This Quick Reference Guide will assist you in finding the information you’re looking for.

A Table of Contents is included after the Foreword.

Prepared for:

Reference:
  Equipment #
  Serial #

Description:
  HD50
READ THIS MANUAL THOROUGHLY BEFORE OPERATING AND / OR WORKING ON THE EQUIPMENT

1. Only well-trained and experienced personnel should attempt to operate or maintain this equipment.
2. NEVER adjust, lubricate and/or repair the unit when it is in operation or lifted above ground level.
3. NEVER remove, paint over and/or cover warning or safety labels. If labels become damaged or unreadable, replace immediately.
4. All personnel should wear approved safety clothing including HARD HATS, SAFETY SHOES, SAFETY GLASSES and HEARING PROTECTION when near this equipment.
5. 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.
6. When maintaining and/or repairing the equipment, NEVER substitute parts not supplied or approved in writing by APE.
7. Insure that all lifting equipment, including cranes, wire rope, slings, hooks, shackles, etc., Are properly sized for the worst caseloads anticipated during operations.
8. If there are any questions about the weights, specifications and/or performance of the unit, contact APE before handling and/or operating the equipment.
9. If the equipment is to be used for anything other than driving plumb holes, contact APE before using the unit.
10. Check wire rope clips for tightness and wire ropes for wear daily.
11. Insure that ground vibrations will not damage or collapse adjacent structures or excavations.
12. Remove all tools, parts and/or electrical cords before starting the unit.

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

**DANGER**

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING**

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

**NOTICE**

NOTICE is used to address practices not related to personal injury.

**NOTE**

- NOTE indicates information that may help or guide you in the operation or service of the equipment.

**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.

**DANGER**

Do NOT weld or flame cut on this equipment.

**WARNING**

NEVER use or store flammable liquids on or near the engine.

**NOTICE**

• NOTE indicates information that may help or guide you in the operation or service of the equipment.
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.
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. 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.)
34. KEEP HANDS AWAY FROM ROTATING FLIGHTING, AUGER SHAFT AND/OR ROTARY JOINT.
35. KEEP HANDS, FEET AND/OR TOOLS WELL CLEAR OF THE FLIGHTING GUIDES.
36. Do NOT allow clothing, hoses, ropes, etc., To become entangled in, or wrap around, rotating flighting, Auger shaft and/or rotary joint..
37. When operating in a closed area, pipe exhaust fumes outside. (Warning: Breathing exhaust fumes can cause serious injury or even death.)
38. Make sure the control pendant is in the “LOCAL” position before starting the unit.
39. Never stand under hammer at any time and keep you eyes on the hammer when it is in operation.
40. When loading or unloading the power unit using a forklift, the forks must be placed under the entire depth of the unit.
American Piledriving Equipment, Inc. (APE) warranties new products sold by it to be free from defects in material or workmanship for a period of one (1) 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 WARRANTY

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 WARRANTY 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.
This manual covers the **APE HELICAL DRIVER** installation, maintenance and use.

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 original manual.
- Please visit [www.apevibro.com](http://www.apevibro.com) for product data-sheets and manual.

**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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**SPECIFICATIONS**

**DIMENSIONS**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Length</td>
<td>53 in</td>
<td>(135 cm)</td>
<td></td>
</tr>
<tr>
<td>Overall Width</td>
<td>25 in</td>
<td>(64 cm)</td>
<td></td>
</tr>
<tr>
<td>Overall Height</td>
<td>59 in</td>
<td>(150 cm)</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>3,800 lbs</td>
<td>(1,724 kg)</td>
<td></td>
</tr>
</tbody>
</table>

**Hydraulics**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque Low Speed</td>
<td>31,180 ft-lbs</td>
<td>(42,274 Nm)</td>
<td></td>
</tr>
<tr>
<td>Torque High Speed</td>
<td>13,450 ft-lbs</td>
<td>(18,236 Nm)</td>
<td></td>
</tr>
<tr>
<td>Driver Speed Low Speed</td>
<td></td>
<td>38 RPM</td>
<td></td>
</tr>
<tr>
<td>Driver Speed High Speed</td>
<td></td>
<td>58 RPM</td>
<td></td>
</tr>
<tr>
<td>Max. Hydraulic Flow</td>
<td>50 gpm</td>
<td>(189 lpm)</td>
<td></td>
</tr>
<tr>
<td>Max. Hydraulic Pressure</td>
<td>5,000 psi</td>
<td>(320 bar)</td>
<td></td>
</tr>
</tbody>
</table>

Bale assembly is modular and can be removed to reduce weight and height.

Hydraulic motor is recessed in the driver housing to be fully protected.

APE Patented modular drive socket and socket retainer.

Through hole grout system.

Forklift bracket allows additional options.
GENERAL INFORMATION

Safety / Warning Labels

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

Do not operate this equipment without a safety gate in place. Failing to use a safety gate may allow the pile to fall during driving.
Power Unit Parts Overview

- Top Cage
- Grouting System
- Driver Housing
- Drive Socket
- Forklift Bracket
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 bolts fastening the driver housing to the top cage and all grout clamp bolts, to insure they are tight.
- 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.
- Wash out all grout from drive socket and grouting system to maintain proper fit and function.

*It is absolutely imperative 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.*
Lifting the Helical Driver

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

- Use necessary Personal Protective Equipment (PPE) when working with the helical driver.
- Support the driver properly from the forklift brackets as shown in the image to the right.
- Use only appropriate equipment and attachments for lifting and positioning the driver.
- Always use the lifting equipment properly and check the load bearing capacities.
- Prevent unintended use of the driver motor during installation and maintenance procedures by preventing the pressurization of the hydraulic lines.
- The operating temperature of the motor may be over 140° F (60°C) which is hot enough to cause severe burns.

Beware of hot hydraulic fluid when disconnecting the hydraulic connections.
Connecting the Hydraulics

Drive FWD  Case Drain  Drive REV
Connecting / Filling the Hydraulic Lines

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

**New hydraulic fluid is NOT clean oil!**

*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

**Attention!**

While filling the hydraulic lines, the driver 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 hydraulic 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.
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.

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

Flush 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 the hydraulic fluid through a filter installed in place of the motor.

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

The helical pile driver is usually shipped with the driver motor hoses full of hydraulic oil and the unit may be used immediately.

If the drive hoses have been removed from the driver motor they will need to be filled before full speed operation.

1. The motor case is going to need to be filled by removing the top fill plug in port labeled "Y" and pouring in new clean hydraulic oil. Port "2" is the connection for the case drain hose.
2. With all hoses connected, run the excavator or 127 power unit at low engine RPM and engage drive FWD. Continue to send the small amount of flow to the driver motor for 2 minutes. This will push the air that is present in the system through the hoses to bleed all the air out of the hoses and driver motor.
3. Switch the driver direction to REV and allow the driver to run for another 2 minutes.
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.

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)"

(See Warranty document regarding fluid cleanliness)

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

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.
**Operating Pressures**

**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 or 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 driver motor.

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

**Case Drain**

The case drain line is the return line for the driver housing cavity. Case pressure is induced 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.*

---

**Operating Temperatures**

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.
Understanding the Hydraulic Circuit

The APE Auger Driver 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

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

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” under the Reference / Notes Section*
*See Warranty document regarding fluid cleanliness at the beginning of this manual*

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

Hydraulic Schematic

LOW SPEED 19.93 RPM

DRILL MOTOR

CASE FLUSH SAE-6

FXCA-XAN 1 GPM

SHV3

DSCH-XHN - BODY

FROM THE EXCAVATOR/SKID STEER AUXILIARY CIRCUIT FLOW REQUIRED 79 GPM

REV (R)  FWD (L)  DR1

B1  A1

#24

SCHROEDER FIL:
K31K22SSD8G

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## MAINTENANCE

### Maintenance Chart

For reference when paired with APE 127 Power unit.

<table>
<thead>
<tr>
<th>DAILY</th>
<th>WEEKLY</th>
<th>250 HOURS OR 6 MONTHS</th>
<th>1500 HOURS OR 1 YEAR</th>
<th>6000 HOURS OR 2 YEARS</th>
<th>6000 HOURS OR 3 YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Check operator’s report</td>
<td>• Check air intake system for wear points or damage to piping, loose clamps, and leaks.</td>
<td>• Change lubricating oil</td>
<td>• Adjust valves and injectors</td>
<td>• Clean cooling system and change coolant and antifreeze</td>
<td>• Clean and calibrate the following:</td>
</tr>
<tr>
<td>• Check oil and bring to correct level</td>
<td>• Check air cleaner restriction</td>
<td>• Change lubricating oil filters</td>
<td>• Steam clean engine</td>
<td>• Inspect Temperature regulator</td>
<td>• Injectors</td>
</tr>
<tr>
<td>• Check coolant and bring to correct level</td>
<td>• Check and clean air cleaner element</td>
<td>• Change fuel filter</td>
<td>• Check torque on turbocharger mounting nuts</td>
<td>• Inspect/rebuild turbocharger</td>
<td>• Fuel pump</td>
</tr>
<tr>
<td>• Visually inspect fan.</td>
<td>• Drain moisture from tanks</td>
<td>• Clean crankcase breather</td>
<td>• Check torque on engine mounting bolts</td>
<td>• Inspect/rebuild starter</td>
<td>• Fan Clutch</td>
</tr>
<tr>
<td>• Visually inspect engine for damage, leaks, loose or frayed belts and correct or record or future action</td>
<td>• Replace final fuel filter/clean primary fuel filter. Drain water from fuel tank</td>
<td>• Check engine coolant concentration level</td>
<td>• Replace hoses as required</td>
<td>• Inspect/rebuild turbocharger</td>
<td>• Water pump</td>
</tr>
<tr>
<td>• Drain fuel-water separator</td>
<td>• Inspect/replace alternator fan and accessory drive belts</td>
<td>• Replace final fuel filter/ clean primary fuel filter. Drain water from fuel tank</td>
<td>• Check/adjust engine valve lash</td>
<td>• Inspect/rebuild starter</td>
<td>• Fan Hub</td>
</tr>
<tr>
<td></td>
<td>• Inspect/replace hoses and clamps</td>
<td></td>
<td>• Check/adjust low idle speed</td>
<td></td>
<td>• Fan idler pulley assembly</td>
</tr>
<tr>
<td></td>
<td>• Lubricate fan drive bearings</td>
<td></td>
<td>• Test/exchange fuel injection nozzles</td>
<td></td>
<td>• Vibration damper</td>
</tr>
<tr>
<td></td>
<td>• Clean/check battery electrolyte level</td>
<td></td>
<td>• Inspect/rebuild alternator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Follow the manufacturer’s recommended maintenance procedures for the starter, alternator, batteries, electrical components, and fan clutch.

At each scheduled maintenance interval preform all previous checks which are due for scheduled maintenance.
Preventative maintenance includes normal servicing that will keep the power unit 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 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.

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.

Storage

During short-term storage of a power unit, 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
- The power unit should not be stored in an area with substances that have an aggressive corrosive nature; i.e., solvents, acids, alkalies 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 power unit 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 time frames should only be considered as guide values.
## REPLACEMENT PARTS

### Common Replacement Parts

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>PART NUMBER</th>
<th>QTY</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Spacer Ring</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Seal VP45005250-0</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Seal VP45005250-1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Seal VP45005250-2</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Vee Packing Lube Spacer</td>
<td>1000875</td>
<td>1</td>
</tr>
</tbody>
</table>

### DRIVE SOCKETS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SECONDARY DESCRIPTION</th>
<th>APE PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5 Drive Socket</td>
<td>HDS 4.5</td>
<td>1000359</td>
</tr>
<tr>
<td>5.5 Drive Socket</td>
<td>HDS 5.5</td>
<td>1000360</td>
</tr>
<tr>
<td>7 Drive Socket</td>
<td>HDS 7</td>
<td>1000361</td>
</tr>
<tr>
<td>9.625 Drive Socket</td>
<td>HDS 9.625</td>
<td>100361</td>
</tr>
<tr>
<td>11.75 Drive Socket</td>
<td>HDS 11.75</td>
<td>100363</td>
</tr>
<tr>
<td>13.375 Drive Socket</td>
<td>HDS 13.375</td>
<td>100364</td>
</tr>
</tbody>
</table>
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.

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

Sample 1 (see photo 1)

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

Sample 2 (see photo 2)

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Particles per ml*</th>
<th>ISO 4406 Code range</th>
<th>ISO Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>4μ[c]</td>
<td>492</td>
<td>320~640</td>
<td>16</td>
</tr>
<tr>
<td>6μ[c]</td>
<td>149</td>
<td>80~160</td>
<td>14</td>
</tr>
<tr>
<td>10μ[c]</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14μ[c]</td>
<td>15</td>
<td>10~20</td>
<td>11</td>
</tr>
<tr>
<td>21μ[c]</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38μ[c]</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TARGET ISO CLEANLINESS CODES

When setting target ISO fluid cleanliness codes for hydraulic and lubrication systems it is important to 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 μl/c/6μl/c/14 μl/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.

<table>
<thead>
<tr>
<th>Pumps</th>
<th>Fixed Gear</th>
<th>Fixed Piston</th>
<th>Fixed Vane</th>
<th>Variable Piston</th>
<th>Variable Vane</th>
<th>Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Media (μl/c)</td>
<td>Pressure</td>
<td>Media (μl/c)</td>
<td>Pressure</td>
<td>Media (μl/c)</td>
<td>Pressure</td>
</tr>
<tr>
<td>&lt; 140 bar</td>
<td>100</td>
<td>212 bar</td>
<td>100</td>
<td>&gt; 212 bar</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>&lt; 2000 psi</td>
<td>(μl/c = 200)</td>
<td>3000 psi</td>
<td>(μl/c = 200)</td>
<td>3000 psi</td>
<td>(μl/c = 200)</td>
<td></td>
</tr>
<tr>
<td>20/18/15</td>
<td>12μl/c (25 μl)</td>
<td>19/17/15</td>
<td>12μl/c (12 μl)</td>
<td>17/15/12</td>
<td>12μl/c (12 μl)</td>
<td>18/16/13</td>
</tr>
<tr>
<td>Variable Piston</td>
<td>18/16/13</td>
<td>7μl/c (6 μl)</td>
<td>17/15/13</td>
<td>7μl/c (3 μl)</td>
<td>16/14/12</td>
<td>7μl/c (3 μl)</td>
</tr>
<tr>
<td>Variable Vane</td>
<td>18/16/13</td>
<td>7μl/c (6 μl)</td>
<td>17/15/12</td>
<td>7μl/c (3 μl)</td>
<td>16/14/11</td>
<td>7μl/c (6 μl)</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Operating Pressure</th>
<th>ISO Code</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>156 bar, 2200 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most Sensitive Component</td>
<td>Directional Solenoid</td>
<td>19/17/14</td>
</tr>
<tr>
<td>Fluid Type</td>
<td>Water Glycol</td>
<td>18/16/13</td>
</tr>
<tr>
<td>Operating Conditions</td>
<td>Remote location, repair difficult</td>
<td>17/15/12</td>
</tr>
</tbody>
</table>
### Torque-Tension Relationship for A307A, Grade 5, 8 & 9 Bolts

<table>
<thead>
<tr>
<th>Nominal Dia. x threads per in.</th>
<th>Tensile Stress Area</th>
<th>Clamp Load (1/16 in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in.²</td>
<td>K = 0.15</td>
</tr>
<tr>
<td>1/4 x 20</td>
<td>0.0191</td>
<td>950</td>
</tr>
<tr>
<td>5/16 x 18</td>
<td>0.0254</td>
<td>1418</td>
</tr>
<tr>
<td>7/32 x 18</td>
<td>0.0275</td>
<td>1492</td>
</tr>
<tr>
<td>1/2 x 13</td>
<td>0.0411</td>
<td>2491</td>
</tr>
<tr>
<td>9/16 x 12</td>
<td>0.0519</td>
<td>4412</td>
</tr>
<tr>
<td>5/8 x 11</td>
<td>0.0602</td>
<td>5402</td>
</tr>
<tr>
<td>3/4 x 10</td>
<td>0.1345</td>
<td>9030</td>
</tr>
<tr>
<td>7/8 x 9</td>
<td>0.1617</td>
<td>12467</td>
</tr>
<tr>
<td>1 x 8</td>
<td>0.2007</td>
<td>16355</td>
</tr>
<tr>
<td>1 1/4 x 7</td>
<td>0.2091</td>
<td>21616</td>
</tr>
<tr>
<td>1 1/2 x 6</td>
<td>0.4093</td>
<td>37042</td>
</tr>
</tbody>
</table>

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 25% 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 = KDP, where:

- K = 0.15 for "lubricated" conditions
- K = 0.17 for zinc plated and dry conditions; we have 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 content accurately. Extreme caution should be used when using a formula for torque/tension relationships. Torque is only an indirect indication of tension. Undercrewing tightening of fasteners can result in costly equipment failure or personal injury.
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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