies.
5. Install the new dies and spacers.
   Note: Select dies and spacers that are appropriate for the drill pipe in use. Refer to “Appendix B: Tool Joint Usage Chart”.
6. Install the die keeper plates.
   Note: Torque the retaining bolts to 100 ft-lb.

How to Remove the Grabber Actuating Piston

The grabber must be empty before you can perform this procedure.

Caution: This procedure requires the removal and replacement of small parts. If possible, use the EXTEND function to move the bottom of the grabber away from hole center. Cover all exposed areas around well center to prevent parts from falling through the table.

1. Cut the lock wires on the lower grabber retractor pins.
2. Remove the retractor pins (2).
3. Label the ‘grabber-open’ and ‘grabber-close’ hydraulic hoses, then remove them. Cap the hoses.

Caution: Ensure that the GRABBER switch is in the neutral position and the auxiliary pump is shut off.

4. Slide the complete clamping box assembly out of the torquing box.
5. Remove the piston retaining bolts (2) and the retraction plate from the clamping box.
6. Remove the hydraulic extension ports (2).
7. Slide the cylinder assembly out of the clamping box. You do not need to remove the die and die holder at this time.
8. Repair or replace the piston or seals as required.
   Note: If you are replacing the piston assembly, then you must remove the die holder and install it onto the new piston.

How to Reinstall the Grabber Actuating Piston

The following procedure assumes that all grabber cylinder components are assembled.

1. Install the die holder plate on the end of the grabber cylinder.
2. Torque the retainer plate bolts to 40 ft-lb.
3. Slide the cylinder assembly into the clamping box.
   Note: Ensure that the port extensions are oriented upward.
4. Install the retraction place and piston retaining bolts (2), and torque the bolts to 100 ft-lb.
5. Install the port extensions (2).
6. Invert the clamping box.
7. Install the dies, keeper plates, and die keeper bolts.
8. Secure all drilled bolts in place with lockwire.
9. Slide the clamping box into the outer torquing box.
10. Install the retraction pins (2) and secure them in place with lock wire.
11. Connect the grabber open/close hydraulic lines.
12. Reset the grabber height. For more information, refer to “How to Reset the Grabber Height” on page 37.

How to Repair the Grabber Cylinder

This procedure assumes that the grabber cylinder has been removed from the clamping box. Refer to "Appendix B: Tool Joint Usage Chart" to determine which dies and spacers to use for the tool joint in use.

1. Remove the die holder plate from the cylinder assembly.
2. Use the gland nut spanner supplied by TESCO to remove the brass gland nut from the end of the cylinder.
3. Pull the piston out of the cylinder.
4. Replace the seals and inspect the cylinder for internal damage.
   Note: Use a fine emery cloth or a fine grit cylinder hone to remove small surface defects.
5. Install new gland seals as required.

Caution: Exercise caution when you reassemble this component. The piston open/close ports can damage the gland seals.

6. Assemble the piston components.
   Note: Ensure that all bolts and O-rings are coated with light grease before assembly.
7. Actuate the cylinder with oil to purge the air from the cylinder.

Danger! Air in the cylinder will act as an accumulator. Accumulation of pressure can cause injury when the piston is tested.

8. Pressure-test the piston assembly to 2,000 psi on both the open and close side of the circuit.

How to Remove and Reinstall the Lower Grabber Leg

Remove the Lower Grabber Leg

1. Remove the safety chain from the back of the lower grabber leg.
2. Prepare the leg for removal according to one of the following conditions:
   - If the top drive can be hoisted off of the grabber leg, then lower the grabber to the end of its travel stroke and use blocks to support it.
   - If the top drive cannot be hoisted, ensure that there is enough clearance below the top drive to remove the grabber leg. This might require setting the top drive handling frame on blocks.
3. Ensure that the grabber is fully supported from beneath.
   Note: The weight of the leg is approximately 400 lb (181 kg).
4. Remove and cap the grabber-open and grabber-close hydraulic lines.
   Note: Label all hoses to make it easier to reinstall them correctly.
5. If possible, hoist the top drive off the grabber leg.
   Note: If it is not possible to hoist the top drive, use a manual chain fall to support the weight of the grabber leg. Remove the support blocks and lower the leg to the ground.
6. Remove the height adjustment pins to release the grabber leg.
7. Remove the grabber leg assembly from the working area.
8. Repair the components as required.

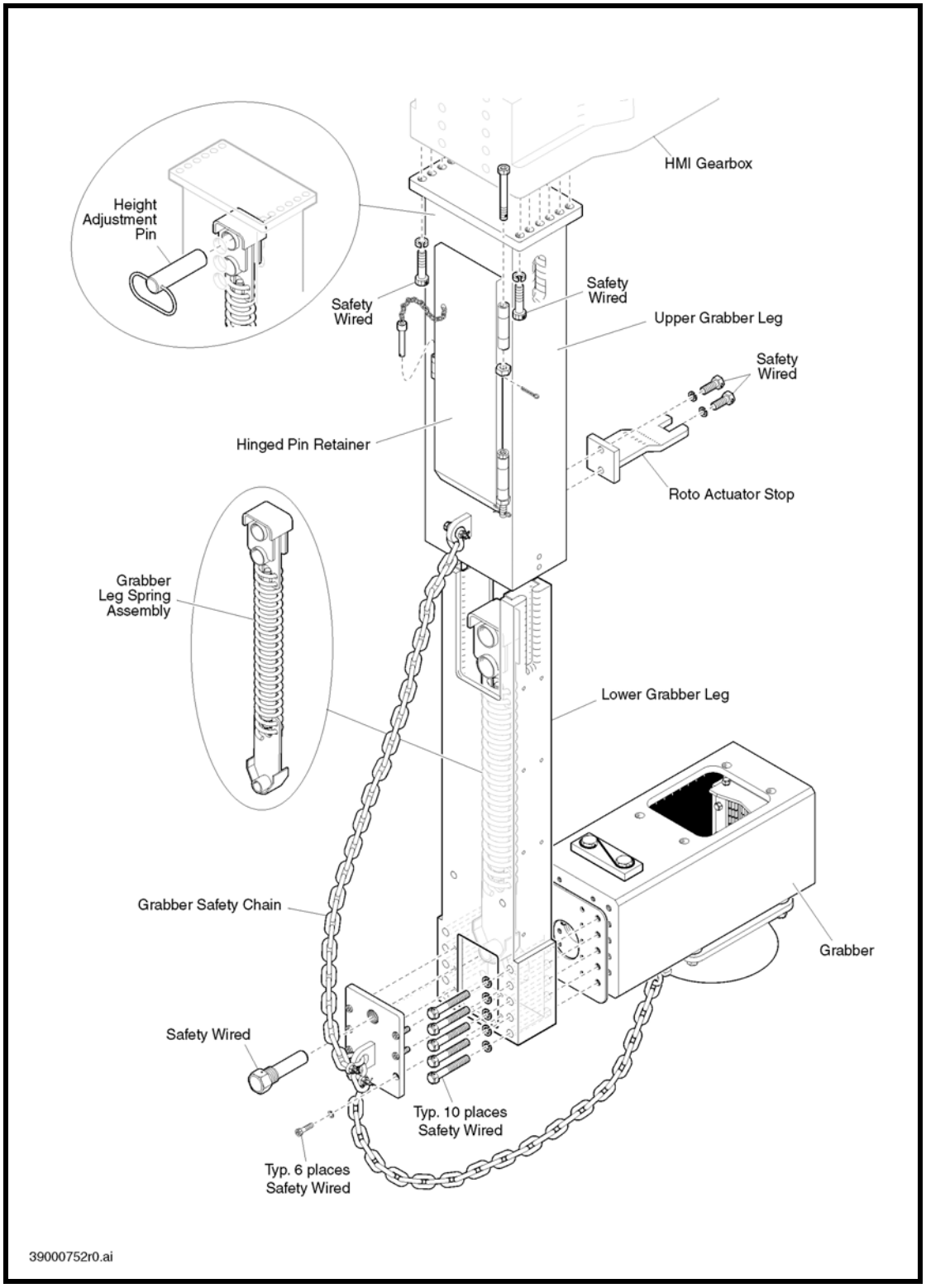
Reinstall the Lower Grabber Leg

9. Position the grabber leg below the top drive.
10. If possible, lower the top drive and allow the grabber leg to travel into the upper grabber leg.If the top drive cannot be lowered, raise the grabber leg into position using manual chain fall or similar device.

Caution: Be careful while inserting the grabber leg so that no damage occurs to the cylinder or hydraulic lines. Carefully monitor the spring assembly.

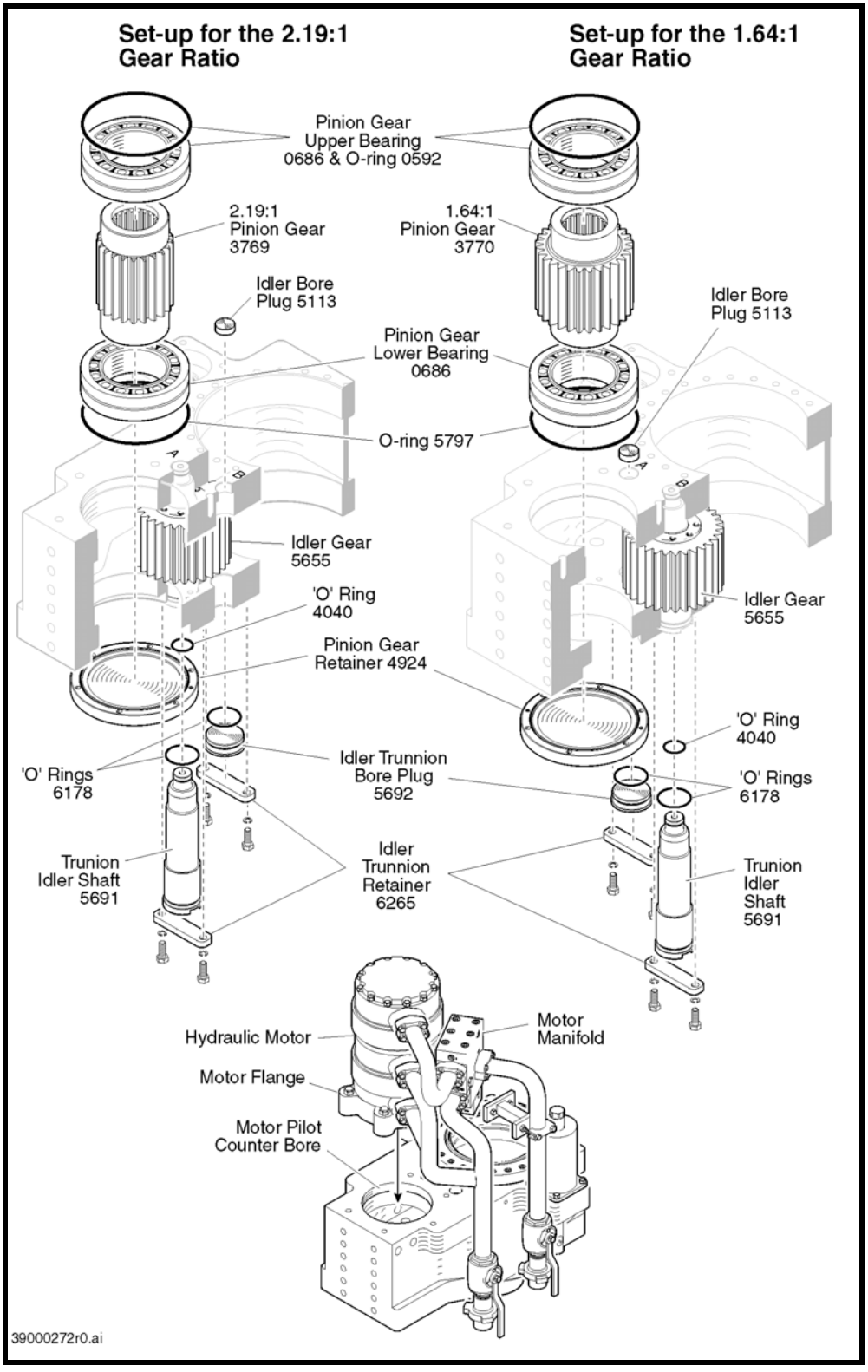
11. When the grabber leg is in position, insert the height adjustment pin.
12. Adjust the height of the grabber as described in “How to Reset the Grabber Height” on page 37..
13. Install the grabber leg safety chain.
14. Install the hydraulic lines for the GRABBER-OPEN and GRABBER-CLOSE circuits.

Figure 5-3: HMI grabber assembly



HOW TO CHANGE THE HMI GEAR RATIO

Figure 5-4: Gear ratio configuration



Use the following procedure to move the idler gear and change pinion gear from 21T (1.64:1) to 28T (2.19:1).

1. Drain all of the oil from the gearbox.
   Note: If you replace the oil, ensure that all waste oil is correctly disposed of.
2. Remove the motor and manifold as a single unit.
   - To remove the motor and manifold, you must remove the six bolts that hold the motor in place.
   - Label all control hoses, disconnect and put protective covers on all hose ends.
3. Remove the 21T-pinion gear from the motor pilot bore.

Caution: Ensure that the bearing below the pinion gear (in the base of the gearbox) is not moved out of alignment when you remove the pinion gear.

4. Inspect the lower bore area for metal deposits or debris. If you find dirt or debris, thoroughly clean the gearbox.
5. Remove the retainer plate for the 1.64:1 trunnion idler pin from the bottom of the gearbox.
6. Remove the 2.19:1 idler bore plugs from the top and bottom of the gearbox.
   Note: At the top of the gearbox this is a frost plug, at the bottom it is a blank plate.
7. Remove the retainer plate for the trunnion idler and immediately install a thread-protecting bolt into the tapped idler pin hole.

Caution: These threads are important for correct gear installation. Do not damage these threads.

8. Remove the idler pin and replace both O-rings.
9. Move the idler gear to align with the bore position of the 2.19:1 trunnion idler pin.
10. Apply lubrication to the idler bearings.
    Note: This will help maintain alignment when you install the idler pin.
11. Install a long bolt or ready-rod in the idler pin.
12. Pull the pin into the 2.19:1 gearbox bore.

Caution: Do not misalign the bearing set in the idler gear.

13. Secure the pin with the retaining plate for the idler pin.
14. Install the 2.19:1 pinion gear.

Caution: Do not misalign the bearings in the pinion bore.

15. Install the idler bore plug in the 1.64:1 position (top of gearbox).
16. Apply silicone to the frost plug.
17. Replace the O-ring on the trunnion bore plug and install the plug in the 1.64:1 position (bottom of the gearbox).

18. Replace the O-ring on the motor pilot flange and apply silicone to the space plate.
19. Replace the motor and manifold assembly.
20. Replace the gearbox oil.
    Note: Refer to fluid specification EM000042 for information on what lubricants can be used in this application.

CHAPTER 6: LONG TERM PRESERVATION AND STORAGE

INTRODUCTION

Use the following guidelines whenever you place a TESCO top drive into long term storage.

Before you begin these procedures, ensure that all necessary unit maintenance is complete and the unit is fully functional.

If all repairs cannot be completed, ensure that you create the following:

- a detailed list of maintenance/repair requirements
- a complete list of parts required

BEFORE SYSTEM SHUT DOWN

Before you shut down the top drive system, do the following:

1. Add corrosion inhibitor to the gearbox. Most oil inhibitors require some mixing with the base oil. Prepare the corrosion inhibitor according to the manufacturer's instruction.
2. Check the cooling fluid. If the system will be stored at temperatures below 0° Celsius, ensure the prime mover cooling fluid level is at 'full.' If required, add GDX Diesel anti-freeze. If necessary, drain the cooling system replace the cooling fluid.
3. Determine if you will need to perform a load path inspection before you re-start the unit. If an inspection will be required, ensure that all load path connections are broken out now. This will allow you (or another inspector) to inspect the top drive system without having to supply power to the unit.

The following procedures assume that the top drive system has already been correctly decommissioned as described in the Rig Out Procedures section of the Installation Guide for your unit.

TOP DRIVE

Junction Boxes (Auxiliary Panel)

1. Open the motor sensor junction box.
2. Check for moisture.
3. Install a new desiccant pack.
4. Tighten all wire terminals in the junction box.
5. Close and reseal the junction box.

When these procedures are complete, seal all junction boxes with corrosion inhibitor tape. Also, ensure that all breather openings are sealed.

Main Drive Quill

1. Clean and inspect the quill connections.
   Note: The mudsaver valve must be removed before you can inspect the lower connection.
2. Coat all connections with thread compound or preservative grease.
3. Wrap all connections with corrosion inhibitor tape.

Load Nut

If you remove the quill, service the load nut as follows:

1. Clean and inspect all parts of the load nut.
2. Coat all segments with light oil, then reinstall.
3. Apply a coat of grease to the outside of the load nut, particularly the load shoulder.

Grabber Leg

1. Remove the grabber leg.
2. Apply a liberal coat of grease to the sliding section of the lower leg.
3. Apply grease or anti-seize compound to all pin pockets and threads.
4. Reinstall the grabber leg.
5. Remove the grabber cylinder from the grabber assembly. See “How to Remove the Grabber Actuating Piston” on page 56.
6. Remove the die holder plates and dies.
7. Inspect and clean all die holder plates and dies.
8. Apply grease or anti-seize compound to all die holder plates and dies.
9. Reassemble the grabber components.
10. Coat the entire torque box with a light film of grease.
11. Install the grabber cylinder in the grabber assembly.

Elevators

1. Remove the elevator inserts.
2. Use a wire brush to clean and brush the inserts.
3. Apply a thin coat of grease or anti-seize compound to the inside of the elevators and all sides of the inserts.
4. Apply anti-seize compound to all stop bolts.
5. Install the elevator inserts.
6. Operate the elevators and thoroughly grease the body and hinge.
7. Apply grease to the exposed rod shafts of the elevator operating cylinders.
8. Grease all retainer bolts on the elevator link(s).

Mudsaver Valve

1. Remove the actuator.
2. Clean and inspect the threads on the mudsaver valve.
3. Clean the inside of the valve.
4. Manually close the valve.
5. Pour oil into the ball of the valve.
6. Operate the valve.
7. Repeat steps 4-6 for both sides of both balls.
8. Apply liberal amounts of thread dope to all connections.
9. Use a wire brush to clean and brush the outside of the valve.
10. Apply grease to the valve stem area and valve body.
11. Clean and inspect the actuator.
12. Grease the inside of the actuator.
13. Reinstall the actuator on the mudsaver valve.
    Note: Use anti-seize compound on all fasteners and hex nuts.

Saver Subs

1. Clean and inspect all threads.
2. Apply pipe dope and install thread protectors.

HOSE STORAGE REEL

Main Storage Reel

1. Perform the following for all hose ends and quick couplers:
   • clean and inspect
   • apply a thin coat of grease
   • wrap with corrosion inhibitor tape
   • check the rubber seals within the hammer unions
   • ensure the isolation valves are closed
2. Grease the bearings on the storage reel saddle.
3. Ensure that protective caps are installed on all hose connections.
4. Grease the drive chain on the storage reel.
5. Remove the hydraulic control for the storage reel.
6. Store the hydraulic control in the top drive shipping container or other sheltered location.

Perform the following steps for the 37C conductor cables (2):

1. Spool the 225 ft. cable onto a shipping reel.
2. Spool the 160 ft. pigtail onto a power cable post.
3. Spray the connector ends with light oil.
4. Wrap the connectors with corrosion inhibitor tape.

DRILLER'S PANEL

1. Open the driller's panel.
2. Check for moisture or damage.
3. Clean the interior.
4. Verify that all wire terminals are torqued to specification.
5. Install a new desiccant bag.
6. Clean all the connectors.
7. Spray the ends of the connectors with light oil.
8. Wrap all of the connectors with corrosion inhibitor tape.
9. Store the driller's panel in the top drive shipping container or other sheltered location.

Interlocks

1. Clean all interlock valves.
2. Spray the valves with light oil.
3. Clean all of the connectors.
4. Spray the ends of the connector with light oil.
5. Wrap all of the connectors with corrosion inhibitor tape.

TORQUE ARREST SYSTEM

Torque Track Assembly

1. Clean and inspect all sections of the torque track.
2. Use a wire brush on the end connection points of all torque track sections.
3. Clean and dry the ends of the track sections.
4. Apply a thin coat of grease to the ends of the track sections.
5. Install protective end caps.
6. Coat all bolts and studs with anti-seize compound.
7. Apply paint or corrosion inhibitor to any bare spots along the length of the torque tracks.

Torque Bushing/Extend Frame

1. Clean and inspect all pin sockets.
2. Apply a thin coat of grease to all pin sockets.
3. Wrap all pin sockets with corrosion inhibitor tape.
4. Grease the ends of all cylinder pivots and the exposed cylinder rods.
5. Clean the hydraulic quick-couplers for the EXTEND mechanism.
6. Apply a thin coat of grease to all quick-couplers.
7. Wrap the quick-couplers with corrosion inhibitor tape.
8. Inspect the liner of the torque bushing for wear.
   Note: Replace the liner prior to storage, if required.

Studs for Torque Track

Clean and grease.

Hanging Sling Assembly

1. Clean and inspect the hanging sling assembly.
2. Apply a thin film of grease to the entire assembly including cables and cable clamps.

Torque Beam and T-Bar

1. Clean and inspect the T-bar.
2. Apply a thin film of grease to the entire T-bar.
3. Clean and inspect the T-bar clamp on the torque beam.
4. Apply grease to the inside of the clamp plates.
5. Apply anti-seize compound to all bolts.
6. Reinstall the clamp.
7. Apply a thin coat of grease to the threaded rods of the clamp.
   Note: Apply grease to the entire length of rods.

POWER UNIT

Hydraulic Oil Storage Tank

1. Add oil inhibitor to the tank.
   Note: Check the manufacturer's specifications for correct inhibitor concentration.
2. Close all valves.
3. Apply a light coat of grease to all valve stems.
4. Seal all tank breather ports.
5. Apply a light coat of grease to hose end connectors.
6. Wrap hose ends with corrosion inhibitor tape.
7. Open the terminal boxes for the tank thermostat on the forward side of the tank.
8. Check the boxes for moisture.
9. Place a desiccant bag in each box.
10. Apply anti-seize compound to the cover bolts and reinstall the covers.
11. Grease the cover seal to prevent moisture from entering.

Air/Oil Cooler

1. Clean the cooler.

Caution: The cooler fins are easily damaged. Use extreme care during cleaning.

2. Check for visible damage and repair if required.
3. Prepare the cooler unit for storage.
   Note: If the unit will be stored in a shipping container, no further preparation is required.

   Note: If the unit will be exposed to the elements during storage, fabricate a cooler cover using tarps, plywood or other available materials.

Optional Stand-Alone Plate Exchanger

1. Open the unions to the water side of the cooler.
2. Ensure that the inside is dry.
3. If the unit has been operated using seawater, flush with fresh water.
4. Apply a light coat of grease to all unions and reinstall the caps.

Auxiliary Oil Pump

1. Open the electrical junction box.
2. Ensure the box is clean and dry.
3. Apply a light coat of grease to the sealing surface of the cover plate.
4. Coat all bolts with an anti-seize compound and reinstall the bolts.
5. Remove the coupler cover plate.
6. Spray light penetrating oil onto the coupler.
7. Reinstall the cover plates.

Filter Manifold

1. Remove the caps on the hammer union.
2. Lightly grease the caps and reinstall them.
3. Apply a light grease to all filter caps and relief plugs.

Pump Drive and Main Hydraulic Pumps

1. Apply light grease to all unpainted metal parts to protect against corrosion.
2. Apply grease to the threads of all mounting studs.
3. Add corrosion inhibitor to the pump drive oil.
   Note: Check the manufacturer's specifications for correct inhibitor concentration.
4. Seal and cover all breather ports and vents.

Prime Mover

1. Add corrosion inhibitor oil to the engine crankcase.
   Note: Check the manufacturer's specifications for correct inhibitor concentration. Change the oil and the filter.
2. Service and protect the radiator.
   Note: See "Air/Oil Cooler" on page 69 for more information.
3. Grease all belt tensioners and pulleys.
4. Perform the following battery maintenance if required (and if equipped):
   a. Remove the battery terminals and coat them with grease.
   b. Check the electrolyte level of the battery.
   c. Ensure battery is fully charged prior to storage.
5. Seal all crank case breathers and wrap them with corrosion inhibitor tape.
6. Wrap the alternator (if equipped) in an airtight bag that contains desiccant packs.
7. Ensure the bag is completely sealed.
8. Wrap the ECM modules (if equipped) in an airtight bag that contains desiccant packs.
9. Ensure the bags are completely sealed.
10. Spray the engine air starter with light penetrating oil.
11. Coat the connection for the air line with grease.

Main Electrical Panel

1. Open the panel and check for moisture.
2. Replace all desiccant packs.
3. Seal the door and wrap the seam with corrosion inhibitor tape.
4. Spray light inhibitor oil on all external switch points.

General

1. Clean and inspect all electrical connections.
2. Spray all electrical connections with light oil.
3. Wrap all cable ends with corrosion inhibitor tape.
4. Grease all hose end unions.
5. Install protective caps.

STORAGE CONTAINERS

When the final inspection is complete, all equipment should be placed in shipping containers. All shipping containers should be stored in a cool, dry place.

Equipment can be efficiently stored in the following configuration:

Container 1

- power unit

Container 2

- top drive
- assorted small items (multi-conductor cables)

Container 3

- torque arrest system components
- cable storage reel

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APPENDIX A: TORQUE STANDARDS FOR HIGH STRENGTH FASTENERS

The following information originated from the Standards document STD0015.

PURPOSE

This Standard should be used as a guideline for all fasteners used in production where the torque values are not specified on the Engineering documentation and drawings. All TESCO Standards on fasteners should be adhered to, as non-conformance can lead to the following:

- low quality products
- rework cost
- warranty claims
- late delivery
- customer dissatisfaction
- lower production.

STANDARDS

1. All capscrews, bolts and nuts have to be Grade 8 or equivalent unless noted otherwise (U.N.O.).
2. Fasteners must be torqued in accordance with tables 1, 2, and 3 U.N.O. Torques should be applied smoothly and with a calibrated wrench.
3. Multiple fastener arrays must be made up evenly using an appropriate torque sequence to minimize distortion. Fasteners shall be tightened using intermediate torque settings of 40% and 75% of values in the tables. All fasteners must be made up snug prior to starting the tightening sequence.
4. Fastener torques for bolting dissimilar materials must be based on the torque requirements for the lower strength material U.N.O.
5. Fasteners and holes should be free of burrs or damage. Damaged threads must be repaired using the appropriate tooling to ensure a free and smooth assembly.
6. When thread locking compound is used, holes and fasteners should be cleaned (free of oil or grease) and the compound should be applied in conformance with manufacturer's recommendations.
7. Allowable bolt tension and torque based on bolt thread engagement must be in accordance with Table 4 U.N.O.
8. Special fasteners must be installed and torqued in accordance with Table 2.
9. When threadlock is used, fasteners must be torqued in accordance with Table 1, Table 2 and Table 3, using the 'Lubricated' Torque data U.N.O.

10. For torque values for B7 studs with 2H nuts, see Table 3.

11. Lubricated fasteners must have oil or thread locking compound applied to the threads only.

12. Where metals with strongly varying electromotive properties are bolted together, such as steel and aluminum, thread locking compounds should be applied to limit the effects of galvanic corrosion.

13. A minimum of two full threads should project above any nut or locknut installed on a stud or as part of a bolted connection. Additional length is allowed to install safety pines or cotter pins to prevent fasteners from falling into overhead equipment.

TABLES

Table A-1: Standard torques

Material	Aluminum (ft·lbs)		Mild Steel (ft·lbs)		High Strength Steel (ft·lbs)	
Size	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
1/4 in.-20 UNC	9	7	10	8	12	9
5/16 in.-18 UNC	16	12	19	15	25	19
3/8 in.-16 UNC	33	25	40	30	45	34
7/16 in.-14 UNC	47	36	57	43	70	53
1/2 in.-13 UNC	86	64	100	75	110	83
9/16 in.-12 UNC	118	88	141	106	160	120
5/8 in.-11 UNC	163	122	195	146	220	165
3/4 in.-10 UNC	278	209	333	250	400	300
7/8 in.-9 UNC	436	327	523	393	645	484
1 in.-8 UNC	667	500	800	600	970	728
1-1/8 in.-7 UNC	950	713	1142	856	1370	1028
1-1/4 in.-7 UNC	1317	988	1575	1181	1900	1425
1-1/2 in.-6 UNC	2283	1713	2742	2056	3200	2400
Recommended torques are based on bolt tensions of approximately 80% of the yield strength and a minimum of one bolt diameter class 2B thread engagement in the material, or bolt head bearing pressures, whichever is less.						

Table A-2: Special fastener torques

Fastener Description	Minimum Engagement	Mild Steel (ft·lbs)		High Strength Steel (ft·lbs)	
		Dry	Lubricated	Dry	Lubricated
UNBRAKO 5/16 in.-18 UNRC	3/8 in.	27	20	35	26
UNBRAKO 1/2 in.-13 UNRC	1/2 in.	118	88	154	115
UNBRAKO 5/8 in.-11 UNRC	5/8 in.	217	162	283	212
Special fasteners shall be used only in critical locations or special applications. Thread engagement is based on the minimum class 2B tapped threads in mild steel capable of developing bolt tension 80% of bolt yield. When using hardened steel washers on mild steel, use torque values for high strength steel.					

Table A-3: B7 Stud torques

Stud Size	Dry (ft·lbs)	Lubricated (ft·lbs)
1/2 in.-3 UNC	85	64
5/8 in.-11 UNC	175	131
3/4 in.-10 UNC	300	225
7/8 in.-9 UNC	450	338
1 in.-8 UNC	680	510
1-1/8 in.-7 UNC	880	660
1-1/4 in.-7 UNC	1260	945
1-3/8 in.-6 UNC	1700	1275
1-1/2 in.-8 UN	2300	1725
Recommended torques are based on bolt tensions of approximately 75% of stud yield strength.		

Table A-4: Thread engagements

Material	Aluminum	Mild Steel	High Strength Steel
Engagement*	% of Full Torque	% of Full Torque	% of Full Torque
100%	100%	100%	100%
90%	100%	100%	100%
80%	100%	100%	100%
70%	100%	100%	100%
60%	90%	100%	100%
50%	70%	100%	100%
40%	60%	75%	100%
30%	45%	60%	75%
20%	30%	40%	55%

* Engagement as a% of the bolt diameter
Values represent the percentage of torque from Table 1. Engagement does not include chamfer or incomplete threads. Engagements of less than one bolt diameter in tapped holes shall not be used without the engineer's approval.

APPENDIX B: TOOL JOINT USAGE CHART

Use the following chart to configure the grabber and grabber dies to accommodate the current drill pipe.

Table B-1: Tool joint usage chart

Tool Joint O.D.	TESCO Part #	Qty	Description
3-1/8 in. – 6-5/8 in.	3051	2	Die holder
	1047	8	Socket head capscrew, 1/2-13UNC x 2-1/2 in.
	3054	2	Bottom keeper plate
	8378	2	Top die retainer plate
	3725	4	Hex head capscrew, 3/8-16UNC x 1 in.
	1045	4	Socket head capscrew, 1/2-13UNC x 1 in.
	6654	2	Spacer
	9070	4	Tong die, 1 in. thick x 1-1/4 in. wide x 5-7/8 in. long
	4891 (opt.)	4	Tong die, 1 in. thick x 1-1/4 in. wide x 3-7/8 in. long
	3055 (opt.)	4	Die spacer
4 in. – 7-1/2 in.	3051	2	Die holder
	1047	8	Socket head capscrew, 1/2-13UNC x 2-1/2 in.
	3054	2	Bottom keeper plate
	8378	2	Top die retainer plate
	3725	4	Hex head capscrew, 3/8-16UNC x 1 in.
	1045	4	Socket head capscrew, 1/2-13UNC x 1 in.
	6654	2	Spacer
	1676	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 5-7/8 in. long
	2526 (opt.)	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 3-7/8 in. long
	3055 (opt.)	4	Die spacer
5 in. – 8-1/2 in. (standard)	3051	2	Die holder
	1044	8	Socket head capscrew, 1/2-13UNC x 1 in.
	3054	2	Bottom keeper plate
	1045	4	Socket head capscrew, 1/2-13UNC x 1 in.
	1676	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 5-7/8 in. long
	2526 (opt.)	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 3-7/8 in. long
	3055 (opt.)	4	Die spacer
8-1/2 in. – 8-3/4 in.	8760	2	Die holder
	1045	4	Socket head capscrew, 1/2-13UNC x 1 in.
	7443	2	Shim, 1/8 in.
	1676	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 5-7/8 in. long
	2526 (opt.)	4	Tong die, 1/2 in. thick x 1-1/4 in. wide x 3-7/8 in. long
	3055 (opt.)	4	Die spacer

Table B-2: Tool joint usage chart

Tool Joint O.D.	TESCO Part #	Qty	Description
2-7/8 in. – 4 in.	5807	4	Die holder retainer, for 1/2 in. shims
	5808	2	Shim, 1/2 in.
	7588	4	Tong die, 1 in. thick x 1-1/4 in. wide x 5 in. long
	3852	2	Break-away tab
	6244	2	Die retainer
	8626	8	Cap screw, hex head, 3/8 in. x 1-1/2 in.
3-1/4 in. – 4-1/2 in.	5807	4	Die holder retainer, for 1/2 in. shims
	5808	2	Shim, 1/2 in.
	1677	4	Tong die, 1 in. thick x 1-1/4 in. wide x 5 in. long
	3852	2	Break-away tab
	6244	2	Die retainer
	8626	8	Cap screw, hex head, 3/8 in. x 1-1/2 in.
3-1/2 in.– 6-5/8 in.	3845	4	Die holder retainer
	1677	4	Tong die, 1 in. thick x 1-1/4 in. wide x 5 in. long
	3852	2	Break-away tab
	6244	2	Die retainer
	3725	8	Cap screw, hex head, 3/8 in. x 1 in.

APPENDIX C: FUSES FOR THE CONTROL TRANSFORMER

Danger! Electrical voltages of different potentials are used throughout the Tesco top drive components. ONLY qualified personnel should install, maintain, and/or troubleshoot the electrical systems. A severe safety hazard exists for personnel not accustomed to, or familiar with, electrical hazards and procedures.

GENERAL

The electrical protection requirements for the primary and secondary of this transformer will be clearly marked in an area close to the fuse locations. This will be on the Plexiglas barrier. The information will indicate the following:

- Type
- Voltage Rating
- Current Rating
- Interrupting Rating

CAT II: Power supply to control power transformer and receptacle outlet circuits (120 volt AC); The fuses on the 120 volt primary side of the control transformer are 10 amps.

CAT I: Protected electronic control circuits, control power (24 volt DC); The fuses on the 24 volt secondary side of the control transformer are 20 amps.

FUSE, MAIN POWER 480 VAC 3 PHASE L1, L2, L3

- Manufacture: Bullet
- Type: 80 Amp, CSA Type D, HRCI - R
- Dual Element Class RK 5
- Current Limiting
- Listed Fuse DL 93 - 91

FUSE 120 VOLT, L1, L2, & AC - 15

L1 Power Supply to 15 amp breakers for:

- AC - 15 Primary side of control transformer
- AC _ 4 Receptacles
- AC _ 3 Lights
  - Type BAF
  - 250 VAC 30 amp
  - IR 10 kA
  - OMT 30

L2 Control power to:

- Auxiliary pump
- Circulation pump
- Cooling Fan
  - Type: Edison Fast Acting MOL 8 amp
  - 250 VAC IR 200 amp
  - 125 VAC IR 10 kA
- AC–15_24 VDC Power Supply Input
  - Type: BAF 10
  - 250 VAC IR 200 amp
  - 125 VAC IR 10 kA

FUSE 24 VDC POWER SUPPLY OUTPUT

- Type: Buss AGC 20
- 32 volt
- 20 amp

FUSE 24 VDC POWER SUPPLY TO TORQUE CIRCUIT

- Type: Edison Fast Acting
- MOL 1 amp
- 250 VAC IR 100 amp
- 125 VAC IR 10 kA

CONTROL POWER SUPPLY NAMEPLATE INFORMATION

- Type: Custom Rectifier Level I, ACME
- Electric, Power Products Group
- Standard Power
- 500 B 24H
- 0002 - 101943 - 01
- 115 / 230 volt 50 / 60 Hz
- 24 v, 20 OA - DC
- EIA - 413974440 G

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APPENDIX D: SAMPLE INSPECTION LOGS

The following pages contain examples of inspection logs. It is important to keep detailed inspection records for all load path and torque arrest system components. Please use the following pages as a guide.

Use this log to schedule and track inspections for each load path component.

In this field	Do this
Serial Number	Record the component serial number.
Inspection Date	Enter the date of the most recent component inspection.
Days in Service	Enter the cumulative hours (or days) of service the component has been in service on the date of inspection.
Inspected By	Enter the name of the company that performed the inspection. Note: Attach a copy of the inspection results to this inspection log.
Results/Comments	Summarize the test results, and note any special action taken in the Additional Comments section at the bottom of the page. If a component is replaced, include the serial number for the replacement part.
Next Service Due	Enter the hours (or days) of service when the component requires its next inspection.
Additional Comments	Enter additional information as required.

QUILL INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

INTEGRATED SWIVEL INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

LOAD NUT RETAINER AND SPLIT COLLAR INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

MUDSAVER VALVE INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

SAVER SUB INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

LOAD COLLAR INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

ELEVATOR LINKS INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

ELEVATOR INSPECTION LOG

Top Drive Number:	Service Facility:	Service Activation Date:
Top Drive Type:	Location:	Other:

Serial #	Inspection Date	Days in Service (Cumulative)	Inspected By	Results/Comments	Next Service Due
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	
				❑ Good Condition ❑ Repaired ❑ Replaced	

Additional Comments:

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APPENDIX E: SERVICE CHECKLISTS

This Appendix contains examples of the following checklists:

- Daily Checklist (see also Maintenance and Service Schedules)
- Weekly Checklist (see also Maintenance and Service Schedules)
- Monthly Checklist (see also Maintenance and Service Schedules)
- Six-Month Checklist
- Megger Test Chart
- Daily Top Drive Report

The Daily Top Drive Report exists in booklet form and can be ordered from TESCO.

DAILY CHECKLISTS

Date:	**Supervisor:**
Rig:	**Time:**

Daily: Top Drive

Inspect	For	Inspector
Gearbox oil	correct oil level	
Hydraulic hoses and connections at the top drive	leaks	
Grabber dies	excessive wear	
Mudsaver valve (lower ball)	manually operate the valve to check function	
Saver sub threads	excessive wear	
Swivel oil level	correct level	
Grabber	check and reset grabber height	

Lubricate	With	Inspector
Upper quill bearing retainer (1)	EP2 mutli-purpose grease	
Lower quill bearin retainer (1)	EP2 mutli-purpose grease	
Upper input shaft retainer (1)	EP2 mutli-purpose grease	
Lower input shaft retainer (1)	EP2 mutli-purpose grease	
Slew drive grease nipple (2)	#200 Schaeffer Silver Streak® or Shell Malleus® Grease GL	3 each
Grease nipples on the EXTEND cylinder (4), if applicable	EP2 multi-purpose grease	
Lower bearing retainer of gearbox grease ports	EP2 multi-purpose grease	
Upper bearing retainer of gearbox grease ports (2)	EP2 multi-purpose grease	
Swivel pins (6)	EP2 multi-purpose grease	
Grease ports on the load collar (1)	EP2 multi-purpose grease	
LINK TILT cylinders (4)	EP2 multi-purpose grease	
Grease ports on the elevator (3)	EP2 multi-purpose grease	
Elevator handle pins (2)	EP2 multi-purpose grease	
Elevator hinge pin (1)	EP2 multi-purpose grease	
Yoke pins (2), if applicable	EP2 multi-purpose grease	
Mudsaver valve actuator (3)	Metalon EP1.5 -TESCO Part #2996	
Pipe handler lock (1)	EP2 multi-purpose grease	
Sheave pins (4), if applicable	EP2 multi-purpose grease	
Adaptor link pins (2) (if applicable)	EP2 multi-purpose grease	
Swivel link pins (2) (if applicable)	EP2 multi-purpose grease	

Lubricate	With	Inspector
Wash pipe (1)	EP2 multi-purpose grease	

Daily: Torque Arrest System

Inspect	For	Inspector
All connections	damage or decay	
All overhead equipment (T-bar, torque beam, torque track, torque bushing)	damage or decay	

Daily: Auxiliary Hydraulic Power Unit

Inspect	For	Inspector
Auxiliary hydraulic oil tank	correct oil level	
Coolant tank	correct coolant level	
Modine air exchanger	radiator cleanliness	
Cooling coil on the Trane chiller	cleanliness	
All flow meters	reporting correct flow	

Daily: Power Module

Inspect	For	Inspector
All panels and floor	coolant leaks	
Drive components **Caution:** Condensation in the drive components can cause **severe** damage if not immediately addressed. See “Condensation” on page 13	moisture .	
Indicator lights	correct function (replace if required)	
VFD Blower	proper operation	
Door fan	proper operation	
Chopper fan	proper operation	
Selection switch, ESD push button	correct function (replace if required)	
Braking register module	for sign of overheating	

Comments/Notes:

Daily: Prime Mover

Inspect	For	Inspector
All hoses and belts	leaks, tightness	
Exhaust system	routing, loose clamps and bolts; check visually	
Oil level	low idle oil level; check for leaks	
Coolant level	correct level	
Oil pressure	correct operating range; consult the manufacturer's service and maintenance documentation for your prime mover module	
Operating fuel pressure	adequate pressure; consult the manufacturer's service and maintenance documentation for your prime mover module	
Air filter restriction indicator	consult the manufacturer's service and maintenance documentation for your prime mover module	
Rig saver	confirm correct position (open)	

Daily: Pump Drive

Inspect	For	Inspector
Oil level	adequate oil level; fill if required	
Oil system	leaks	
Cooling system	excessive dirt, general condition; check the heat exchanger	
Pump drive lubrication system	correct lubrication of the pump splines (check at the oil filler cap)	

Daily: Filter Manifold

Inspect	For	Inspector
Filter housing and manifold	leaks	
Charge pressure differential (one gauge on the inlet and one gauge on the outlet of the charge pressure manifold)	correct differential pressure • maximum differential is 100 psi; if differential is greater than 100 psi, replace the filter elements • use the manufacturer's recommended filter element	

Daily: Oil Reservoir

Inspect	For	Inspector
Reservoir and area	leaks	
Return oil tank filters	dirt; inspect the dirt alarm and replace the filter if required	
Low oil level shutoff equipment	correct connection; inspect visually	
Tank oil	correct operating level	

Daily: Cooling System

Inspect	For	Inspector
Air/oil cooler	• leaks • correct fan operation Note: Set the fan switch to manual before you check operation. • fan cleanliness • correct hot oil shuttle flow Note: if the unit is operating, check the flow meter on the opposite side of the electrical panel.	
Water/oil cooler (if installed)	leaks or damage; check visually	
All sides, including under	leaks; complete visual inspection	
Cooler core	debris, blockages	

Comments/Notes:

WEEKLY CHECKLISTS

Date:	**Supervisor:**
Rig:	**Time:**

Weekly: Top Drive

Inspect	For	Inspector
All fasteners (nuts, bolts and lock wires)	correct location, tightness	
Auxiliary manifold	general condition	
Connection locking clamps	correct location, tightness	
Hydraulic fittings	tightness/leaks	
Hydraulic connections and hoses on the top drive	oil leaks	
Load collar	adequate load ride height on the spring; load ride height should be 3/8"–1/2"; if it is not, contact Tesco's Maintenance and Service Group	
Mud saver valve actuator sleeve	general condition; disassemble, clean, grease, coat with corrosion inhibitor and reinstall (see "How to Disassemble and Service the Roto-Actuator" on page 56)	
Motor termination boxes	-moisture -terminal nut	
Robotics and sensor panels	moisture; tightness of wire terminations	
Gearbox lubrication filter	-cleanliness -check filter bypass and magnetic plug	
Upper quill bearing preload	proper preload (see "How to Adjust the Preload" on page 69)	
Pipe handler rotation motors	check for tightness	
Load collar springs	-damage -breaks	

Weekly: Swivel

Inspect	For	Inspector
Hammer unions	damage/decay and tightness	
Swivel oil level	correct level	

Weekly: Service Loop

Inspect	For	Inspector
All service loop components	damage, excessive wear	
Urethane capture blocks (at top drive and roller saddle)	hose placement, tightness	
Fluid quick couplers (auxiliary and cooling)	damage or decay, tightness	
All cable connections (power sensor robotics and ground cables)	tightness	

Weekly: Torque Arrest System

Inspect	For	Inspector
All bolts and threaded rods	damage or decay, tightness	
Torque track hanging assembly	damage; close visual inspection is required	
Torque bushing liners or torque arrest beam liners	wear (the bushing liner must be replaced before the liner mounting bolts come in contact with the torque tube)	
Torque bushing clearance	amount of clearance (it might be necessary to remove a torque bushing shim if there is more than 1/4 in. clearance between the torque bushing and the torque tube, or if there is excessive torque bushing movement)	
Torque track stabilization components	cracks or loose fasteners; close visual inspection is required	

Weekly: Power Module

Inspect	For	Inspector
Air filters on the heat pump	cleanliness (filters can be washed)	
Air filters on the door fan and chopper module	cleanliness (filters can be washed)	
Ventilation louvers	cleanliness, obstructions, restrictions	
Cooling ducts	cleanliness, obstructions, restrictions	

Weekly: Prime Mover

Inspect	For	Inspector
Battery (if applicable)	correct electrolyte level; evidence of corrosion	
Water pump/seal drain	evidence of leaks	
Weep hole plugs	correct placement, evidence of leaks	
Fan hub	correct lubrication; see the appropriate Engineering Memo document for lubrication specifications	
Universal joint on the drive shaft	correct lubrication; grease if required (do not over-lubricate or this can damage the seals)	

Weekly: Pump Drive

Inspect	For	Inspector
Breather filter cap	cleanliness	
Mating bolts (mounting to prime mover)	tightness	

Weekly: Auxiliary Hydraulic Power Unit Service

Inspect	For	Inspector
Electric motor and hydraulic pump	Unnatural noise	

Comments/Notes:

MONTHLY CHECKLISTS

Date:	**Supervisor:**
Rig:	**Time:**

Monthly: Top Drive

Inspect	For	Inspector
Gearbox oil	abnormalities (take samples to test for water, metal particles, etc.; every 900 operating hours)	
Roto-actuator sleeve	general condition; disassemble, clean, grease, coat with corrosion inhibitor and reinstall (see “How to Disassemble and Service the Roto-Actuator” on page 40)	
Grabber dies	excessive wear	
Sensor panel	moisture; tightness of wire terminations	
Quill hub preload	correct preload	
11-station manifold	general condition/leaks	
Load collar	correct spacing between load collar and load nut	
Mud valve (lower ball)	manually operate to ensure correct function	
All fasteners (nuts, bolts, and lock wires)	correct location, tightness	
Top Drive hydraulic connections and hoses	oil leaks/deformation	
Saver sub threads	excessive thread wear, seal face condition	
Connection locking clamps	correct location, tightness	
Grabber leg safety chain/shackles	broken components/lock wires	
Pipe bumper/motor guard	dents or bends that may indicate bolt damage	
Counter-balance system	ensure proper function, setup, cushion height, pressure and hose integrity	
Hammer union on Kelly hose	integrity and tightness	
Grabber/drawworks and mud valve/mud pump interlocks	function test	
Gearbox lubrication system hoses	• oil leaks • adequate circulation (press 60-120 psi)	
Motor cooling fan	• function test • unnatural noises	
Torquewear liners (if applicable)	• wear • damage	
Block support wear liners (if applicable)	• wear • damage	
Wash pipe	leakage	

Inspect	For	Inspector
Pipe handler slewing drive	• backlash > 0.60” • damage	
Auxiliary manifold	general condition	
Grabber dies	excessive wear	

Lubricate	With	Inspector
Hinge pins and extend frame	spray with penetrating oil (WD 40, or spray lithium)	

Monthly: Service Loop

Inspect	For	
Wire terminals in the driller’s panel	tightness	
All multi-conductor connections	moisture, dirt; open and check, then spray with electrical cleaner/moisture dispersant	
Main service cable connectors	cleanliness; open, clean, reinstall	
All hoses	leaks, damage	
Threads, isolation valves	damage, loose parts	

Monthly: Auxiliary Hydraulic Power Unit

Inspect	For	Inspector
Auxiliary system pressure relief	correct setting	
Auxiliary system function light pressure switch	correct setting	
Auxiliary hydraulic filter	cleanliness; inspect and change	
Auxiliary hydraulic fluid	complete fluid analysis (every 900 operating hours)	

Monthly: Power Module

Danger! Do not perform he following checks unless the main breaker panel is disconnected and locked out.

Danger! Only qualified personnel should perform the following maintenance activities.

Inspect	For	Inspector
All wire terminal screws	tightness	
All bolted connections on both the incoming and outgoing waterfall	tightness	
input and output power connections	correct position and tightness	

Inspect	For	Inspector
Electrical connections for the main drive component	correct torque **Critical**: These connections must be torqued to specification. Severe component damage can result if they are over-tightened.	
IGBT's and related bus works	correct torque **Critical**: These connections must be torqued to specification. Severe component damage can result if they are over-tightened.	
Cooling connectors	tightness	
All external power connections (to the top drive from the mechanical module)	cleanliness, moisture; these should be disassembled, sprayed with electrical cleaner/ moisture dispersant, and reconnected	

Monthly: Prime Mover

Inspect	For	Inspector
Electrical control panels	dirt, moisture; replace desiccant packs	
Radiator cap	damage or corrosion	
Drive belts	correct tension, cracks and erosion	
Air starter filter	cleanliness, clean as required	
Crankcase oil and filter (use recommended OEM filters; refer to the prime mover manual for frequency)	cleanliness; these filters should be changed every 300 operating hours (refer to the equipment service manual for the correct oil) a complete oil analysis should be conducted every third oil change (900 operating hours) Note: It is best to change the oil immediately after equipment operation, when the current oil is warm.	
Radiator and heat exchanger	cleanliness; inspect and clean every 300 operating hours **Caution**: Never use high pressure spray to clean the radiator. Pressure can bend and damage the cooling fins. Never spray a hot radiator with cold water. Always stop the engine before cleaning the radiator.	
Fuel filters (primary and secondary; use recommended OEM filters)	cleanliness; inspect periodically, replace according to manufacturer's specifications. Note: More frequent replacement might be required where the fuel supply quality is poor.	
Exhaust system	carbon build-up; also, use rig up or operational downtime to inspect bolts and flanges	
Centrifugal oil filter (if equipped)	cleanliness; service every 900 operating hours, or according to manufacturer's specifications.	
Cooling system filter	cleanliness; replace every 900 operating hours	
Coolant	perform a coolant analysis every 900 operating hours, replace as required	

Monthly: Pump Drive

Inspect	For	Inspector
Pump shaft splines and adapters	wear, correct lubrication refer to Tesco's fluid specifications for hydraulic units (EM000039, EM000041, EM000042)	
Pump drive oil	cleanliness; change as required • do not over-fill; excess oil causes heat build-up • refer to Tesco's fluid specifications for hydraulic units (EM000039, EM000041, EM000042) • it is best to change the oil immediately after equipment operation, when the oil is warm	

Monthly: Filter Manifold

Inspect	For	Inspector
Oil filters (closed loop)	cleanliness • oil filters should be replaced as indicated by oil analysis, or every 4,000 operating hours • use the manufacturer's recommended filter	
Oil filters (tank)	cleanliness • oil filters should be replaced every 900 operating hours or as indicated by the canister dirt alarms • use the manufacturer's recommended filter	

Monthly: Oil Reservoir

Inspect	For	Inspector
Return oil tank filter	correct connections; inspect visually	
Filter canister	correct bolt; correct torque	
Tank (all sides, including underneath)	leaks	

Monthly: Cooling System

Inspect	For	Inspector
All mounting bolts and fittings	tightness	

Comments/Notes:

SIX-MONTH CHECKLIST

Date:	**Supervisor:**
Rig:	**Time:**

The six-month checklist repeats many of the tests and inspections required in the weekly and monthly checklists. Complete the regular weekly and monthly checklist requirements, and perform the following additional tests and inspections.

Inspection Point	Notes/Data/Actions	Inspector
Power building	dust, dirt (clean if required; use dry air or vacuum)	
Driller's panel	replace desiccant packs	
Top drive robotics junction box	replace desiccant packs	
PA44 motors on top drive	perform an insulation (Megger) test; record the results	
Load path components	MPI and WMPI tests	
Cooling fan motor	amps	
Drive pump/motor	amps	
Top drive circulation pump/motor	amps	
Heat pump/motor	amps	
Chiller circulation pump/motor (high ambient)	amps	
Chiller compressors	amps	
Chiller condenser fan (high ambient)	amps	

Lubrication

Lubricate	With	Inspector
Top and bottom motor bearings	Shell Cyprina® Grease RA	
Worm drive bearings	EP2 multi-purpose grease	
Slewing bearing	EP2 multi-purpose grease	

Comments:

MEGGER TEST CHART

Set the Megger to 1000V/2000Mohm. Test for 5 seconds. Use this chart to record the test results for the following:

- feed cable connections to drive motors
- motor connection terminals

Motor and Pigtail

	Grd	A	B	C
A		X		
B		X	X	
C		X	X	X

Service Loop

	Grd	A	B	C
A		X		
B			X	
C				X

Any reading below 1 mega-ohm at 1,000 volts is unacceptable. Any reading below 5 mega-ohms at 1,000 volts should be flagged.

DAILY TOP DRIVE REPORT

Order the Daily Top Drive Report booklet from TESCO.

EMI 400 ELECTRIC TOP DRIVE DAILY OPERATIONS CHECKLIST

TESCO

Company Name:				Oil Company Name:			
Date:		Top Drive Unit No:		Top Drive Supervisor Name:			
Rig:		Location:		Days On Well:		Total Days On Top Drive:	
Rotating Hrs. Today	Hrs.	Rotating Hrs. On Well:	Hrs.	Total Rotating Hours On Top Drive:			Hrs.
Downtime Hrs. Today (explain at the bottom of page in "Concerns"):		Hrs.	Total Downtime Hours This Well:	Hrs.	Total Downtime Hrs:		Hrs.
Select Unit Type:	EMI 400 250T	EMI 400 150T					

PERFORM THESE CHECKS THREE TIMES DAILY:

Time of day			String weight		
Ambient Temp			Bit type & size		
Operation			"Set" RPM, @ Driller's Panel		
Present depth			"Delivered" RPM @ Driller's Panel		
R.O.P.			"Set" Torque @ Driller's Panel		
W.O.B.			"Delivered" Torque @ Driller's Panel		

Top Drive "SET" Speeds & Torque Values Programmed In The Drillers Panel:

Function	Speed	Torque	Function	Speed	Torque
Connect Forward			Drill Forward		
Connect Reverse			Drill Reverse		
Pipe Handler Forward					
Pipe Handler Reverse					

Settings Input By
Name:
M/D/YR:

Top Drive Information:

						Initials
Gear box oil press.(70psi/70RPM)	____/____	____/____	____/____	Top drive serviced by daylight crew	Y / N	
Gear box oil temp. C				Top drive serviced by night crew	Y / N	
Gear box oil level full	Y / N	Y / N	Y / N	Hydraulic cylinder eyes damaged	Y / N	
All safety pins are in place	Y / N	Y / N	Y / N	New saver sub installed ~ (m / d / yr)		
Any oil or coolant leaks	Y / N	Y / N	Y / N	Saver sub threads checked by ~~		

Information from main electrical panels in power module:

indicators" are ON		Y / N		Y / N	Y / N
Building thermostat set @ 65F		Y / N			
Record Building temp. (60°F - 68°F)					
Quill speed:			Quill Torque:		
V Bus (?-?):	P1.16 (TP)		Total Current (?-?)		

Information from Mechanical Module ~~~ normal operating parameters are listed in brackets;

Hyd. Tank temp.	(40C)		
Hyd. Circ. Press.	(300 ~ 400 psi)	(300 ~ 400 psi)	
Auxiliary Hyd. Skid Pressure (2,300psi)			

Information required if Top Drive is powered from rig electrical distribution system:

Ground fault indication lights in SCR building, all dim ;	Y / N	Y / N	Y / N
% AC ground fault meter reading, if available. (0 amps)			
% DC ground fault meter reading, if available. (0 amps)			
Hyd. oil tank			

Concerns and Corrective Actions:

Hydraulic Top Drive
Daily Operations Report

Date		Top Drive Unit #	PU#:	TD#:
Operator		Job #		
TD Tech		Contractor / Rig #		
Location		Current Depth (m)		
Well #		Projected Depth (m)	/TVD	/TMD
Weather/Temp	/°F	Date – Start of Well		
Job Start Date		Days Remaining		

Drill Pipe / Torque			Casing Size / Depth (m)		
Tubular	Tool Joint	Make-up Torque	Surface	Intermediate	Production
		/ft/lbs	m.	m.	m.
		/ft/lbs	Drill Range Switch Setting		
Set Torque		Max Torque	Low (X)		High (X)
Fr/Chart /ft/lbs		Fr/Chart /ft/lbs	Auto-Max Torque Switch Settings		
Rsmt /psi		Rsmt /psi	On (X)	Off (X)	Low (X) / High (X)

Charge System			Closed Loop System		
Time of Readings			Time of Readings		
Operation			Quill RPM		
Ambient Temperature	/°F	/°F	Main Loop Flow @ Meters (gpm)		
Charge Flow (fr/chart)	/gpm	/gpm			
Shuttle Flow	/gpm	/gpm	Total Loop Flow (meters)	/gpm	/gpm
Mtr. Case Drain (Aux Off)	/gpm	/gpm	Loop Flow (fr/chart)	/gpm	/gpm
Pump Case Drain (Calc.)	/gpm	/gpm	Drillers Loop Gauge	/psi	/psi
Swash Plate Pres. (psi)	F / R	F / R	Rosemount Reading	/psi	/psi
Pump Case Drain Temperature (°F)			Torque (fr/chart)	/ft/lbs	/ft/lbs
			Tank Temperature	/°F	/°F
Charge Pressure (psi)	/in /out	/in /out	Loop Temp. @ Shuttle	/°F	/°F
Oil Temp (Water Cool °F)	/in /out	/in /out	Oil Temp. (After Modine)	/°F	/°F
Auxiliary Set Pressure	/psi		Auxiliary Pump Flow	/gpm	

Engine			Pump Drive		
RPM			Lube Flow	/gpm	/gpm
Oil Pressure	/psi	/psi	Lube Temp.	/°F	/°F
Coolant Temperature	/°F	/°F	Lube Pressure	/psi	/psi
Coolant Pressure	/psi	/psi	Days Since Last Spline Check		/days
Total Engine Hours @ 24:00		/hrs	Total Pump Drive Hours @ 24:00		/hrs
Engine Hours @ Last Oil Change		/hrs	"Engine Hours" @ Last Oil Change		/hrs
Next Oil Change Due @ Engine Hours		/hrs	Next Oil Change Due @ "Engine Hours"		/hrs
Sample Taken @ Oil Change	Yes (X) / No (X)		Sample Taken @ Oil Change	Yes (X) / No (X)	

Top Drive - Swivel				
Operating Days Since 500 Day Re-certification *("In shop" Major Rebuild of all Components in Top Drive)*				/days
Operating Days Since 60 Day Load-path *(M.P.I. Inspection of all "Oilfield Connections" in TD Load-path)*				/days
Operating Days Since End-play Check	Gearbox	/days	Swivel	/days
Oil Change @ "Engine Hours"	Gearbox	/hrs	Swivel	/hrs
Sample Taken @ Last Oil Change	Gearbox Yes (X) / No (X)		Swivel	Yes (X) / No (X)

Saver Sub in Service (ser#)		*(Document any changes in "overhead", serial numbered equipment)*
Comments:		

White Copy – Business Unit Office Pink Copy – Issuer (*"Critical Information" Binder)*

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