50 / 75 / 80
Black Bruin Drill

USER MANUAL

SERIAL NUMBER

AMERICAN PILEDRIVING EQUIPMENT

800-248-8498

WWW.APEVIBRO.COM

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50 / 75 / 80 Black Bruin Drill
Top Drive Auger

Operations / Maintenance Manual

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Top Drive Auger

Operations / Maintenance Manual

TABLE OF CONTENTS

FOREWARD

- Warranty Information I
- Customer Information II
- Safety Precautions ..... III-IV
- Preface / Abbreviations V
- Illustrations / Drawings / Tables VI

1. **GENERAL INFORMATION**
   - 1-1. Daily Checklist 1
   - 1-2 Product Specifications
     - 1-2.1 50BB 2
     - 1-2.2 75BB 3
     - 1-2.3 80BB 4
   - 1-3 Serial Number Tag 5

2. **INSTALLATION INSTRUCTIONS**
   - 2-1 Lifting the Drill 6
   - 2-2 Connecting the Hydraulic Lines 7
   - 2-3 Filling the Hydraulic Lines 8

3. **OPERATING INSTRUCTIONS**
   - 3-1 Commissioning Procedure 9
   - 3-2 Flushing the Hydraulic System 10
   - 3-3 Air Bleeding Procedure 11
   - 3-4 Break-in Period 12
   - 3-5 Storage 13

4. **HYDAULIC SYSTEM INSTRUCTIONS**
   - 4-1 Fluid Cleanliness 14
   - 4-2 Operating Temperature 15
   - 4-3 Operating Pressures
     - 4-3.1 Charge Pressure 16
     - 4-3.2 Drive Pressure 16
     - 4-3.3 Case Drain 16

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50 / 75 / 80 Black Bruin Drill
Top Drive Auger

Operations / Maintenance Manual

TABLE OF CONTENTS

4-4 Understanding the Hydraulic Circuit
- 4-4.1 Full / Half Displacement Mode 17
- 4-4.2 Valves 18
- 4-4.3 Hydraulic Schematic 19
- 4-4.4 Drive Manifold on Skid 20

5. **MAINTENANCE**
- 5-1 Information 20
- 5-2 Rear Bearing 21
- 5-3 Accumulator 22
- 5-4 Grout Swivel
  - 5-4.1 Grout Swivel 23
  - 5.4.2 Grout Swivel BOM 24-25

6. **BILL OF MATERIALS**
- 6-1 DH50 Skid
  - 6-1.1 Drawing / BOM 26-27
- 6-2 Lifting Bale ASM
  - 6-2.1 Drawing / BOM 28
- 6-3 Guide Rails ASM
  - 6-3.1 Drawing / BOM 39
- 6-4 Drive Manifold ASM
  - 6-4.1 Drawing / BOM 30

7. **Reference Documents**
- 9-1 Understanding ISO Cleanliness Codes 31
- 9-2 Target ISO Codes 32
- 9-3 Bolt Torque Chart 33

8. **Revision Record** 34
Anytime an item changes within this manual it will be added to the Revision Record

9. **Notes** 35-36

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50 / 75 / 80 Black Bruin Drill
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WARRANTY INFORMATION

Effective: _____

American Piledriving Equipment, Inc. (APE) warranties new products sold by it to be free from defects in material or workmanship for a period of two (2) years after the date of delivery to the first user and subject to the following conditions:

- APE's obligation and liability under this WARRANTY is expressly limited to repairing or replacing, at APE's option, any parts which appear to APE upon inspection to have been defective in material or workmanship. Such parts shall be provided at no cost to the user, at the business establishment of APE or the authorized APE distributor of the product during regular working hours.
- This WARRANTY shall not apply to component parts or accessories of products not manufactured by APE, and which carry the warranty of the manufacturer thereof, or to normal maintenance (such as engine tune-up) or normal maintenance parts (such as filters).
- Replacement or repair parts installed in the product covered by this WARRANTY are warranted only for the remainder of the warranty as if such parts were original components of said product.
- APE makes no other warranty, expressed or implied, and makes no warranty of merchantability of fitness for any particular purpose.
- APE's obligations under this WARRANTY shall not include any transportation charges, costs of installation, duty, taxes or any other charges whosoever, or any liability for direct, indirect, incidental or consequential damage or delay.
- If requested by APE, products or parts for which a warranty claim is made are to be returned, transportation prepaid, to APE.

OIL MUST MEET ISO CLEANLINESS CODE 17/15/11. OIL THAT DOES NOT MEET CLEANLINESS CODE WILL *VOID* THE WARRNTY

ANY IMPROPER USE, INCLUDING OPERATION AFTER DISCOVERY OF DEFECTIVE OR WORN PARTS, OPERATION BEYOND RATED CAPACITY, SUBSTITUTION OF ANY PARTS WHATSOEVER, USE OF PARTS NOT APPROVED BY APE OR ANY ALTERATION OR REPAIR BY OTHERS IN SUCH A MANNER AS, IN APE'S JUDGMENT, AFFECTS THE PRODUCT MATERIALLY AND ADVERSELY, SHALL *VOID* THIS WARRANTY.

ANY TYPE OF WELDING ON APE'S EQUIPMENT WILL *VOID* THE WARRNTY UNLESS AUTHORIZED IN WRITING BY APE

NO EMPLOYEE AUTHORIZED TO CHANGE THIS WARRANT IN ANY WAY OR GRANT ANY OTHER WARRANTY UNLESS SUCH CHANGE IS MADE IN WRITING AND SIGNED BY AN OFFICER OF APE, INC.

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Operations / Maintenance Manual

CUSTOMER INFORMATION DISCLAIMER

Prepared for: Goettle Co.

Reference: Equipment # D238
Serial # GOE-20160518

Description: 50 / 75 / 80

DISCLAIMER:

This unit was tested and flushed before leaving our facility. In order to help provide years of trouble free usage, please review the following documentation and make sure to clean and flush the field piping before connecting it to the power unit.

Refer to schematic diagrams and the BOM (Bill of Materials) for component part specifications and recommended spare parts.

When calling APE (American Piledriving Equipment), always inform them of the supplied serial # in order to obtain quicker service

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SAFTEY PRECAUTIONS

(These precautions must be followed at all times to ensure personal and equipment saftey)

READ THIS MANUAL THOROUGHLY BEFORE OPERATING AND / OR WORKING ON THE EQUIPMENT

1. Read and follow any safety instructions in the CATERPILLAR ENGINE OPERATOR'S MANUAL.
2. Only well-trained and experienced personnel should attempt to operate or maintain this equipment.
3. ***NEVER*** adjust, lubricate and/or repair the unit when it is in operation or lifted above ground level.
4. ***NEVER*** remove, paint over and/or cover warning or safety labels. If labels become damaged or unreadable, replace immediately.
5. All personnel should wear approved safety clothing including HARD HARTS, SAFETY SHOES, SAFETY GLASSES and HEARING PROTECTION when near this equipment.
6. Do ***NOT*** stand any closer to this equipment than necessary when it is in operation. Parts may loosen and fall. Dirt and rocks may fall from flighting. ***NEVER*** stand under operating or elevated equipment.
7. When maintaining and/or repairing the equipment, ***NEVER*** substitute parts not supplied or approved in writing by APE.

Do NOT weld or flame cut on this equipment.

8. ***NEVER*** use or store flammable liquids on or near the engine.
9. Ensure that all lifting equipment, including cranes, wire rope, slings, hooks, shackles, etc., are properly sized for the worst caseloads anticipated during operations.
10. If there are any questions about the weights, specifications and/or performance of the unit, contact APE before handling and/or operating the equipment.
11. If the equipment is to be used for anything other than drilling plumb holes, contact APE before using the unit.
12. Check wire rope clips for tightness and wire ropes for wear **DAILY**.
13. Ensure that ground vibrations will not damage or collapse adjacent structures or excavations.
14. Remove all tools, parts and/or electrical cords before starting the unit.

When operating in an enclosed area, exhaust fumes should be piped outside. Continued breathing of exhaust fumes may prove FATAL.

15. When servicing batteries, do ***NOT*** smoke and/or use an open flame in the vicinity. Batteries generate explosive gas during charging. There must be proper ventilation when charging batteries.
16. When filling the fuel tank, do ***NOT*** smoke and/or use an open flame in the vicinity.
17. If abnormal equipment operation is observed, discontinue use immediately and correct the problem.
18. Do ***NOT*** leave the equipment control pendant (radio control) unattended.
19. Store oily rags in approved containers and away from the engine exhaust system.
20. Make sure that the Auger rotation switch is in NEUTRAL before starting the Power Unit engine
21. Do ***NOT*** adjust and/or set the hydraulic pressures higher and/or lower than those specified in this Manual.
22. ***NEVER*** operate this equipment with hydraulic hoses that are damaged or 'kinked'. Replace damaged hoses immediately.

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SAFTEY PRECAUTIONS

(These precautions must be followed at all times to ensure personal and equipment saftey)

23. Do ***NOT*** lift and/or support hydraulic hoses with wire rope slings.
24. ***NEVER*** attempt to connect Quick Disconnects (QDs) when the Power Unit is running.
25. Do ***NOT*** pull on and/or attempt to move equipment with the hydraulic hoses.
26. Do ***NOT*** attempt to locate hydraulic leaks with your hands. High-pressure leaks can penetrate skin and cause severe damage, blood poisoning and/or infection.
27. Do ***NOT*** attempt to repair leaks while the equipment is in operation.
28. Do ***NOT*** attempt to tighten and/or loosen fittings and/or hoses when the machine is in operation.
29. Power Unit must always be placed on level, stable ground.
30. Do ***NOT*** remove Power Unit heat shields. Do ***NOT*** attempt to use the Power Unit without heat shields. Severe fires may result.

A properly maintained fire extinguisher, suitable for oil fires, MUST be kept in the immediate vicinity of equipment operations.

31. When moving and/or transporting this equipment, insure that the vehicle and/or vessel is of sufficient capacity to handle the load. Make sure that the equipment is properly tied down.
32. When moving and/or transporting this equipment, be sure that the QD Dust Caps are tight and that the cap safety cables are in place. Be sure that all equipment parts are tight and/or properly secured before shipment. Unsecured parts may vibrate loose and fall during transport causing injury and/or property damage.
33. Keep crane booms, flighting, leads, wire rope and/or other equipment at least 15’ (5M) from electrical power lines, transformers and/or other electrical equipment or at such a distance as required by applicable safety codes.
34. Rounded and/or damaged bolt heads and/or nuts should be replaced so that proper torque values may be obtained. Proper torque values are necessary to prevent parts on this equipment, leads and/or crane booms from loosening and/or falling. (Refer to the torque chart in this manual for the proper values.)
35. Make sure that the crane and/or leads have sufficient capacity to handle the Auger, flighting and/or dirt expected on the job. High-down pull forces can be generated if the flighting screws itself into the ground.
36. Ensure that the leads are adequately secured against rotation before starting the drilling operations.
37. When extracting flighting from the ground, check the crane load/radius tables to be sure the crane capacity is adequate for maximum allowable extraction pull.
38. When extracting flighting and/or any other drilling operations, always be sure that the crane line is aligned with the centerline of the flighting.
39. Do ***NOT*** side load the crane boom and/or Auger. Dangerous crane boom and/or Auger damage may result.
40. When extracting flighting, do ***NOT*** exceed the rated capacity of the Auger.

KEEP HANDS AWAY FROM ROTATING FLIGHTING, AUGER SHAFT AND/OR ROTARY JOINT. KEEP HANDS, FEET AND/OR TOOLS WELL CLEAR OF THE FLIGHTING GUIDES.

41. API flighting connectors must be secured to prevent unscrewing during reverse (CCW) rotation. Flighting may fall.
42. Do ***NOT*** allow clothing, hoses, ropes, etc., to become entangled in, or wrap around, rotating flighting, Auger shaft and/or rotary joint.
43. When drilling angled or horizontal holes, insure that the heads and/or crane boom have sufficient bending strength to handle the worst caseload. Consult APE with questions.

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PREFACE

This manual covers the **Black Bruin S-Series, Model D** hydraulic motor installation and use. Please read all instructions carefully before installing or commissioning the motor.

The data provided in this manual gives the necessary information to operate and maintain APE equipment. The listed procedures are to be performed by qualified personnel who have an understanding of the equipment and who follow all safety precautions.

All information given in this manual is current and valid according to the information available at the time of publication. American Piledriving, Inc. reserves the rights to implement changes without prior notice.

Using this manual:

- Refer to the Table of Contents for the page location of applicable sections.
- All weights and measurements are in English and Metric units.
- Any revisions to this manual will appear on the Revision Record page at the back` of this manual. The revisions themselves will be attached to the back of the manual and entitled ADDENDA with references back to the page in question in the origional manual.
- Please visit www.apevibro.com for product datasheets and manual.

Abbreviations:

The following are abbreviations used within this manual:

PPE	Personal Protective Equipment
BOM	Bill of Materials
PSI	Pounds Per Square Inch
ISO	International Organization of Standardization
BB	Black Bruin

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ILLUSTRATIONS / TABLE LIST

ILLUSTRATIONS

FIGURE	TITLE	PAGE
1	Serial Number Plate	5
2	Lifting the Drill	6
3	Filling the BB Drill Motor with Oil	7
4	Filling the BB Drill Motor with Oil	7
5	Drive Forward	8
6	BB Air Bleed Ports	11
7	Hydraulic Schematic	19
8	Drive Manifold On Skid	20
9	Drive Manifold On Skid	20
10	BB Grease Ports	22
11	BB Grease Prts	22
12	Grout Swivel Grease Ports	23
13	Grout Swivel BOM	24
14	DH 50 Skid Assembly	26
15	Lifting Bale Assembly	28
16	Guide Rail Assembly	29
17	Drive Manifold Assembly	30

TABLES

TABLE	TITLE	PAGE
1	50BB Product Specifications	2
2	75BB Product Specifications	3
3	80BB Product Specifications	4
4	Drive Manifold Block	20
5	Grout Swivel BOM	25
6	DH 50 Skid Assembly	27
7	Lifting Bale Assembly	28
8	Guide Rail Assembly	29
9	Drive Manifold Assembly	30
10	Understanding ISO Codes	31
11	Target ISO Cleanliness Codes	32
12	Bolt Torque Chart	33

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General Information

1-1 - DAILY CHECKLIST

Check the entire unit prior to and during set-up each day or at the beginning of each shift

Prior to starting the unit or at the beginning of each shift, check the following:

- Visually inspect all bolts, nuts and screws. This includes the pins and bolts fastening the drill housing to the bale assembly, output shaft and all grout clamp bolts, to insure they are tight.
- Grease sheave pin.
- Grease grout swivel
- Visually inspect all hydraulic fittings for leaks. If a leak is found or suspected, shutdown the power unit. If a fitting appears to be damaged, replace with a new fitting.

It is <u>absolutely imperative</u> that no dirt or other impurities be permitted to contaminate the hydraulic fluid. Any contamination will drastically shorten the life of the high-pressure hydraulic system.

Vibration loosens bolts. Check them thoroughly.

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General Information

1-2 - PRODUCT SPECIFICATIONS

1-2.1 50BB

Specifications		Standard	Metric
Low Speed High Torque	Torque	9,688 ft-lbs per 1000 PSI	1,339.41 kgm per 69 bar
	Max Pressure	5,800 psi	399.9 bar
	Rotation Speed	36 rpm	
	Max Flow	120 gpm @ 3.33 gal / rev	454 lpm @ 12.61 lit / rev
	Max Horse Power	406 hp	302.75 kW
High Speed Low Torque	Torque	4,844 ft-lbs per 1000 PSI	669.71 kgm per 69 bar
	Max Pressure	4,570 PSI	315.09 bar
	Rotational Speed	72 rpm	
	Max Flow	120 gpm @ 1.66 gal / rev	454 lpm @ 6.28 lit / rev
	Max Horese Power	320 hp	238.62 kW
Crowd Force		150,000 lbs	68,038.86 kg
Suspended Weight		4,530 lbs	2,054.77 kg
Depth		25 in	635 cm
Width (Lead Section)		26 in	660.4 cm
Shipping Width (Overall)		48 in	1,219.2 cm
Height		61.5 in	1,562.1 cm
ID of Output Shaft		3 in	76.2 cm
ID of Rotary Joint		3 in	76.2 cm
Adapters		3 inch, 4 inch	
Lead Adapters		8 x 26, 8 x 32 Custom Available	

TABLE 1

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General Information

1-2 - PRODUCT SPECIFICATIONS

1-2.2 75BB

Specifications		Standard	Metric
Low Speed High Torque	Torque	12,150ft-lbs per 1000 PSI	1,679.8 kgm per 69 bar
	Max Pressure	5,800 psi	399.9 bar
	Rotation Speed	30 rpm	
	Max Flow	120 gpm @ 4.17 gal / rev	454 lpm @ 15.79 lit / rev
	Max Horse Power	508 hp	378.82 kW
High Speed Low Torque	Torque	6,075 ft-lbs per 1000 PSI	839.9 kgm per 69 bar
	Max Pressure	5,800 PSI	399.9 bar
	Rotational Speed	60 rpm	
	Max Flow	120 gpm @ 2.09 gal / rev	454 lpm @ 67.91 lit / rev
	Max Horese Power	406 hp	302.75 kW
Crowd Force		150,000 lbs	68,038.86 kg
Suspended Weight		4,630 lbs	2,100.13 kg
Depth		25 in	635 cm
Width (Lead Section)		26 in	660.4 cm
Shipping Width (Overall)		48 in	1,219.2 cm
Height		61.5 in	1,562.1 cm
ID of Output Shaft		3 in	76.2 cm
ID of Rotary Joint		3 in	76.2 cm
Adapters		3 inch, 4 inch	
Lead Adapters		8 x 26, 8 x 32 Custom Available	

TABLE 2

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General Information

1-2 - PRODUCT SPECIFICATIONS

1-2.3 80BB

Specifications		Standard	Metric
Low Speed High Torque	Torque	14,572 ft-lbs per 1000 PSI	2,014.65 kgm per 69 bar
	Max Pressure	5,500 psi	379.21 bar
	Rotation Speed	30 rpm	
	Max Flow	120 gpm @ 5 gal / rev	454 lpm @ 18.93 lit / rev
	Max Horse Power	401 hp	299.03 kW
High Speed Low Torque	Torque	7,266 ft-lbs per 1000 PSI	1,004.56 kgm per 69 bar
	Max Pressure	4,500 PSI	310.26 bar
	Rotational Speed	61 rpm	
	Max Flow	120 gpm @ 2.5 gal / rev	454 lpm @ 9.46 lit / rev
	Max Horese Power	328 hp	244.59 kW
Crowd Force		150,000 lbs	68,038.86 kg
Suspended Weight		4,630 lbs	2,100.13 kg
Depth		25 in	635 cm
Width (Lead Section)		26 in	660.4 cm
Shipping Width (Overall)		48 in	1,219.2 cm
Height		61.5 in	1,562.1 cm
ID of Output Shaft		3 in	76.2 cm
ID of Rotary Joint		3 in	76.2 cm
Adapters		3 inch, 4 inch	
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TABLE 3

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General Information

1-3 - SERIAL NUMBER TAG

Figure 1

This information is important when contacting APE for replacement parts or other information.

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Installation Instructions

2-1 - LIFTING THE DRILL

The following instructions apply to all procedures associated with the motor. Read these instructions carefully and follow them closely.

- Use necessary Personal Protective Equipment (PPE) when working with the motor.
- Support the motor properly. Make sure that the motor cannot fall over or accidentally turn around.
- Use only appropriate equipment and attachments for lifting and transferring the motor.
- Always use the lifting equipment properly and check the load bearing capacity.
- Prevent unintended use of the motor during installation and maintenance procedures by preventing the pressurization of the hydraulic lines.
- The operating temperature of the motor may be over 60° C (140° F) which is hot enough to cause severe burns.

Beware of hot hydraulic fluid when disconnecting the hydraulic connections

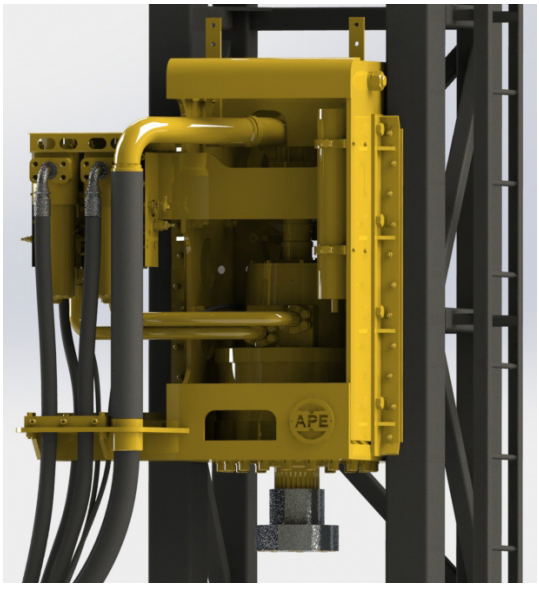

Figure 2

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Installation Instructions

2-2 - CONNECTING THE HYDRAULIC LINES

Connecting the hoses is one of the most critical aspects of commissioning an APE drill. Take extreme care to keep these connections absolutely clean. This procedure is one of the most comment ways for foreign particles to be introduced into a hydraulic system.

New hydraulic fluid is NOT clean oil

Attention!

Oil must meet ISO cleanliness code 17/15/11

- Connect the hose bundle. Make sure all connections are properly tightened
- Fill the motor case with clean hydraulic fluid

Figure 3

Figure 4

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Installation Instructions

2-3 - FILLING THE HYDRAULIC LINES

CAUTION

While filling the hydraulic lines, the drill motor shaft will rotate.

Please do the following:

- Set the engine at idle
- Run at idle for about 10 minutes to fill the lines
- Energize 'Drive Fwd' - The motor shaft will rotate slowly and push any remaining air in the lines back to the reservoir

Attention!

Pressurizing the system while there is air entrained in the fluid may cause damage to the components.

Let the system run at idle for an additional 10 minutes to allow the air to rise into the airspace of the hydraulic reservoir.

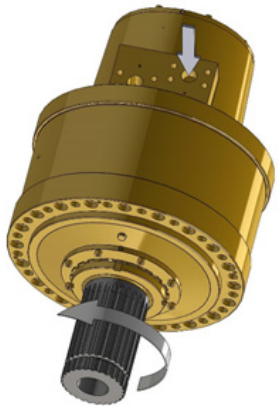

Figure 5

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Operating Instructions

3-1 - COMMISSIONING PROCEDURE

Attention!

Do not start the motor if the air bleeding procedure has not been carried out.

Stressing an unused motor with full power may cause premature wear or failure.

During all installation and service procedures, plug any open ports and hoses. When filling the reservoir, add oil through a filter.

Ensure that the following steps are met before starting a new or rebuilt Auger:

- The hydraulic circuit of the motor is flushed
- The motor is installed appropriately
- An air bleeding procedure is carried out
- The reservoir of the hydraulic system is full

During the initial stages of starting a new or rebuilt Auger, please consider the following:

- Do ***NOT*** run the motor immediately with full power
- Increase the load and speed of rotation gradually
- Observe the motor and the hydraulic system for external leaks or abnormal noises during the commissioning procedure
- Start the motor break-in period

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Operating Instructions

3-2 - FLUSHING THE HYDRAULIC SYSTEM

Prior to connecting the motor as part of the hydraulic system, the hydraulic circuit of the motor must always be flushed. This is done by circulating hydraulic fluid through a filter installed in place of the motor.

The flushing is carried out by circulating hydraulic fluid through the system with a minimum of pressure for at least 1 hour.

Flushing the hydraulic system should be performed after every service and/or repair.

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Operating Instructions

3-3 - AIR BLEEDING PROCEDURE

The air bleeding procedure is carried out to completely fill the housing of the motor with hydraulic fluid. Air is removed from the housing with air bleeding screws as follows:

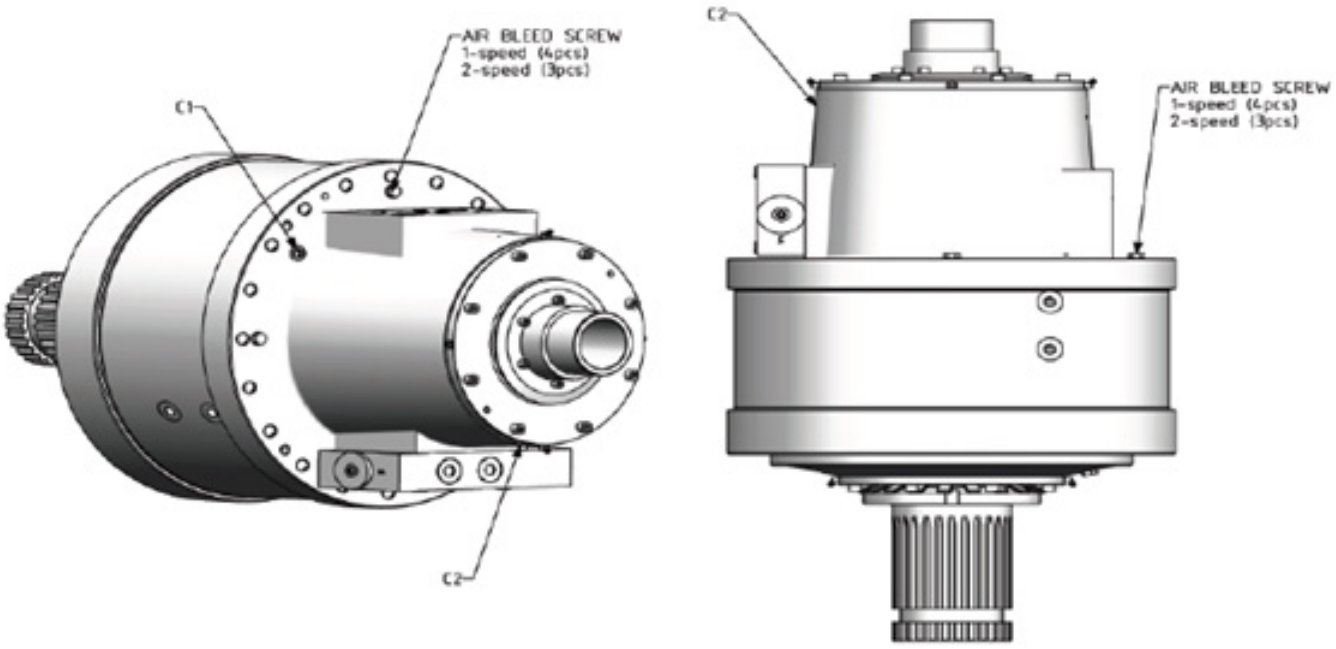

Figure 6

- Connect port ‘C2’ to a drain line and feed hydraulic fluid into the motor via port ‘C1’ throughout the air bleeding procedure.
  - Locate the topmost air bleed screw of the housing
  - Unscrew the air bleeding screw by half a turn and let the air escape from the housing
  - Close the screw when only hydraulic fluid is pouring through it
  - Tighten the screw to a torque of 28 lbf/ft (39 +/- 3 Nm)

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Operating Instructions

3-4 - BREAK-IN PERIOD

New motors require a break in procedure.

The motor achieves its final properties during the first hours of use. All new and reconditioned motors should go through an initial break-in period.

Items to consider during this period:

- Break-in should last for, at least, **the first 8 hours of use.**
- The power output should remain under **50% of the maximum power capacity** of the motor.
- To limit the power output, constrain the working pressure, speed of rotation or both.
- The working pressure should be curbed so that pressure peaks which last over 2 seconds (2s) remain under 75% of the allowed pressure.

During this break-in period, the moving parts of the motor wear against each other. This means the wear of the parts sets to a stable state for the entire service life of the motor.

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Operating Instructions

3-5 - STORAGE

During short-term storage of a motor, the following should be taken into consideration:

- Cover any pressure openings and open threaded holes with suitable caps
- Protect the unpainted surfaces from dirt and moisture
- Store the motor in a dry place with a relatively stable temperature
- The motor should not be stored in an area with substances that have an aggressive corrosive nature; i.e., solvents, acids, alkalis and/or salts.

For long-term storage (over 9 months), the following additional actions are recommended:

- Damages to surface paint must be repaired before item is stored
- Protect the unpainted surfaces with suitable anti-corrosion treatment such as CRC SP-350, CorrosionX corrosion inhibitor, or WD-40 Long Term Corrosion Inhibitor.
- Fill the motor completely with hydraulic fluid

If these instructions are followed to the letter, the motor may be stored for approximately 2-years. However, as storage conditions do have a significant effect, all suggested timeframes should only be considered as guide values.

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Hydraulic System Instructions

4-1 - FLUID CLEANLINESS

It is imperative that the hydraulic fluid is kept clean to a minimum ISO Code 17/15/11

New hydraulic fluid is NOT clean oil

(See attached document 'Understanding ISO Codes-Page 37)

(See Warranty document regarding fluid cleanliness-Page I)

Bulk oil does not typically meet the cleanliness standards required by APE equipment.

New motors require a break-in procedure. (See Section 3-4 of this manual for Break-in Steps.)

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Hydraulic System Instructions

4-2 - OPERATING TEMPERATURE

The Operating Temperature references the internal temperature of the motor.

Take into consideration the following requirements:

- 70°C (158°F) – Avoid going over this Operating Temperature for improved service life
- 85°C (185°F) – Highest permissible intermittent Operating Temperature
- -35°C (-31°F) – Lowest permissible Operating Temperature
- 60°C (140°F) – Temperature difference between the motor and the hydraulic fluid

The Operating Temperature may be measured from the hydraulic fluid returning from the motor. Take into account the temperature of the hydraulic fluid returning from the case drain line. (See Figure 5)

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Hydraulic System Instructions

4-3 - OPERATING PRESSURES

4-3.1 CHARGE PRESSURE

The charge pressure is used to ensure that the pistons of the motor stay constantly engaged to the cam ring. Depending upon the operation function, the charge pressure is required either in the feed or return line (working line ports A or B).

The recommended charge pressure is **200PSI / 13.8 bar higher than the case pressure**. The actual required charge pressure depends upon the viscosity and flow rate of the hydraulic fluid.

The required charge pressure in the return line (back pressure) is only 5 bar higher than the case pressure if the motor is ***NOT*** switched to partial displacement or short circuit connection.

Attention!

Charge pressure that is too low may cause the pistons to disengage from the cam ring causing a clattering noise when the pistons re-engage. This condition will cause damage to the drill motor.

Constant us with a charge pressure that is too low may cause premature wear or failure of the motor.

4-3.2 DRIVE PRESSURE

Refer to product specification in section 1-2, Page 2-4 of this manual.

4-3.3 CASE DRAIN

The case drain line is the return line for the drill housing cavity. Case pressure can be controlled by the pressure drop in the case drain line. The case drain line is connected to port 'C2' on the motor and 'DR2' port on the drive manifold.

It is imperative that the case drain has an unobstructed route back to the hydraulic reservoir. If a case drain filter is required, consult the factory for proper sizing.

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Hydraulic System Instructions

4-4 - UNDERSTANDING THE HYDRAULIC CIRCUIT

4-4.1 FULL / HALF DISPLACEMENT MODE

The APE Auger Drill has a 2-speed direct drive Radial Piston Motor.

Full Displacement Mode:

- All of the pistons are engaged to deliver maximum torque
- Full displacement mode is limited to ½ maximum output speed

Half Displacement Mode:

- ½ of the pistons are engaged to deliver double speed
- Half displacement mode is limited to ½ maximum output torque

Changing displacement while drilling is permissible. To 'shift on the fly' it is necessary to hold the displacement shift spool in position with a minimum of 650PSI.

A 2-position, 4-way, Pilot Valve is required to select displacement.

Full Displacement	Activate Port: Y2	Drain Port: Y1
Half Displacement	Activate Port: Y1	Drain Port: Y2

NOTE: In some applications the maximum pressure setting for half displacement mode must be lowered due to through-put horsepower limitations internal to the motor. Refer to the data sheet of the specific motor installed.

When the motor is transitioning from full displacement to half displacement, the load induced pressure will double.

When the motor is transitioning from half displacement to full displacement, the flow requirement will double.

AVOID SHIFTING FROM HALF TO FULL WHEN THE MOTOR IS TURNING IN EXCESS OF ½ OF THE MAXIMUM SPEED.

4-4 - UNDERSTANDING THE HYDRAULIC CIRCUIT

4-4.2 VALVES

The drill has an integral valve package designed to protect the motor from damage. (Refer to the hydraulic schematic Figure 7 / Page 19 for details)

- Pressure filters clean the hydraulic fluid going to the drill motor and manifold in the forward and reverse directions.
- Vented Relief Valves - VR1 and VR2: Limit the maximum pressure that the drill motor is exposed to. When the load induced pressure exceeds the setting of the vented relief, the valve will open creating a short circuit around the drill motor.
- The vented Relief Valve may be set to a lower setting by energizing the Directional Valve (DV1) which connects the pilot section of VR1 and VR2 to the secondary Pilot Relief Valve (RV1).
- Some motors are limited in their capacity to carry 'through-out horsepower' when they are in the high speed/half displacement mode.
- Check Valves - CV2 and CV3: These isolate the pilot sections of VR1 and VR2 from each other.
- Counterbalance Valves - CB1 and CB2: These are in-line with the drill motor and set at 400PSI. Their primary function is to maintain 'charge pressure' to the drill motor.
- Hot Oil Shuttle Valve - HOS1: This will shift when the drill is activated to direct oil flow from the low-pressure side to flush the case of the drill motor.
- Flow Control Valve - FC2: This regulates the amount of case flushing flow.
- Check Valves - CV4 and CV5: These connect the high-pressure side when the drill is activated. This will supply the Accumulator with pressurized hydraulic fluid to be stored for additional charge pressure.
- Flow Control Valve - FC1: This limits the rate of flow being diverted to the Accumulator.
- Pressure Reducing Valve – PRV: This is a normally open valve that will close when the pressure being stored in the Accumulator exceeds the PRV setting. If the pressure in either motor line drops below this setting, the PRV will open thus allowing the fluid stored in the Accumulator to keep the motor ports pressurized.
- Check Valves - CV6 and CV7: These create direct flow from the Accumulator circuit to the low-pressure side of the drill motor.
- Pop Off Valve - PO1: This is intended to protect the drill motor case from over-pressurization.

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Hydraulic System Instructions

4-4 - UNDERSTANDING THE HYDRAULIC CIRCUIT

4-4.3 HYDRAULIC SCHEMATIC 1005653

NOTES:

1. These pressure settings are specific to the Black Bruin (BB) Drill
2. Maximum flow rate is 120 GPM

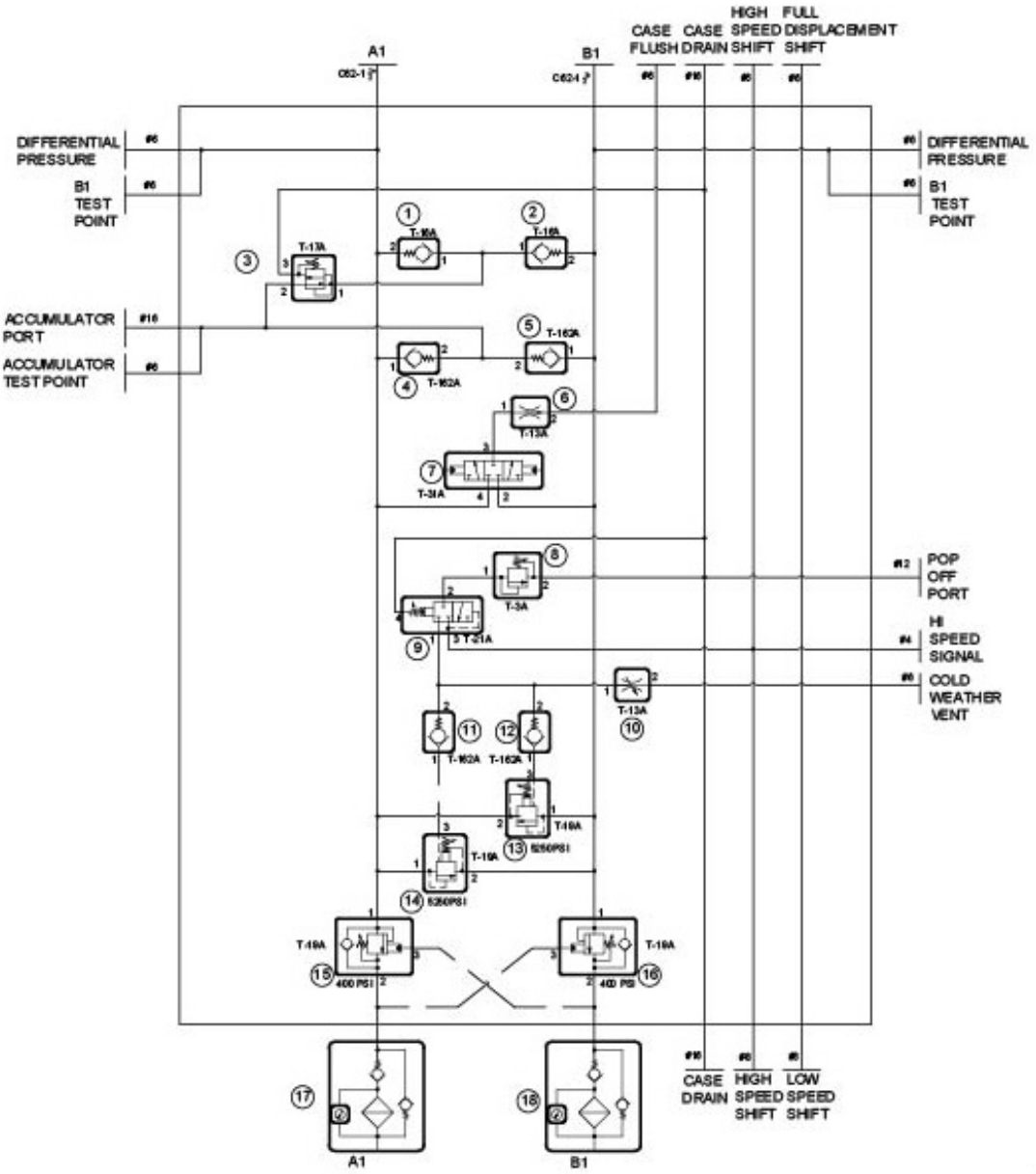

Figure 7

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4-4 - UNDERSTANDING THE HYDRAULIC CIRCUIT

4-4.5 DRIVE MANIFOLD ON SKID

Figure 8

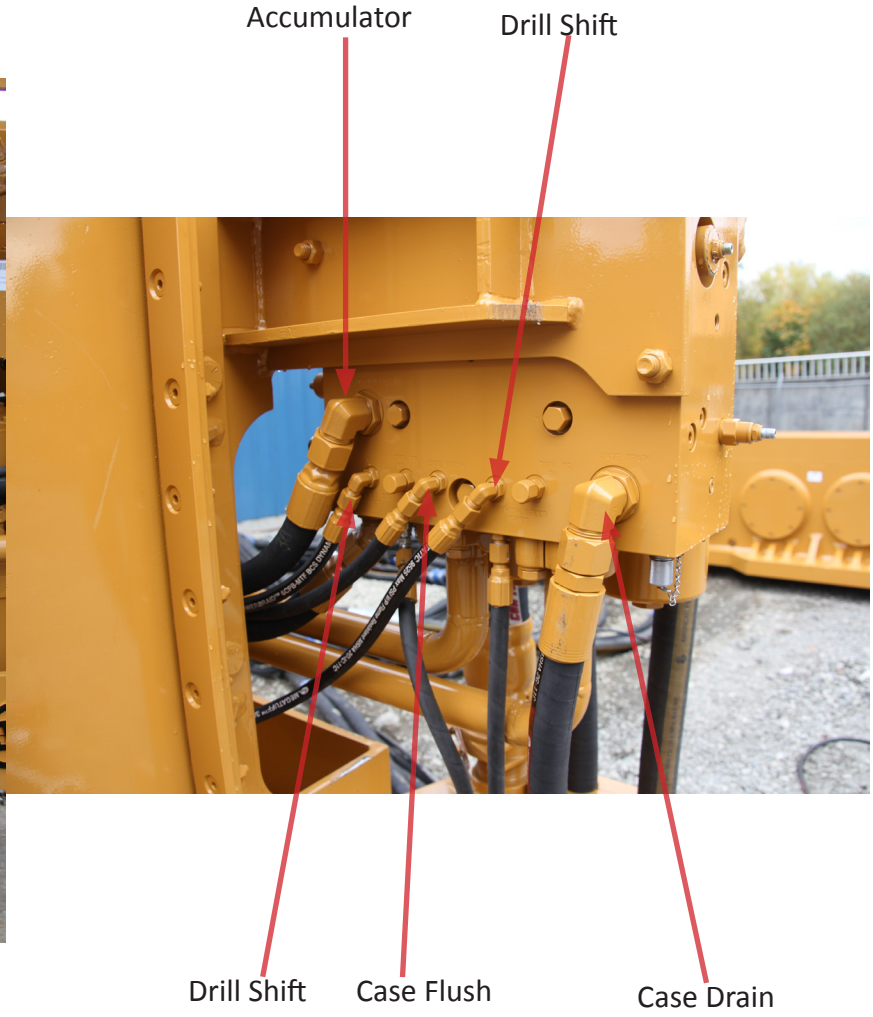

Figure 9

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Maintenance

5-1 - INFORMATION

Preventative Maintenance

Preventative maintenance includes normal servicing that will keep the Top Drive Auger in peak operative condition and prevent unnecessary trouble from developing. This servicing consists of periodic lubrication and inspection of moving parts and accessories of the unit.

Lubrication

Lubrication is an essential part of preventative maintenance controlling, to a great extent, the useful life of the unit. Different lubricants are needed and some components in the unit require more frequent lubrication than others. Therefore, it is important that the instructions regarding types of lubricants and frequency of their application be closely followed.

Services / Inspections

To prevent minor irregularities from developing into serious conditions that might involve shutdown and major repair, several other services or inspections are recommended for the same intervals as the periodic lubrications. The purpose of these services or inspections is to assure the uninterrupted operation of the unit.

- Thoroughly clean all lubrication fittings, caps, filler and level plugs along with their surrounding surfaces before servicing.
- Prevent dirt from entering with lubricants and coolants.

The intervals given in the schedule are based upon normal operation.

Perform these services, inspections, etc., more often as needed for operation under abnormal or severe conditions.

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Maintenance

5-2 - REAR BEARING

APE recommends using grease having the following requirements:

- Operating temperature range: -40°F - 320°F
- Mineral oil based lithium soap grease
- Consistency class: NLGI #1
- Meet DIN KP2.5K-30 or ISO-L-XCCIB2.5 standard specifications

Attention!

DO NOT USE A PNEUMATIC GREASE GUN
SEAL DAMAGE MAY occur

Every 40 hours, do the following:

- Grease the top seal by pumping grease into either grease fitting until clean grease comes out of the Relief Valves. (Figure 11)
- When the Top Drive Auger is washed down, it is very important and helpful to grease the top seal to see the water come out along with clean grease out of the Relief Valves.

Figure 10

Figure 11

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5-3 / 5-4 - ACCUMULATOR / GROUT SWIVEL

5-3 ACCUMULATOR

Check the nitrogen pre-charge every filter element change.

Nitrogen pressure should be 150 PSI

5-4.1 GROUT SWIVEL

- Visually check all hoses for signs of damage or cuts that might cause hose failure during operation. Be sure that all connections are tight.
- Grease the rotary joint packing box (the upper fitting) with 3 to 5 shots of any good multi-purpose grease at the beginning of the shift and then every 2-4 hours always while rotating under no pressure (Figure 12).
- Grease the rotary joint bearing housing (the lower fitting) with any good multi-purpose grease after 1-hour of rotating until grease exits the bearing housing.

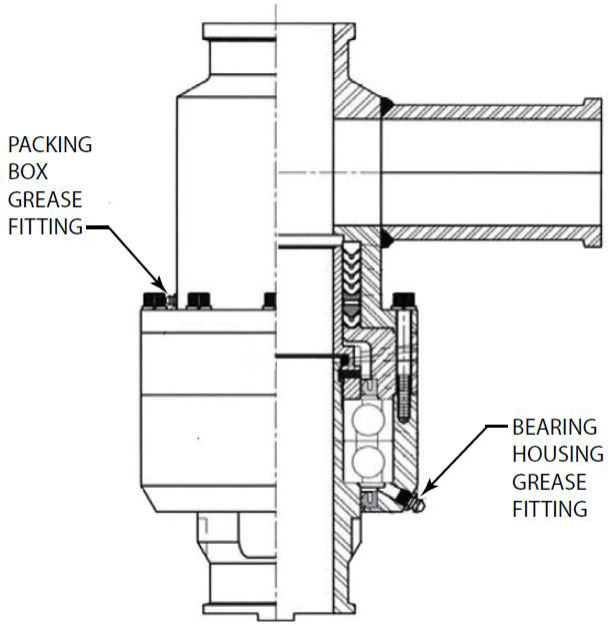

Figure 12

5-4 - GROUT SWIVEL

5-4.2 GROUT SWIVEL BOM WD-3APE10500001

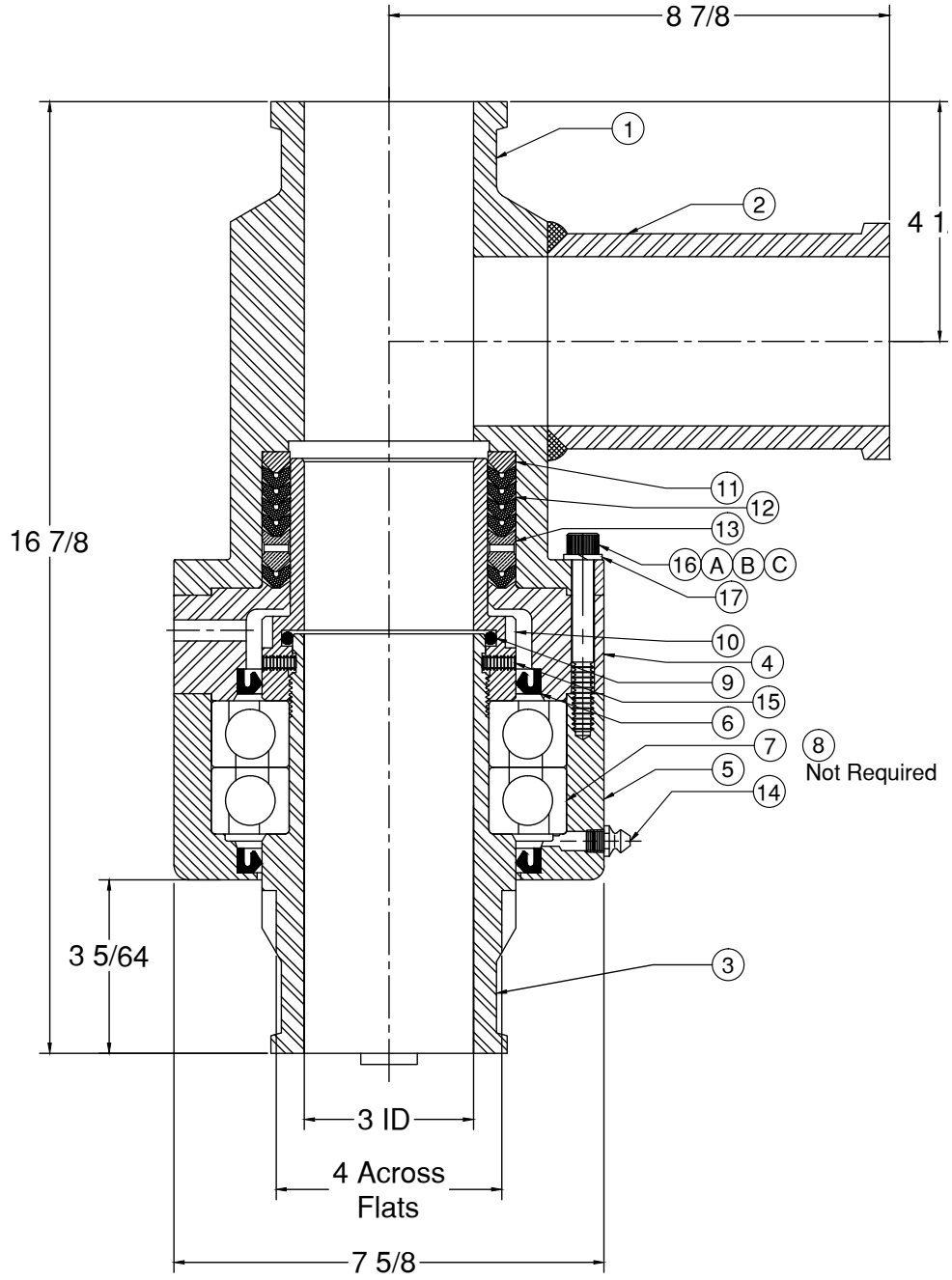

Figure 13

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Maintenance

5-4 - GROUT SWIVEL

5-4.2 GROUT SWIVEL BOM WD-3APE10500001

CALLOUT	PART #	APE PART NUMBER	DESCRIPTION	QTY
1	3WRAM-01C		Gooseneck w/ Side Connection	1
2	3WRAM-01A		Side Connection	1
3	3WRAM-08A	630808A	Spindle 3” VIC	1
4	3WRAM-04		Adapter Plate	1
5	3WRAM-14		Bearing Housing	1
6	3WRAM07	630812	Grease Seal (Housing)	2
7	3BLW-12	630805	Bearing	2
8			Bearing Shim (not required)	1
9	OR-340	630810A	O-Ring (f washpipe)	1
10	3WRAM-25	630809	Washpipe w/ Set Screws	1
11	5JW-06S	630802	Packing Adapter (Steel)	1
12	3WRAM-20	630807	Packing (4 Rings)	SET
13	5JW-21	630808	Lantern Ring	1
14	S-GFITTINGS-.12		Grease Fitting	2
15	S-SHSS-0.25X0.62		Set Screw (Washpipe	2
16A	S-HHCS8-0.38-3.00		Bolt-Bearing Housing	10
16B	S-STUD8-0.38-4.00		Stud	2
16C	S-NUT8-0.38		Nuts	2
17	S-LW-0.38		Lock Washer	12

Table 5

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Bill of Materials

6-1 - DH50 BOM

6-1.1 DH50 SKID ASSEMBLY 1006045

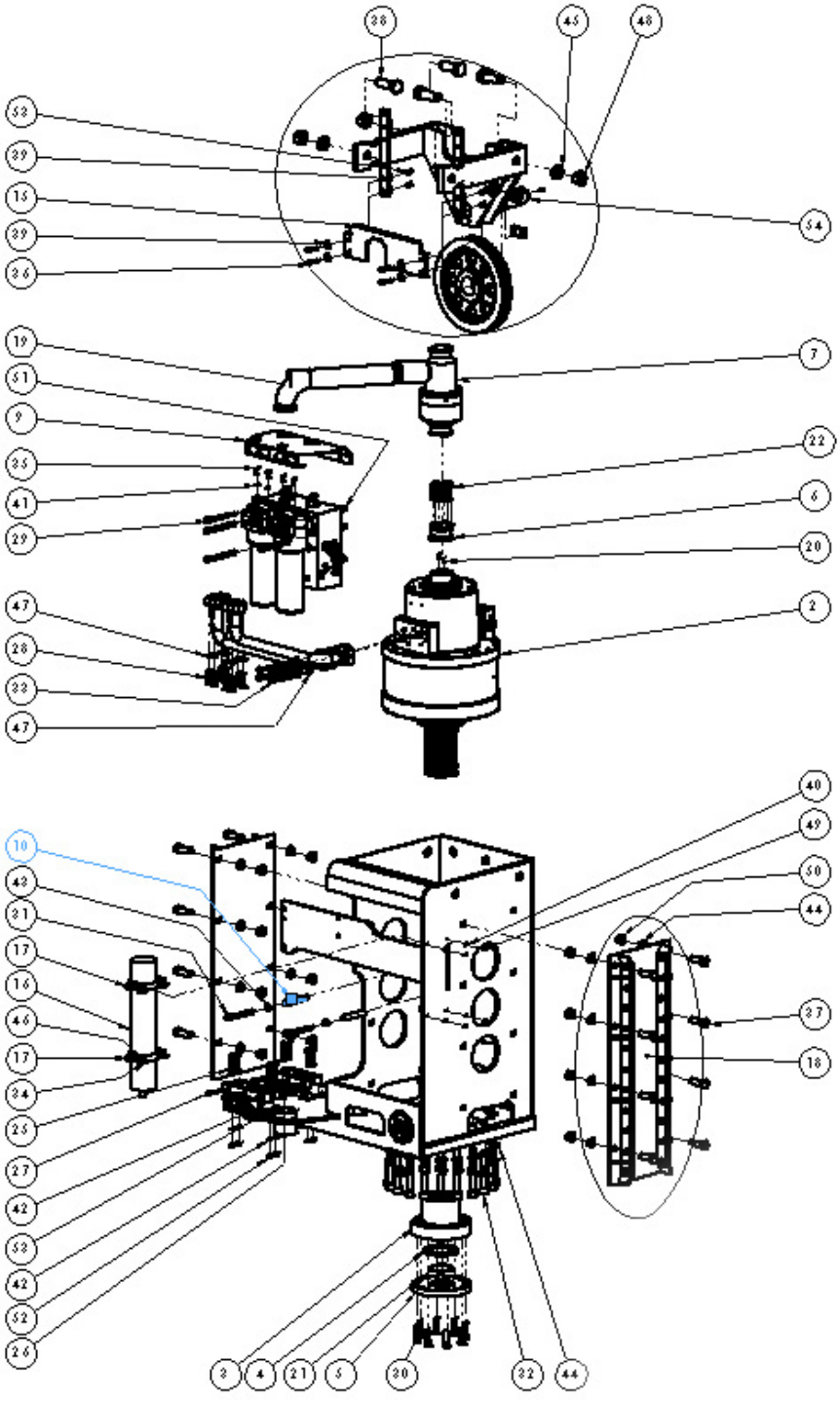

Figure 14

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Bill of Materials

6-1 - DH50 BOM

6-1.1 DH50 SKID ASSEMBLY 1006045

CALLOUT	PART NUMBER	APE PART NUMBER	DESCRIPTION	QTY
1		1004161	DH50 Skid	1
2	SD158340002		Black Bruin Motor	1
3		600530BB	Drive Hub	1
4		630511	Split Ring	1
5		630514	Seal Plate	1
6		1000595	Grout Adapter Black Bruin	1
7		630001	3 IN Rotary Joint	1
8	016018	1004515	Drill Manifold ASM	1
9		1004275	Manifold Guard	1
10		1006092	Cable Guide Spacer	2
11		1004267	Pipe Assembly A	1
12		1004268	Pipe Assembly B	1
13		1004258	Hose Clamp -6 -6 -16	2
14		1004259	Hose Clamp -24 -24	2
15		1006076	Anti-Rotational Stop	1
16		1000397	Accumulator	1
17		1001044	Accumulator Mount	2
18		1005201	Guide Rail Assembly 26 x 8	1
19		1004272	Grout Tube	1
20			8mm x 25mm Hardened pin	2
21	2-347	100712	Seal Plate O- Ring	1
22	SHCS M8-1.25 x 70		Grout Adapter To Motor	10
23	6801-06-06		-6 SAE to JIC 90°	7
24	6801-16-16		-16 SAE to JIC 90°-	2
25	SHCS 1/2-13 X 3		Hose Clamp To Skid	8
26	SHCS 1/2-13 X 3.75		-6 -6 -16 Hose Clamp	3
27	SHCS 1/2-13 X 4		-24 -24 Hose Clamp	3

Table 5

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Bill of Materials

6-1 - DH50 BOM

6-1.1 DH50 SKID ASSEMBLY 1006045

CALLOUT	PART NUMBER	APE PART NUMBER	DESCRIPTION	QTY
28	HBOLT 5/8-11 X 2.25		Hard Pipe to Manifold	8
29	SHCS 5/8-11 X 7		Manifold to Skid	5
30	SHCS 3/4-10 X 2.5		Seal Plate to Hub	8
31	SHCS 3/4-10 X 6		Cable Guide	2
32	SHXS 1-8 X 4		Motor to Skid	20
33	HBOLT M16-2.0 X 70		Hardpipe to Motor	8
34	HBOLT 5/16-18 X 1.25		Accumulator to Skid	4
35	HBOLT 3/8-16 X 1		Manifold Guard to Filter	4
36	HBOLT 1-8 X 3		Anti Rotational Stop	4
37	HBOLT 1-8 X 3		Guide Rail to Skid	16
38	HBOLT 1.5-6 X 4		Lifting Bale to skid	4
39	Regular FL 1/2		Anti Rotational Stop	8
40	Heavy LW 5/16		Accumulator to Skid	4
41	Regular LW 3/8		Manifold Guard to Filter	4
42	Heavy LW 1/2		Hose Clamps	14
43	Heavy LW 3/4		Cable Guide	2
44	Heavy LW 1		Motor to Skid / Guide Rails	36
45	Heavy LW 1.5		Lifting Bale to Skid	4
46	Regular FW 5/16		Accumulator to Skid	4
47	Heavy LW 5/8		Hard Pipe	16
48	HNUT 1.5-6		Lifting Bale to skid	4
49	HNUT 5/16-18		Accumulator to Skid	4
50	HNUT 1/2-13		Motor to Skid / Guide Rails	16
51	Nylock Nut 5/8-11		Manifold to Skid	5
52	HNUT 1/2-13		Hose Clamp to Skid	8
53	Nylock Nut 1/2-13		Anti-Rotational Stop / Hose Clamp	10
54	1004271		Lifting Bale Assembly	1

Table 5 Continued

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6-2 - DH50 BOM

6-2.1 LIFTING BALE ASSEMBLY 1004271

Figure 15

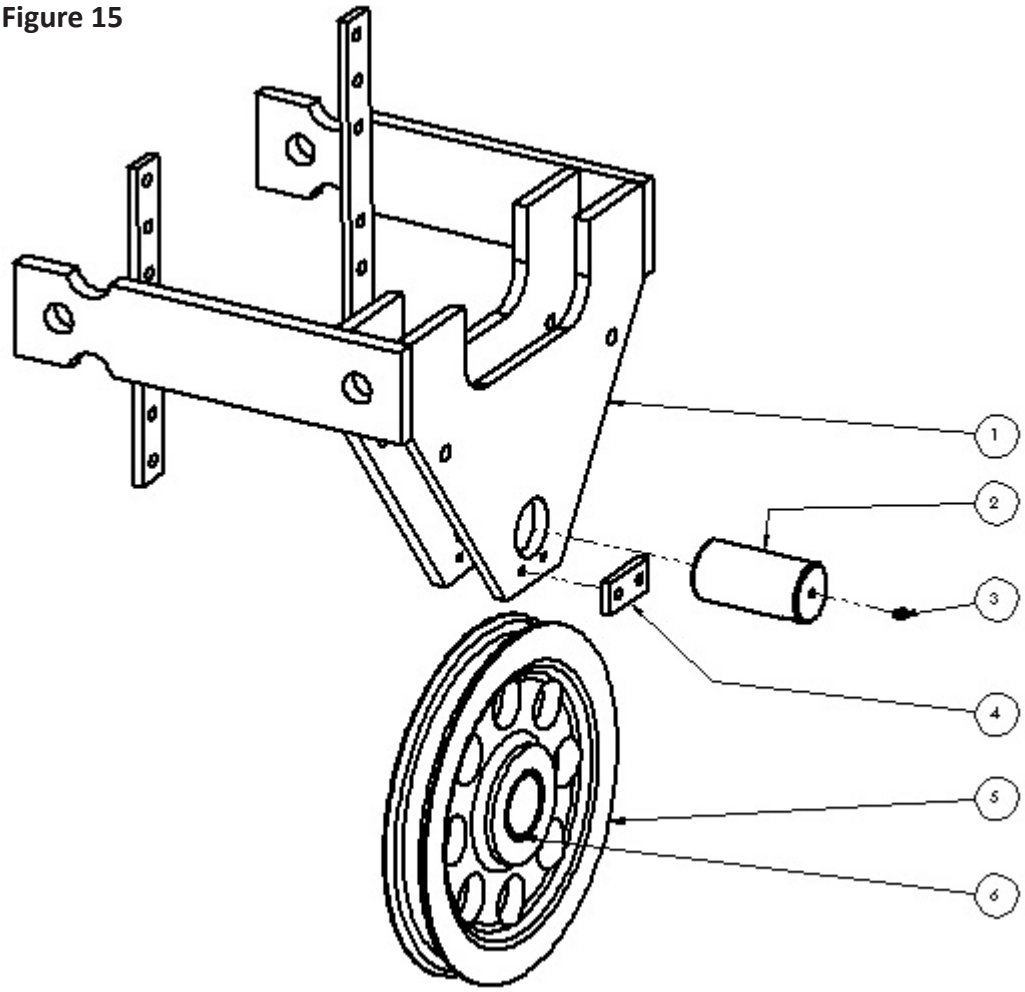

Table 6

CALLOUT	APE PART NUMBER	DESCRIPTION	QTY
1	1004274	Lifting Bale Housing	2
2	1005021	Sheave Pin	1
3	221001	Grease Fitting-1/8 NPT Zert	1
4	1005022	Sheave Pin Keeper	1
5	950901	Sheave-Finished 18”	1
6	950903	Sheave Pin Bushing	1

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6-3 - DH50 BOM

6-3.1 GUIDE RAIL ASSEMBLY 1006084

Figure 16

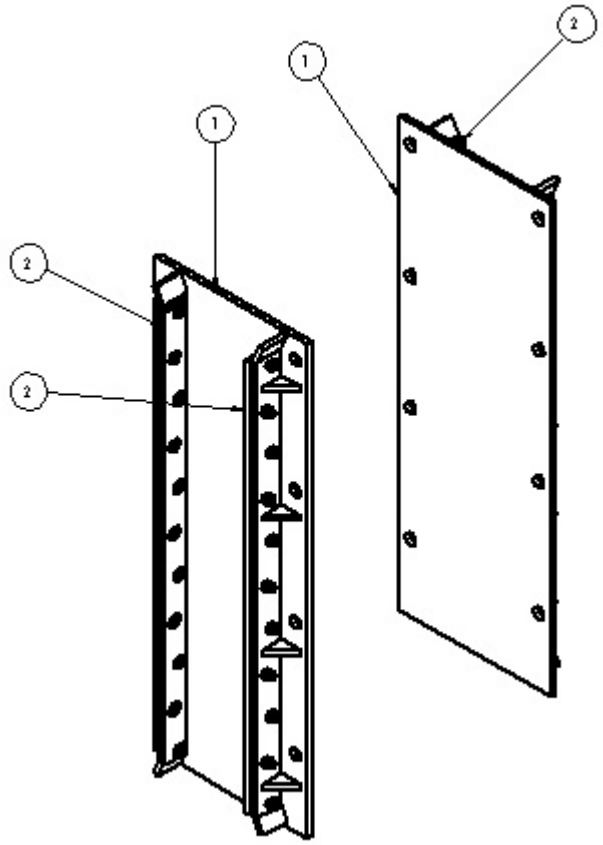

Table 7

CALLOUT	APE PART NUMBER	DESCRIPTION	QTY
1	1005014	Guide Rail	2
2	1005023	Guide Rail Plastic	4
3	CS SHCS 1/2-13 X 1.75	Plastic to Guide Bolt	44
4	Nylock Nut 1/2-13	Plastic to Guide Nut	44

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6-4 - DH50 BOM

6-4.1 DRIVE MANIFOLD ASSEMBLY 016018

Figure 17

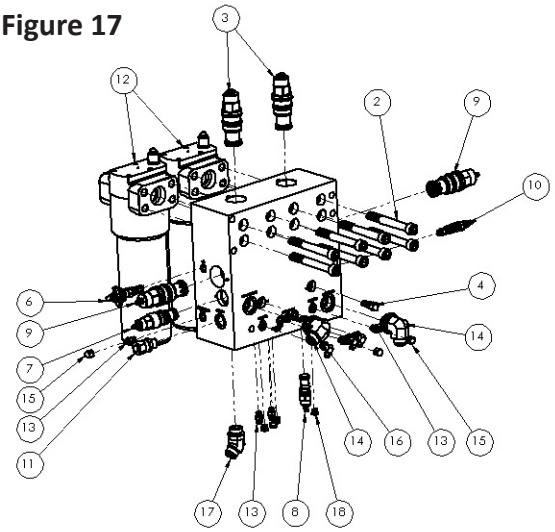

Table8

CALLOUT	PART NUMBER	APE PART NUMBER	DESCRIPTION	QTY
1		016017	Manifold	1
2	SHCS 3/4-10 X 6.5		Filter Mount Bolts	8
3	CBIA-LBN	631063	3:1 Pilot Ratio Counterbalance Valve	2
4	CXBA-XCN	1000837	30 PSI Check Valve	2
5	FXCA-XAN		Fixed Orfice Flow Control Valve	1
6	NFCC-YCN		Fully Adjustable Needle Valve	1
7	PRHB-LAN		1000PSI Pressure Reducing Valve	1
8	RBAA-LAN		Direct Acting Relief Valve	1
9	RVIS-LCN		Poppet Relief Valve	2
10	DRBN-LDN		Directional Flow Valve Normally Closed	1
11		321009	Pop Off Relief	1
12	HS6013XXF32D13		Filter	2
13	6400-06-06		-6 SAE Straight	5
14	6801-16-16		-16 SAE to JIC 90°	2
15	304-C-06		-6 JIC Cap	3
16	6801-06-06		-6 SAE to JIC 90°	3
17	6802-16-16		-16 SAE to ORB 45°	1
18	6408-HHP-06		-6 SAE Plug	4

7 - REFERENCE DOCUMENTS

UNDERSTANDING ISO CODES

The ISO cleanliness code is used to quantify particulate contamination levels per milliliter of fluid at 3 sizes 4µ[c], 6µ[c], and 14µ[c]. The ISO code is expressed in 3 numbers (ie 19/17/14). Each number represents a contaminant level code for the correlating particle size. The code includes all particles of the specified size and larger. It is important to note that each time a code increases the quantity range of particles is doubling.

ISO 4406 Chart		
Range Code	Particles per milliliter	
	More than	Up to/including
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64

Sample 1 (see photo 1)

Particle Size	Particles per ml*	ISO 4406 Code range	ISO Code
4µ[c]	151773	80000~160000	24
6µ[c]	38363	20000~40000	22
10µ[c]	8229		
14µ[c]	3339	2500~5000	19
21µ[c]	1048		
38µ[c]	112		

Sample 2 (see photo 2)

Particle Size	Particles per ml*	ISO 4406 Code range	ISO Code
4µ[c]	492	320 ~ 640	16
6µ[c]	149	80 ~ 160	14
10µ[c]	41		
14µ[c]	15	10 ~ 20	11
21µ[c]	5		
38µ[c]	1		

Photo 1

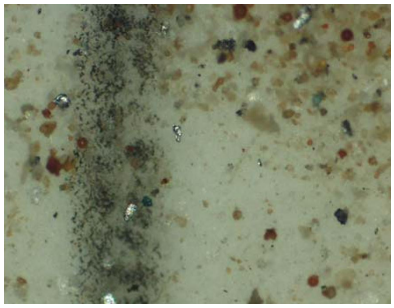

Photo 2

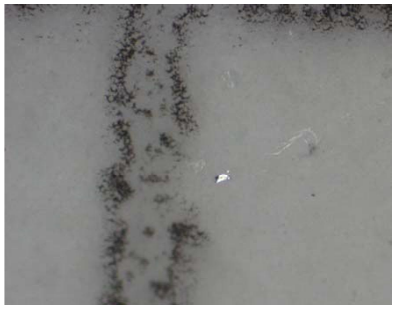

Table 10

7 - REFERENCE DOCUMENTS

TARGET ISO CLEANLINESS CODES

When setting target ISO fluid cleanliness codes for hydraulic and lubrication systems it is important keep in mind the objectives to be achieved. Maximizing equipment reliability and safety, minimizing repair and replacement costs, extending useful fluid life, satisfying warranty requirements, and minimizing production down-time are attainable goals. Once a target ISO cleanliness code is set following a progression of steps to achieve that target, monitor it, and maintain it justifiable rewards will be yours.

Set the Target.
The first step in identifying a target ISO code for a system is to identify the most sensitive on an individual system, or the most sensitive component supplied by a central reservoir. If a central reservoir supplies several systems the overall cleanliness must be maintained, or the most sensitive component must be protected by filtration that cleans the fluid to the target before reaching that component.

Other Considerations
Table 1 recommends conservative target ISO cleanliness codes based on a several component manufacturers guidelines and extensive field studies for standard industrial operating conditions in systems using petroleum based fluids. If a non-petroleum based fluid is used (i.e. water glycol) the target ISO code should be set one value lower for each size (4 µ[c]/6µ[c]/14µ[c]). If a combination of the following conditions exists in the system the target ISO code should also be set one value lower:

- Component is critical to safety or overall system reliability.
- Frequent cold start.
- Excessive shock or vibration.
- Other Severe operation conditions.

Recommended* Target ISO Cleanliness Codes and media selection for systems using petroleum based fluids per ISO4406:1999 for particle sizes 4µ[c] / 6µ[c] / 14µ[c]

	Pressure < 140 bar < 2000 psi	Media βx[c] = 1000 (βx = 200)	Pressure 212 bar 3000 psi	Media βx[c] = 1000 (βx = 200)	Pressure > 212 bar > 3000 psi	Media βx[c] = 1000 (βx = 200)
Pumps						
Fixed Gear	20/18/15	22µ[c] (25 µ)	19/17/15	12µ[c] (12 µ)	-	-
Fixed Piston	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)	17/15/12	7µ[c] (6 µ)
Fixed Vane	20/18/15	22µ[c] (25 µ)	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Variable Piston	18/16/13	7µ[c] (6 µ)	17/15/13	5µ[c] (3 µ)	16/14/12	7µ[c] (6 µ)
Variable Vane	18/16/13	7µ[c] (6 µ)	17/15/12	5µ[c] (3 µ)	-	-
Valves						
Cartridge	18/16/13	12µ[c] (12 µ)	17/15/12	7µ[c] (6 µ)	17/15/12	7µ[c] (6 µ)
Check Valve	20/18/15	22µ[c] (25 µ)	20/18/15	22µ[c] (25 µ)	19/17/14	12µ[c] (12 µ)
Directional (solenoid)	20/18/15	22µ[c] (25 µ)	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Flow Control	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Pressure Control (modulating)	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)	17/15/12	7µ[c] (6 µ)
Proportional Cartridge Valve	17/15/12	7µ[c] (6 µ)	17/15/12	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)
Proportional Directional	17/15/12	7µ[c] (6 µ)	17/15/12	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)
Proportional Flow Control	17/15/12	7µ[c] (6 µ)	17/15/12	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)
Proportional Pressure Control	17/15/12	7µ[c] (6 µ)	17/15/12	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)
Servo Valve	16/14/11	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)	15/13/10	5µ[c] (3 µ)
Bearings						
Ball Bearing	15/13/10	5µ[c] (3 µ)	-	-	-	-
Gearbox (industrial)	17/16/13	12µ[c] (12 µ)	-	-	-	-
Journal Bearing (high speed)	17/15/12	7µ[c] (6 µ)	-	-	-	-
Journal Bearing (low speed)	17/15/12	7µ[c] (6 µ)	-	-	-	-
Roller Bearing	16/14/11	7µ[c] (6 µ)	-	-	-	-
Actuators						
Cylinders	17/15/12	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)	15/13/10	5µ[c] (3 µ)
Vane Motors	20/18/15	22µ[c] (25 µ)	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Axial Piston Motors	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)	17/15/12	7µ[c] (6 µ)
Gear Motors	20/18/14	22µ[c] (25 µ)	19/17/13	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Radial Piston Motors	20/18/15	22µ[c] (25 µ)	19/17/14	12µ[c] (12 µ)	18/16/13	12µ[c] (12 µ)
Test Stands, Hydrostatic						
Test Stands	15/13/10	5µ[c] (3 µ)	15/13/10	5µ[c] (3 µ)	15/13/10	5µ[c] (3 µ)
Hydrostatic Transmissions	17/15/13	7µ[c] (6 µ)	16/14/11	5µ[c] (3 µ)	16/14/11	5µ[c] (3 µ)

*Depending upon system volume and severity of operating conditions a combination of filters with varying degrees of filtration efficiency might be required (I.e. pressure, return, and off-line filters) to achieve and maintain the desired fluid cleanliness.

Example		ISO Code	Comments
Operating Pressure	156 bar, 2200 psi		
Most Sensitive Component	Directional Solenoid	19/17/14	recommended baseline ISO Code
Fluid Type	Water Glycol	18/16/13	Adjust down one class
Operating Conditions	Remote location, repair difficult		Adjust down one class, combination
	High ingression rate	17/15/12	of critical nature, severe conditions

Table 11

7 - REFERENCE DOCUMENTS

Torque-Tension Relationship for A307A, Grade 5, 8 & 9 Bolts

Nominal Dia.	threads per inch	Tensile Stress Area	ASTM A307 Grade A				SAE J429 Grade 5				SAE J429 Grade 8				FNL Grade 9			
			Clamp Load	Tightening Torque			Clamp Load	Tightening Torque			Clamp Load	Tightening Torque			Clamp Load	Tightening Torque		
(in.)		(sq. in.)	(Lbs.)	K = 0.15	K = 0.17	K = 0.20	(Lbs.)	K = 0.15	K = 0.17	K = 0.20	(Lbs.)	K = 0.15	K = 0.17	K = 0.20	(Lbs.)	K = 0.15	K = 0.17	K = 0.20
Unified Coarse Thread Series																		
1/4	20	0.0318	859	32 in-lbs	37 in-lbs	43 in-lbs	2029	76 in-lbs	86 in-lbs	101 in-lbs	2864	107 in-lbs	122 in-lbs	143 in-lbs	3357	126 in-lbs	143 in-lbs	168 in-lbs
5/16	18	0.0524	1416	66	75	88	3342	157	178	209	4719	221	251	295	5531	259	294	346
3/8	16	0.0775	2092	10 ft-lbs	11 ft-lbs	13 ft-lbs	4940	23 ft-lbs	26 ft-lbs	31 ft-lbs	6974	33 ft-lbs	37 ft-lbs	44 ft-lbs	8174	38 ft-lbs	43 ft-lbs	51 ft-lbs
7/16	14	0.1063	2870	16	18	21	6777	37	42	49	9568	52	59	70	11214	61	70	82
1/2	13	0.1419	3831	24	27	32	9046	57	64	75	12771	80	90	106	14969	94	106	125
9/16	12	0.1819	4912	35	39	46	11599	82	92	109	16375	115	130	154	19193	135	153	180
5/8	11	0.2260	6102	48	54	64	14408	113	128	150	20340	159	180	212	23840	186	211	248
3/4	10	0.3345	9030	85	96	113	21322	200	227	267	30101	282	320	376	35281	331	375	441
7/8	9	0.4617	12467	136	155	182	29436	322	365	429	41556	455	515	606	48707	533	604	710
1	8	0.6057	16355	204	232	273	38616	483	547	644	54517	681	772	909	63899	799	905	1065
1 1/4	7	0.9691	26166	409	463	545	53786	840	952	1121	87220	1363	1545	1817	102229	1597	1810	2130
1 1/2	6	1.4053	37942	711	806	949	77991	1462	1657	1950	126473	2371	2688	3162	148237	2779	3150	3706
Fine Thread Series																		
1/4	28	0.0364	982	37 in-lbs	42 in-lbs	49 in-lbs	2319	87 in-lbs	99 in-lbs	116 in-lbs	3274	123 in-lbs	139 in-lbs	164 in-lbs	3837	144 in-lbs	163 in-lbs	192 in-lbs
5/16	24	0.0581	1568	73	83	98	3702	174	197	231	5226	245	278	327	6125	287	325	383
3/8	24	0.0878	2371	11 ft-lbs	13 ft-lbs	15 ft-lbs	5599	26 ft-lbs	30 ft-lbs	35 ft-lbs	7905	37 ft-lbs	42 ft-lbs	49 ft-lbs	9265	43 ft-lbs	49 ft-lbs	58 ft-lbs
7/16	20	0.1187	3205	18	20	23	7568	41	47	55	10684	58	66	78	12523	68	78	91
1/2	20	0.1600	4319	27	31	36	10197	64	72	85	14396	90	102	120	16873	105	120	141
9/16	18	0.2030	5480	39	44	51	12940	91	103	121	18268	128	146	171	21412	151	171	201
5/8	18	0.2560	6911	54	61	72	16317	127	144	170	23036	180	204	240	27000	211	239	281
3/4	16	0.3730	10070	94	107	126	23776	223	253	297	33566	315	357	420	39343	369	418	492
7/8	14	0.5095	13756	150	171	201	32479	355	403	474	45853	502	568	669	53743	588	666	784
1	14	0.6799	18357	229	260	306	43343	542	614	722	61190	765	867	1020	71720	896	1016	1195
1 1/4	12	1.0729	28970	453	513	604	59548	930	1055	1241	96565	1509	1710	2012	113182	1768	2004	2358
1 1/2	12	1.5810	42688	800	907	1067	87747	1645	1865	2194	142292	2668	3024	3557	166778	3127	3544	4169

The torque values can only be achieved if nut (or tapped hole) has a proof load greater than or equal to the bolt's minimum ultimate tensile strength.
Clamp load calculated as 75% of the proof load when specified by the standard. ASTM A307 utilized 75% of 36,000 PSI.
Torque values for 1/4 and 5/16-in series are in inch-pounds. All other torque values are in foot-pounds.
Torque values calculated from formula T=KDF, where

K = 0.15 for "lubricated" conditions
K = 0.17 for zinc plated and dry conditions; we have also found various forms of customer applied thread lockers to have a similar K value.
K = 0.20 for plain and dry conditions
D = Nominal Diameter
F = Clamp Load

Note: When using Zinc Plated (lubricated with wax) Top Lock Nuts, the K value can vary between 0.12-0.16

Caution: All material included in this chart is advisory only, and its use by anyone is voluntary. In developing this information, Fastenal has made a determined effort to present its contents accurately. Extreme caution should be used when using a formula for torque/tension relationships. Torque is only an indirect indication of tension. Under/over tightening of fasteners can result in costly equipment failure or personal injury.

engineer@fastenal.com

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Table 12

AMERICAN PILEDRIVING EQUIPMENT, INC
7032 S. 196th Street
Kent, Washington 98032
253-872-0141 / 800-248-8498
www.apevibro.com

8 - REVISION RECORD

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Kent, Washington 98032
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All information given in this Manual is current and valid per the information available at the time of publication. (Please check the updated revision date at the bottom of each page.)

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AMERICAN PILEDRIVING EQUIPMENT, INC.
7032 S. 196th Street
Kent, Washington 98032
Office: 253-872-0141
Toll Free: 800-248-8498
Fax: 253-872-8710