

24. PSE



W.S. Darley & Co.
REPAIR SERVICE INSTRUCTIONS
TYPE PSE ENGINE MOUNTED FIRE PUMP
WITH INJECTION PACKING

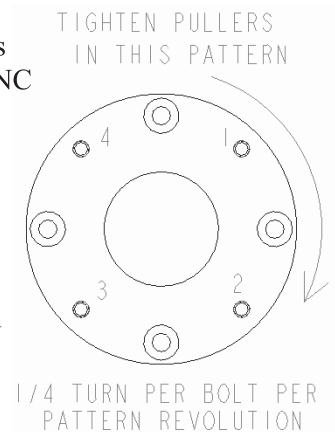
PSE PUMP DISASSEMBLY FOR OVERHAUL

Refer to Drawings DPC0605, DPC0008 & DPC0011

1. Remove the following items from the pump:
 - Gage Line Tubing
 - Heater Piping
 - Primer Tubing
 - Tachometer Drive Cable
2. Drain oil from gear case. Inspect oil for debris, or cloudiness (entrapped water).
3. Remove twelve 3/8-16UNC nuts and remove discharge head assembly from volute (30).
4. Remove eight 3/8-16UNC cap screws and suction adapter (34) from volute (30). Discard gasket (33).
5. Provide an overhead hoist to support the weight of the pump. Place a nylon strap or a chain around the discharge flange of the volute (30) and take up the slack.
6. Remove four 3/8-16UNC cap screws and remove bearing cap (113) by using the 5/16-18UNC puller holes. Discard gasket (22).
7. Remove three 1/2-13UNC cap screws holding the volute (30) and spacers (17) to the gear case (27). Separate the volute and impeller shaft (99) assembly from the gear case while keeping the parts square with each other to avoid damage to pinion gear (24) and impeller shaft. If prying is required, pry evenly on both sides.
8. Remove twelve 3/8-16UNC cap screws and remove the suction head (31) from the volute (30) by using the two 3/8-16UNC puller holes. Discard o-rings (32) & (114).
9. If necessary to replace outboard seal ring (35), pry or tap it out of suction head (31).
10. Remove cotter key (38), impeller nut (37), and washer (41) from impeller shaft (99).
11. Push impeller (36) off impeller shaft (99) with the two 3/8-16UNC holes in impeller hub.
12. Tap the impeller shaft assembly out of volute (30), keeping the shaft square with the bore to avoid damage to parts.
13. Pull or pry the oil seal (18) out of volute (30). Remove water slinger (26) from cavity.
14. If necessary to replace, remove four 1/4-20NC stainless flush head machine screws (130) and remove the stuffing box (39) from the volute (30) using the four 1/4-20NC puller holes. To remove, apply pressure with puller screws in a circular pattern, one-quarter turn per bolt per pattern revolution. The flush head machine screws may be used as the puller screws for stuffing box removal. Discard stuffing box o'ring (129).

Note:

 - Pumps older than Jan, 2002 may not have the stainless flush head machine screws. If this is the case with the pump you are repairing, press the stuffing box out of the volute.
 - The number of puller holes was changed from two to four June 2006.
15. If necessary to replace, pry inboard seal ring (35) out of volute (30).
16. Press bearing (6), spacer (103), and pinion gear (24) off the impeller shaft (99) all at once.
17. Remove pinion gear key (20).



18. Press bearing (108) off of impeller shaft (99).
19. Remove retaining ring and backup washer from impeller shaft (99). **[NOTE:** A shoulder has been added to the impeller shaft to eliminate the use of the retaining ring, and backup washer on pumps newer than Dec. 1995.]

GEAR CASE DISASSEMBLY FOR OVERHAUL

20. Provide a hoist to support the weight of the transmission. Place a nylon strap or chain around pump mounting arms of gear case (27) and around engine adapter (1) and take up the slack.
21. Remove the screws holding engine adapter (1) to engine.
22. Slide transmission straight away from rear of engine, be careful to avoid damaging trans. shaft (11).
23. Remove four 3/8-16UNC socket head cap screws and remove engine adapter (1) from gear case (27).
24. Remove four 3/8-16UNC cap screws and remove bearing cap (47) by using the 5/16-18UNC puller holes. Remove and discard gasket material.
25. Remove eight 3/8-16UNC cap screws and remove oil pan (3). Discard gasket (4).
26. Press transmission shaft (11) out of drive gear (5), spacer (49), bearing (6), and gear case (27) all at once.
27. Remove the drive gear key (50).

Note: After Jan 2002, the tachometer assembly became an option, it is possible that your pump does not have any tachometer parts.

28. If present, remove tachometer retainer (10) and slide tachometer worm (8) off transmission shaft (11).
29. If present, remove tachometer drive key (55).
30. Press bearing (6), and spacer off the transmission shaft (11). **[NOTE:** Spacer not present in pumps manufactured after Dec. 1995.]

NOTE: Tachometer disassembly is usually not required unless parts are severely worn.

31. If present, tap the drive lock pin (95) out of the tachometer gear (14).
32. If present, remove tachometer shaft (13) from gear (14) and bushing (12). Remove tachometer gear.
33. If present, press or tap tachometer bushing (12) and tachometer plug (96) out of engine adapter (1).

PARTS INSPECTION AND MEASUREMENT

1. Clean all parts and carefully examine for wear or deterioration. Replace any questionable parts.
2. Measure the impeller seal rings and the seal rings for wear. Use the following table for comparison.

Impeller Seal Ring O.D. - original	----- 6.623 - 6.625"
Impeller Seal Ring I.D. - original	----- 6.315 - 6.317"
Seal Ring O.D. - original	----- 6.639 - 6.641"
Seal Ring I.D. - original	----- 6.299 - 6.301"
Clearance O.D. - original	----- 0.014 - 0.018"
Clearance I.D. - original	----- 0.014 - 0.018"
3. If clearance exceeds 0.025" on diameter, impeller seal rings can be restored to its original size by soldering a ring over trued surface which retains at least 0.090" wall thickness. Stationary seal rings should also be replaced or you may purchase undersized rings. Call customer service for details.
4. Measure the impeller shaft and stuffing box for wear. Use the following table for comparison

Impeller Shaft diameter at packing area	----- 1.749 - 1.750"
Stuffing Box bore - original	----- 1.759 - 1.760"
Stuffing Box bore - max.	----- 1.765 - 1.760"
Clearance on Diameter - original	----- 0.013 - 0.015"

Clearance on Diameter - max. allowable ----- 0.020"

5. Measure bearing housing bores for proper size. Use the following table for comparison. If any bore exceeds the high limit by 0.0005", the part should be replaced.

PART	REP. NO.	ORIGINAL BORE DIAMETER
Bearing Cap -----	113 -----	3.5433 - 3.5442"
Gear Case -----	27 lower two bores-----	3.5433 - 3.5442"
Volute -----	30 -----	4.3307 - 4.3316"

6. Measure shaft bearing journals for proper size. Use the following table for comparison. The low limit under bearing is required to insure a press fit with inner bearing race.

PART	REP. NO.	ORIGINAL JOURNAL DIA.
Impeller Shaft -----	99 -----	small 1.5749 - 1.5753" large 1.7490 - 1.7495"
Transmission Shaft -----	11 -----	both 1.5749 - 1.5753"

7. The original impeller shaft diameter under the pinion gear is 1.7490 - 1.7495". The original pinion gear bore is 1.7495 - 1.7500" providing a 0.0000 to 0.0010" clearance. The parts are still serviceable up to 0.0015" clearance. The pinion gear may be reversed to work the other side of gear teeth.
8. The original transmission shaft diameter under the drive gear is 1.7490 - 1.7495". The original drive gear bore is 1.7500 - 1.7505" providing 0.0005 to 0.0015" clearance. The parts are still serviceable up to 0.0020" clearance. The drive gear may be reversed to work the other side of gear teeth.
9. The original transmission shaft diameter under the tachometer worm is 1.5605 - 1.5613". The original tachometer worm bore is 1.5616 - 1.5622" providing from 0.0003 to 0.0017" clearance. The parts are still serviceable up to 0.0030" clearance.

ASSEMBLY OF TYPE PSE ENGINE MOUNT FIRE PUMP

Refer to Drawings DPC0605, DPC0008 & DPC0011

TRANSMISSION ASSEMBLY

1. If present, press the tachometer bushing (12) into engine adapter (1), flush with inside of gear pocket.
2. If present, press the tachometer plug (96) into engine adapter (1). Allow .015" gap between the tachometer gear (14) and the tachometer plug (96).
3. If present, place tachometer gear (14) into position.
4. If present, insert tachometer shaft (13) through bushing (12) and into tachometer gear (14) with .104" square key drive hole end facing tachometer cable pocket.
5. If present, tap a 3/32" x 7/16" drive lock pin into tachometer gear (14) through the tachometer shaft (13).
6. If present, gear (14) and shaft (13) must rotate freely. Fill tachometer gear teeth, and tachometer pocket 1/3 - 1/2 full with grease.
7. Press oil seal (9) into engine adapter (1) with lip spring of seal facing tachometer pocket. Fill grease cavity of the oil seal 1/3 - 1/2 full with grease and lubricate oil seal lips.
8. Support gear case (27).
9. Place drive gear (5) in gear case (27).
10. Apply a light coating of oil to the transmission shaft (11). Place drive gear key (50) into transmission shaft keyway. Align with keyslot in drive gear (5); press shaft evenly into drive gear bore until shaft shoulder is tight against side of gear.
11. Apply a light coating of oil to both the inside and outside diameters of bearing (6). With the use of a sleeve to apply even pressure to both races, press the bearing onto the transmission shaft (11), and into the gearcase (27) on the engine side until the bearing is tight against shaft shoulder.
12. Slide spacer onto the transmission shaft (11). **[NOTE:** Spacer not present in pumps manufactured after Dec 1995.]

13. If present, place the woodruff key (55) into the slot in the transmission shaft (11) and press or slide the tachometer worm (8) onto the transmission shaft until the worm, spacer (if present) and inner race of bearing (6) are tight together. Install the retaining ring (10) with the sharp edge towards the splined end of the transmission shaft.
14. Tap spacer into gear case (27). [**NOTE:** Spacer not present in pumps manufactured after Dec 1995.]
15. Apply a thin layer of Loctite Master Gasket 518 or equivalent to the flange area of the gear case (27) where it engages the engine adapter (1).
16. Slide the engine adapter (1) over the transmission shaft (11) and into position against gear case (27). Apply Loctite 243 or equivalent to the threads of four 3/8-16UNC x 1/2" socket head cap screws and attach the adapter to the gear case (27) using these cap screws and four high collar lock washers. Torque to 23 ft-lb.
17. Slide spacer (49) onto transmission shaft (11).
18. Apply a light coating of oil to both the inside and outside diameters of bearing (6). With the use of a sleeve to apply even pressure to both races, press the bearing onto transmission shaft (11), and into gear case (27) until shaft shoulder, drive gear (5), spacer (49), and bearing (6) are tight together.
19. Apply Loctite 243 or equivalent to the threads of four 3/8-16UNC x 7/8" cap screws and apply a thin layer of Loctite Master Gasket 518 or equivalent to the flange area of bearing cap. Attach bearing cap (47) and with these cap screws and lock washers. Torque to 23 ft-lb. [**NOTE:** For pumps manufacture prior to Dec. 1995 use 1/64" paper gasket (not shown on DPC0002)]
20. Attach the oil pan (3) and gasket (4) to gear case (27) with eight 3/8-16UNC x 7/8" cap screws and lock washers. Use Loctite 243 or equivalent on the threads, and torque to 23 ft-lb.
21. Lift the transmission with the hoist. Slide the transmission shaft (11) into the drive disc (2) on the engine. Attach engine adapter (1) to engine with cap screws and lock washers. Use Loctite 243 or equivalent on the threads, and torque to 23 ft-lb.

PUMP ASSEMBLY

22. Press inboard seal ring (35) into volute (30) until seated.

NOTE: Pumps older than Jan, 2002 may not have the stainless flush head machine screws holding stuffing boxes in. If this is the case with the pump you are repairing, apply Loctite 603 to the outside of stuffing box (39) and press into volute (30) until seated. **CAUTION:** The packing gland holes in the stuffing box must be aligned with the packing gland hole(s) in the volute. The cooling holes in the stuffing box must also be aligned with the cooling line(s) in the volute.

23. Apply a silicone lubricant to stuffing box o'ring (129), and place in groove of volute (30).
24. Align stuffing box (39) with volute (30) by placing four 1/4-20 NC x 3 cap screws through mounting holes of stuffing box and screw into corresponding tapped holes of volute. Press stuffing box into position and remove alignment cap screws. Apply Loctite 243 (or equivalent) to threads of, and install four 1/4-20 NC stainless flush head machine screws (130) to secure stuffing box in volute. Torque to 72 in-lbs.
25. Slide impeller shaft (99) into volute (30), through stuffing box (39).
26. Pack the stuffing box (39) using only Garlock style #926-AFP plastallic packing material, which can be purchased from W. S. Darley as part no. 3817101. Other packing materials will void warranty. (For procedure to follow when packing the pump, see "DARLEY INJECTION TYPE STUFFING BOX ADJUSTMENT")
27. Remove impeller shaft (99) and clean out any packing and/or debris that may have gotten into the 1/4" wide lantern groove in the stuffing box (39).
28. Apply grease to one side of water slinger (26). Firmly place greased side of water slinger into position against stuffing box (39). [**NOTE:** Grease is for retaining water slinger position during assembly only.]

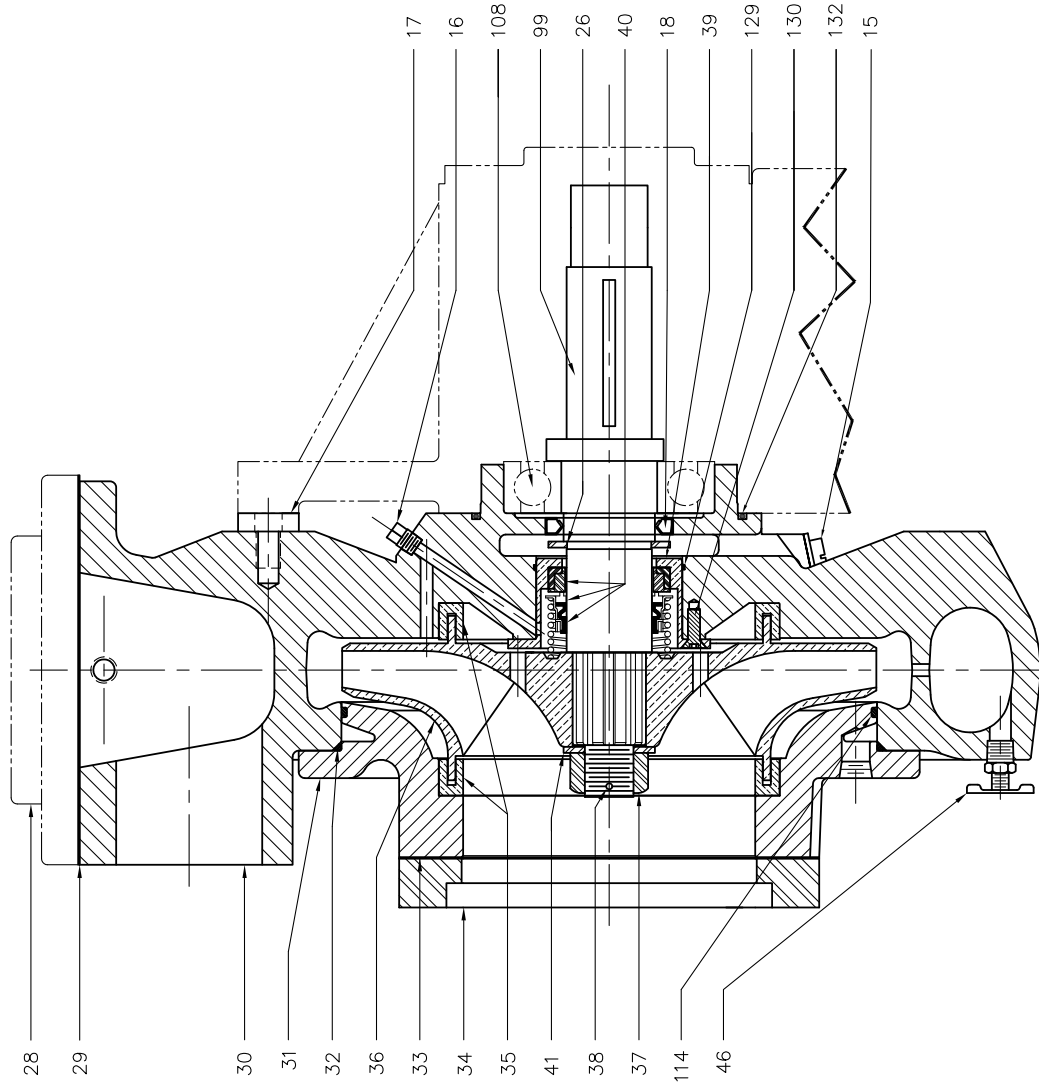
29. Press oil seal (18) into volute (30) with lip spring of seal facing bearing cavity. Fill grease cavity 1/3 - 1/2 full with grease and lubricate oil seal lips.
30. Apply a light coating of oil to impeller shaft (99). Place pinion gear key (20) in impeller shaft keyway, align with keyslot in pinion gear (24) and press shaft evenly into pinion gear bore until shaft shoulder is tight against side of gear.
31. Place retaining ring in groove on impeller shaft (99) with sharp edge towards pinion gear (24). Retaining ring should be tight in groove. Replace ring if it is loose. Slide bearing backup washer onto impeller shaft (99). **[NOTE: A shoulder has been added to the impeller shaft to eliminate the use of the retaining ring, and backup washer on pumps newer than Dec. 1995.]**
32. Press bearing (108) onto impeller shaft (99) against shaft shoulder.
33. Slide spacer (103) onto impeller shaft (99).
34. Apply a light coating of oil to the inside diameter of bearing (6), and press it onto impeller shaft (99) until inner race of bearing, spacer (103), and pinion gear (24) are tight together.
35. Apply a light coating of oil to outside diameter of bearing (108), and gently tap impeller shaft (99) through water slinger (26), and into volute (30) until bearing is seated in bearing pocket of volute. Make sure oil seal (18) is seated. Slide water slinger (26) into position in groove in the impeller shaft.
36. Slide impeller (36) and impeller washer (41) onto impeller shaft (99).
37. Temporarily tighten impeller nut (37) finger tight until it contacts the impeller washer (41)
38. Apply a thin layer of Loctite Master Gasket 518 or equivalent to the flange surface of the volute (30) where it engages the gear case (27).
39. Apply oil to the outer diameter of bearing (6) on the impeller shaft (99).
40. Lift the pump with the hoist.
41. Insert pinion gear (24) into gear case (27) and slide flange of volute (30) into the gear case pilot. With the three spacers (17) between the mounting pads of the volute and the mounting arms of the gear case, attach the volute to gear case with three 1/2-13UNC x 1-1/2" cap screws and lock washers with Loctite 243 or equivalent applied to the threads. Torque to 57 ft-lb. **[NOTE: Tighten the cap screws in the opposing arms first, then tighten the third one.]**
42. Apply Loctite 243 or equivalent to the threads of four 3/8-16UNC x 7/8" cap screws and attach bearing cap (113) and gasket (22) with these cap screws and lock washers. Make sure that bearing (6) enters evenly into the bearing pocket in the bearing cap. Torque to 23 ft-lb.
43. Remove impeller nut (37).
44. Clean and dry threads of both the impeller shaft (99) and impeller nut (37). All dirt, grease, and oil must be removed. (Loctite Klean N' Prime can be used to clean parts and shorten cure time of thread-locker.)
45. Apply Loctite 243 or equivalent thread-locker to impeller shaft (99) thread.
46. Tighten impeller nut (37) finger tight until it contacts the impeller washer (41), then turn to the next cotter key hole. **DO NOT OVER TIGHTEN.**
47. Install a 1/8" x 1" STAINLESS STEEL cotter key (38) through the impeller nut (37) and impeller shaft (99) cotter key hole.
48. Press outboard seal ring (35) into suction head (31).
49. Apply a silicon lubricant, such as Dow Corning Compound 111 or equivalent to suction head o-rings (32) and (114) and place on suction head (31).
50. Apply Loctite 243 or equivalent to the threads of the twelve suction head mounting studs in the volute (30). Tap the suction head (31) into position on the volute and attach with twelve 3/8-16UNC nuts. Torque to 23 ft-lb.

51. Apply Loctite 243 or equivalent to the threads of the twelve discharge head mounting studs. Attach the discharge head assembly to the volute (30) with twelve 3/8-16UNC nuts. Torque to 23 ft-lb.
52. Apply Loctite 243 or equivalent to the threads of the eight 3/8-16UNC cap screws and attach the suction adapter (34) to the suction head (31). Torque to 23 ft-lb.
53. Reconnect the following items to the pump:
 - Gage Line Tubing
 - Heater Piping
 - Primer Tubing
 - Tachometer Drive Cable
54. Fill gear case (27) with SAE80W/90 gear lube oil to the level of the oil-level plug on the gear case.

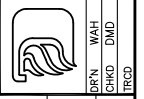
**IF FURTHER INFORMATION IS NEEDED, CALL W.S. DARLEY & CO. at
CHIPPEWA FALLS, WI at 800-634-7812 or 715-726-2650**

REVISONS

LTR	DESCRIPTION	DATE	CHG NO.	APPR'D
A	ADDED O-RING	2JUL2004	2004-192	DAB



REP#	NAME OF PART	QTY
15	PACKING HOLE PLUG	2
16	PLUG - 1/8 NPT	2
17	SPACER - GEARCASE	1
18	OIL SEAL - IMPELLER SHAFT	1
26	WATER SLINGER	1
28	DISCHARGE FLANGE	1
29	DISCHARGE GASKET	1
30	VOLUTE	1
31	SUCTION HEAD	1
32	PUMP CASING O'RING	1
33	SUCTION FLANGE GASKET	1
34	SUCTION FLANGE	1
35	SEAL RING	2
36	IMPELLER	1
37	IMPELLER NUT	1
38	COTTER KEY	1
39	MECHANICAL SEAL BOX - REMOVABLE	1
40	MECHANICAL SEAL	1
41	IMPELLER SHAFT WASHER	1
46	DRAIN COCK	1
99	IMPELLER SHAFT	1
108	BEARING - IMPELLER SHAFT	1
114	O-RING - HEATER CHAMBER	1
129	O-RING - 3.00 x 3.12 x 0.06	1
130	FHMS - .250-20 x 0.63, SS	4
132	O-RING - PUMP/GEARCASE	1 (A)



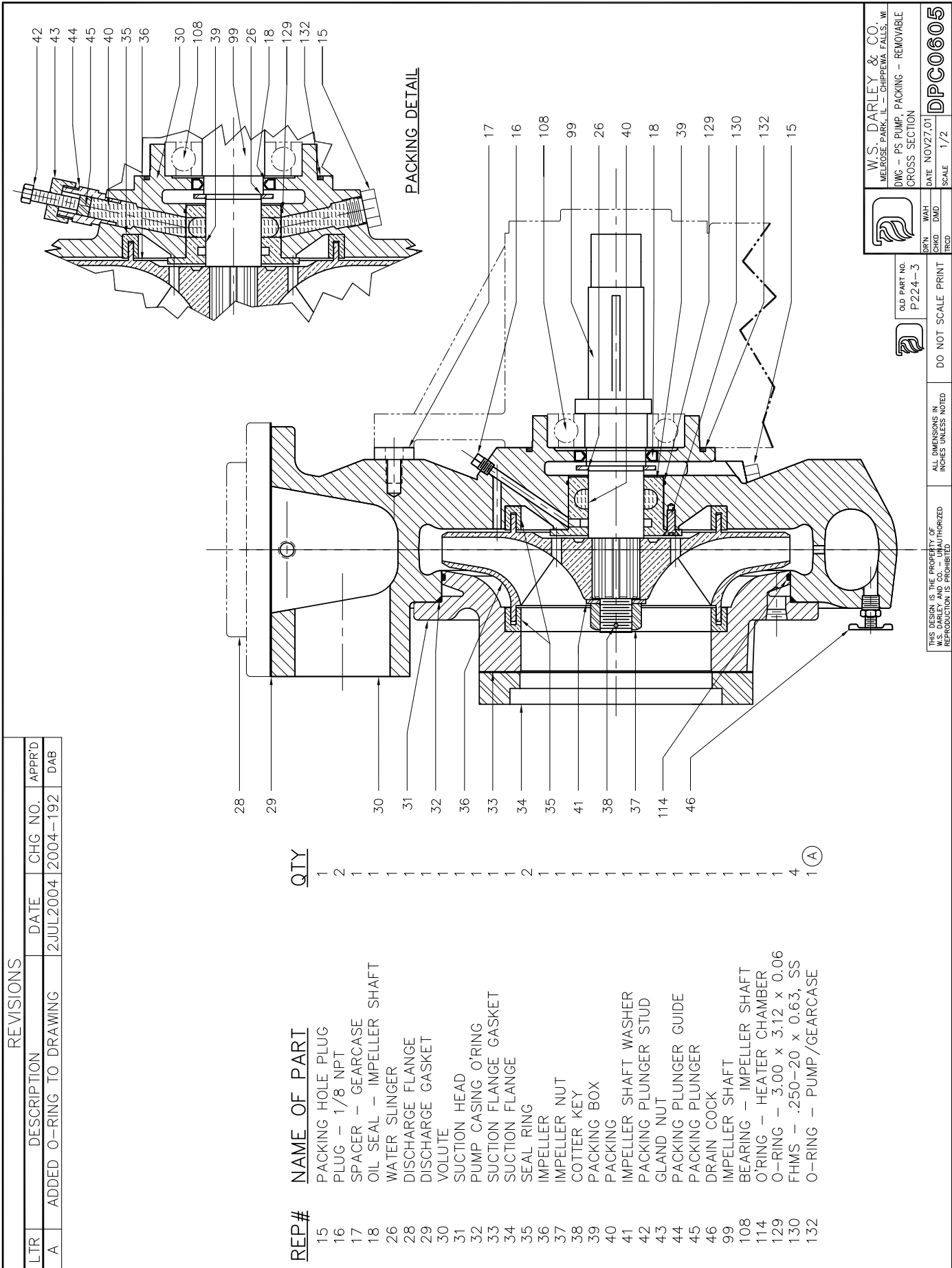
W.S. DARLEY & CO.	
MELROSE PARK, IL - CHIPPewa FALLS, WI	
DWG - PS PUMP, MECH SEAL - REMOVABLE	
CROSS SECTION	
DATE NOV27,01	SCALE 1/2
DRN WAH	CHKO DMD
TRCD	

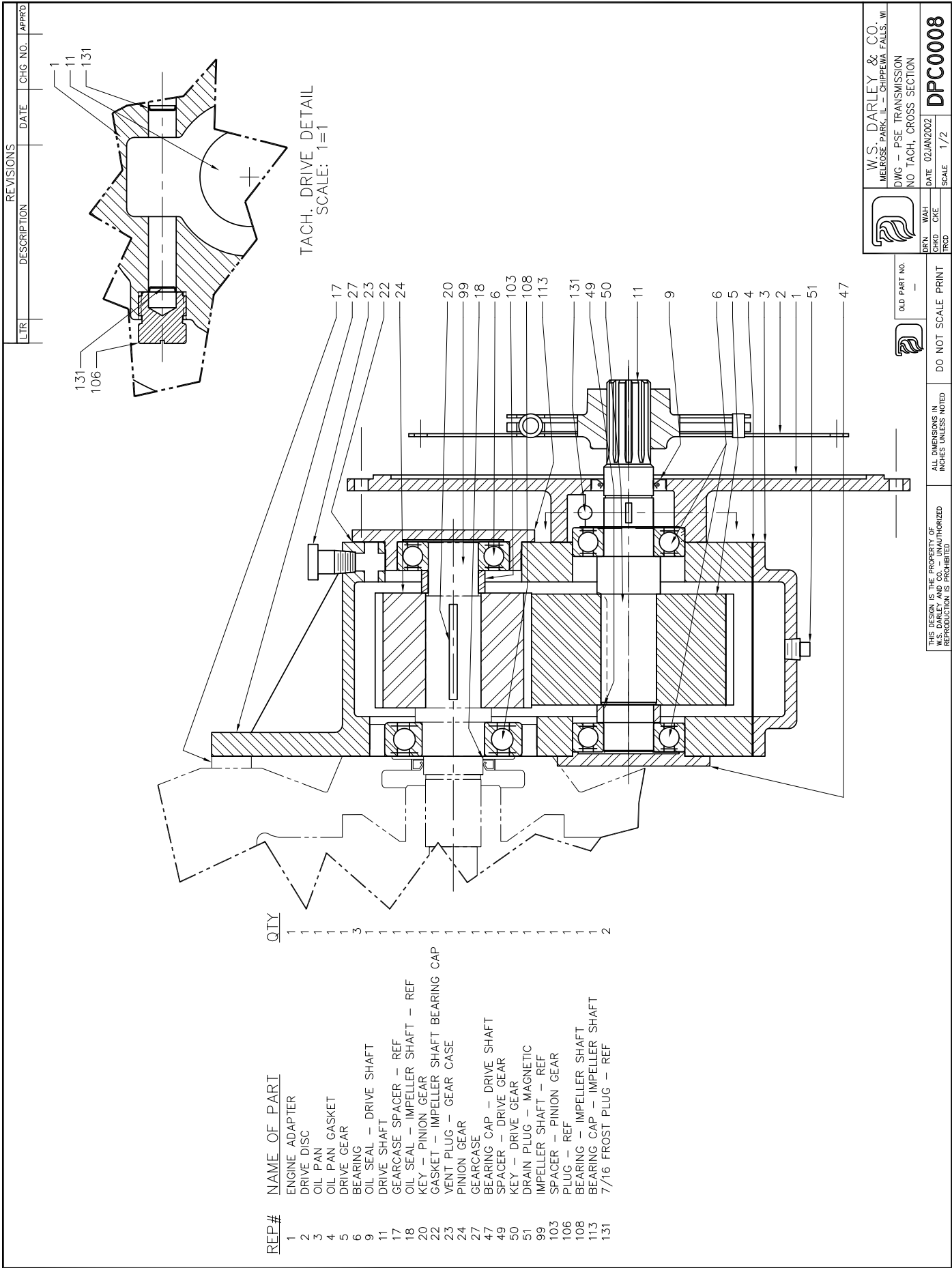
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P224-2	

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DP00604





W.S. DARLEY & CO.
MELROSE PARK, IL - CHIPPewa FALLS, WI

DWG - PSE TRANSMISSION
NO TACH, CROSS SECTION

DATE 02JAN2002
SCALE 1/2

OLD PART NO. -

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DPC0008

REVISIONS			
LTR	DESCRIPTION	DATE	CHG NO. APPR'D

REP#	NAME OF PART	QTY
1	ADAPTER - REF	1
6	BEARING - REF	3
8	TACH WORM	1
9	OIL SEAL - DRIVE SHAFT - REF	1
10	RETAINING RING - TACH WORM	1
11	DRIVE SHAFT - REF	1
12	BUSHING - TACH DRIVE	1
13	TACH DRIVE SHAFT	1
14	TACH GEAR	1
27	GEARCASE - REF	1
55	WOODRUFF KEY - TACH WORM	1
95	DRIVE LOCK PIN - TACH DRIVE	1
96	PLUG - TACH DRIVE	1
106	PLUG - TACH	1

		W.S. DARLEY & CO. MELROSE PARK, IL - CHIPPEWA FALLS, WI	
OLD PART NO. —		DWG - OPTIONAL PSE & PSF TACH DRIVE CROSS SECTION	
SPEC NO. —		DATE 03JAN2002 SCALE 1/1	
THIS DESIGN IS THE PROPERTY OF W.S. DARLEY AND CO. UNAUTHORIZED REPRODUCTION IS PROHIBITED		DO NOT SCALE PRINT	



W. S. DARLEY & CO.

DARLEY INJECTION TYPE STUFFING BOX ADJUSTMENT

⚠ Prop 65 Warning: This product contains lead, a chemical known to the State of California to cause cancer, birth defects, and other reproductive harm. Wash hands after handling.

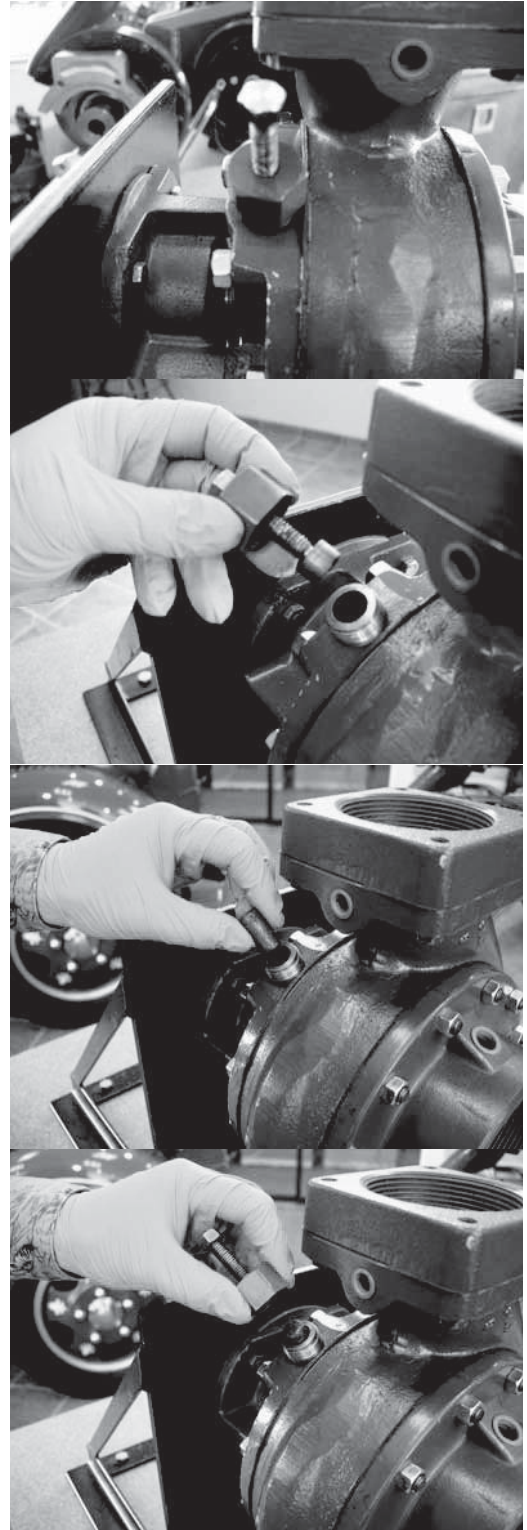
⚠ Caution: Do not attempt to use anything but Darley injection packing. Using the wrong packing material in your pump may cause catastrophic failure of the pump shaft sealing components.

Only use W.S. Darley & Co.'s plastallic injection packing material. It is made of a special composition of shredded fibers, and a special bonding and lubricating compound.

It is important that the stuffing box is completely filled solid with packing and compressed firm during adjustment to prevent formation of voids and excessive leakage.

To pack the stuffing box when empty and assembled in the pump, remove the packing screw and nut assembly, and insert pellet form packing into the packing plunger guide. Replace the packing screw assembly and use a hand speed wrench to force the pellets into the gland. DO NOT USE A POWER TOOL! Repeat pellet additions while turning the impeller shaft by hand until resistance to turning is felt when the stuffing box is almost full. Continue turning packing screw by hand using a standard 6" long 9/16" end wrench until 4 lb. of force is felt at the end of the wrench. This is equivalent to 2 ft-lb or 24 in-lb torque. Continue turning until a few flakes of packing are extruded out the opening between the impeller shaft and the stuffing box hole. The gland is now ready for pressure testing or pumping.

After priming the pump with water, start the pump and raise the discharge pressure to 50 psi. Tighten the packing screw using a 6" long 9/16" end wrench until 4 lb. force is felt at the end of the wrench (24 in-lb torque). Continue operating the pump at 50 psi for 5 minutes to dissipate packing pressure against the shaft and permit cooling water to flow between the shaft and stuffing box hole. Make sure that water actually does come through before operating pump at any higher pressure. The normal drip rate may vary between 5 and 60 drops per minute.



Operate the pump for 10 minutes at the highest normal operating pressure flowing sufficient water to prevent overheating. Do not run the pump blocked tight. Lower discharge pressure to 50 psi and repeat the packing screw tightening procedure outlined above.

The pump may now be operated for any time period required within its rated capacity. However, the drip rate should be monitored more frequently during the first few hours, and adjusted if necessary to achieve a stable flow rate. Several more adjustments may be required.



For a list of approximate quantity of packing pellets required by model (completely repacked), see below:

Model	Approximate # Packing Pellets
A	6
2BE	6
EM	15
H	8
JM	8
KD	10
KS	8
LD	15
LS	9
P	10
U2	5
U4	10

If further information is needed, call **W.S. DARLEY & CO.**
at Chippewa Falls, WI. at 800-634-7812 or 715-726-2650



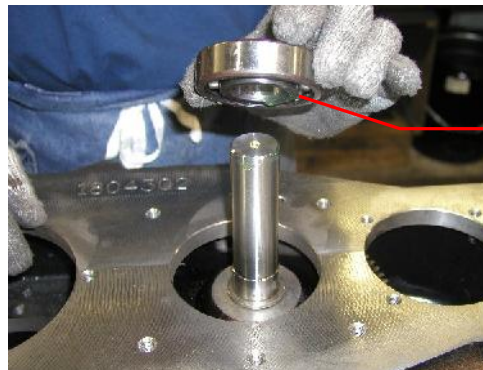
DARLEY

BASIC ASSEMBLING TECHNIQUES

- Work with clean tools in clean surroundings during assembly.
- Clean parts thoroughly and keep free from nicks and abrasions.
- Keep loose parts marked otherwise identified to avoid error in assembly.
- **Bearings:** Keep bearings in original containers until ready to install.
- **Bearings/Press fits:** Clean and oil bearing seats and other parts having press fits to prevent galling.
- **Bearings:** When pressing a bearing onto a shaft, the bearing must be started perpendicular (square) to the shaft.



- **Bearings:** When pressing bearings onto a shaft all forces applied to the bearing need to be applied to the inner race.
- **Bearings:** When pressing bearings into a pocket all forces applied to the bearing need to be applied to the outer race.
- **Bearings:** When installing a bearing with one shield, the open side goes toward the oil cavity/gear case. Typically the single shield will be next to an oil seal.



**OPEN SIDE
OF BEARING**

- **Bearings:** When pressing a bearing onto a shaft, lightly lube the bore of the bearing and the shaft journal for the bearing with oil. Also when installing bearings into bearing pockets, lightly lube the OD of the bearing and the bore of the bearing pocket with oil.



- **Bearings:** If necessary to remove a ball bearing from a shaft by forcing against the outer race, the bearing should be discarded and replaced.
- **Press fits:** Use suitable machined pushers (The end faces of the pusher should be flat, parallel and burr free) for pressing operations.



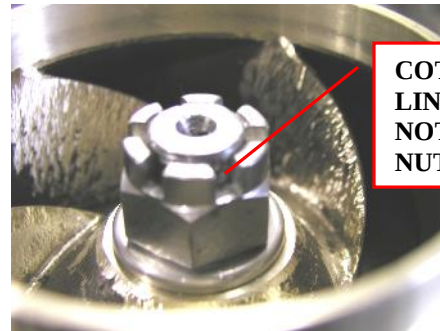
SUITABLE
PUSHERS



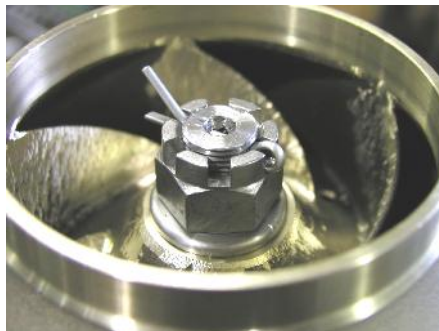
- **Press fits:** When pressing a part into housing (ex. Stuffing box, seal ring, etc.), the part needs to be started perpendicular to the housing.



- **Press fits:** Use a press for forcing press fits whenever possible. If necessary to use a hammer, use one having soft plastic heads. Do not use brass or lead hammers, for the face of the hammer may easily chip or flake, contaminating the assembly, which can cause severe damage to bearings and other precision components.
- **Impeller Nuts:** When installing impeller nuts, DO NOT use an impact wrench. Use of impact wrenches has proven to damage the impeller washers, impellers, and impeller shafts. Proper tightening procedure is to bring it snug tight, and then tighten it to the next available cotter pin hole in shaft and notch in the castle nut. Then install stainless steel cotter pin.



**COTTER PIN HOLE
LINED UP WITH
NOTCH IN CASTLE
NUT**



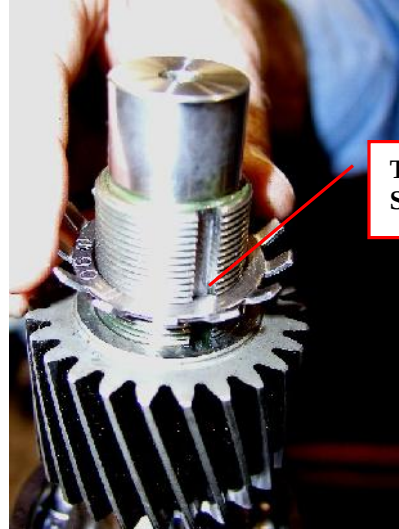
**STAINLESS STEEL
COTTER PIN**

- **Lock Washer/Lock Nut:** Secure shaft so that it doesn't rotate when tightening lock nut. Line up tab on lock washer with keyway slot in shaft and slide washer onto shaft. Screw lock nut onto shaft until snug, then turn until a tab and slot line up. Using a punch, tap tab from lock washer into slot on lock nut. Using a punch, tap tab from lock washer into slot on lock nut.

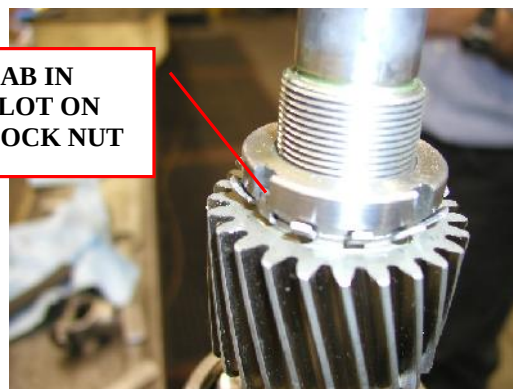
**PROPER
FIXTURE TO
HOLD SHAFT**



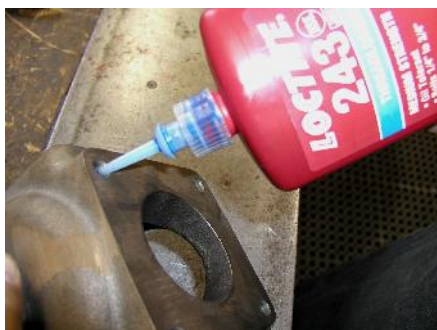
**TAB IN KEYWAY
SLOT**



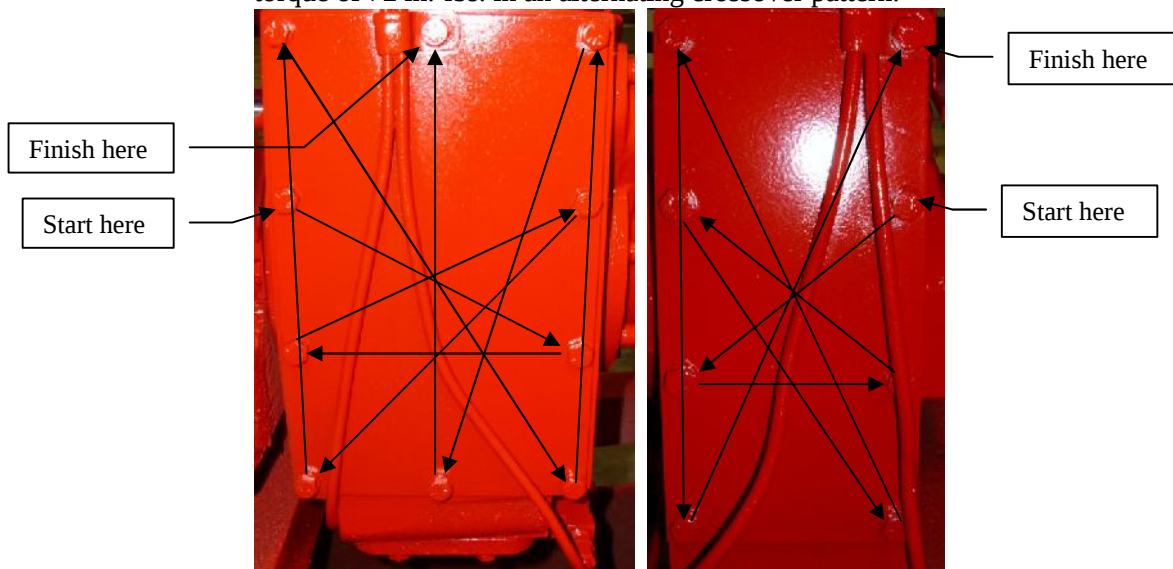
**TAB IN
SLOT ON
LOCK NUT**



- **Loctite/thread locker:** When applying Loctite/thread lockers, only use one small drop per hole, unless explicitly told differently by engineering, a WI, or assembly/repair instruction or assembly supervisor.
- **Loctite/thread locker:** When applying Loctite/thread lockers to lock fasteners going into captive holes (a hole that is only open on one end), apply the thread locker to the threads of the hole.



- **Loctite/thread locker:** When applying Loctite/thread lockers, to lock fasteners that are going to be installed with a pneumatic/power wrench, apply the thread locker to the female threads.
- **Transmission Threads:** Use only lock washers on captive holes. The only exception is if it is an aluminum gear case, then use Loctite 243, or equivalent, and no lock washers.
- **Transmission Threads:** Use lock washers and Loctite 243, or equivalent, if holes are tapped thru.
- **Inspection Plate Fasteners:** Use Loctite 243, or equivalent, on the fasteners that hold the rectangular inspection plate to the side of the transmissions gear case. When installing these fasteners, install all of the fasteners to finger tight, then torque them to a final torque of 72 in.-lbs. in an alternating crossover pattern.



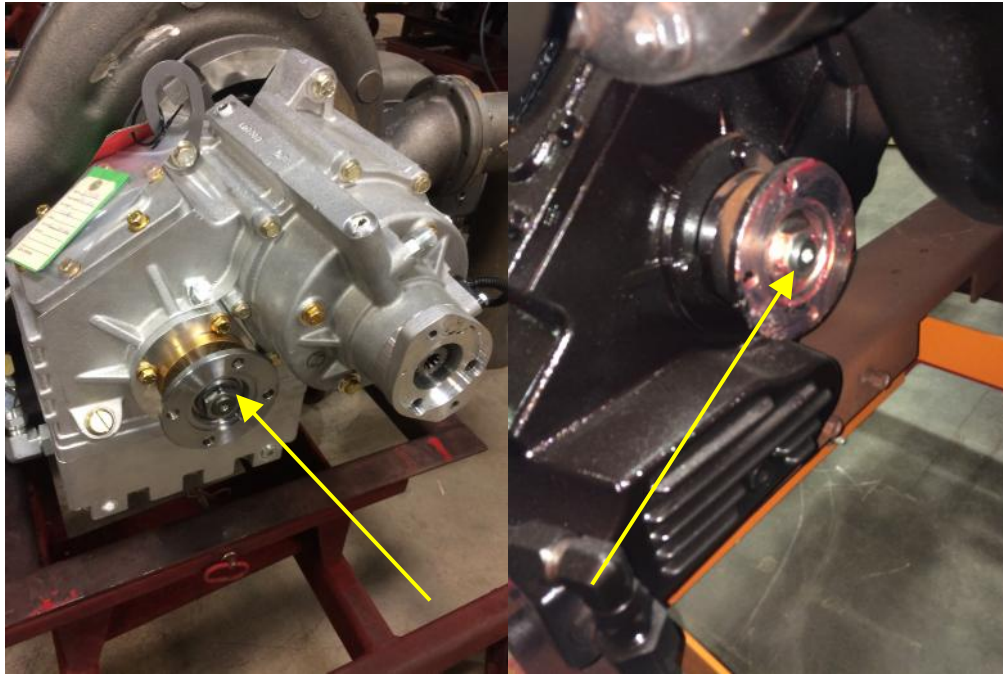
- **Fastener Lock Washers and Aluminum:** Do not use lock washers against aluminum. Use the appropriate thread locker instead.

- **O-rings/Quad rings:** When installing o-rings and quad rings LIGHTLY lube with oil or silicon grease (Dow Corning 111). Be careful not to apply too thick of a film of lubricant when using the silicone grease because over application of the grease can cause the o-ring/quad ring to bridge and leak.



- **Gear Lube:** When filling the gear case with oil, fill with SAE80W/90 gear lube oil to the bottom of the oil level plug on the gear case, or the oil level mark on the dipstick. Maintain the gear case oil level every 25 hours or 3 months, which ever comes first, and change the oil every 50 hours or 6 months.
- **Oil Seal lubrication:** When lubricating oil seals prior to installation, apply a minimal amount of SAE 80/W90 oil on the outside diameter of the seal and the sealing lip on the inside diameter of the seal. Do not use any lubricant other than SAE 80W/90 oil unless a Darley document dated after February 14, 2012 specifically calls it out.

- **Yoke nut installation torque for PUC and PUC-3G pumps:** Torque PUC and PUC-3G yoke nuts to 300-350 ft-lb. After the yoke nut has been torqued down, check to make sure the yoke nut engages the yoke face it bumps up against.



PUC and PUC-3G yoke nuts are tightened to 300-350 lb-ft.

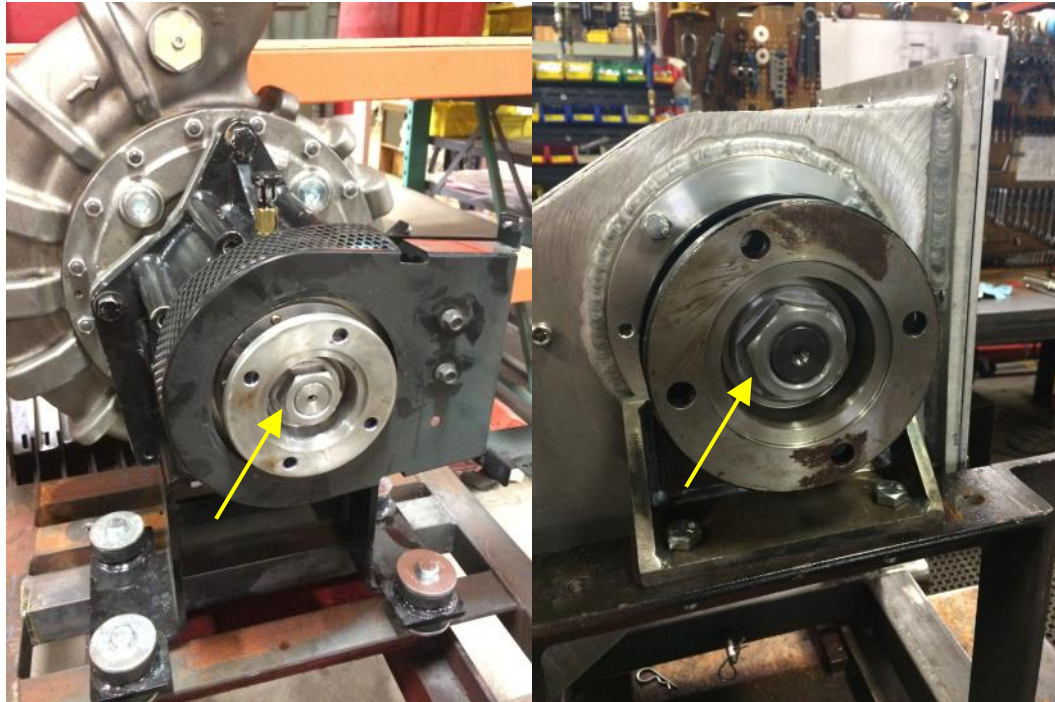
- **Yoke nut torque for 1.75-12 thread, 1.25-12 thread and 7/8-14 thread yoke nuts:** Unless otherwise specified, torque 1.75-12 interference threaded yoke nuts to 150-200 ft-lb. Unless otherwise specified, torque all 1.25-12 thread yoke nuts to 150-200 ft-lb. Unless otherwise specified, torque all 7/8-14 interference threaded yoke nuts to 125 ft-lb. After the yoke nut has been torqued down, check to make sure the yoke nut engages the yoke face it bumps up against.



1.75-12 thread yoke nuts are typically used on Midship pump.
1.25-12 thread yoke nuts are typically used on ZSD & ZSP pumps.
7/8-14 thread yoke nuts are used on PTO pumps.



All 1.75-12 interference threaded yoke nuts are torqued to 150-200 ft-lb.



All 1.25-12 threaded yoke nuts are torqued to 150-200 ft-lb.

Prepared by: DLH
 Approved by: Engineering
 Revised by: WAH

10 of 29

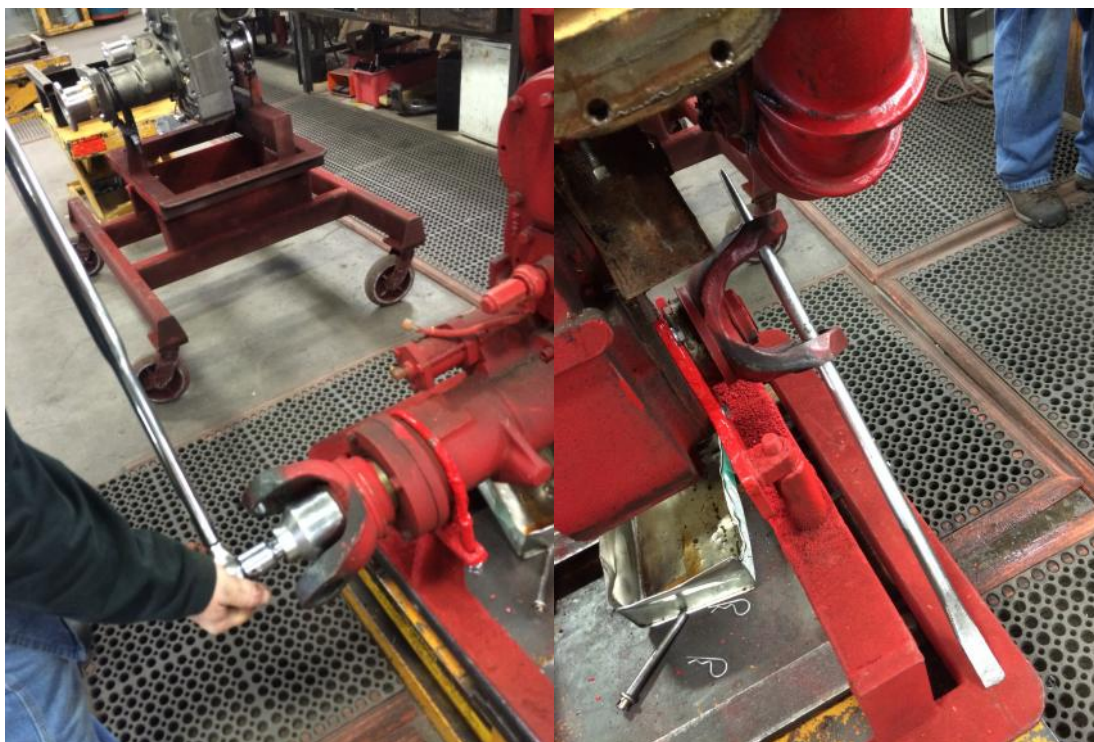
Rev.#: 6
 Date: 4/19/05
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 Rev Date: 16 Dec, 2015 ECO 11241



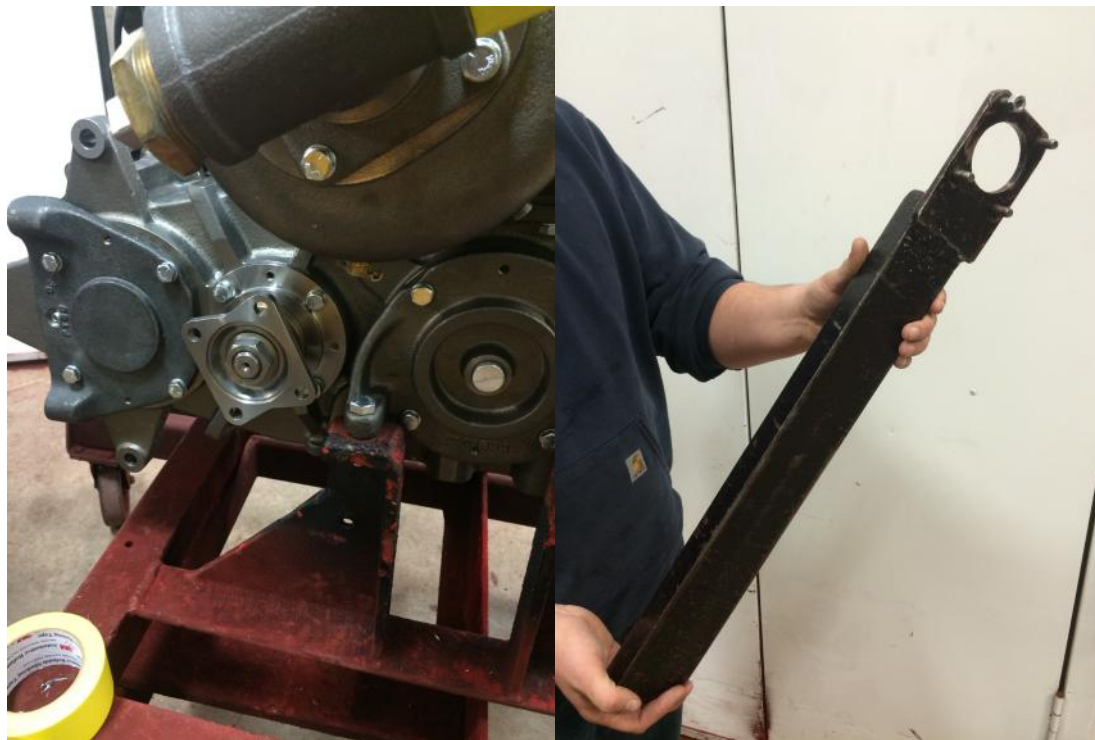
All 7/8-14 interference thread yoke nuts are tightened to 125 ft-lb.



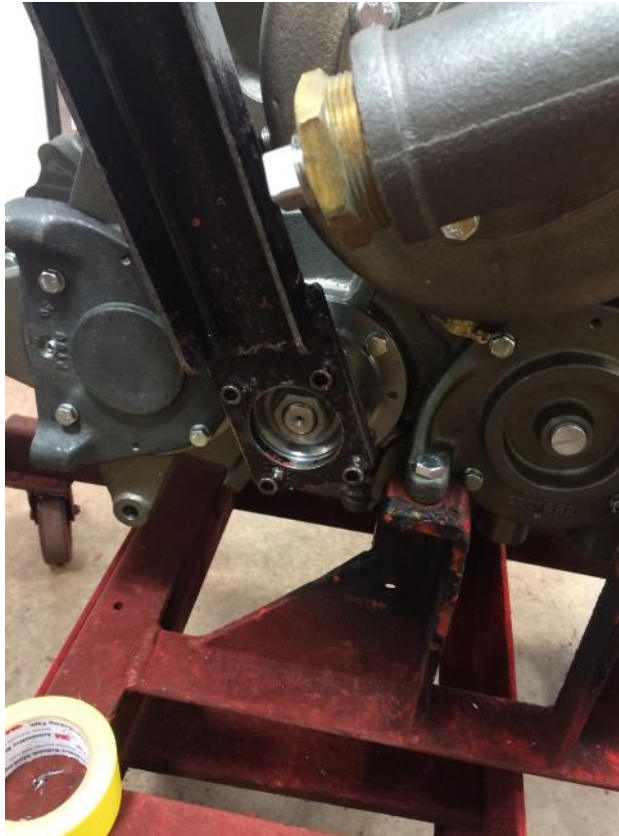
After torquing the yoke nut down, check to make sure there is not a gap between the yoke nut and the yoke.



To help with the yoke nut torquing on midship pumps, shift the transmission into road mode. Put a bar thru the yoke that is not being torqued down to stop the driveline from rotating. Then the driveline will not rotate as the yoke nut is being torqued.



To help with tightening yoke nuts on PTO pumps use the tool shown in the above picture.



Place the tool over the companion flange as shown above. Make sure to finger tighten a nut on one of the tool's fasteners to secure the tool to the yoke.



Now let the tool bump up against a rigid surface and use the torque wrench to tighten the yoke nut as shown above.

Recommended fastener tightening torque unless otherwise specified: The following tables will give recommended tightening torques depending upon the fasteners material and if a Loctite type product was used. Use these recommended tightening torques if you are not confident torqueing a fastener. For fasteners that had a Loctite type product applied to their threads, use the K = .20 (Clean non-plated bolt) recommended tightening torque even if either the nut or bolt was zinc electroplated.

Best practice is to; use an SAE Grade 8 bolt with an SAE Grade 8 nut, use an SAE Grade 5 bolt with and SAE Grade 5 nut, use an SAE Grade 2 bolt with an SAE Grade 2 nut and use the same bolt material as what the nut is made from.

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 8	18 to 27 in-lb	654 to 981 lb
#6 – 40 Grade 8	20 to 30 in-lb	730 to 1,095 lb
#8 – 32 Grade 8	33 to 50 in-lb	1,009 to 1,513 lb
#8 – 36 Grade 8	35 to 52 in-lb	1,060 to 1,591 lb
#10 – 24 Grade 8	48 to 72 in-lb	1,262 to 1,893 lb
#10 – 32 Grade 8	55 to 82 in-lb	1,440 to 2,159 lb
¼ - 20 Grade 8	115 to 172 in-lb	2,291 to 3,437 lb
¼ - 28 Grade 8	131 to 196 in-lb	2,619 to 3,928 lb
5/16 – 18 Grade 8	20 to 29 ft-lb	3,775 to 5,662 lb
5/16 – 24 Grade 8	22 to 33 ft-lb	4,181 to 6,271 lb
3/8 – 16 Grade 8	35 to 52 ft-lb	5,579 to 8,369 lb
3/8 – 24 Grade 8	40 to 59 ft-lb	6,324 to 9,485 lb
7/16 – 14 Grade 8	56 to 84 ft-lb	7,654 to 11,481 lb
7/16 – 20 Grade 8	62 to 93 ft-lb	8,548 to 12,821 lb
½ - 13 Grade 8	85 to 128 ft-lb	10,217 to 15,325 lb
½ - 20 Grade 8	96 to 144 ft-lb	11,517 to 17,275 lb
5/8 – 11 Grade 8	170 to 254 ft-lb	16,272 to 24,408 lb
5/8 – 18 Grade 8	192 to 288 ft-lb	18,429 to 27,643 lb
¾ - 10 Grade 8	301 to 452 ft-lb	24,081 to 36,122 lb
¾ - 16 Grade 8	336 to 503 ft-lb	26,853 to 40,280 lb
7/8 – 9 Grade 8	485 to 727 ft-lb	33,245 to 49,867 lb
7/8 – 14 Grade 8	535 to 802 ft-lb	36,682 to 55,023 lb
1 – 8 Grade 8	727 to 1,090 ft-lb	43,614 to 65,421 lb
1 – 12 Grade 8	796 to 1,193 ft-lb	47,739 to 71,608 lb

The above table is for SAE Grade 8 fasteners, K = .20 (Clean non-plated fasteners or Loctited zinc electroplated fasteners)

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 8	20 to 30 in-lb	654 to 981 lb
#6 – 40 Grade 8	22 to 33 in-lb	730 to 1,095 lb
#8 – 32 Grade 8	36 to 55 in-lb	1,009 to 1,513 lb
#8 – 36 Grade 8	38 to 57 in-lb	1,060 to 1,591 lb
#10 – 24 Grade 8	53 to 79 in-lb	1,262 to 1,893 lb
#10 – 32 Grade 8	60 to 90 in-lb	1,440 to 2,159 lb
¼ - 20 Grade 8	126 to 189 in-lb	2,291 to 3,437 lb
¼ - 28 Grade 8	144 to 216 in-lb	2,619 to 3,928 lb
5/16 – 18 Grade 8	22 to 32 ft-lb	3,775 to 5,662 lb
5/16 – 24 Grade 8	24 to 36 ft-lb	4,181 to 6,271 lb
3/8 – 16 Grade 8	38 to 58 ft-lb	5,579 to 8,369 lb
3/8 – 24 Grade 8	43 to 65 ft-lb	6,324 to 9,485 lb
7/16 – 14 Grade 8	61 to 92 ft-lb	7,654 to 11,481 lb
7/16 – 20 Grade 8	69 to 103 ft-lb	8,548 to 12,821 lb
½ - 13 Grade 8	94 to 140 ft-lb	10,217 to 15,325 lb
½ - 20 Grade 8	106 to 158 ft-lb	11,517 to 17,275 lb
5/8 – 11 Grade 8	186 to 280 ft-lb	16,272 to 24,408 lb
5/8 – 18 Grade 8	211 to 317 ft-lb	18,429 to 27,643 lb
¾ - 10 Grade 8	331 to 497 ft-lb	24,081 to 36,122 lb
¾ - 16 Grade 8	369 to 554 ft-lb	26,853 to 40,280 lb
7/8 – 9 Grade 8	533 to 800 ft-lb	33,245 to 49,867 lb
7/8 – 14 Grade 8	588 to 883 ft-lb	36,682 to 55,023 lb
1 – 8 Grade 8	800 to 1,199 ft-lb	43,614 to 65,421 lb
1 – 12 Grade 8	875 to 1,313 ft-lb	47,739 to 71,608 lb

The above table is for SAE Grade 8 fasteners, K = .22 (Zinc electroplated bolt or nut)

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 5	16 to 24 in-lb	589 to 883 lb
#6 – 40 Grade 5	18 to 27 in-lb	657 to 986 lb
#8 – 32 Grade 5	30 to 45 in-lb	908 to 1,362 lb
#8 – 36 Grade 5	31 to 47 in-lb	954 to 1,432 lb
#10 – 24 Grade 5	43 to 65 in-lb	1,136 to 1,704 lb
#10 – 32 Grade 5	49 to 74 in-lb	1,296 to 1,943 lb
¼ - 20 Grade 5	81 to 122 in-lb	1,623 to 2,434 lb
¼ - 28 Grade 5	93 to 139 in-lb	1,855 to 2,783 lb
5/16 – 18 Grade 5	14 to 21 ft-lb	2,674 to 4,011 lb
5/16 – 24 Grade 5	15 to 23 ft-lb	2,961 to 4,442 lb
3/8 – 16 Grade 5	25 to 37 ft-lb	3,952 to 5,928 lb
3/8 – 24 Grade 5	28 to 42 ft-lb	4,479 to 6,719 lb
7/16 – 14 Grade 5	40 to 59 ft-lb	5,422 to 8,133 lb
7/16 – 20 Grade 5	44 to 66 ft-lb	6,055 to 9,082 lb
½ - 13 Grade 5	60 to 90 ft-lb	7,237 to 10,855 lb
½ - 20 Grade 5	68 to 102 ft-lb	8,158 to 12,236 lb
5/8 – 11 Grade 5	120 to 180 ft-lb	11,526 to 17,289 lb
5/8 – 18 Grade 5	136 to 204 ft-lb	13,054 to 19,581 lb
¾ - 10 Grade 5	213 to 320 ft-lb	17,057 to 25,586 lb
¾ - 16 Grade 5	238 to 357 ft-lb	19,021 to 28,532 lb
7/8 – 9 Grade 5	343 to 515 ft-lb	23,548 to 35,323 lb
7/8 – 14 Grade 5	379 to 568 ft-lb	25,983 to 38,975 lb
1 – 8 Grade 5	515 to 772 ft-lb	30,893 to 46,340 lb
1 – 12 Grade 5	564 to 845 ft-lb	33,815 to 50,723 lb

**The above table is for SAE Grade 5 fasteners, K = .20 (Clean non-plated fasteners or
Loctited zinc electroplated fasteners)**

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 5	18 to 27 in-lb	589 to 883 lb
#6 – 40 Grade 5	20 to 30 in-lb	657 to 986 lb
#8 – 32 Grade 5	33 to 49 in-lb	908 to 1,362 lb
#8 – 36 Grade 5	34 to 52 in-lb	954 to 1,432 lb
#10 – 24 Grade 5	47 to 71 in-lb	1,136 to 1,704 lb
#10 – 32 Grade 5	54 to 81 in-lb	1,296 to 1,943 lb
¼ - 20 Grade 5	89 to 134 in-lb	1,623 to 2,434 lb
¼ - 28 Grade 5	102 to 153 in-lb	1,855 to 2,783 lb
5/16 – 18 Grade 5	15 to 23 ft-lb	2,674 to 4,011 lb
5/16 – 24 Grade 5	17 to 25 ft-lb	2,961 to 4,442 lb
3/8 – 16 Grade 5	27 to 41 ft-lb	3,952 to 5,928 lb
3/8 – 24 Grade 5	31 to 46 ft-lb	4,479 to 6,719 lb
7/16 – 14 Grade 5	43 to 65 ft-lb	5,422 to 8,133 lb
7/16 – 20 Grade 5	49 to 73 ft-lb	6,055 to 9,082 lb
½ - 13 Grade 5	66 to 100 ft-lb	7,237 to 10,855 lb
½ - 20 Grade 5	75 to 112 ft-lb	8,158 to 12,236 lb
5/8 – 11 Grade 5	132 to 198 ft-lb	11,526 to 17,289 lb
5/8 – 18 Grade 5	150 to 224 ft-lb	13,054 to 19,581 lb
¾ - 10 Grade 5	235 to 352 ft-lb	17,057 to 25,586 lb
¾ - 16 Grade 5	262 to 392 ft-lb	19,021 to 28,532 lb
7/8 – 9 Grade 5	378 to 567 ft-lb	23,548 to 35,323 lb
7/8 – 14 Grade 5	417 to 625 ft-lb	25,983 to 38,975 lb
1 – 8 Grade 5	566 to 850 ft-lb	30,893 to 46,340 lb
1 – 12 Grade 5	620 to 930 ft-lb	33,815 to 50,723 lb

The above table is for SAE Grade 5 fasteners, K = .22 (Zinc electroplated bolt or nut)

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 2	8 to 12 in-lb	300 to 450 lb
#6 – 40 Grade 2	9 to 14 in-lb	335 to 502 lb
#8 – 32 Grade 2	15 to 23 in-lb	462 to 693 lb
#8 – 36 Grade 2	16 to 24 in-lb	486 to 729 lb
#10 – 24 Grade 2	22 to 33 in-lb	579 to 868 lb
#10 – 32 Grade 2	25 to 38 in-lb	660 to 990 lb
¼ - 20 Grade 2	53 to 79 in-lb	1,050 to 1,575 lb
¼ - 28 Grade 2	60 to 90 in-lb	1,200 to 1,801 lb
5/16 – 18 Grade 2	108 to 162 in-lb	1,730 to 2,595 lb
5/16 – 24 Grade 2	120 to 180 in-lb	1,916 to 2,874 lb
3/8 – 16 Grade 2	16 to 24 ft-lb	2,557 to 3,836 lb
3/8 – 24 Grade 2	18 to 27 ft-lb	2,898 to 4,347 lb
7/16 – 14 Grade 2	26 to 38 ft-lb	3,508 to 5,262 lb
7/16 – 20 Grade 2	29 to 43 ft-lb	3,918 to 5,876 lb
½ - 13 Grade 2	39 to 59 ft-lb	4,683 to 7,024 lb
½ - 20 Grade 2	44 to 66 ft-lb	5,278 to 7,918 lb
5/8 – 11 Grade 2	78 to 117 ft-lb	7,458 to 11,187 lb
5/8 – 18 Grade 2	88 to 132 ft-lb	8,447 to 12,670 lb
¾ - 10 Grade 2	138 to 207 ft-lb	11,037 to 16,556 lb
¾ - 16 Grade 2	154 to 231 ft-lb	12,308 to 18,462 lb
7/8 – 9 Grade 2	133 to 200 ft-lb	9,142 to 13,714 lb
7/8 – 14 Grade 2	147 to 221 ft-lb	10,088 to 15,131 lb
1 – 8 Grade 2	200 to 300 ft-lb	11,994 to 17,991 lb
1 – 12 Grade 2	219 to 328 ft-lb	13,128 to 19,692 lb

The above table is for SAE Grade 2 fasteners, K = .20 (Clean non-plated fasteners or Loctited zinc electroplated fasteners)

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32 Grade 2	9 to 14 in-lb	300 to 450 lb
#6 – 40 Grade 2	10 to 15 in-lb	335 to 502 lb
#8 – 32 Grade 2	17 to 25 in-lb	462 to 693 lb
#8 – 36 Grade 2	18 to 26 in-lb	486 to 729 lb
#10 – 24 Grade 2	24 to 36 in-lb	579 to 868 lb
#10 – 32 Grade 2	28 to 41 in-lb	660 to 990 lb
¼ - 20 Grade 2	58 to 87 in-lb	1,050 to 1,575 lb
¼ - 28 Grade 2	66 to 99 in-lb	1,200 to 1,801 lb
5/16 – 18 Grade 2	119 to 178 in-lb	1,730 to 2,595 lb
5/16 – 24 Grade 2	132 to 198 in-lb	1,916 to 2,874 lb
3/8 – 16 Grade 2	18 to 26 ft-lb	2,557 to 3,836 lb
3/8 – 24 Grade 2	20 to 30 ft-lb	2,898 to 4,347 lb
7/16 – 14 Grade 2	28 to 42 ft-lb	3,508 to 5,262 lb
7/16 – 20 Grade 2	31 to 47 ft-lb	3,918 to 5,876 lb
½ - 13 Grade 2	43 to 64 ft-lb	4,683 to 7,024 lb
½ - 20 Grade 2	48 to 73 ft-lb	5,278 to 7,918 lb
5/8 – 11 Grade 2	85 to 128 ft-lb	7,458 to 11,187 lb
5/8 – 18 Grade 2	97 to 145 ft-lb	8,447 to 12,670 lb
¾ - 10 Grade 2	152 to 228 ft-lb	11,037 to 16,556 lb
¾ - 16 Grade 2	169 to 254 ft-lb	12,308 to 18,462 lb
7/8 – 9 Grade 2	147 to 220 ft-lb	9,142 to 13,714 lb
7/8 – 14 Grade 2	162 to 243 ft-lb	10,088 to 15,131 lb
1 – 8 Grade 2	220 to 330 ft-lb	11,994 to 17,991 lb
1 – 12 Grade 2	241 to 361 ft-lb	13,128 to 19,692 lb

The above table is for SAE Grade 2 fasteners, K = .22 (Zinc electroplated nut or bolt)

Fastener Size	Recommended tightening torque	Clamp load
#6 – 32	3 to 5 in-lb	125 to 188 lb
#6 – 40	4 to 6 in-lb	140 to 210 lb
#8 – 32	6 to 10 in-lb	193 to 290 lb
#8 – 36	7 to 10 in-lb	203 to 305 lb
#10 – 24	9 to 14 in-lb	242 to 363 lb
#10 – 32	10 to 16 in-lb	276 to 414 lb
¼ - 20	22 to 33 in-lb	439 to 659 lb
¼ - 28	25 to 38 in-lb	502 to 753 lb
5/16 – 18	45 to 68 in-lb	724 to 1,085 lb
5/16 – 24	50 to 75 in-lb	801 to 1,202 lb
3/8 – 16	80 to 120 in-lb	1,069 to 1,604 lb
3/8 – 24	91 to 136 in-lb	1,212 to 1,818 lb
7/16 – 14	128 to 193 in-lb	1,467 to 2,201 lb
7/16 – 20	143 to 215 in-lb	1,638 to 2,457 lb
½ - 13	16 to 24 ft-lb	1,958 to 2,937 lb
½ - 20	18 to 28 ft-lb	2,207 to 3,311 lb
5/8 – 11	32 to 49 ft-lb	3,119 to 4,678 lb
5/8 – 18	37 to 55 ft-lb	3,532 to 5,298 lb
¾ - 10	58 to 87 ft-lb	4,616 to 6,923 lb
¾ - 16	64 to 97 ft-lb	5,147 to 7,720 lb
7/8 – 9	93 to 139 ft-lb	6,372 to 9,558 lb
7/8 – 14	103 to 154 ft-lb	7,031 to 10,546 lb
1 – 8	139 to 209 ft-lb	8,359 to 12,539 lb
1 – 12	152 to 229 ft-lb	9,150 to 13,725 lb

The above table is for Stainless Steel, Bronze or Aluminum fasteners. By fasteners we are implying nuts or bolts – not stationary components in the clamped joint. K = .20 (Clean non-plated fasteners with or without a Loctite type product)

Socket set screw size	Minimum tightening torque for alloy steel socket set screws	Minimum tightening torque for stainless socket set screws
#6	10 in-lb	7 in-lb
#8	19 in-lb	16 in-lb
#10	34 in-lb	26 in-lb
¼	78 in-lb	70 in-lb
5/16	156 in-lb	130 in-lb
3/8	23 ft-lb	230 in-lb
7/16	36 ft-lb	28 ft-lb
1/2	51 ft-lb	42 ft-lb
5/8	110 ft-lb	82 ft-lb
3/4	179 ft-lb	142 ft-lb
7/8	428 ft-lb	333 ft-lb
1	584 ft-lb	467 ft-lb

The above table is the recommended minimum tightening torque for alloy steel and stainless socket set screws. Please note the recommended tightening torque is the same for both fine threaded and coarse threaded set screws

For reference, Recommended tightening torque is found by the following equation;

$$T = KDP$$

T = Tightening torque in units of inch-pound.

K = Nut factor and it is unit less.

D = Nominal bolt diameter in units of inch.

P = Clamp load in units of pounds.

Nut factor = K = .20 or .22 in these tables. K = .20 for clean non-plated bolts. K = .25 for zinc electroplated bolts. See IFI handbook 6th edition on page M-64 for more details.

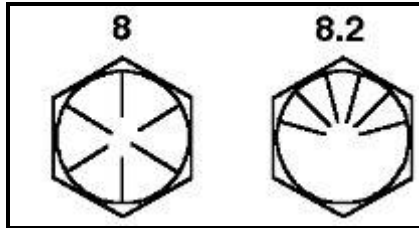
Our recommended tightening torques is intended to maintain a clamp load of 60% to 90% of the bolt's proof load. See Mechanical Engineering Design ISBN 0-07-056888-X page 382 for more details.

We assumed a Grade 8 proof load of 120,000 psi for all fasteners sizes.

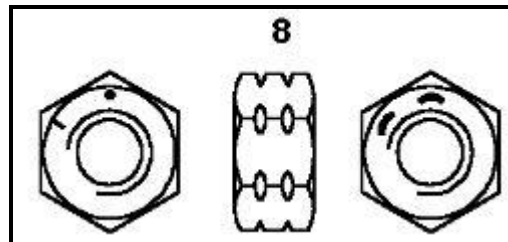
We assumed a Grade 5 proof load of 85,000 psi for fasteners ¼" in bolt diameter up to 1" in bolt diameter. We assumed a Grade 5 proof load of 108,000 psi for fasteners #6 up to #10 in bolt diameter. We assumed a Grade 2 proof load of 33,000 psi for fasteners larger than 3/4" in bolt diameter up to 1-1/2" in bolt diameter. We assumed a Grade 2 proof load of 55,000 psi for fasteners #6 in bolt diameter up to 5/8" in bolt diameter.

We assumed a proof load of 23,000 psi for all Stainless Steel, Bronze and Aluminum material fasteners. Sand cast 356.0-T6 aluminum has a yield strength of 24,000 psi listed in the ASM Specialty Handbook Aluminum and Aluminum Alloys on page 720.

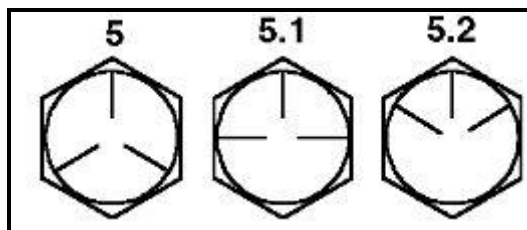
Fastener Size	Nominal bolt diameter (in)	Tensile stress area (square inch)	Stainless, Brass, Bronze or Aluminum proof load (lb)	SAE Grade 2 proof load (lb)	SAE Grade 5 proof load (lb)	SAE Grade 8 proof load (lb)
#6 – 32	.1380	.00909	209	500	981	1,090
#6 – 40	.1380	.01015	233	558	1,095	1,217
#8 – 32	.1640	.0140	322	770	1,513	1,681
#8 – 36	.1640	.01474	339	810	1,591	1,767
#10 – 24	.1900	.0175	403	964	1,893	2,104
#10 – 32	.1900	.0200	460	1,100	2,159	2,399
¼ - 20	.250	.0318	732	1,750	2,705	3,819
¼ - 28	.250	.0364	837	2,001	3,092	4,365
5/16 – 18	.3125	.0524	1,206	2,884	4,457	6,292
5/16 – 24	.3125	.0580	1,336	3,194	4,936	6,968
3/8 – 16	.375	.0775	1,782	4,262	6,587	9,299
3/8 – 24	.375	.0878	2,020	4,831	7,465	10,539
7/16 – 14	.4375	.1063	2,445	5,847	9,036	12,757
7/16 – 20	.4375	.1187	2,730	6,529	10,091	14,246
½ - 13	.500	.1419	3,264	7,804	12,061	17,028
½ - 20	.500	.1599	3,679	8,797	13,596	19,194
5/8 – 11	.625	.226	5,198	12,430	19,210	27,120
5/8 – 18	.625	.256	5,887	14,078	21,759	30,715
¾ - 10	.750	.334	7,693	18,395	28,429	40,135
¾ - 16	.750	.373	8,578	20,513	31,702	44,755
7/8 – 9	.875	.462	10,620	15,237	39,247	55,408
7/8 – 14	.875	.509	11,718	16,813	43,305	61,137
1 – 8	1.000	.606	13,932	19,990	51,488	72,689
1 – 12	1.000	.663	15,250	21,880	56,359	79,565



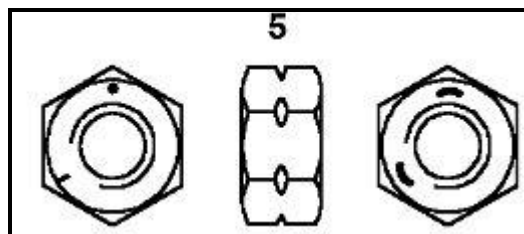
The above image shows how SAE Grade 8 hex head bolts can be identified.



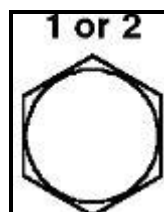
The above image shows how SAE Grade 8 hex nuts can be identified.



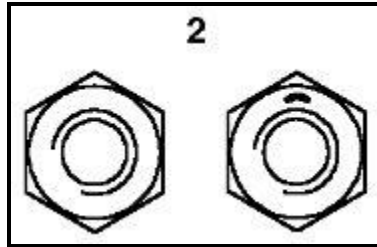
The above image shows how SAE Grade 5 hex head bolts can be identified.



The above image shows how SAE Grade 5 hex nuts can be identified.



The above image shows how SAE Grade 2 hex head bolts can be identified.



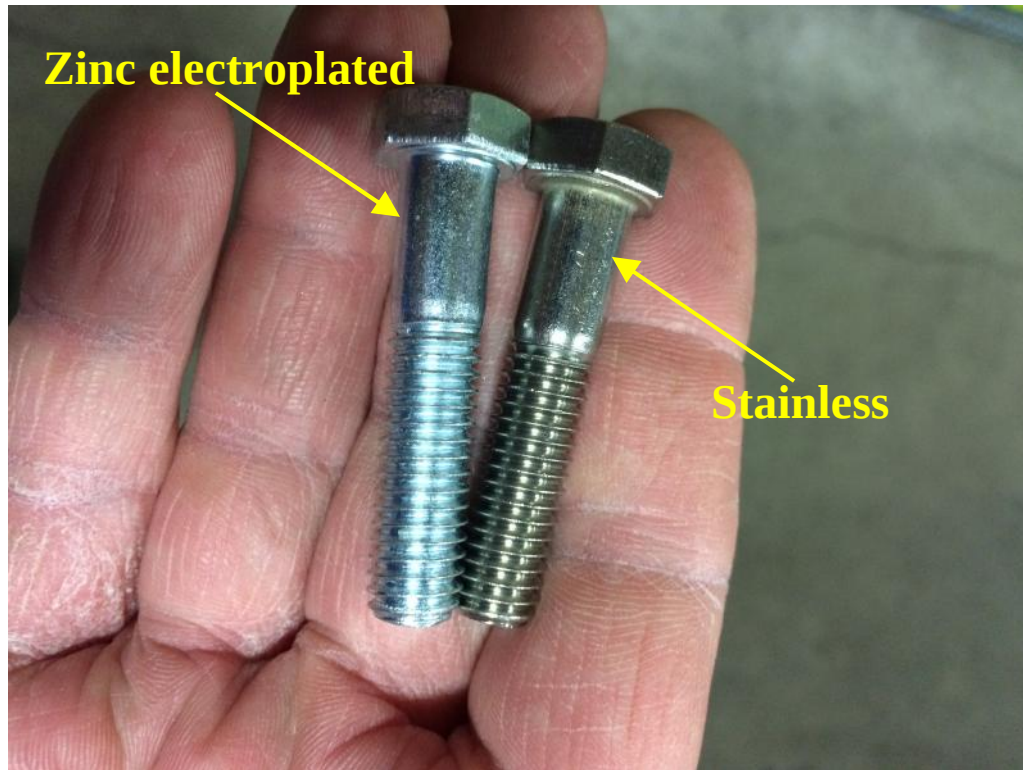
The above image shows how SAE Grade 2 hex nuts can be identified.



The above images show different types of zinc electroplated fasteners.



The above images show different types of clean non-plated fasteners.



**The bolt on the left is zinc electroplated.
The bolt on the right is stainless steel.**



The above image is a brass machine screw and brass hex nut.



All alloy steel socket head cap screws have an 180,000 psi tensile strength for ½” and smaller bolts and 170,000 psi tensile strength for 5/8” and larger bolts. Use the SAE Grade 8 recommended tightening torque tables for socket head cap screws.



All alloy steel socket flat countersunk head cap screws have a 150,000 psi minimum tensile strength. Use the SAE Grade 8 recommended tightening torque tables for alloy steel socket flat countersunk head cap screws.



All alloy steel socket button head cap screws have a 137,000 psi minimum tensile strength. Use the SAE Grade 5 recommended tightening torque tables for alloy steel socket button head cap screws.



The fasteners on the left are alloy steel socket set screws. The fasteners on the right are stainless socket set screws.

If further information is needed, call **Darley** at
Chippewa Falls, WI. - 800-634-7812 or 715-726-2650

Prepared by: DLH
Approved by: Engineering
Revised by: WAH

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Rev.#: 6
Date: 4/19/05
1205529.doc
Rev Date: 16 Dec, 2015 ECO 11241