HYDRAULIC POWER UNIT OWNER'S MANUAL

MODEL 33

SERIAL NUMBER

_____

AMERICAN PILEDRIVING EQUIPMENT APE
800-248-8498
WWW.APEVIBRO.COM

Quick Reference Guide

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

GENERAL INFORMATION

MAINTENANCE

TROUBLE SHOOTING

REPLACEMENT PARTS

REFERENCE / NOTES

A Table of Contents is included after the Foreword.

Prepared for:

_____

Reference:

Equipment # _____

Serial # _____

Description:

33 POWER 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

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
6. GLASSES and HEARING PROTECTION when near this equipment.
7. 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.
8. 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.*

9. NEVER use or store flammable liquids on or near the engine.
10. Insure that all lifting equipment, including cranes, wire rope, slings, hooks, shackles, etc., are properly sized for the worst caseloads anticipated during operations.
11. If there are any questions about the weights, specifications and/or performance of the unit, contact APE before handling and/or operating the equipment.
12. If the equipment is to be used for anything other than drilling plumb holes, contact APE before using the unit.
13. Check wire rope clips for tightness and wire ropes for wear daily.
14. Insure that ground vibrations will not damage or collapse adjacent structures or excavations.
15. 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.)

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

16. 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.
17. When filling the fuel tank, do *NOT* smoke and/or use an open flame in the vicinity.
18. If abnormal equipment operation is observed, discontinue use immediately and correct the problem.
19. Do *NOT* leave the equipment control pendant (radio control) unattended.
20. Store oily rags in approved containers and away from the engine exhaust system.
21. Make sure that the Auger rotation switch is in NEUTRAL before starting the Power Unit engine
22. Do *NOT* adjust and/or set the hydraulic pressures higher and/or lower than those specified in this Manual.
23. NEVER operate this equipment with hydraulic hoses that are damaged or 'kinked'. Replace damaged hoses immediately.
24. Do *NOT* lift and/or support hydraulic hoses with wire rope slings.
25. NEVER attempt to connect Quick Disconnects (QDs) when the Power Unit is running.
26. Do *NOT* pull on and/or attempt to move equipment with the hydraulic hoses.
27. 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.
28. Do *NOT* attempt to repair leaks while the equipment is in operation.
29. Do *NOT* attempt to tighten and/or loosen fittings and/or hoses when the machine is in operation.
30. Power Unit must always be placed on level, stable ground.
31. 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.

32. 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.
33. 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.
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. KEEP HANDS AWAY FROM ROTATING FLIGHTING, AUGER SHAFT AND/OR ROTARY JOINT.
36. KEEP HANDS, FEET AND/OR TOOLS WELL CLEAR OF THE FLIGHTING GUIDES.
37. Do *NOT* allow clothing, hoses, ropes, etc., to become entangled in, or wrap around, rotating flighting, Auger shaft and/or rotary joint..
38. When operating in a closed area, pipe exhaust fumes outside. (Warning: Breathing exhaust fumes can cause serious injury or even death.)
39. Make sure the control pendant is in the "LOCAL" position before starting the unit.
40. Never stand under hammer at any time and keep you eyes on the hammer when it is in operation
41. When loading or unloading the power unit using a forklift, the forks must be placed under the entire depth of the unit.

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 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.

FOREWORD

This manual covers the **APE Hydraulic Power Unit** 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 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.

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SPECIFICATIONS

DIMENSIONS

Overall Length	40.25 in	(1,022 cm)
Overall Width	36.13 in	(198 cm)
Overall Height	54.63 in	(1,387 cm)
Weight	1,500 lbs	(680 kg)
Fuel Capacity	12 gal	(45 L)

ENGINE

Type	Caterpillar C1.5	
Horse Power	33 hp	
Displacement	91 in^3	(1,496 cc)
Compression Ratio	22.5:1	
Engine Speed	1,500-3,000 rpm	
Engine Oil	Caterpillar Diesel Engine Oil 10W30 or 15W40	
	6.3 qt	(6 L)

Hydraulics

Drive Pressure	0-2,500 psi	(172 bar)
Drive Flow	20 gpm	(76 lpm)
Hydraulic Oil	Envirologic 146	
	30 gal	(114 L)

GENERAL INFORMATION

Safety / Warning Labels

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

Hydraulic oil needs to be kept full at all times. Overfilling the tank may cause leakage when hot due to insufficient space to expand when hot. Each power unit has two electronic hydraulic sensors to monitor low oil level and oil level shutdown, to prevent damage to the power unit.

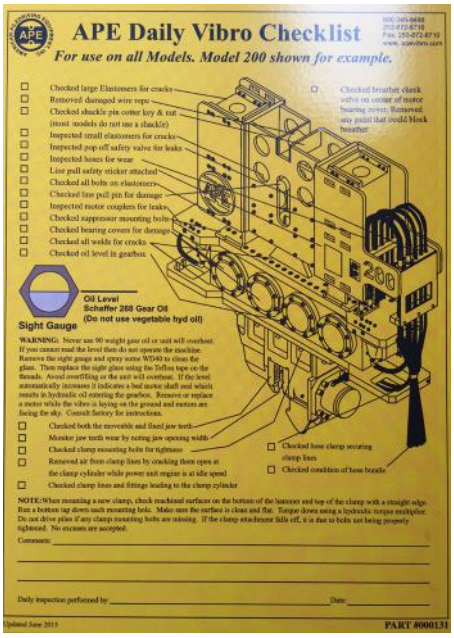
Do now weld on or around the power unit unless authorized in writing by APE. Doing so will void all warranties and may cause damage to the power unit or vibro.

Do NOT fill fuel tank past 3/4 tank. It is necessary to have a sufficient air gap in the tank to allow for expansion of the fuel. Failing to do so may cause fuel leakage when hot.

The power unit service record sticker is located on control panel door and records all service done on the power unit.

Make sure all QD's are installed and connected completely. Failing to do so may cause damage or prevent proper operation.

Ship with this end forward to prevent damage to the radiator cooling package at the front of the power unit skid.



The daily checklist sticker is located on the control panel door and has a list of everything that needs to be checked on the vibro. Failing to do the daily vibro check may cause damage to the vibro.

Power Unit Parts Overview

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.
- Check water level in radiator
- Check fuel level
- Check oil level in pump drive
- Check hydraulic oil level
- Check engine oil
- Check fan belts on engine
- 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 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 Power Unit

The power unit is always loaded with the hydraulic tank facing the front of the truck to prevent damage to the cooler and the radiator from flying debris. When lifting the power unit position the forklift forks as shown and have the forks in as far as possible to prevent any load shifts.

Connecting the Hydraulics

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 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

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' - With the auger free hanging will push any remaining air in the lines back to the reservoir

Start / Warm Up Procedure

Before operation it is necessary to bring the power units hydraulic oil to a working temperature of 80ºF. To start and warm up the power unit follow the steps below.

1. On the main control panel turn main power switch to the on position.
2. Press and hold engine start/stop button until engine in running. This should only take a few seconds.
3. Idle power unit in drive until oil temp is above 80ºF before doing hard work. Failing to do so may cause seal failures, leaks and excessive pressures through the hydraulic system.

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. (See Figure 5)

MAINTENANCE

Maintenance Chart

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

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.

Engine Oil

Change engine oil every 250 hours or 6 months whichever occurs first. Oil should be replace with Caterpillar 15W-40 or equivalent oil.

Hydraulic Oil

When adding or changing hydraulic fluid APE uses only Shell Tellus S2 M68 hydraulic fluid, which is not-toxic and will not harm soil or water and is biodegradable. Consult your local oil supplier for recommendations on mixing hydraulic oils. Change hydraulic oil if it looks milky, this is an indication that water or other contamination may have occurred.

Pump Drive Oil

Check oil level before starting the power unit. The pump drive requires approximately 2 gallons of oil. APE recommends filling the pump drive with Shell Spirax S4 AX 85W-140 when doing oil changes or adding oil. It is recommended to change the pump drive oil every 500 working hours, or 2 years which ever occurs first.

Air Cleaner Replacement

Check and clean the air cleaner weekly. If the air cleaner needs replaced use Caterpillar part number 6I-2510.

Return Filter Elements

Change all filters every 500 working hours, 2 years or when indicated dirty, which ever occurs first. To change the return filter element follow the steps below.

1. Shut down power unit.
2. Place warning tag on control panel so that the power unit is not stated while filters are being replaced.
3. Clean area around filters so that when they are removed there is no chance of introducing dirt into the hydraulic system.
4. Using a 1 1/4 wrench or socket, turn the filter counter clockwise and spin the filter element off the filter housing.
5. Install new clean filter making sure the spring and o-ring are in the proper place.

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.

Understanding the Hydraulic System

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.

- Pressure filters: clean the hydraulic fluid going to the drill motor and manifold in the forward and reverse directions.
- M1/M2 DRIVE
- LS LOAD SENSE
- 10/11: RDFA-LCN is a direct acting relief valve that is used to protect hydraulic components from pressure variants.
- 8/16/5/19 COILS
- T1 / PD: Both of these ports return to tank.

Electrical System

The electrical system is a normally closed circuit and runs a self diagnostic when the panel is powered on. If there is a fault in the electrical system a error screen with appear on the control panel display.

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

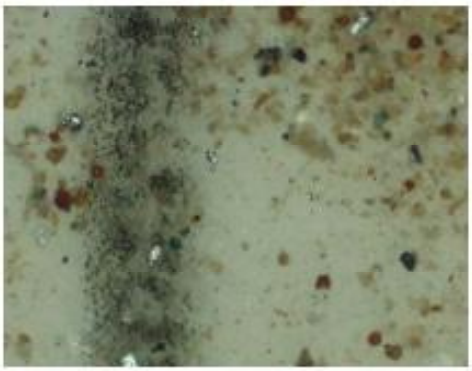
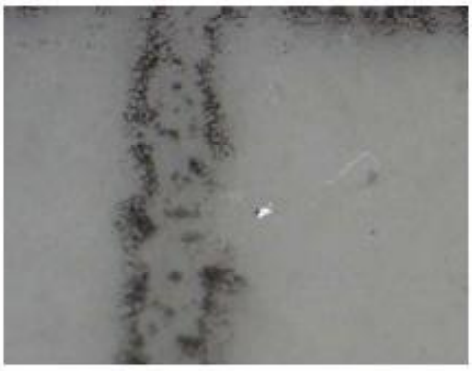


Photo 2



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

QTY	PN	DESCRIPTION	MFG PN	DISTRIBUTOR
1		SKID AND FAB PARTS		PAC FAB
1	400274	JM LOGO 8"		JM INV
1		PAINT		PIONEER
1		ENGINE CATERPILLAR 3013 32.5HP(C1.5)		N C POWER SYSTEMS
1		DRIVE PUMP	P315-A196-FW-AB-12-65	HYDRAULIC INDUSTRIES
1		CONTROL VALVE 3 BANK ASSY	MUN60VS03A-D1-D1-0D1-T 3 SPOOL	HYDRA POWER
3		VALVE, CLYINDER SECTION	MUNCIE 60VS03A VALVE	HYDRA POWER
1		VALVE, END SECTION	MUNCIE 60VS5D1 VALVE	HYDRA POWER
1		VALVE, END SECTION	MUNCIE 60VS03T VALVE	HYDRA POWER
3		VALVE, STUD KIT	MUNCIE 60V-STD-3 VALVE	HYDRA POWER
3		VALVE, HANDLE KIT	MUNCIE 60V-HVK-10 VALVE	HYDRA POWER
1		CONTROLL PANEL AND WIRING HARNESS		CONTROL POWER
1		HOSE,FITTING, AND COMPONETS		WESTERN FLUID
1		EXHAUST KIT		AIR FLOW

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

Nominal Dia. (in.)	threads per inch	Tensile Stress Area (sq. in.)	ASTM A307 Grade A				SAE J429 Grade 5				SAE J429 Grade 8				FNL Grade 9			
			Clamp Load (Lbs.)	Tightening Torque			Clamp Load (Lbs.)	Tightening Torque			Clamp Load (Lbs.)	Tightening Torque			Clamp Load (Lbs.)	Tightening Torque		
				K = 0.15	K = 0.17	K = 0.20		K = 0.15	K = 0.17	K = 0.20		K = 0.15	K = 0.17	K = 0.20		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

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REFERENCE / NOTES

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