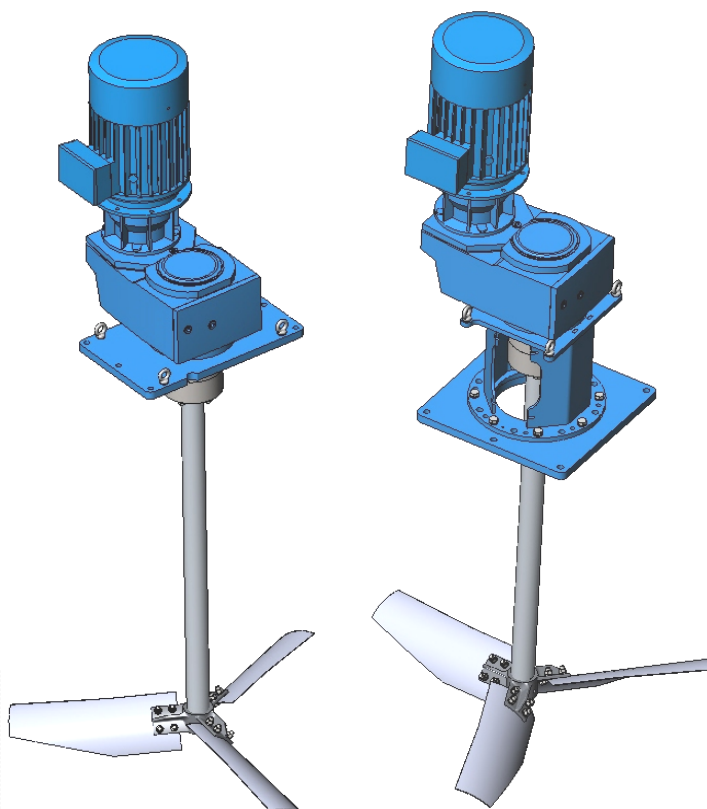


Installation, Operation and Maintenance Manual

MRD and MRP Agitators (Case Size 17-18)



Equipment Reference

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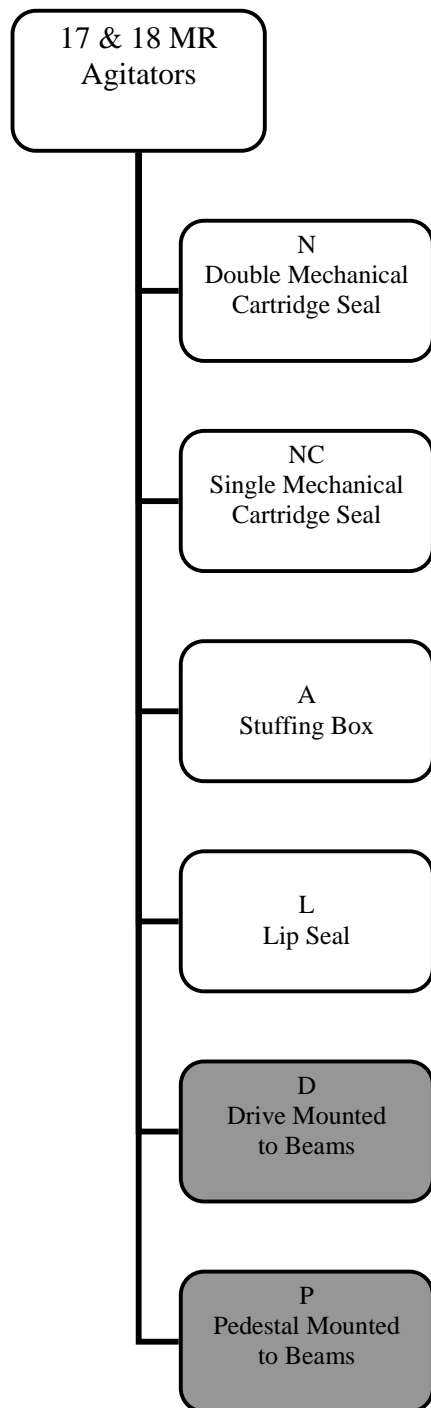
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A. PRODUCT NOMENCLATURE

Models described in this manual are shaded.

NOTE: *The case size referred to in this manual can be determined by the first two numbers in the model designation. For example: "17MRD-5" is a Case Size "17" agitator. Refer to unit assembly drawing or unit nameplate for model designation.*

B. INITIAL INSPECTION

Step 1: Inspect crates. Upon receipt, inspect all crates and equipment for any damage during shipping. If you observe any damage, please report it to your [local Chemineer office](#) or to the factory of origin. A claim should be filed immediately with the carrier involved.

Step 2: Uncrate. Check the contents. Do not un-crate the unit until you have read all the Installation instructions and viewed the assembly drawing shipped with the unit. Be careful in uncrating and handling. Before discarding the crating, make sure that all agitator parts have been removed. Correct assembly of this unit requires referring to both the unit assembly drawing and this manual.

Step 3: Questions? Call Chemineer. If the shipment is not complete or you do not understand what you have received, please contact your [local Chemineer office](#) immediately.

C. CHEMINEER ASSISTANCE

Chemineer maintains a fully staffed Parts and Field Service Department ready to help you with any service requirement. When in doubt contact your local Chemineer office, or Parts/Field Service department at the Chemineer Factory:

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For your convenience, Chemineer offers the following services:

- Installation and maintenance training seminars
- Installation and start-up supervision
- Preventative maintenance planning
- Parts order service



D. SAFETY

D.1 SAFETY SYMBOLS

Please always observe the following safety and information symbols!


	Danger!
	Risk of fatalities and injury
	Attention!
	Machine may be damaged
	Note!
	Useful information

All work including transportation, storage, installation, electrical connection, commissioning, servicing, maintenance and repair must be performed **only by qualified specialist personnel**.

	Danger!
	Installation and maintenance work may only be performed when gear units are at a standstill. The drive must be isolated and secured to prevent accidental start-up. Tighten the drive elements or secure the parallel key before switching on.
	Danger!
	Only transport using the eyebolts attached to the gear unit. No additional loads may be attached. Transportation aids and lifting gear must have an adequate load-bearing capacity.

If geared motors have an additional eyebolt attached to the motor, this must also be used. Avoid pulling the eyebolts at an angle. The thread of the eyebolt must be fully screwed in.

Observe all safety information, including that provided in the individual sections of this Operating Manual. All national and other regulations on safety and accident prevention must also be observed.

	Danger!
	Serious physical and property damage may result from inappropriate installation, non-designated use, incorrect operation, non-compliance with safety information, unauthorised removal of housing components or safety covers, and structural modifications to the gear unit.

D.2 VESSELS

All types of vessels either open or closed pose special safety challenges. It is essential that Installers, Operators and Maintainers of the equipment understand these special hazards.

Particular safety hazards arise because the vessel is typically defined as a “Confined Space”. This creates a number of special hazards, including the risk of having oxygen shortages. Never enter a confined space unless you are fully trained on the procedures and have the correct safety equipment and procedures in place.

One must not enter a confined space unless fully assured that it is safe. Typically, before entering a vessel you should require proof of power and process fluid lock out. Always carry with you an oxygen sensor (in order to verify a safe atmosphere), a suitable safety harnesses and lifting equipment. Typically, a shoulder lift harness and a man-lifting crane are required (a man on the end of a rope or a center back lift offers no safety protection). A suitable safety cover must be provided at all time.

In cases where a vessel has been in service, tests must be made to ensure that no hazardous products or product residues are present.

The work site is often within a designated hazardous area. Where potentially explosive conditions exist, all efforts must be made to make the area safe before proceeding with work. Where this is not possible, a detailed, individual hazard assessment is vital. Special working procedures and tooling are required.

D.3 FASTENERS

Important fasteners should not be re-used. When a fastener is disturbed, always replace it with a new one. Dispose of used fasteners. Do not keep them for re-use.

D.4 CE MARKING (WHERE APPLICABLE)

Any CE marking and associated documentation applies to the mixer only on the basis that it is an individual product. After installation of the mixer into the mixing system, it becomes an integral part of a larger installation. **Chemineer is not responsible for the CE marking once the mixer has been installed into the mixing system.** As a standard, the mounting flange has been designed for the design conditions stated on the arrangement drawing and a fiber flange gasket (supplied by others). Where other conditions apply, they will be stated on the assembly drawing.

D.5 SAFETY CHECKLIST

- ☑ This Installation, Operation and Maintenance Manual, assembly drawings, and any supplements must be reviewed and understood before commencing installation and operation.
- ☑ All site rules must be observed for the installation and operation of this mixer.
- ☑ Ensure all external connections are made in accordance with applicable codes of practice.
- ☑ The mixer must be earthed (connected to ground).
- ☑ Correct rotation must be checked prior to operation.
- ☑ **Do not** exceed the operating pressures, temperatures, and other conditions for which the machine has been designed.
- ☑ **Do not** operate the agitator unless all guards are securely fixed. Do not modify any guarding. Open tanks fitted with agitators must be provided with suitable guarding to prevent personnel contacting agitator-moving parts. The user is responsible for providing these guards.
- ☑ Ensure mechanical seal setting clips are disengaged before operation. These clips should be retained for future use.
- ☑ Ensure gas supply system, (if applicable) is correctly installed, pressurized and ready for operation.
- ☑ **Do not** touch rotating components.
- ☑ During servicing of the mixer, the motor must be isolated from the power supply and the supply locked out.
- ☑ **Do not** operate the mixer for applications other than for its intended use.
- ☑ **Do not** modify the mixer without reviewing the change with Chemineer. It is unsafe to use non-standard parts without Chemineer's approval. When in doubt, ask your local Chemineer office.

WHEN IN DOUBT, ASK!

D.6 DISPOSAL

Observe the current local regulations. In particular, lubricants must be collected and disposed of correctly.

Table 1. DISPOSAL OF GEARBOX COMPONENTS

Gear unit components:	Material:
Toothed wheels, shafts, rolling bearings, parallel keys, locking rings, ...	Steel
Gear unit housing, housing components, ...	Grey cast iron
Radial seals, sealing caps, rubber components,...	Elastomers with steel
Coupling components	Plastic with steel
Flat seals	Asbestos-free sealing material
Gear oil	Additive mineral oil
Synthetic gear oil	Polyglycol-based lubricants
Cooling spiral, embedding material of the cooling spiral, screw fittings	Copper, epoxy, yellow brass

E. STORAGE

Do not remove protective packaging, desiccant, or any protective coatings applied to the wetted parts until the agitator is to be put into service. If the equipment is to be stored, do not stack crates. Store in a clean dry indoor location, which is free from wide variations in temperature. The storage area should be free from vibration and excessive heat.


Inspect for external rust at three-month intervals. Apply a rust preventative to unpainted carbon steel surfaces to prevent corrosion during storage. If the unit has been in storage for more than three months or subjected to adverse moisture conditions, the motor windings may have to be dried prior to operation.

E.1 SHORT-TERM INDOOR STORAGE

The factory storage preparations are acceptable for up to nine months storage. If the storage period will exceed nine months, see the Long-Term Indoor Storage section. The following precautions should be followed:

- Store the gearbox in the running position and secure gear unit against falling
- Lightly grease bare metal housing surfaces and shafts
- Store in dry rooms
- Temperature must not fluctuate beyond the range of -5°C [23°F] to $+40^{\circ}\text{C}$ [104°F]
- Relative humidity less than 60%
- No direct exposure to sunlight or UV light
- No aggressive, corrosive substances (contaminated air, ozone, gases, solvents, acids, alkalis, salts, radioactivity etc.) in the immediate vicinity
- No vibration or oscillation

E.2 OUTDOOR OR LONG-TERM INDOOR STORAGE

	<p>Note!</p> <p>For storage or standstill periods in excess of 9 months, Chemineer recommends the long-term storage option. With the long-term storage option and the use of the measures listed below, storage for up to 2 years is possible. As the actual influences on the unit greatly depend on the local conditions, these times should only be regarded as guide values.</p>
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Storage of agitators and motors outdoors is not recommended. Unless specially prepared, our equipment is supplied with the intent that it will be immediately installed and commissioned or subject to short-term indoor storage only.

Equipment subject to long-term storage can suffer extensive damage due to corrosion. Unlike during operation, during storage the gearbox surfaces are not covered with oil and the moisture due to condensation inside the gearbox does not evaporate. This can rapidly lead to severe rust of the precision components causing extensive damage.

The method employed for long-term storage is to prevent the humidity/temperature changes and airborne chemicals from making contact with the internal components of the equipment. The methods described below provide protection but cannot avoid some level of degradation of the equipment.

- Store in the running position and secure gear unit against falling
- Transportation damage to the external paint must be repaired. Check that a suitable rust inhibitor is applied to the flange bearing surfaces. If necessary apply a suitable rust inhibitor to the surfaces.
- Gear units with the long-term storage option have VCI corrosion protection agents added to the gear oil. (See label on gear unit)
- The sealing band in the vent plug must not be removed during storage. The gear unit must remain sealed tight.
- Store in a dry place.
- In tropical regions, the drive unit must be protected against damage by insects
- Temperature must not fluctuate beyond the range of -5°C [23°F] to $+40^{\circ}\text{C}$ [104°F]
- Relative humidity less than 60%
- If the relative humidity is $<50\%$ the gear unit can be stored for up to 3 years.
- No direct exposure to sunlight or UV light
- No aggressive, corrosive substances (contaminated air, ozone, gases, solvents, acids, alkalis, salts, radioactivity etc.) in the immediate vicinity
- No vibration or oscillation

Measures before commissioning the gearbox

- If the storage or standstill period exceeds 2 years or the temperature during short-term storage greatly deviates from the standard range, the lubricant in the gear unit must be replaced before commissioning.
- If the gear unit is completely filled, the oil level must be reduced before commissioning.

E.2.1 To prevent from corrosion:

Extreme temperatures can cause the oil volume to change. To prevent oil leakage through the seals, it is recommended to reduce the oil capacity if it is known the temperature will vary greatly throughout the storage period.

E.2.2 To protect elastomers:


Elastomers will age, can stick or take set. In order to prevent the elastomers from sticking, regularly rotate shafts in order to redistribute lubricants. Protect the equipment from direct sunlight and from ozone to minimize the rate of aging of the elastomers.

E.2.3 To avoid false brinelling:

Rotate the motor and gear drive shafts 10 to 15 revolutions at least once per month to reduce the possibility of false brinelling of the bearings and to re-distribute bearing grease.

Other problems include vibration related damage. Do not store equipment in a manner that subjects it to vibration.

Motor space heaters, if installed, should be energized during the storage period.

	Note!
	When the equipment is to be stored in a strong chemical environment or near salt-water, protection procedures should be executed immediately upon receipt of the equipment.

E.3 CUSTOMER RESPONSIBILITY

To ensure the original quality of the Chemineer equipment prior to commissioning after storage, all components must be inspected by an authorized Chemineer Service Engineer. Any sub assemblies not manufactured by Chemineer must be inspected by that part supplier/manufacturer's authorized service personnel. Chemineer is not responsible for the cost of such a service.

Because storage location and other unknown site factors are beyond Chemineer's control, Chemineer will not accept any liability for damage to the equipment during the storage period.

F. BEAM MOUNTING

MRD and MRP (open tank) style units usually mount separately from the tank on either a steel structure or a concrete slab over the tank. D style units may include an auxiliary shaft seal as an option. Refer to the agitator assembly drawing for minimum required mounting height to allow for servicing the seal.

The most frequent cause of mechanical difficulty with an agitator is improper mounting. It is imperative to heed the following guidelines:

1. The agitator extension shaft is designed to run in a true vertical position.
2. Do not angle or side mount the agitator unless it was specifically designed for angle mounting by Chemineer.
3. Do not mount on a surface that is not flat and horizontal.
4. Start up of the agitator with the turbine impacted in solids is beyond the scope of these recommendations.
5. The mounting structure must be rigid enough to meet the requirements described in section F.1 and F.2 below.

F.1 DESCRIPTION OF AGITATOR LOADS

During operation of the agitator, the fluid motion in the vessel produced by the rotation of the turbine impeller can exert significant forces and moments on the agitator extension shaft. The forces and moments produced by the turbine rotating in a fluid are; torque, turbine thrust (up or down) and turbine hydraulic (side) force.

The hydraulic forces acting on the turbine generate moments, which act on the shaft and are transmitted to the agitator drive. Because of the random nature of the forces and the rotation of the shaft, the direction of these forces is constantly changing.

A pitched blade or axial flow turbine will impart an upward or downward thrust depending on if it is a down or up pumping turbine, respectively. The thrust force is generally less than the weight of the unit.

Due to the turbulent conditions within the agitated fluid, the actual operating torque, thrust and moment loads can show up to 20% variability over those shown on the assembly drawings supplied with the agitator.

The agitator has been designed to accommodate all of the forces mentioned, and as a result, the forces are transmitted directly to the mounting support. The support structure must be rigid enough to support the agitator weight and the live agitator reactions resulting from the torque, thrust and bending moment. The structure should be sufficiently rigid that, ***assuming a perfectly rigid agitator extension shaft***, the structure deflection will not cause the impeller end of the shaft to deflect more than 2.6 mm per meter of shaft length. See Figure 2 on page 13.

Particular attention should be given to reducing the torsion of the support beams local to the agitator mounting in both the X and Y directions. Lateral beams adjacent to the agitator mount should be sized the same as the longitudinal spans. Gussets of sufficient thickness should be used on the beam structure under the agitator mounting plate to insure full load transfer from the agitator mount to the support structure. See Figure 1 on page 13.

F.2 STRUCTURAL SUPPORT STEEL DESIGN GUIDELINES

The following Design Guidelines should be followed while designing the support structure:

1. The minimum natural flexural frequency of the agitator support structure should be at least five times the maximum impeller rpm.
2. All structural steel should be fabricated and erected in strict accordance with the latest A.I.S.C. specifications unless local code supersedes this specification.
3. Unless otherwise noted, all structural steel shapes and plates should conform to ASTM A529; structural tubing should be ASTM A500, Grade B.
4. Unless otherwise noted, all bolted connections should be designed as bearing type connections.
5. All bolts shall be tightened to within 70% of their minimum tensile strength.
6. Unless the process conditions, environmental conditions, or local codes prohibit, all bolting shall be galvanized or zinc plated carbon steel.

See Table 2, page 16, for recommended beam sizes. Values in this table are keyed to the gearbox model, case size, and tank diameter. Select the appropriate beam size for your application. Beams of equivalent, or greater, section modulus and moment of inertia and/or modulus of elasticity can be used. See Figure 3, page 14 for D style or, Figure 4, page 15 for P style.

THIS INFORMATION IS INTENDED AS A GUIDE, AND DOES NOT RELIEVE THE USER OF COMPLETELY ANALYZING THE ENTIRE MOUNTING SYSTEM. EXTREME APPLICATIONS OR DESIGNS MAY REQUIRE SUPPORT STIFFNESS GREATER THAN THE RECOMMENDATIONS PROVIDED HEREIN. CONSULT CHEMINEER INSIDE SALES FOR DESIGN GUIDANCE.

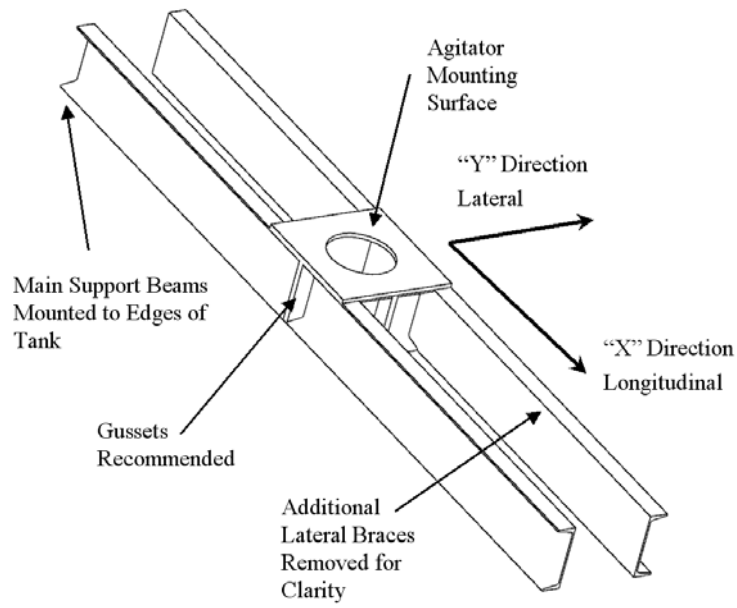


Figure 1. Main Beam / Gusset Orientation

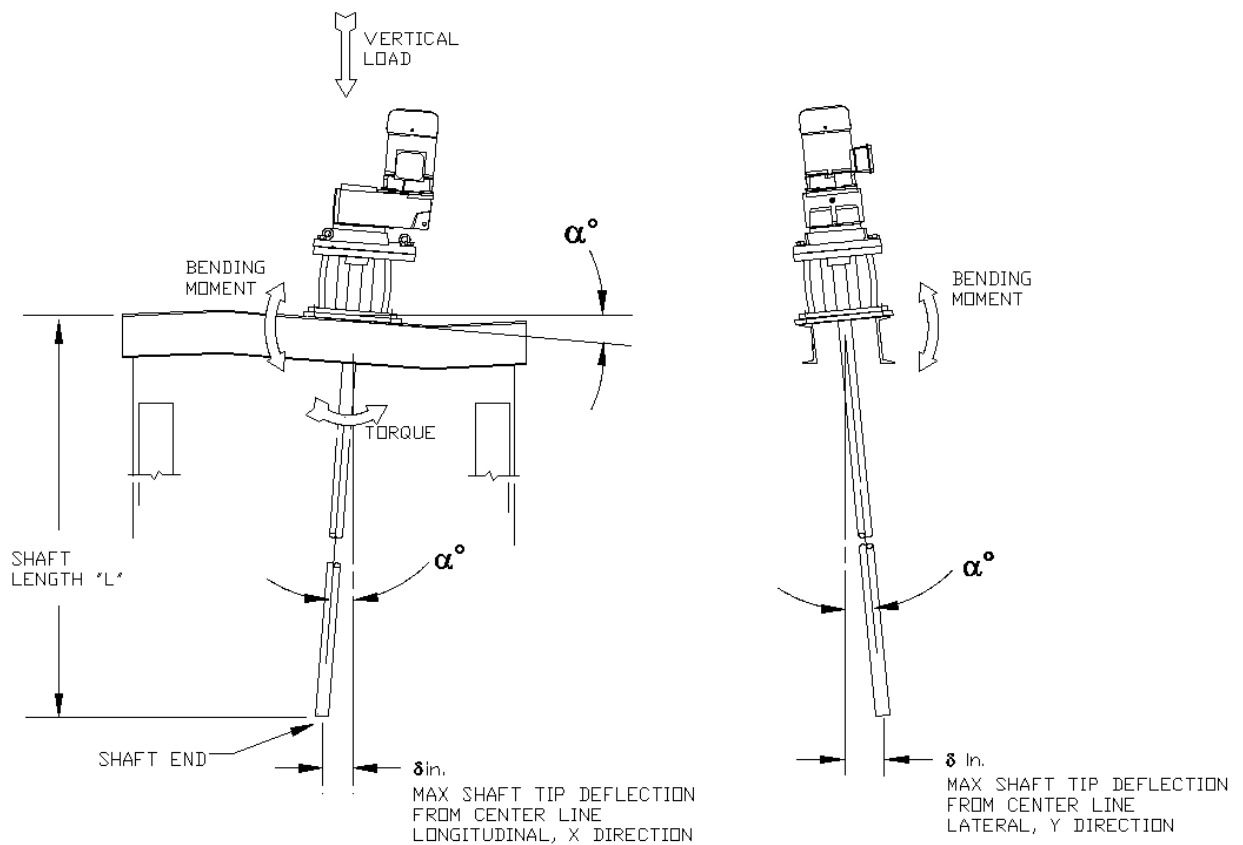


Figure 2. Angular Deflection Diagram

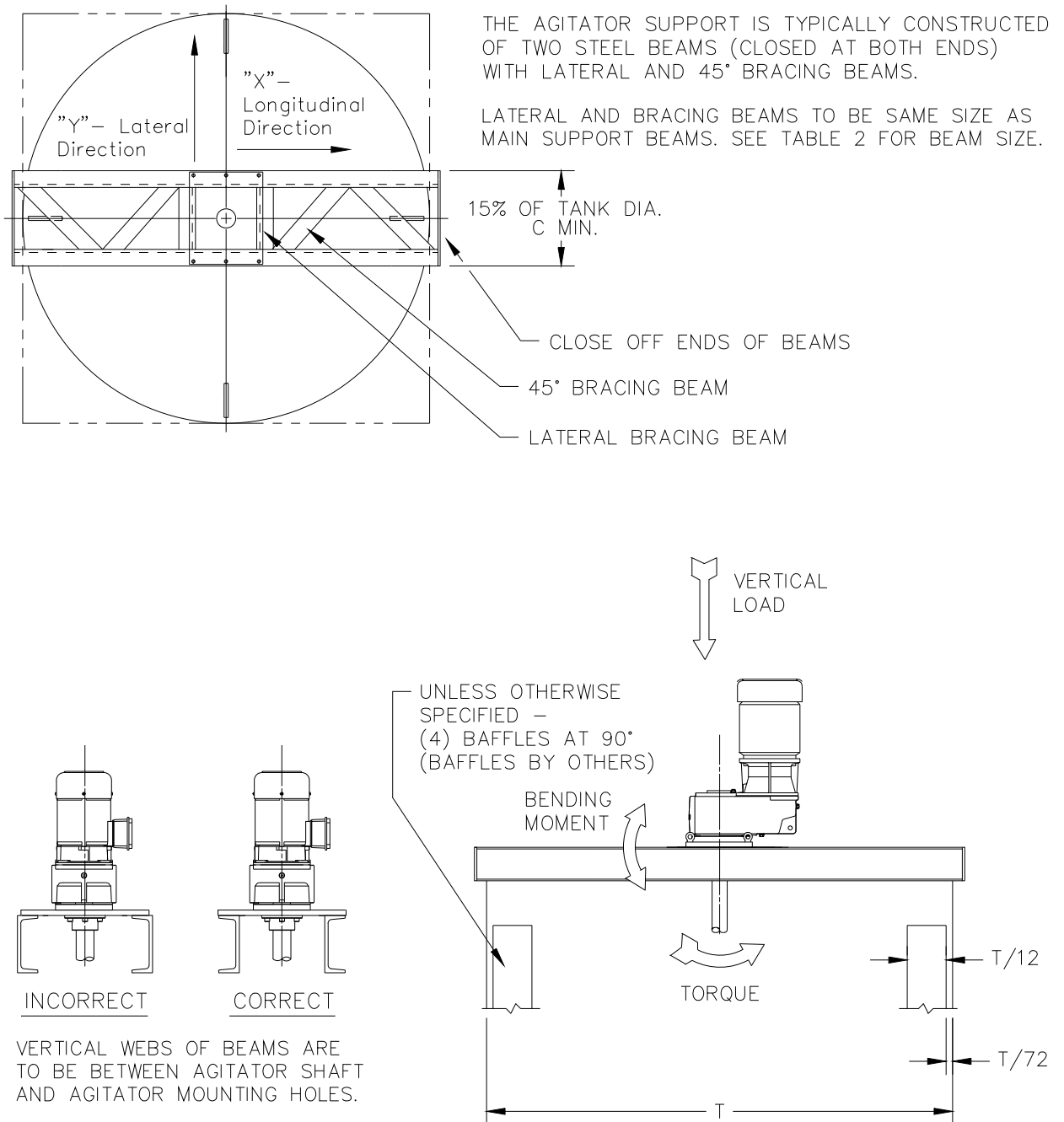


Figure 3. Open Tank Beam Mounting – MRD

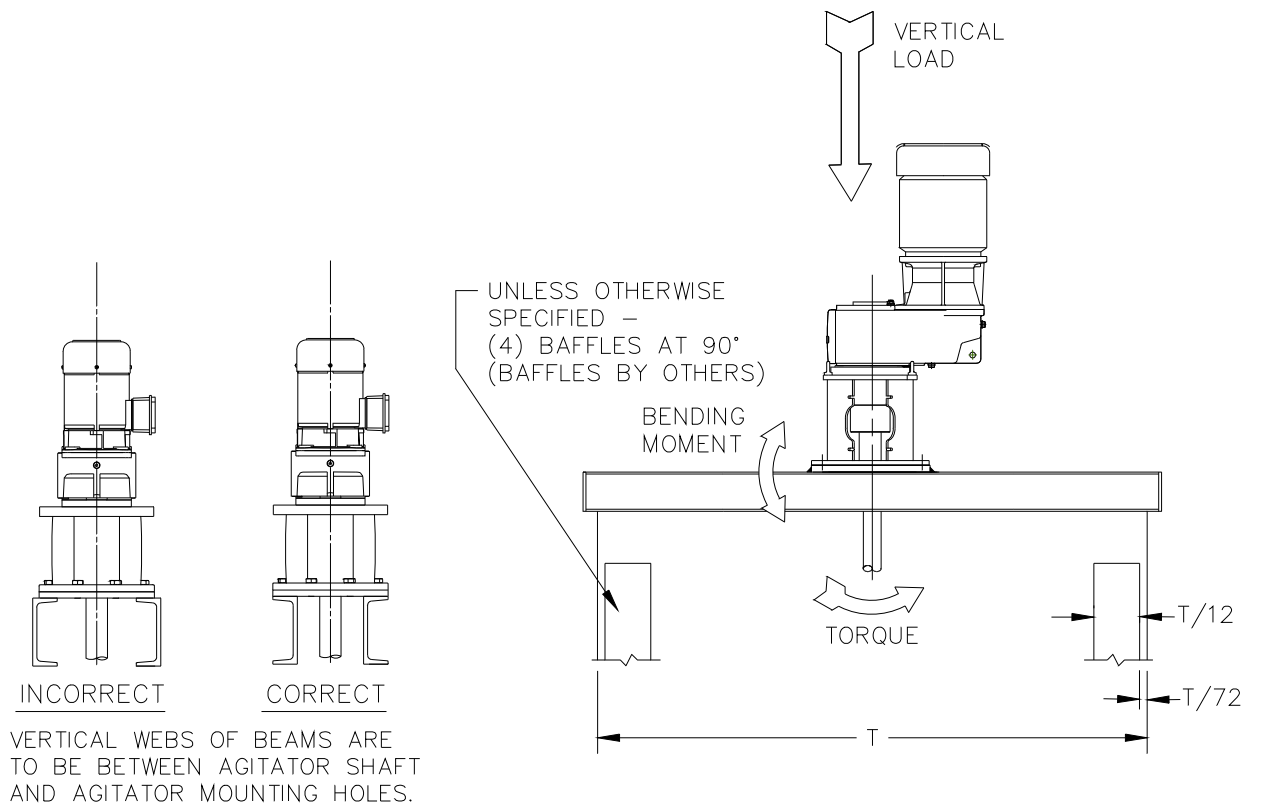
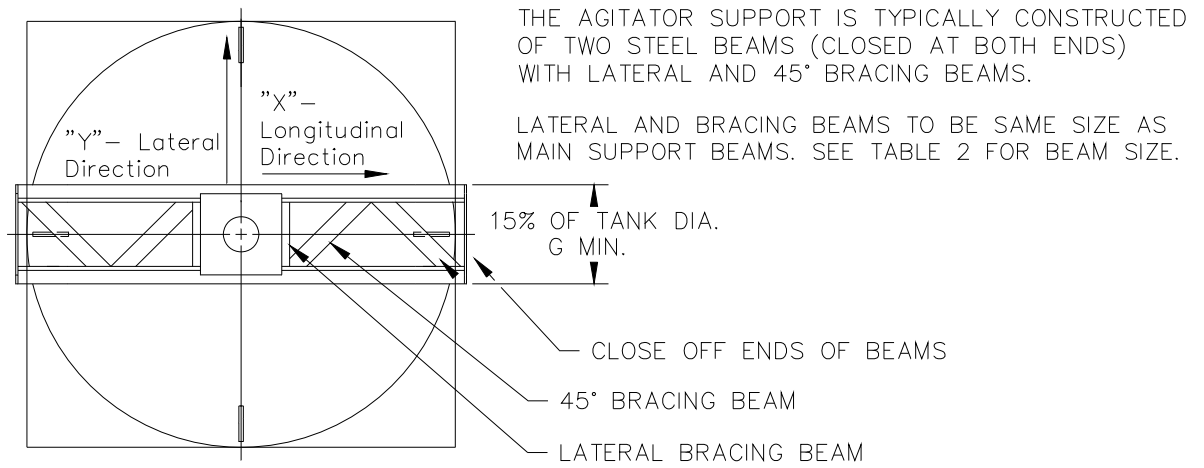


Figure 4. Open Tank Beam Mounting – MRP

Table 2. RECOMMENDED BEAM SIZES


CASE SIZE	TANK DIAMETER Ft (m)						
	8 (2.44)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)
17 MR	W12 X 14	W14 X 22	W18 X 35	W24 X 55	W27 X 84	W30 X 99	W36 X 160
18 MR	W12 X 16	W14 X 22	W18 X 40	W24 X 62	W27 X 84	W30 X 116	W36 X 194

W = Wide Flange Beam


Imperial / ASTM A6	Metric / ASTM A6M
W12in X 14 lb/ft	W310mm X 21 kg/m
W12 X 16	W310 X 24
W14 X 22	W360 X 33
W18 X 35	W460 X 52
W18 X 40	W460 X 60
W24 X 55	W610 X 82
W24 X 62	W610 X 92
W27 X 84	W690 X 125
W30 X 99	W760 X 147
W30 X 116	W760 X 173
W36 X 160	W920 X 238
W36 X 194	W920 X 289

G. AGITATOR INSTALLATION

Correct installation requires both the unit assembly drawing and this manual.

	Note!
	These instructions deal with the highest level of details required to assemble the entire unit. However, the specific unit supplied to you may have some assembly steps completed. Use discretion and omit these steps

1. The agitator is shipped in various crates: one for the agitator gear drive [200], one for the shaft and impeller [500] and typically one for the motor [100]. Optional accessories, multiple shafts, or multiple impellers may be crated separately.

	Attention!
	Coated/rubber covered agitator parts require special handling to avoid damage to coatings/rubber coverings. Do not use chains or hooks on coated/covered surfaces. Special care is required to prevent damage to edges and outside corners. Special installation procedures are required for large one-piece impeller/extension shaft assemblies. Contact Chemineer Field Service for instructions.

2. Remove all shipping restraints. A hoist or crane system for the lifting of the agitator parts must be available. Refer to Figure 15, page 32 for lifting instructions. The approximate net weight of the unit is shown on the unit assembly drawing. Since gear drives are some times supplied with the motor un-mounted, always verify that the motor being mounted is correct for the gear drive by checking the assembly drawing.
3. For MRP style units, install hand hole cover bolts, lock washers [1106, 1107] into the pedestal [1101]. Refer to Section M, page 37. Torque bolts to value shown in the APPENDIX, Page 98.
4. Install gear drive support pedestal assembly (MRP) or just the gearbox (MRD) to mounting structure. Install mounting bolts (supplied by others) and torque to the value shown in the APPENDIX, Page 98.

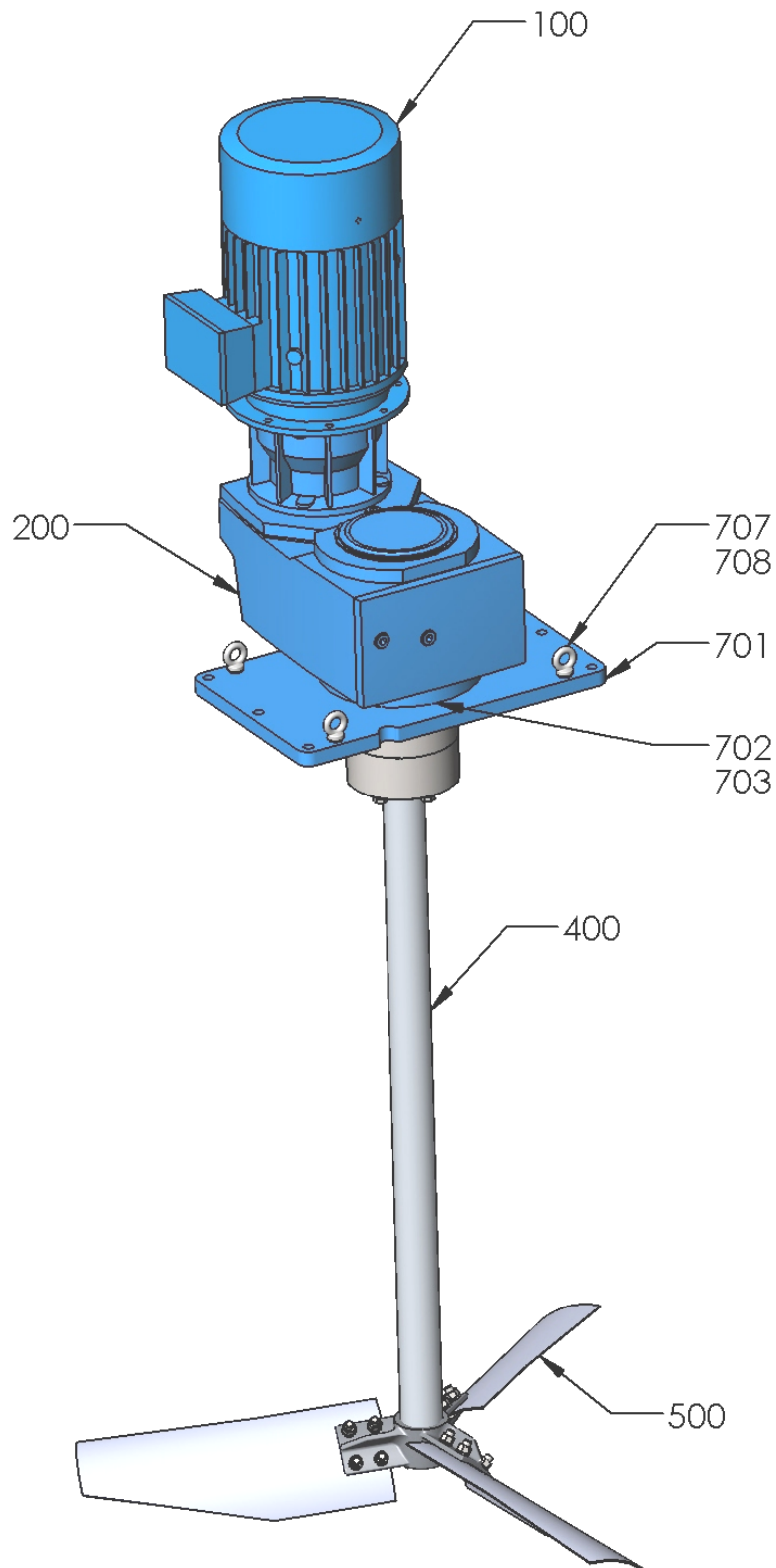


Figure 5. MRD Agitator Assembly

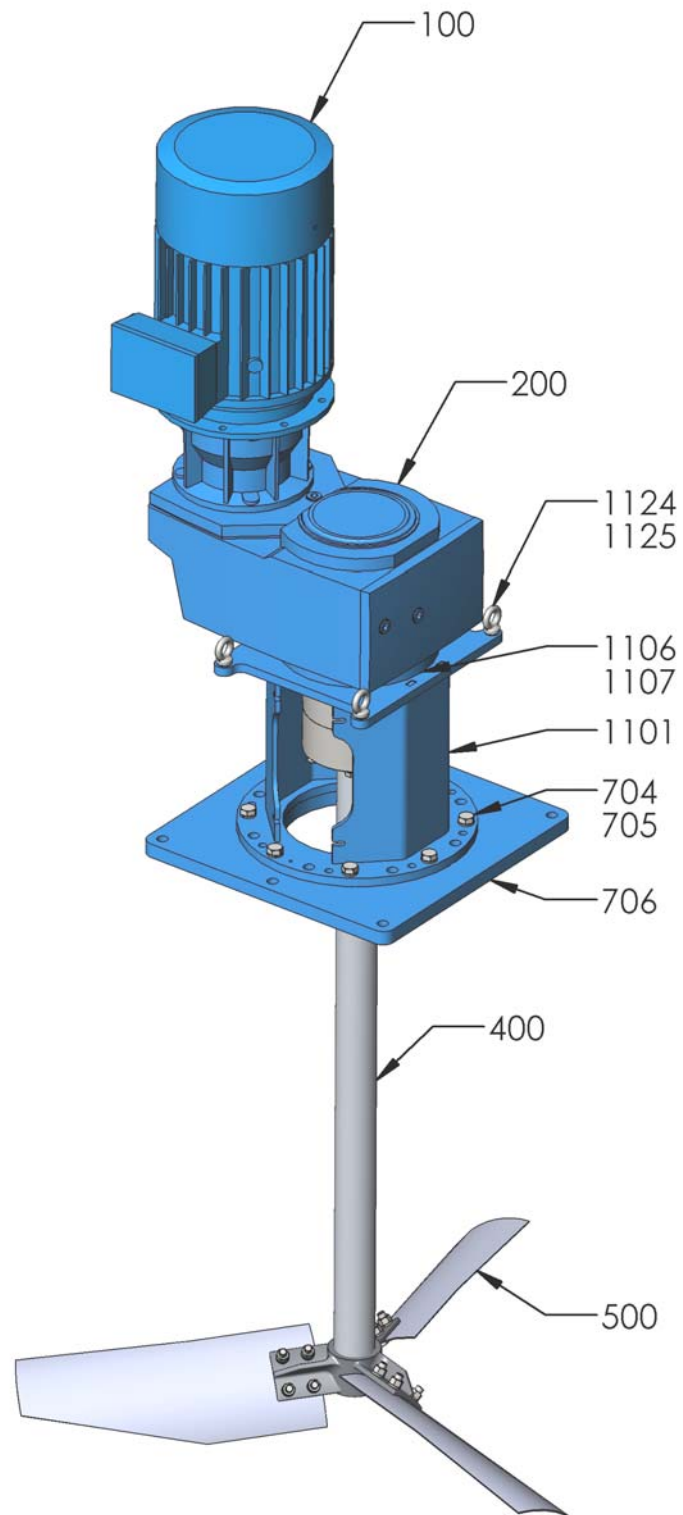


Figure 6. MRP Agitator Assembly

H. SEAL INSTALLATION - AUXILIARY STUFFING BOX

Applicable to: MRD with auxiliary stuffing box seal

Examine Figure 7, Figure 8, and Figure 9 to determine which type of stuffing box was supplied with your unit.

H.1 INTEGRAL-TO-FLANGE STUFFING BOX DESIGN

1. Remove gland plate [1355], split gland [1356], packing [1357] and lantern ring [1358].
2. Assemble the auxiliary stuffing box flange to the vessel with the proper gasket and bolts (supplied by others). *Do not torque the bolts at this time*, finger tighten only.
3. Place packing [1357], lantern ring [1358] and gland plate [1355] over the extension shaft and lower the extension shaft into the vessel through the auxiliary stuffing box flange.
4. If the extension shaft coupling half is not installed, the shaft may be lifted up through the auxiliary stuffing box from inside the vessel. Block the shaft from inside the vessel such that the extension shaft extends above the agitator drive mounting surface. Install packing, lantern ring and gland plate over the extension shaft.
5. Install the extension shaft coupling half if required. Follow instructions in Section J, page 28 in order to install the gearbox and taper bore coupling.
6. Install the auxiliary stuffing box flange bolts finger tight. If the bolt holes in the stuffing box flange and the vessel flange are not properly aligned, the agitator drive will have to be moved laterally or shimmed. If shimming is required, use full width shims under the gear drive mounting surface to provide a solid joint for bolting the agitator drive to the support structure.
7. Tape gland plate [1355] to the extension shaft coupling half. Attach an indicator to the extension shaft and set the point of the indicator on the top face of the stuffing box housing. Manually turn the flexible motor coupling to rotate extension shaft one turn. Shim the agitator drive until the indicator reading is within .005" (.127mm) FIM (Full Indicator Movement) maximum. Torque agitator mounting bolts to value shown in APPENDIX, Page 98
8. In extreme cases, a tapered adapter will be required (supplied by others) to correct the angular misalignment. Call Chemineer Field Service for assistance.
9. Attach an indicator to the extension shaft and set the point of the indicator on the inside diameter of the stuffing box housing. Align the stuffing box housing to within .005" (0.127 mm) FIM of the shaft centerline and then tighten the stuffing box flange bolts (supplied by others). Torque to the value shown in APPENDIX, Page 98.

10. Install packing, lantern ring, split gland, and gland plate [1357, 1358, 1356, 1355]. Install gland nuts and Lock Washers [1353, 1354]. Finger tighten hex adjusting nuts [1352].
11. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten. After starting the unit, the packing will require adjusting. Refer to SHAFT SEALS - OPERATION.
12. Continue with the agitator installation.

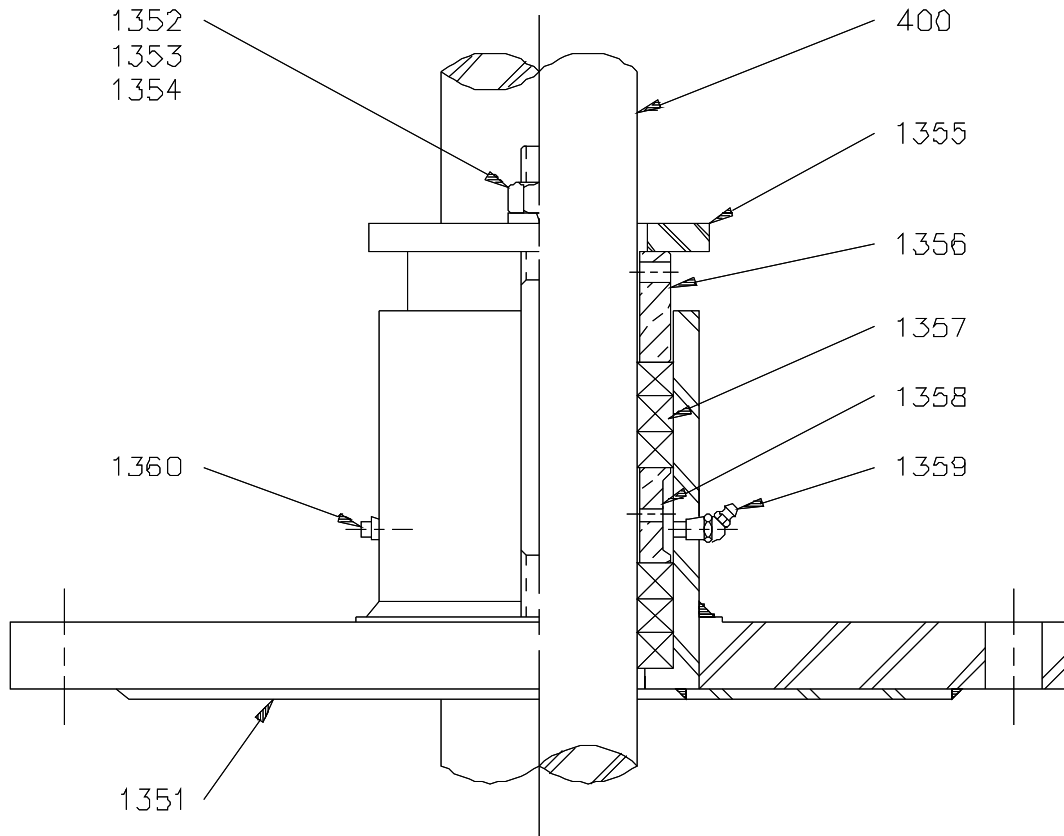


Figure 7. Auxiliary Stuffing Box

H.2 BOLT-IN STUFFING BOX DESIGN (CAST HOUSING)

1. Assemble the flange **[1251]** to the vessel with the proper gasket and bolts (supplied by others).
2. If a removable coupling is supplied with the unit, lift the agitator extension shaft and lower it into the vessel. Lift the shaft up through the mounting flange from inside the vessel and block it in place such that the shaft extends above the gearbox mounting surface. If a welded or shrink fit coupling is already assembled onto the shaft, the shaft will need to be lowered down into the flange and blocked in place in this manner.
3. Place o-ring **[1252]** into the groove in the mounting flange **[1251]**.
4. Install the packing housing **[1314]** and packing rings **[1313]**. Stagger each packing split by 90° during installation. Seat each packing ring one at a time as it is installed.
5. Install the two threaded studs **[1305]** at 180° from each other.
6. Install nuts, Lock Washer and flat washer **[1306, 1307, 1308]** onto studs. *Do not tighten at this time.*
7. Install two bolts, Lock Washers and flat washers **[1309, 1310, 1311]**. *Do not tighten at this time.*
8. Install the extension shaft removable coupling (if applicable). Follow instructions in Section J, page 28, in order to install the gearbox and taper bore coupling.
9. Attach an indicator to the extension shaft and set the point of the indicator on the inside diameter of the stuffing box housing. Align the stuffing box housing to within .005" (0.127 mm) FIM of the shaft centerline and then tighten bolts **[1309]** and nuts **[1306]**. Torque to the value shown in APPENDIX, Page 98.
10. Install split packing gland **[1312]** over threaded studs **[1305]** with gland clamps, flat washers, Lock Washers, and hex adjusting nuts **[1304, 1303, 1302, 1301]**. The split packing gland must be square with the packing housing **[1314]**. Finger tighten the hex adjusting nuts **[1301]**.
11. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten. After starting the unit, the packing will require adjusting. Refer to SHAFT SEALS - OPERATION.
12. Continue with the agitator installation.

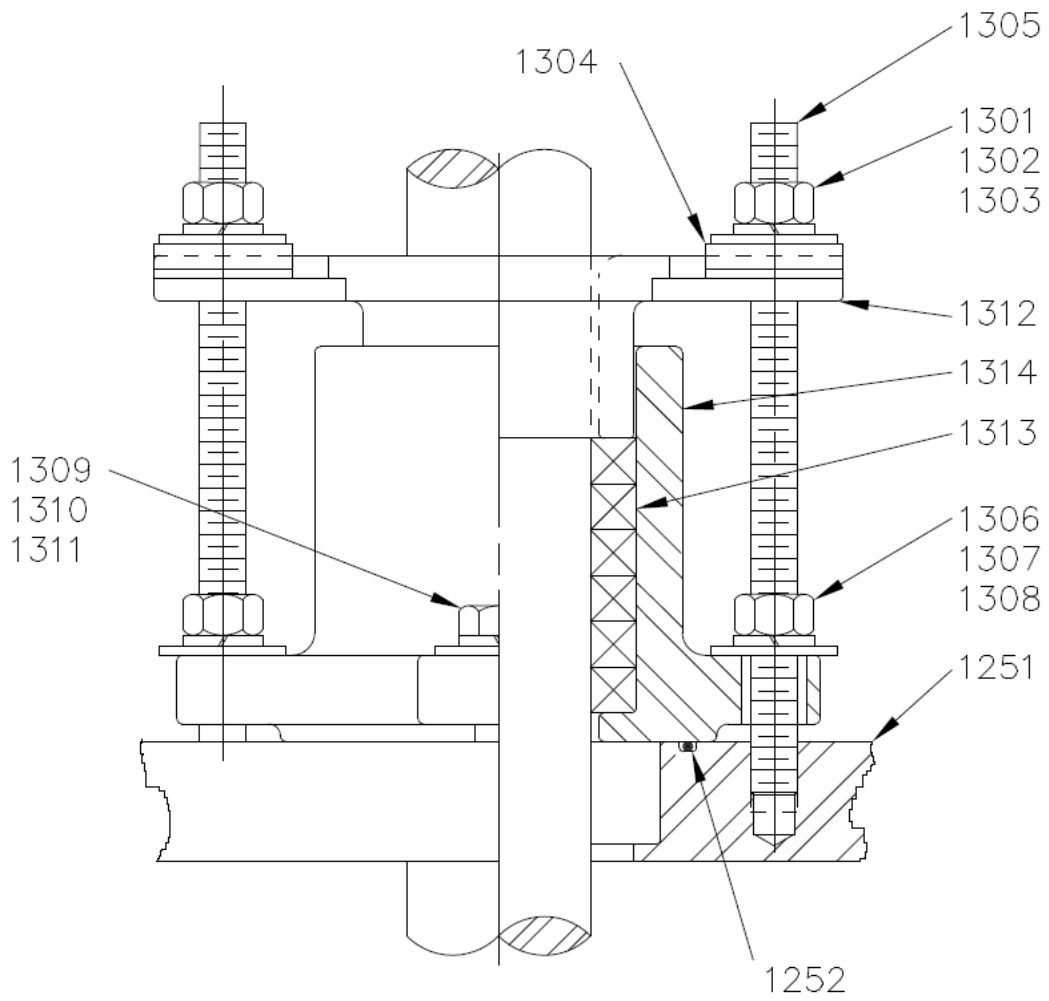


Figure 8. Auxiliary Stuffing Box (cast housing)

H.3 BOLT-IN STUFFING BOX DESIGN (FABRICATED HOUSING)

1. Assemble the flange **[1251]** to the vessel with the proper gasket and bolts (supplied by others).
2. If a removable coupling is supplied with the unit, lift the agitator extension shaft and lower it into the vessel. Lift the shaft up through the mounting flange from inside the vessel and block it in place such that the shaft extends above the gearbox mounting surface. If a welded or shrink fit coupling is already assembled onto the shaft, the shaft will need to be lowered down into the flange and blocked in place in this manner.
3. Place o-ring **[1252]** into the groove in the mounting flange **[1251]**.
4. Install the packing housing **[1314]**, clamping gland **[1315]** and packing rings **[1313]**. Do not bolt down the clamping ring at this time. Stagger each packing split by 90° during installation. Seat each packing ring one at a time as it is installed.
5. Install the two threaded studs **[1305]** at 180° from each other.
6. Install gland plate, nuts and flat washer **[1355, 1306, 1308]** onto studs. *Do not tighten at this time.*
7. Install four flat washers and bolts **[1311, 1316]**. *Do not tighten at this time.*
8. Install the extension shaft removable coupling (if applicable). Follow instructions in Section J, page 28, in order to install the gearbox and taper bore coupling.
9. Tape gland plate **[1355]** to the extension shaft coupling half. Attach an indicator to the extension shaft and set the point of the indicator on the inside diameter of the stuffing box housing. Align the stuffing box housing to within .005" (0.127 mm) FIM of the shaft centerline and then tighten bolts **[1316]** and nuts **[1306]**. Torque to the value shown in APPENDIX, Page 98.
10. Install split gland **[1356]**. The split packing gland must be square with the packing housing **[1314]**. Finger tighten the hex adjusting nuts **[1301]**.
11. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten. After starting the unit, the packing will require adjusting. Refer to SHAFT SEALS - OPERATION.
12. Continue with the agitator installation.

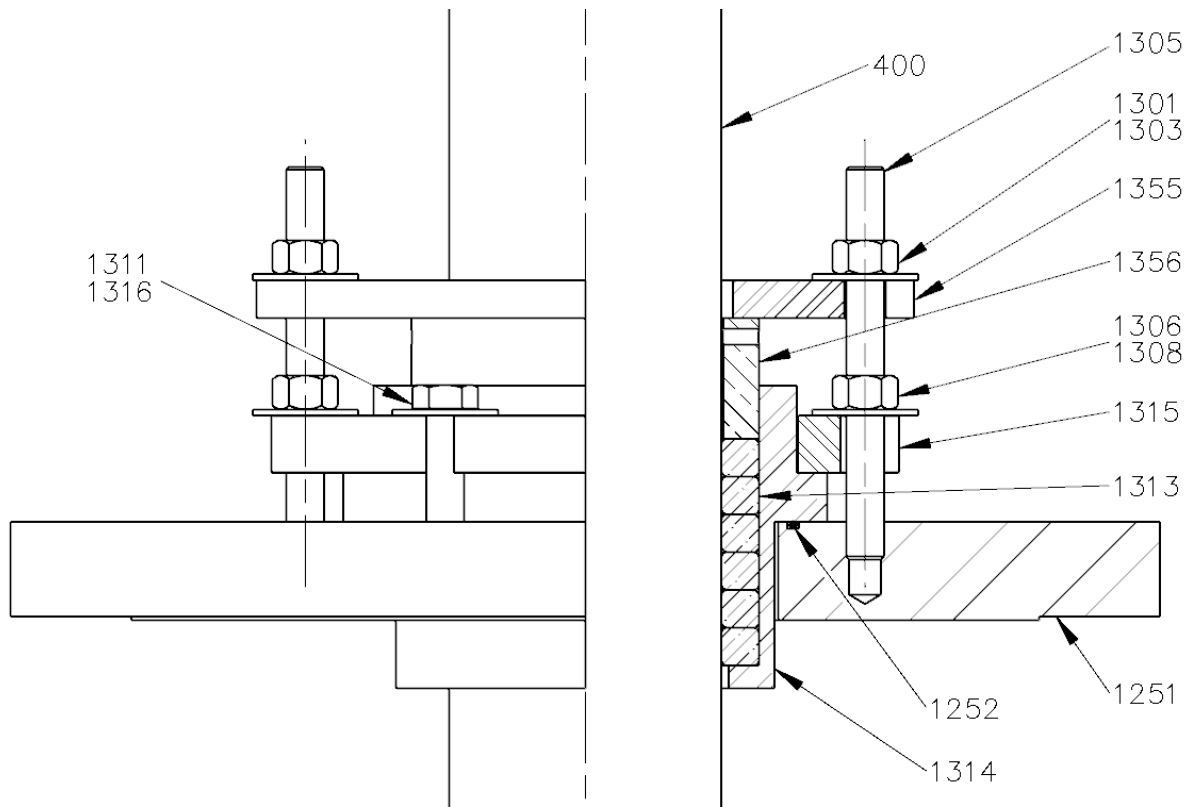


Figure 9. Auxiliary Stuffing Box (fabricated housing)

I. SEAL INSTALLATION - AUXILIARY LIP SEAL

Applicable to: MRD with auxiliary lip seal

1. Remove snap ring [1852] and lip seal [1853] from flange [1851].
2. Assemble the auxiliary lip seal flange to the vessel with the proper gasket and bolts (supplied by others). *Do not torque the bolts at this time, finger tighten only.*
3. Lower extension shaft [400] into the vessel through the auxiliary lip seal flange. If the extension shaft coupling half is not installed, the shaft may be lifted up through the auxiliary lip seal from inside the vessel. Block the shaft from inside the vessel such that the extension shaft extends above the agitator drive mounting surface.

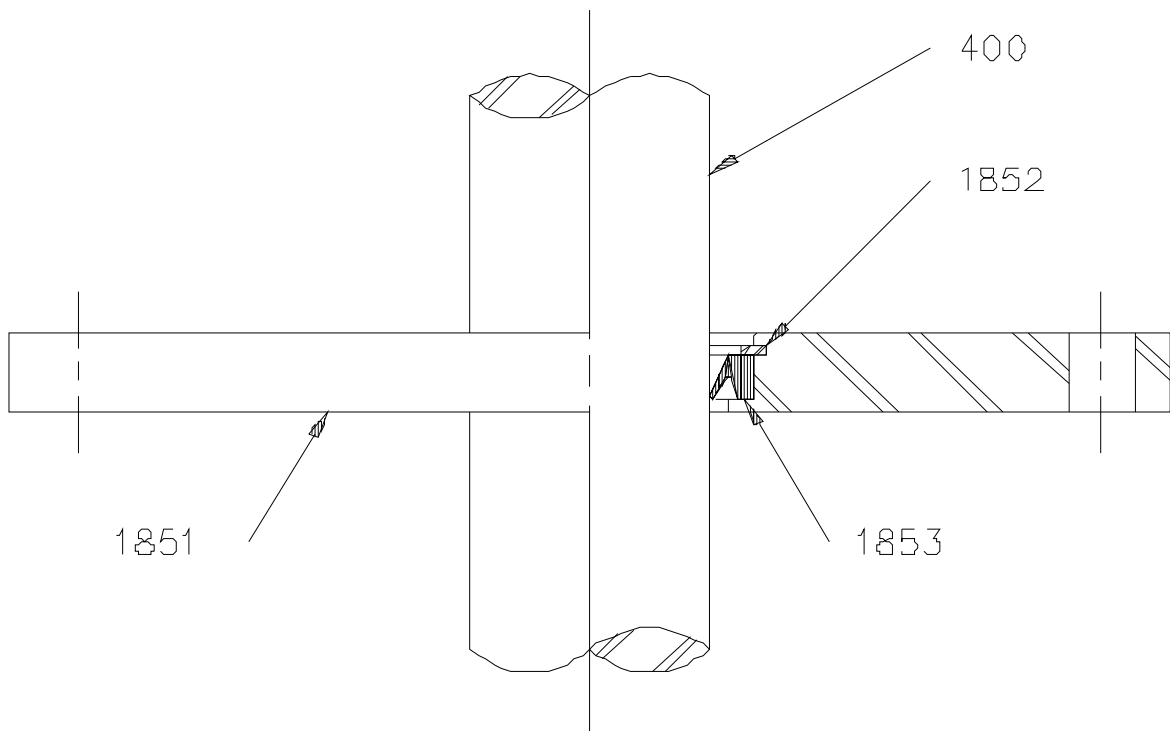




Figure 10. Auxiliary Lip Seal

4. Place the lip seal and the snap ring over the extension shaft. Assemble lip seal and snap ring to the flange.
5. Install the extension shaft coupling half if required. Follow instructions in Section J, page 28 in order to install the gearbox and taper bore coupling.
6. Lift the agitator drive (Figure 1, page 32).

7. Suspend the agitator drive assembly over the extension shaft coupling half, close enough to allow installation of coupling bolts and Lock Washers [359, 360]. The coupling faces and tenons must be clean and free of nicks or burrs. Install two bolts and Lock Washers at 180°. Tighten the bolts to engage the tenon and pull the coupling faces together.
8. Lift the agitator drive assembly and the extension shaft. Remove the shaft blocking. Install the remaining coupling bolts and Lock Washers. Torque to the value shown in APPENDIX, Page 98.
9. Lower the agitator drive assembly onto the support structure. Install the mounting bolts (supplied by others). *Do not tighten the bolts at this time.*
10. Install the auxiliary lip seal flange bolts finger tight. If the bolt holes in the lip seal flange and the vessel flange are not properly aligned, the agitator drive will have to be moved laterally or shimmed. If shimming is required, use full width shims under the mounting feet to provide a solid joint for bolting the agitator drive to the support structure. Torque the agitator drive mounting bolts to the value shown in APPENDIX, Page 98. Then torque the auxiliary lip seal flange bolts to the value shown in APPENDIX, Page 98.
11. Auxiliary lip seals do not require any adjustment or lubrication. Both Buna-N and Teflon lip seals as supplied are not split.
12. Continue with the agitator installation.

J. TAPER BORE COUPLING AND GEAR DRIVE INSTALLATION

	Danger!
	To prevent injury, the danger area must be generously cordoned off . Standing under the gear unit during transport is extremely dangerous .

	Attention!
	<p>Avoid damage to the gear unit. Impacts to the free ends of the shafts may cause internal damage to the gear unit.</p> <p>Use adequately dimensioned and suitable means of transportation. Lifting tackle must be designed for the weight of the gear unit. The weight of the gear unit can be obtained from the dispatch documents or the assembly drawings supplied with your unit.</p>

J.1 PREPARING THE GEARBOX FOR INSTALLATION

The drive unit must be inspected and may only be installed if no transportation damage or leaks are visible. In particular the radial seals and the sealing caps must be inspected for damage. Thoroughly remove rust inhibitor from the drive shafts and flange surfaces before assembly. In applications where an incorrect rotational direction may result in damage or potential risk, the correct rotational direction of the drive shaft is to be established by test running the drive when uncoupled and guaranteeing such for subsequent operation.

Ensure that no aggressive or corrosive substances are present in the area surrounding the installation site or are subsequently expected during operation, which attack metal, lubricants or elastomers.

If a vent plug is fitted, the sealing cord must be removed from the vent plug before commissioning.

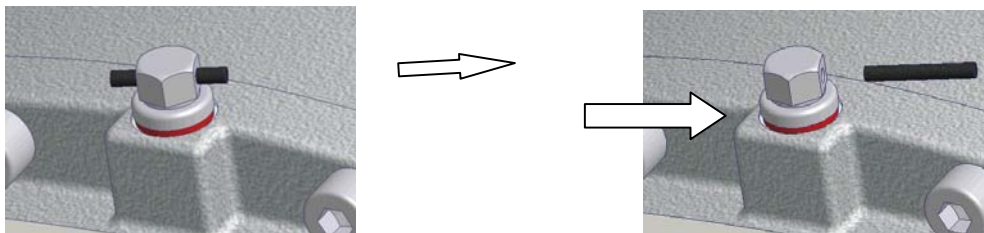


Figure 11. Vent Plug Activation

J.2 GEARBOX OIL FITTINGS/OPTIONS

Note: See section “P” in this manual for lubrication specifications

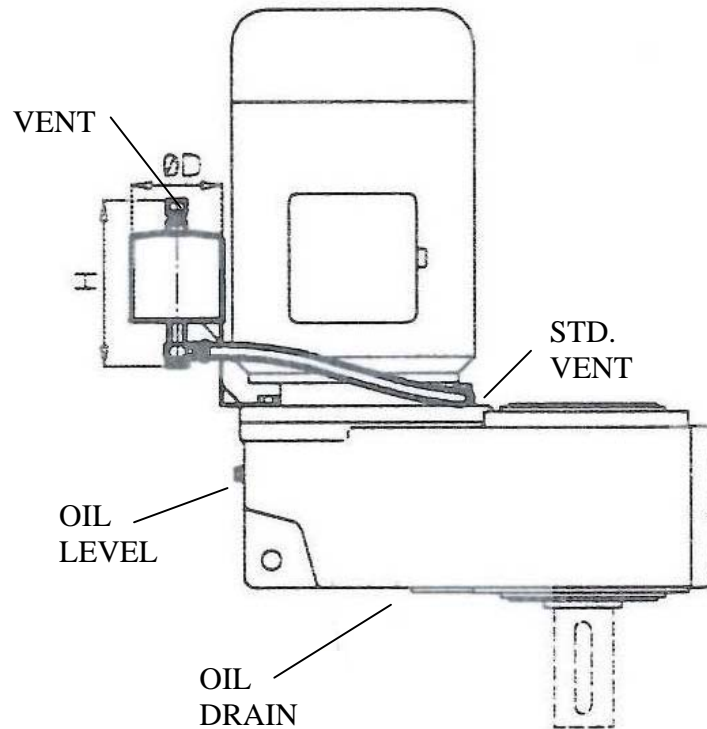



Figure 12. 17 MR Oil Expansion Chamber

Supplied with gearbox when reduction ratio is less than 20:1
 H = 11.81 inch, D = 7.09 inch

The gearbox must be filled almost completely with oil in order to properly supply oil to the first stage gearing. The above operating conditions can result in increased oil churning or splashing losses and heating of the air space above the oil. The oil expansion chamber provides a safe overflow area for the expanded oil/air mixture and eliminates excessive pressure build-up and foaming. As heat is released from the expanded air/oil mixture, gravity allows any residual oil to be returned to the gearbox.

Note: The standard vent is moved from the top of the gearbox to the expansion chamber.

	Attention!
	Expansion Chamber parts shipped loose with gearbox and gearbox shipped full of oil . Be careful when mounting and plumbing up the expansion chamber. Once mounted, check the oil level as noted above. Oil fill type marked on side of gearbox.

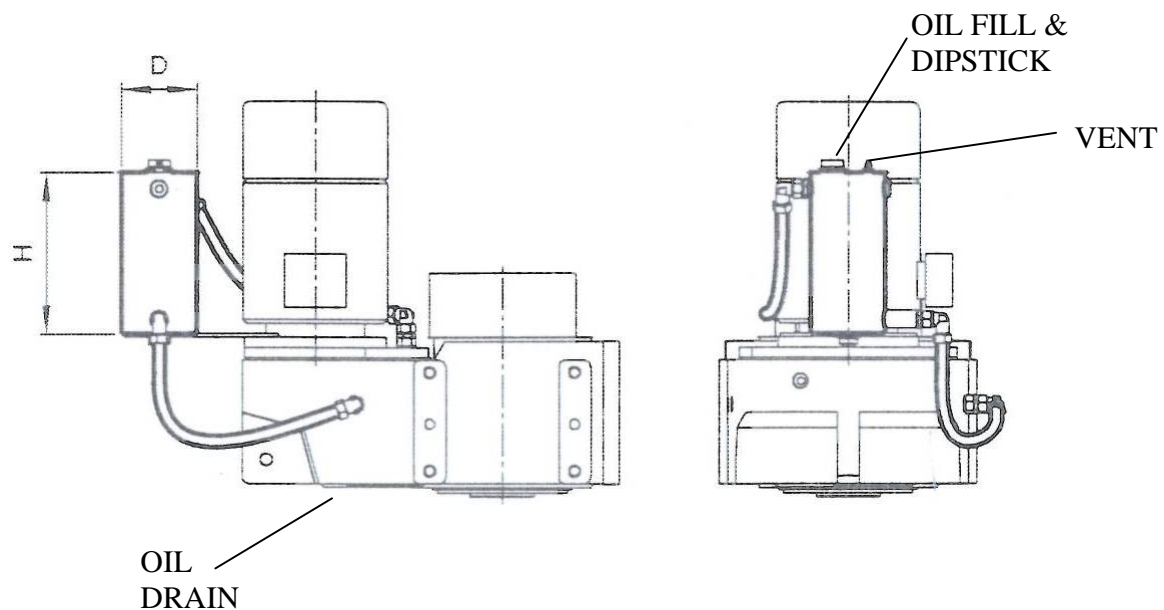



Figure 13. 18 MR Oil Reservoir Tank


Supplied as standard with the 18 MR gearbox
 $H = 15.75$ inch, $D = 7.87$ inch

This larger tank ensures the gearbox is completely filled with oil to prevent excessive foaming and heat build-up. A small amount of oil is present in the reservoir tank to make sure the high-speed gear set and input bearings are properly lubricated with oil. The oil reservoir is vented and promotes passive oil circulation.


	Attention!
	<p>Oil reservoir tank parts shipped loose with gearbox and gearbox shipped full of oil. Be careful when mounting and plumbing up the oil reservoir tank. When mounted, fill oil tank up to “MAX” level on dipstick with approved oil. There will be expansion volume in the tank above the oil level. Make sure to use an oil that is compatible with the oil in the gearbox. Oil fill type marked on side of gearbox.</p>

J.3 SHAFT TAPER COUPLING INSTALLATION

1. Clean the extension shaft [400] and coupling half [351] bore and make sure that both surfaces are free from burrs or nicks. Place key [352] in the coupling keyway to make sure it slides freely. Install the key in the shaft keyway making sure it is properly oriented and fully bottomed in the keyway.

	Attention!
	Do not apply lubricant or anti-seize compound to coupling taper. Shaft and coupling tapers must be clean, dry and free of nicks.

2. Slide the coupling half onto the tapered shaft end until both seat firmly against each other. Make sure that the coupling half is not hung up on the key or cocked at an angle to the shaft.

	Attention!
	Avoid surface damage and bending of the shaft. Protect the tenon and the face of the coupling. These surfaces must be perfectly clean and free of nicks.

3. Install shaft bolts:

2 Bolt Design: Install coupling washer [354]. Install bolts [357] and Lock Washers [358]. Torque bolts to the value shown in the APPENDIX, Page 98.

1 Bolt Design: Install coupling washer [353]. Install bolt [355] and Lock Washer [356]. Torque bolts to the value shown in the APPENDIX, Page 98.

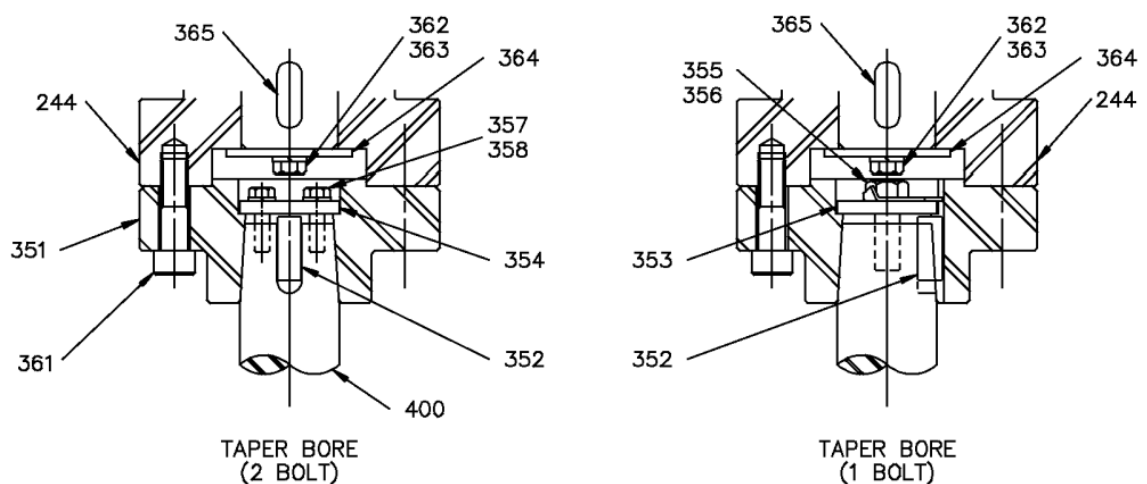



Figure 14. Shaft Coupling Installation

J.4 GEARBOX INSTALLATION

	Danger!
	<p><i>To ensure that the gearbox does not get too warm and to avoid injury to persons, observe the following during installation:</i></p> <ol style="list-style-type: none"> 1. The surfaces of gear units or geared motors may become hot during or shortly after operation. Attention: danger of burns!! Protection against accidental contact may need to be installed. 2. With geared motors, the cooling air of the motor fan must be able to flow unobstructed onto the gear unit. 3. Welding of the gear unit is prohibited. The gear unit must not be used as the earth connection for welding work, as this may cause damage to the bearings and gear wheels. 4. The gear unit must be precisely aligned with the drive shaft of the machine in order to prevent additional forces from being imposed on the gear unit due to tension.

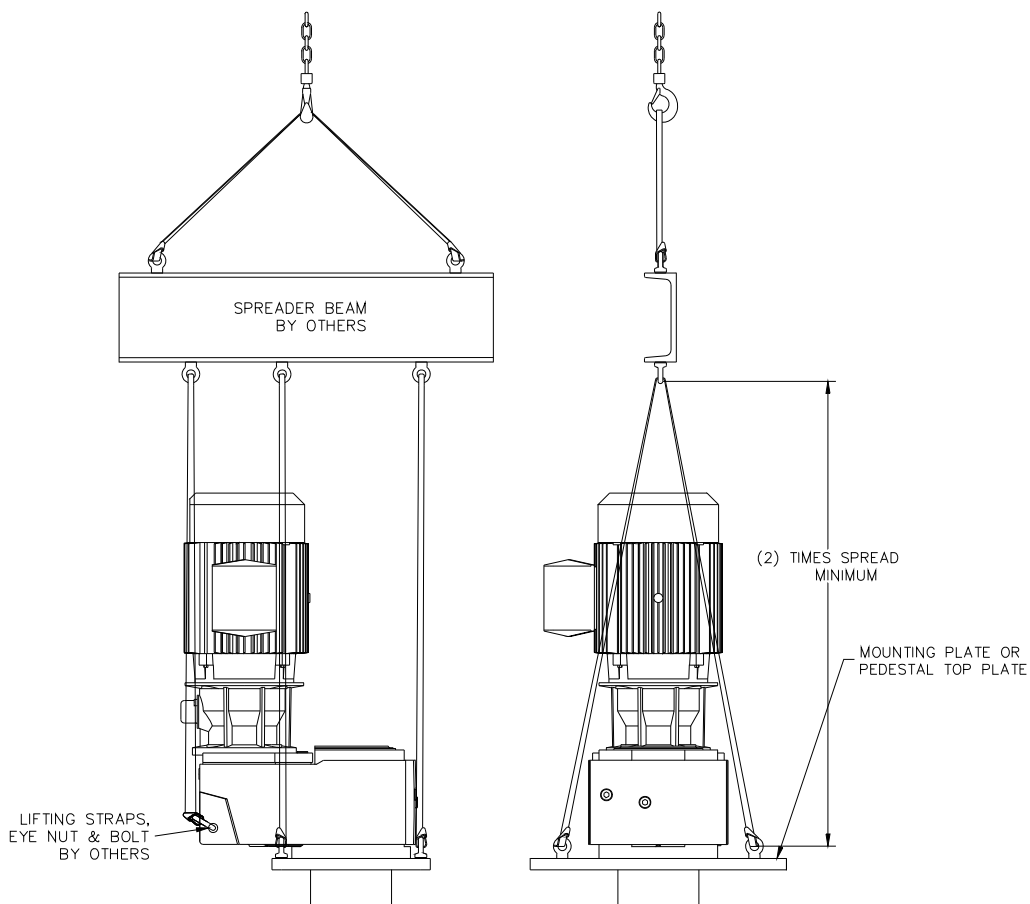



Figure 15. Agitator Lifting System

1. Lift and suspend the agitator drive assembly over the extension shaft coupling half close enough to allow installation of coupling bolts [361]. Install two bolts at 180°. Tighten the bolts to engage the tenon and pull the coupling faces together.
2. Lift the agitator drive assembly and the extension shaft enough to remove shaft blocking. Remove blocking and install the remaining coupling bolts. Torque bolts to the value shown in the APPENDIX, Page 98.
3. **For MRD units only:** Lower the agitator drive assembly onto the support structure. The agitator drive assembly must be **level within** ½° (0.10 inches per foot; 8.8 mm per meter). Steady bearing units or units with close internal clearances are required to be **level within** ¼° (0.05 inches per foot; 4.4 mm per meter). If shimming is required, use full width shims under the agitator drive housing to provide a solid joint for bolting the agitator drive assembly to the support structure. Install the agitator drive mounting bolts (supplied by others) and torque to the value shown in the APPENDIX, Page 98.
Ignore further steps in this section and skip to SHAFT RUNOUT page 36.
4. **For MRP units only:** Lower the gearbox/pedestal assembly onto the mounting plate. Mount with bolts and lock washers [704, 705]. Torque bolts to the value shown in the Appendix, Page 98. Refer to the agitator assembly drawings. Continue to install the hand hole covers per Section M, page 37.

	Attention!
	For retrospective painting of the gear unit, the radial seals, rubber elements, pressure venting valves, hoses, type plates, adhesive labels and motor coupling components must not come into contact with paints, lacquers or solvents, as otherwise components may be damaged or made illegible.

K. MOTOR INSTALLATION

K.1 MOTOR WEIGHTS

The maximum permitted motor weights indicated in the table below must not be exceeded when attaching the motor to an IEC / NEMA adapter

Table 3. Maximum Allowable Motor Weights

<i>Maximum permitted motor weights [kg]</i>														
<i>IEC motor size</i>	63	71	80	90	100	112	132	160	180	200	225	250	280	315
<i>NEMA Motor size</i>		56C	143T	145T	182T	184T	210T	250T	280T	324T	326T	365T		
<i>Max. motor weight</i>	25	30	40	50	60	80	100	200	250	350	500	700	1000	1500

K.2 MOTOR INSTALLATION

Assembly procedure to attach a standard motor to the IEC adapter (Option IEC)/NEMA adapter

1. Clean motor shaft and flange surfaces of motor and IEC /NEMA adapter and check for damage. Mounting dimensions and tolerances of the motor must conform to DIN EN 50347/NEMA MG1 Part 4.
2. Push the coupling sleeve onto the motor shaft so that the motor parallel key engages into the groove in the sleeve on tightening.
3. Tighten the coupling sleeve on the motor shaft in accordance with the motor manufacturer's instructions until it touches the collar. With IEC motor sizes 160, 180 and 225, any spacer bushes must be positioned between the coupling sleeve and the collar. Certain **NEMA adapters** require the adjustment of the coupling in accordance with the specifications indicated on the adhesive plate.
4. Secure the coupling half with the threaded pin. The threaded pin must be coated prior to use with a securing lubricant e.g. Loctite 242, Loxeal 54-03 and tightened to the correct torque. (See Appendix, Page 98 for torque values)
5. Sealing of the flange surfaces of the motor and the IEC /NEMA adapter is recommended if the motor is installed outdoors or in a humid environment. **The flange surfaces** of motor and adapter must be completely coated with **surface sealant** Loctite 574 or Loxeal 58-14 prior to mounting so that the flange seals after mounting.
6. Mount the motor to the IEC /NEMA adapter, do not forget to fit the gear rim or the sleeve. (See Figure 1) Tighten the IEC /NEMA adapter bolts to the correct torque. (See Appendix, Page 98 for torque values)

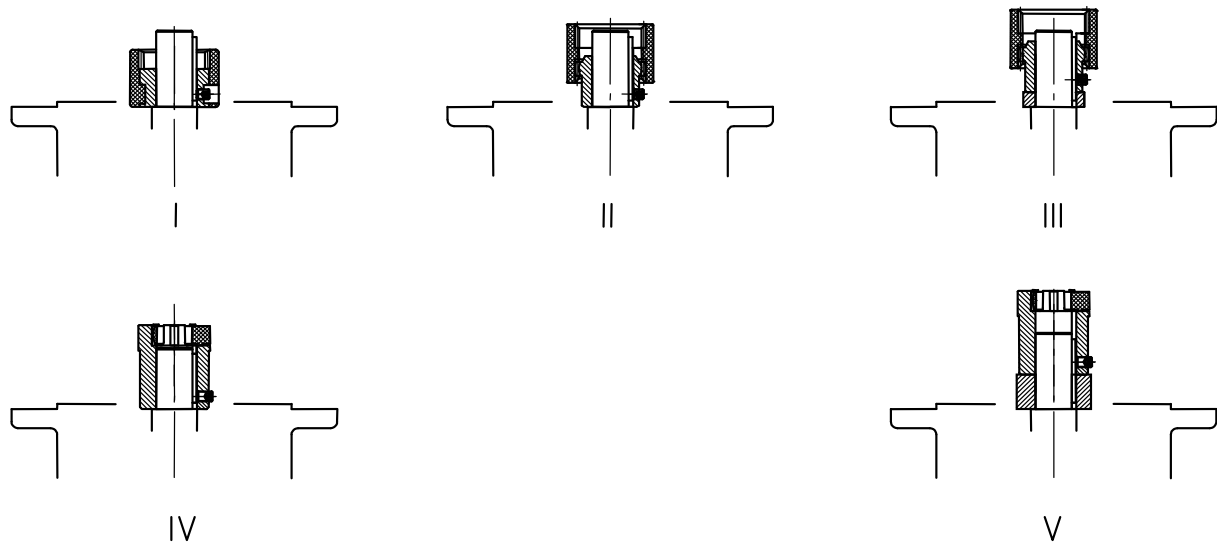



Figure 16. Fitting the Coupling

- I Gear coupling (BoWex[®]), one-part
- II Gear coupling (BoWex[®]), two-part
- III Gear coupling (BoWex[®]), two-part with spacer bush
- IV Claw coupling (ROTEX[®]), two-part
- V Claw coupling (ROTEX[®]), two-part with spacer bush

L. SHAFT RUNOUT

	<p>Note!</p> <p>The runout values provided in this section do not apply to the runout measurements for shafts with steady bearings, but the method to straighten a shaft is the same regardless of whether there is a steady bearing or not.. Refer to the steady bearing section for maximum allowable runout value for shafts with steady bearings.</p>
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1. Check the installed extension shaft runout. Place a dial indicator on the side of the extension shaft at the bottom. Manually turn the flexible motor coupling to rotate the extension shaft one turn.
2. Total shaft runout should not exceed .005" per foot (0.42 mm per meter) FIM (Full Indicator Movement) of shaft length. If the shaft runout is excessive, the shaft can be re-straightened in the field. Rotate the shaft to the maximum positive indicator reading. Apply heat to the shaft at a point 180° from the indicator and just below the first in-tank shaft coupling or just below the mounting surface if there is no in-tank coupling. As heat is applied to the shaft (do not allow surface temperature of shaft to exceed 500°F [260°C]), the shaft will move toward the indicator. After the shaft has moved .030-.060" (0.76-1.52 mm), remove the heat and the shaft will begin to move away from the indicator. The shaft will draw more than it moved initially, and as a result will be straightened. After each heating cycle, recheck the shaft until runout is within tolerance. Do not heat in the same location. Move up or down 2 or 3" (50-70 mm) to avoid reheating the same location.

M. HAND HOLE COVER INSTALLATION

For case sizes 17 and 18: Install well nuts [1111] into the open slots on each side of the pedestal [1101]. Install hand hole covers [1105] on each side of pedestal. Attach flat washer [1110] and bolt [1109] through hand hole cover [1105] and into well nut [1111] and tighten.

Do not over tighten the bolts.

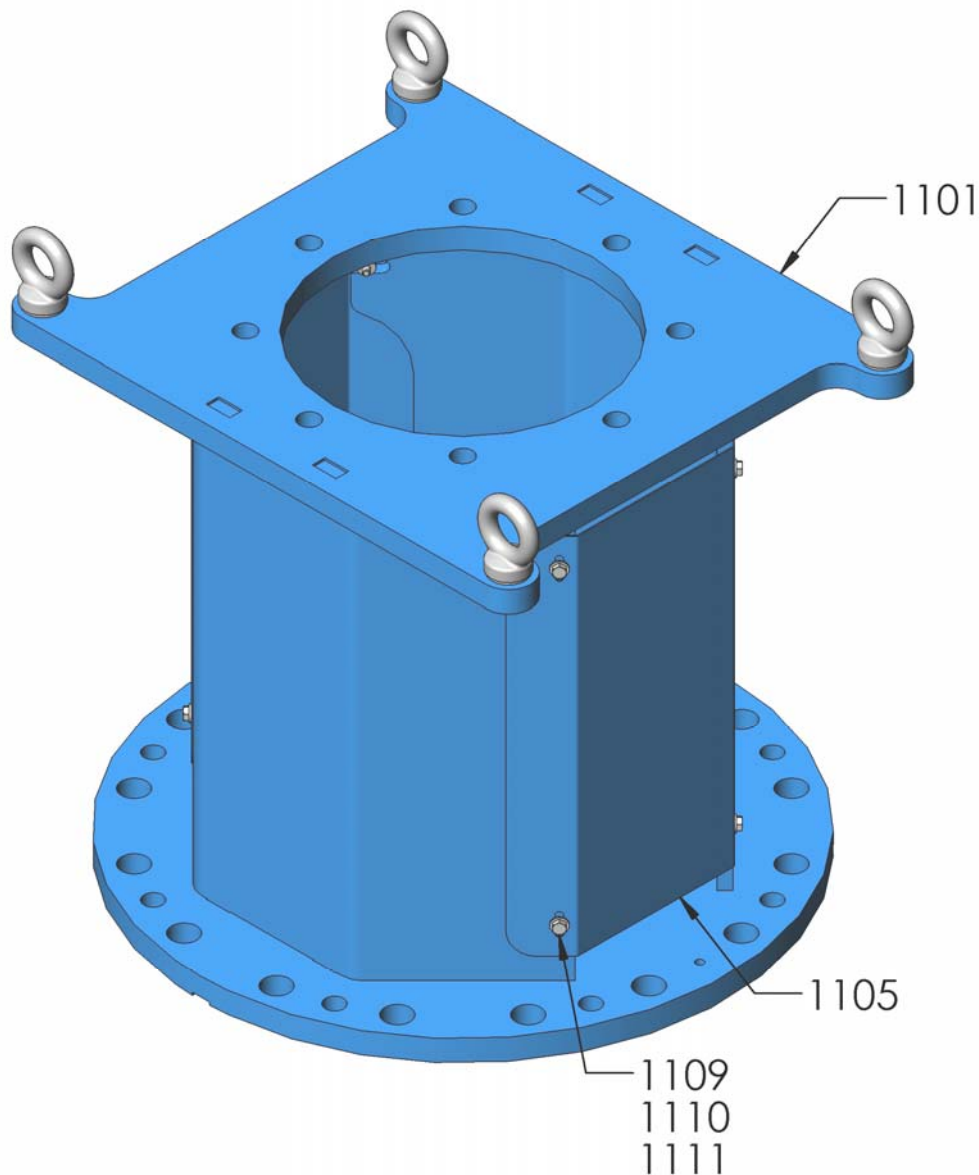



Figure 15. Hand hole Cover Installation 17 and 18 MR

N. IMPELLERS

	<p>Note!</p> <p>The instructions in this section apply to standard impeller geometry. Due to the custom nature of impeller designs for certain applications, your impeller geometry may vary from the standard configurations shown in this manual. Use discretion and consult the supplied customer specific drawings for installation specifics if your impellers do not match those shown in this manual.</p>
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N.1 MATCH-MARKING

Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. Refer to Figure 17, page 39. With extended shaft keyways, the keyway is drilled at intervals for optional impeller placement.

Impeller assemblies (hub, blades, and stabilizer fins [if required]) may be match-marked. Match-marking is used on impellers that have been balanced or as an aid for locating multiple impellers on the shaft. Most agitators operating at or above 100 RPM have match-marked impellers. Check the impeller parts for match-marks before assembly.

Match-marked components are marked as a function of the agitator serial number and impeller location. Impellers are marked sequentially beginning with the bottom impeller and working up toward the agitator mounting surface. The following example assumes an order with two agitators, each having two 4-blade impellers with the lower impeller stabilized.

N.1.1 Markings for Serial Number XXXXXX-1

The lower impeller hub has stub blades marked 1-1, 1-2, 1-3, 1-4. The corresponding extension blades and stabilizer fins are marked 1-1, 1-2, 1-3, 1-4 with respect to the stub blades.

The upper impeller hub has stub blades marked 1-5, 1-6, 1-7, 1-8. The corresponding extension blades are marked 1-5, 1-6, 1-7, 1-8 with respect to the stub blades.

N.1.2 Markings for Serial Number XXXXXX-2


The lower impeller hub has stub blades marked 2-1, 2-2, 2-3, 2-4. The corresponding extension blades and stabilizer fins are marked 2-1, 2-2, 2-3, 2-4 with respect to the stub blades.

The upper impeller hub has stub blades marked 2-5, 2-6, 2-7, 2-8. The corresponding extension blades are marked 2-5, 2-6, 2-7, 2-8 with respect to the stub blades.

N.2 IMPELLERS – INSTALLATION

(Note: See page 46 for special ragless RL-3 impeller hub installation)

1. Slide hub [504] up agitator shaft [400] past the desired key location.
2. Install pin key [402] in the shaft keyway so that pin extends into the drilled hole in the keyway. Slide the hub back down agitator extension shaft, over the key, until the hub rests on the key step.
3. Tighten setscrew [505] firmly onto the key. Torque to the value shown in Table 11, page 98. The tapped hole for the setscrew is usually a self-locking thread form. Auxiliary fastener locking is generally not necessary.
4. Bolt extension blades [506] to the hub [504] with bolts, nuts and lock washers [507, 509, 508]. Refer to Figure 18 through 24, page 40 through 46. Bolt split blades, if furnished, to extension blades with bolts, nuts and lock washers [529, 531, 530]. Bolt stabilizer fins [510], if furnished, to extension blades with bolts, nuts, and lock washers [511, 513, 512]. Torque bolts to the value shown in Table 11, page 98.

	Attention!
<p>Extreme care should be taken to see that bolts are properly tightened. It is recommended that all in-tank fasteners be checked for tightness after the first two weeks of operation.</p>	

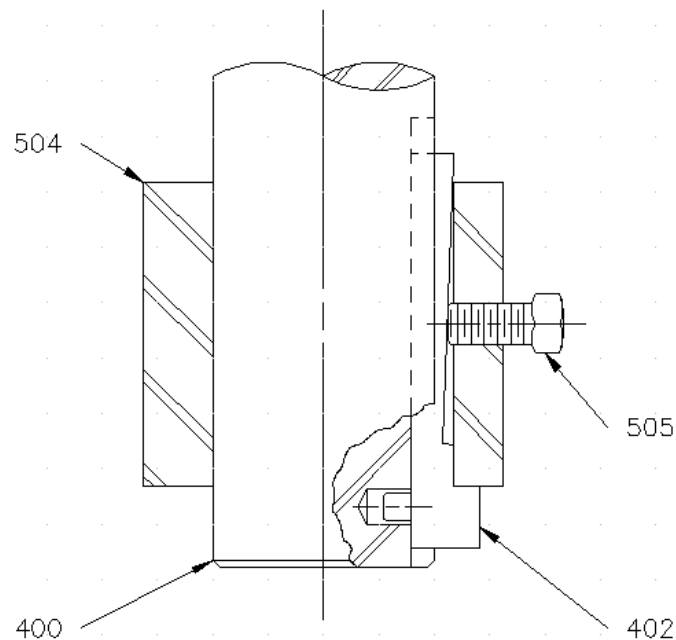


Figure 17. Hub and Pin Key Detail

N.3 IMPELLERS – STYLES

NOTE:
 STABILIZER FINS FURNISHED
 ONLY WHEN NECESSARY

 NUMBER OF BLADE FASTENERS
 MAY VARY WITH APPLICATION

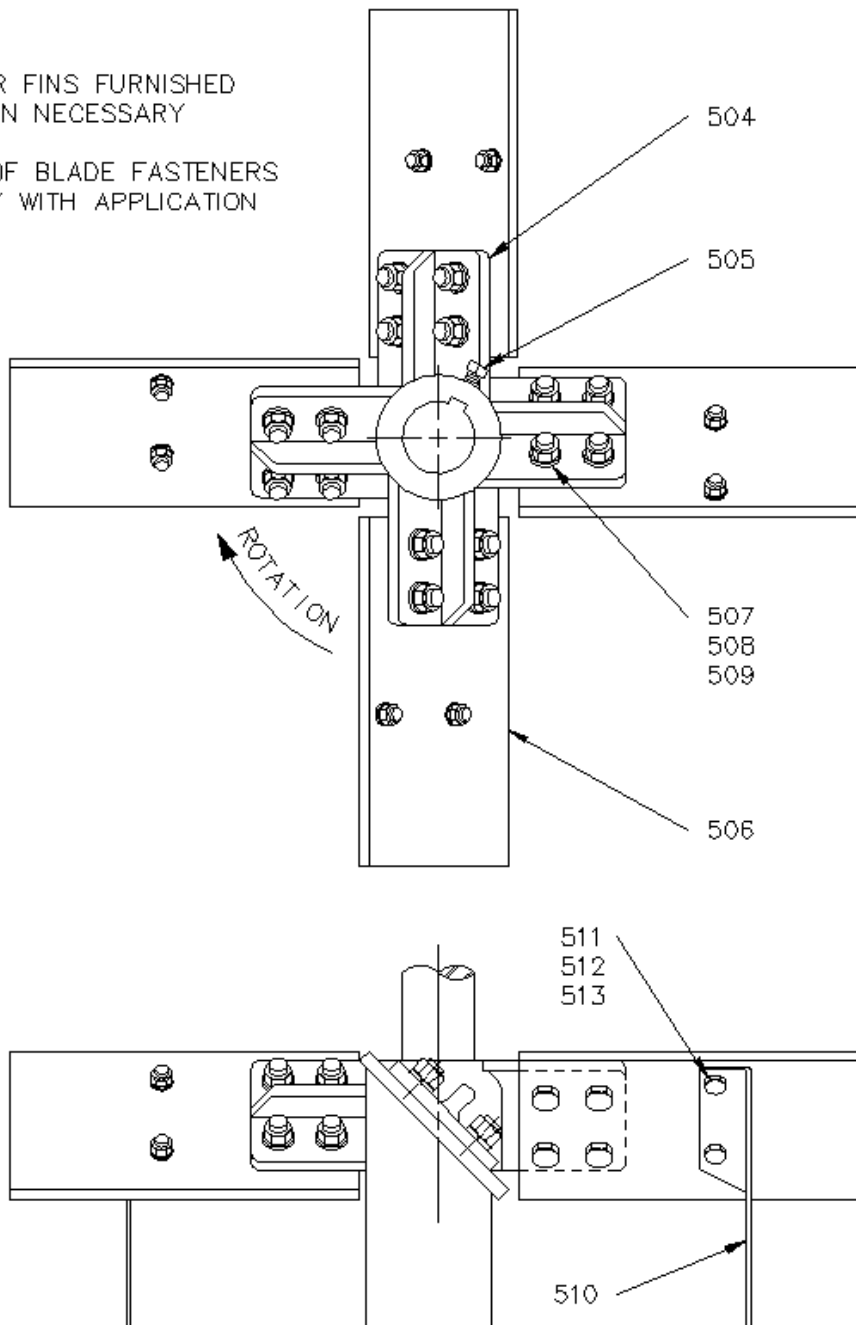
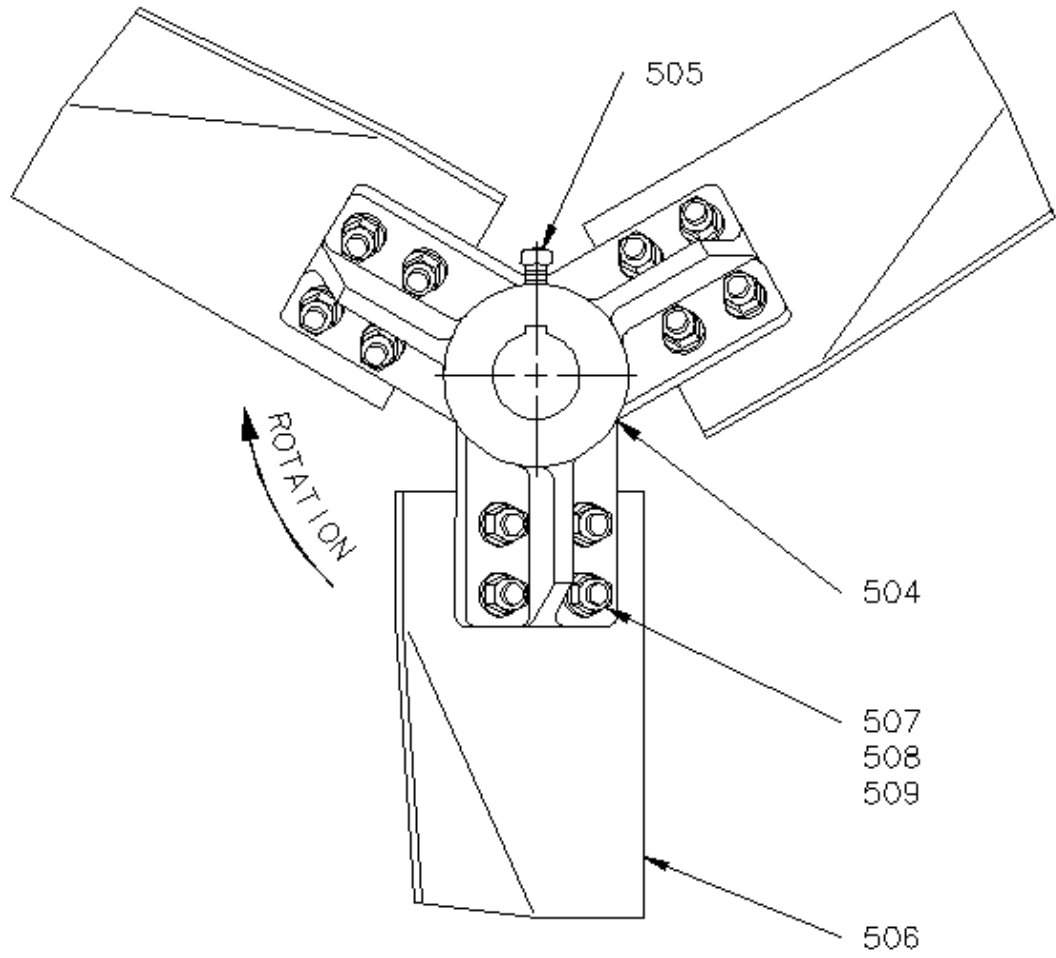


Figure 18. Style P-4 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

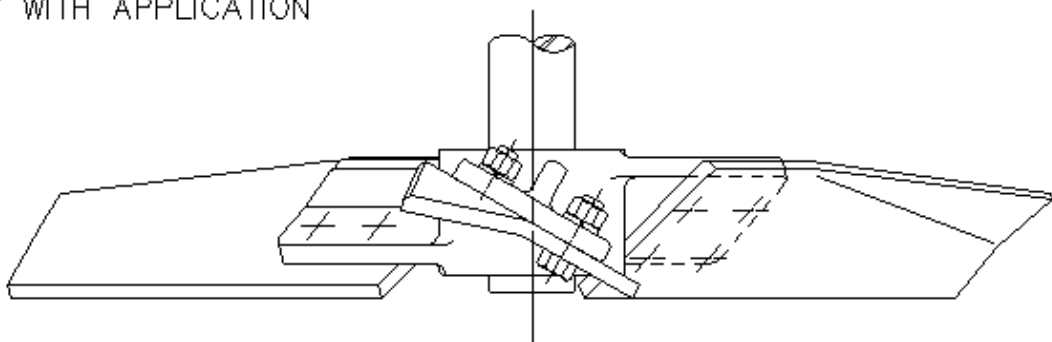
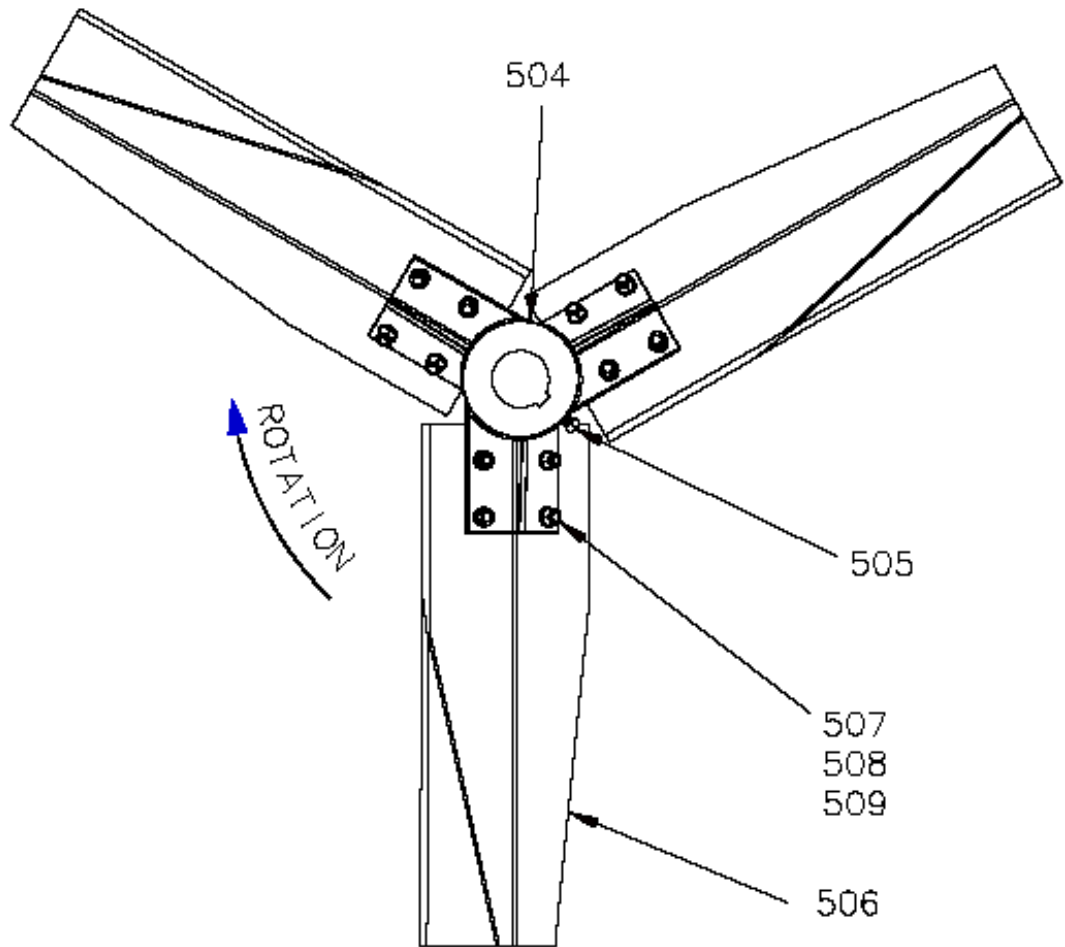


Figure 19. Style HE-3 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

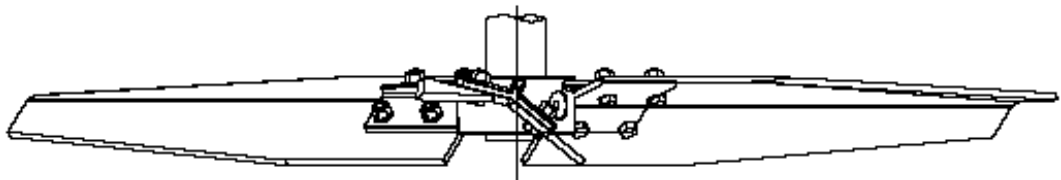


Figure 20. Style XE-3 Impeller

NOTE:
STABILIZER FINS FURNISHED
ONLY WHEN NECESSARY

NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

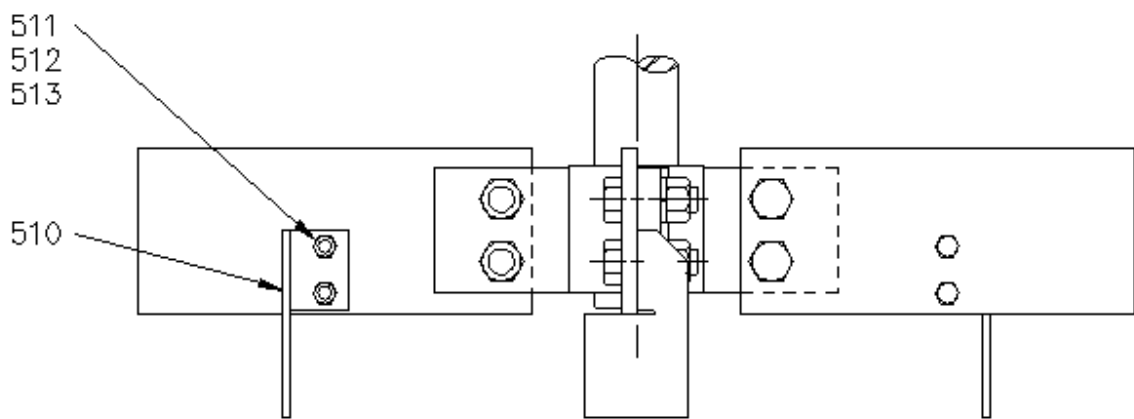
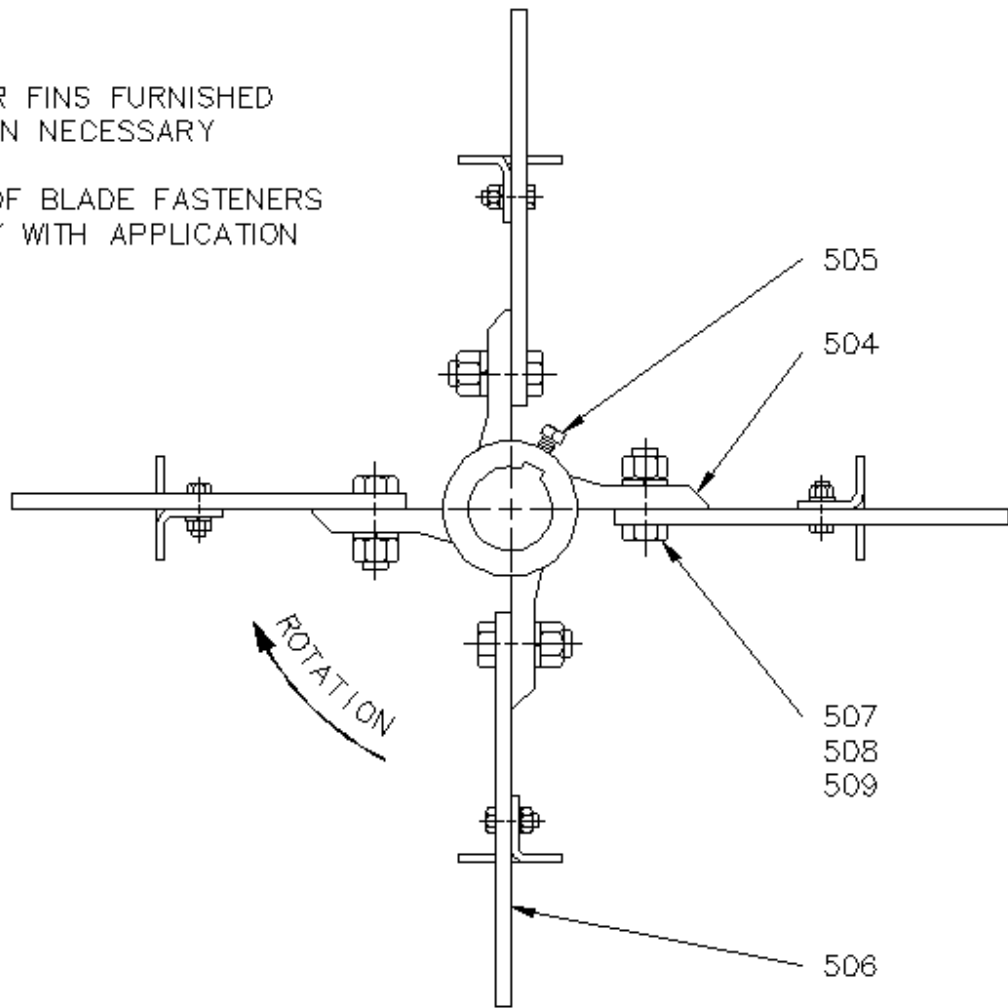


Figure 21. Style S-4 Impeller

NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

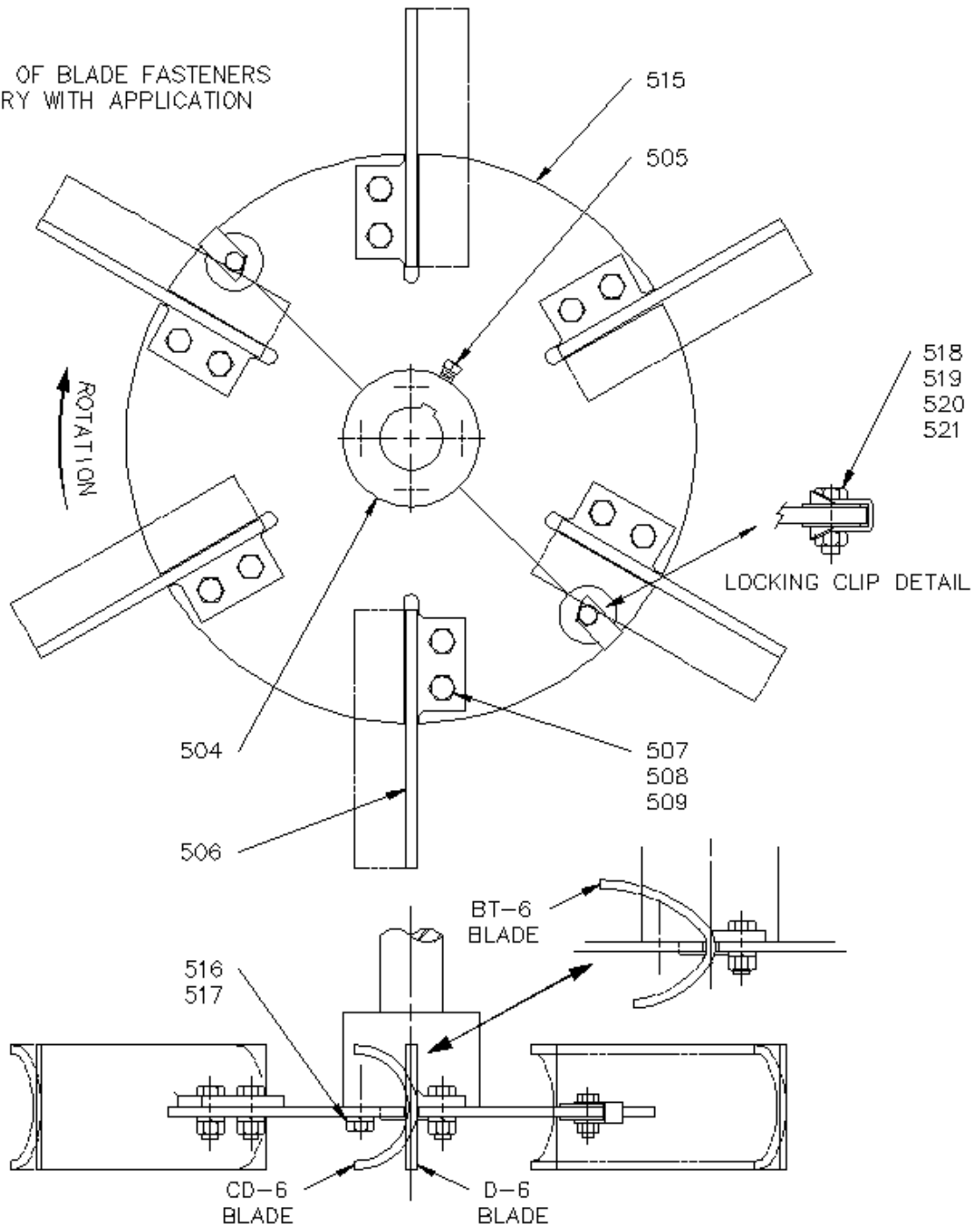
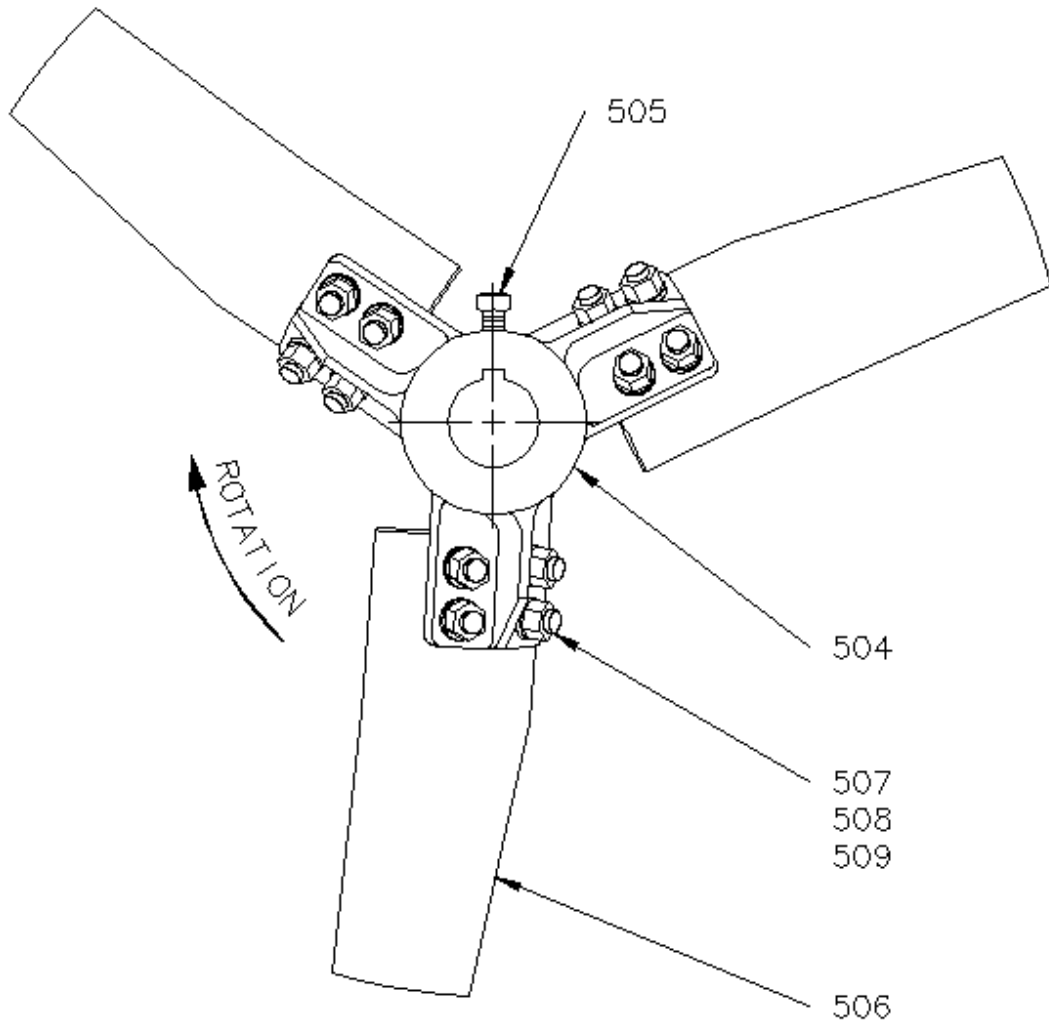


Figure 22. Style D-6, CD-6, BT-6 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

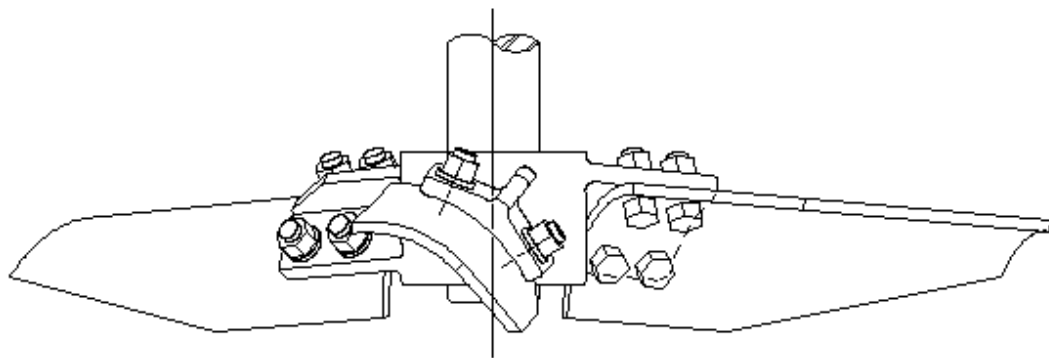
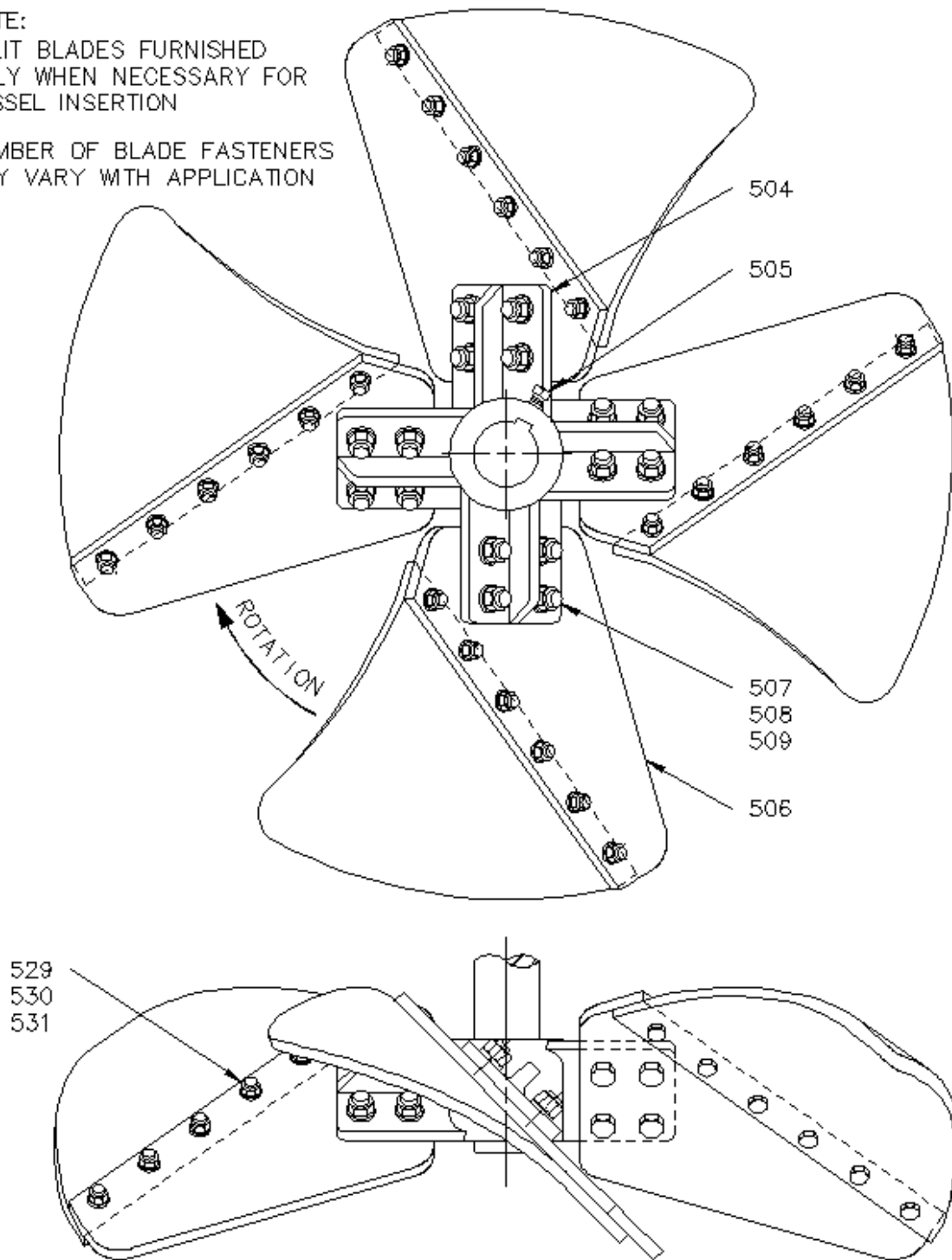


Figure 23. Style SC-3 Impeller

NOTE:
 SPLIT BLADES FURNISHED
 ONLY WHEN NECESSARY FOR
 VESSEL INSERTION

 NUMBER OF BLADE FASTENERS
 MAY VARY WITH APPLICATION



24. Style Maxflo W Impeller

RAGLESS RL-3 IMPELLER INSTALLATION

NOTE: *The ragless RL-3 impeller is designed to shed fibers off the leading edge of the extension blades. To facilitate this, the leading edge of the RL-3 extension blades are polished to a high degree and need to be adequately protected during shipment, handling, lifting, and installation. Any significant nicks, burrs, or other surface imperfections on the leading edge of the extension blade could decrease the shedding capability of the impeller. Under no circumstance are chains to be slug around the impeller for lifting. USE STRAPS ONLY FOR LIFTING, and protect impeller from nicks, dents, burrs, etc.*

In the case that the hub or an unpolished area of the impeller's extension blade is damaged during installation, the nick, dent, burr, etc. will need to be ground down to a smooth transition. If the polished leading edge of the extension blade is damaged, grind to remove the nick, dent, burr, etc without altering the profile of the leading edge's slope, then polish to a 30 Ra (maximum).

1. Install top hub cap [535], if furnished, onto the top of the impeller hub [504] with socket-head cap screws [537]. Do not tighten cap screws at this point.
2. Slide hub [504] up agitator extension shaft [400] past the desired key location.
3. Install pin key [402] in the shaft keyway so that the pin extends into the drilled hole in the keyway. Slide the hub back down the agitator extension shaft, over the key, until the hub rests on the key step.
4. Torque top hub cap fasteners to the value shown in APPENDIX I page 98.
5. Tighten socket-head setscrew [505] firmly onto the key. Torque to the value shown in APPENDIX I page 98. The tapped holes in the hub for the setscrew and cap screws are a self-locking thread form. Auxiliary fastener locking is generally not necessary.
6. Install bottom hub cap [534] onto the bottom of the impeller hub [504] with socket-head cap screws [536] and torque to the value shown in APPENDIX I page 98.

7. It is recommended that common silicon RTV (assuming process compatibility) be applied around the seams between the top cap [535] and shaft [400], the top cap [535] and hub [504], and the bottom cap [534] and hub [504]. It should also be applied in the hub counterbore around any exposed setscrew threads. If the top hub cap is not equipped, apply silicon RTV in the seam between the shaft and hub, including around the exposed key.

NOTE: Although Chemineer’s extensive lab tests of the RL-3 impeller shows no indication that these areas will catch fibers, any crevice does have the potential to catch fibers. Therefore, it is recommended that this step be taken as a preventative measure.

NOTE: Top hub cap [535] not furnished on all units.

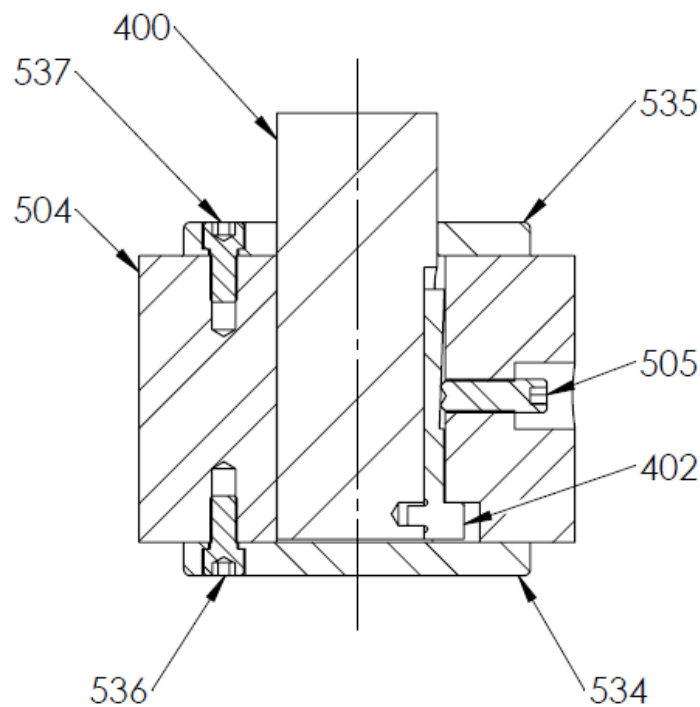
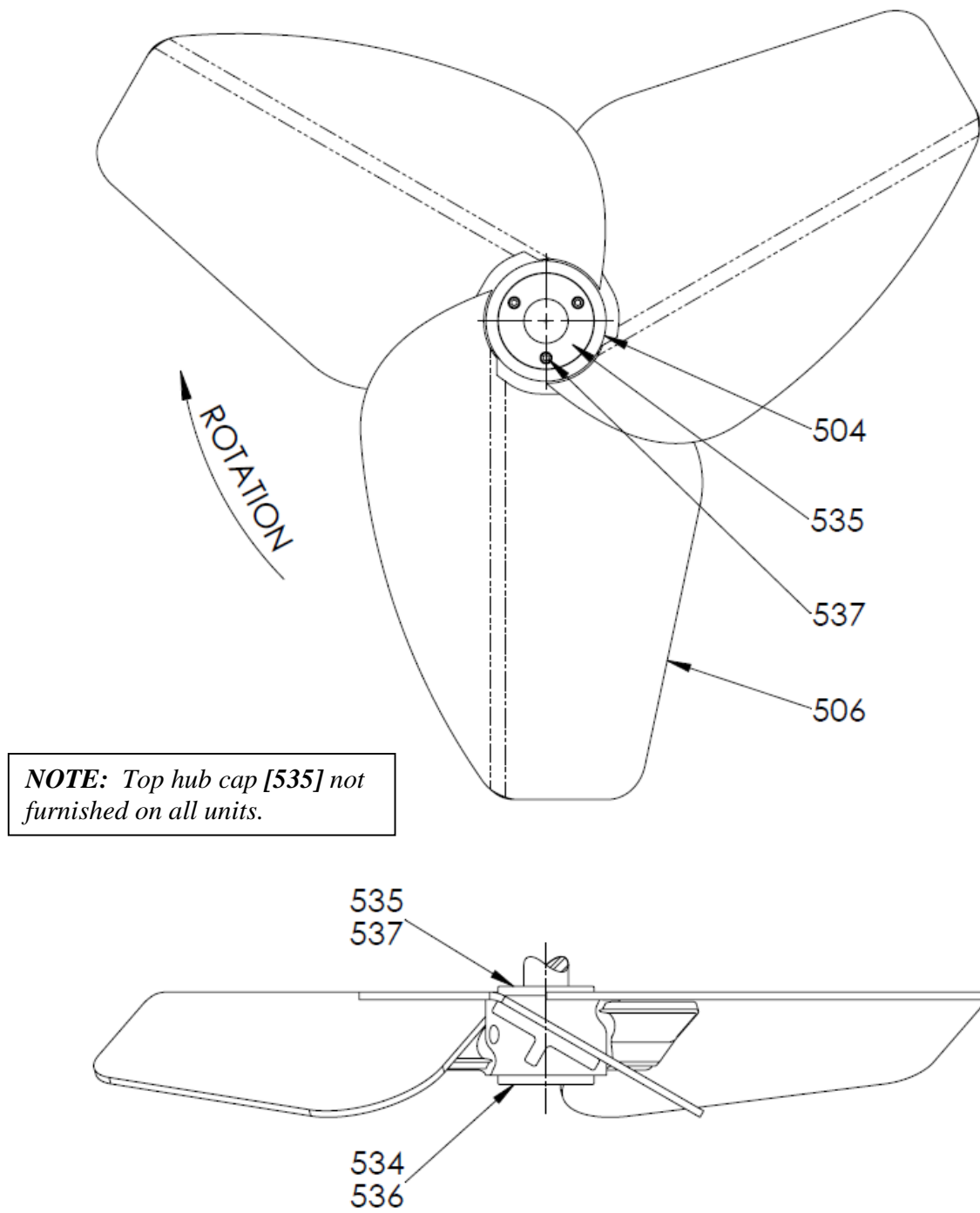


Figure 25. RL-3 Hub, Caps, and Pin Key Detail



NOTE: Top hub cap [535] not furnished on all units.

Figure 26. Style RL-3 Impeller

N.4 IMPELLERS – COATED / RUBBER COVERED

If the unit includes a coating or rubber covering on the wetted parts, follow these instructions for installation. Refer to the unit assembly drawing.


N.4.1 One piece shaft and impeller

The shaft and impeller are usually supplied as a one-piece (welded) coated/covered assembly, and no impeller assembly is required. If your impeller was shipped separate from the shaft, follow the assembly instructions below.

N.4.2 Separate shaft and one piece impeller with thrust bolt impeller attachment

The impeller is supplied as a one-piece (welded) coated/covered assembly. For attachment to the shaft, refer to Figure 27, page 51.

1. Put gasket [522] on top of hub [504].
2. Install key [420] in the shaft keyway.
3. Hoist impeller onto shaft [400], being careful not to damage the coating/covering.
4. Install snap ring [523] in the groove at the bottom of the shaft.

	Attention!
	Do not remove the hoist until mounting bolt assembly [522], [524], [525], and [526] are installed.

5. Place gasket [522] on thrust plate [524].
6. Place the thrust plate over the bottom of the shaft and install mounting bolt [526] with gasket [525]. Torque to the value shown in Table 11, page 98.
7. Remove the hoist from the impeller.

N.4.3 Removable blade type

The rubber covered removable blades are provided with patch kits in order to rubber coat the uncoated surfaces after bolting the blades.

Carefully read the instructions provided with the kit before using it.

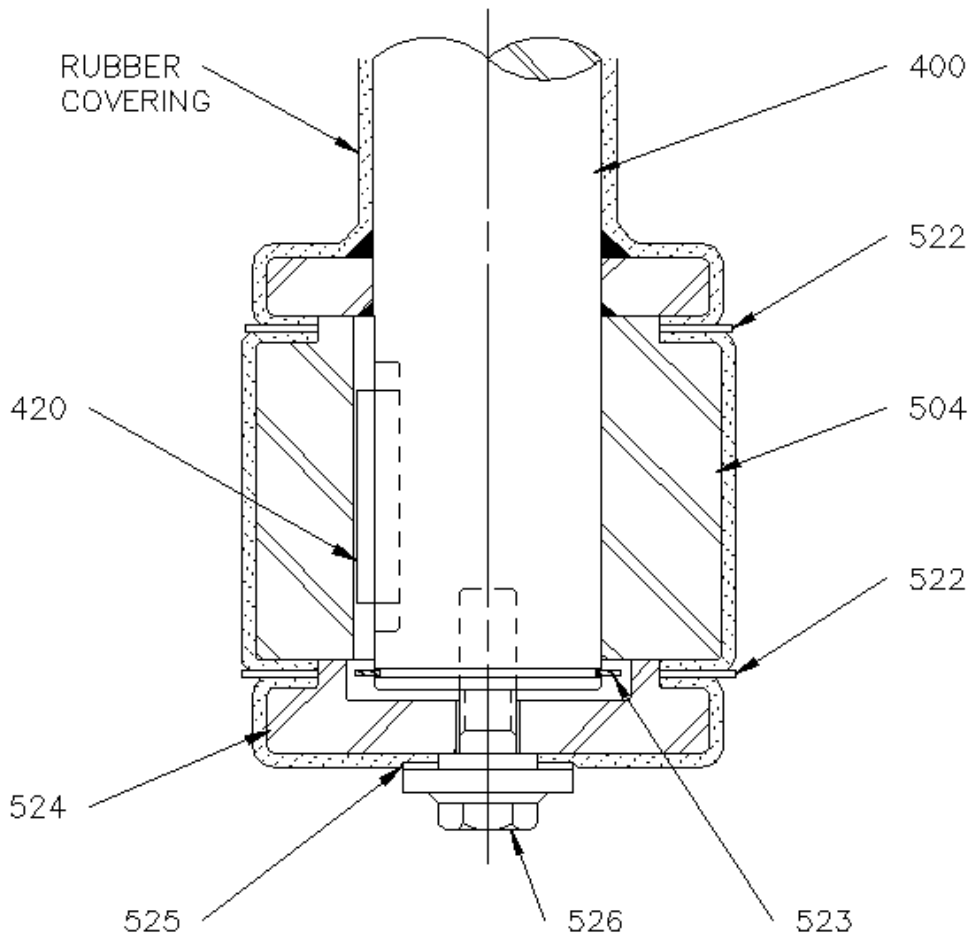



Figure 27. Thrust Bolt Impeller Attachment

O. OPTIONS


O.1 IN-TANK COUPLING

Optional in-tank couplings are available in welded (non-removable) and taper bore (removable) construction. Couplings can be supplied with one removable half and other welded on to the shaft.

	Note!
	Whenever assembly or disassembly of an agitator with an in-tank coupling is referred to in this manual, substitute flanged drive shaft [403] and/or flanged extension shaft [404] (Figure 28 on page 53 or Figure 29 on page 54) for all references to the agitator extension shaft [400].

O.1.1 Assembly of Rigid, Removable, Taper Bore Coupling Half [408, 413]

1. Clean the shaft and coupling bore and make sure that both surfaces are free from burrs or nicks. Place key [409, 414] in the coupling keyway to make sure it slides freely. Place the key in the shaft keyway to make sure it is properly oriented and fully bottomed in the keyway. Install the key in the shaft keyway.
2. Slide the coupling half on the tapered shaft end until both seat firmly against each other. Make sure that the coupling half is not hung up on the key or cocked at an angle to the shaft.

	Attention!
	Do not apply lubricant or anti-seize compound to shaft or coupling taper. Shaft and coupling taper must be clean and dry prior to assembly.

3. Shaft Bolt Installation:

2 Bolt Design:

Install coupling washer [421, 424], Install bolts and lock washers [422, 423, 425, 426]. Torque to the value shown in the APPENDIX, Page 98.

1 Bolt Design:

Install coupling washer [410, 415] and locking clip [412, 416], Install shaft bolt [418, 419]. Torque to the value shown in the APPENDIX, Page 98. Bend exposed tabs of the locking clip around the shaft bolt head.

4. Assemble Coupling Halves:

Connect flanged extension shaft [404] to flanged drive shaft [403] making sure the match marks are lined up and the coupling faces are clean and free from burrs or nicks. Install coupling bolts and lock washers [405, 406] (and nuts [407] if welded construction). Torque to the value shown in the APPENDIX, Page 98.

5. Ensure parts are fitted to the correct shaft.

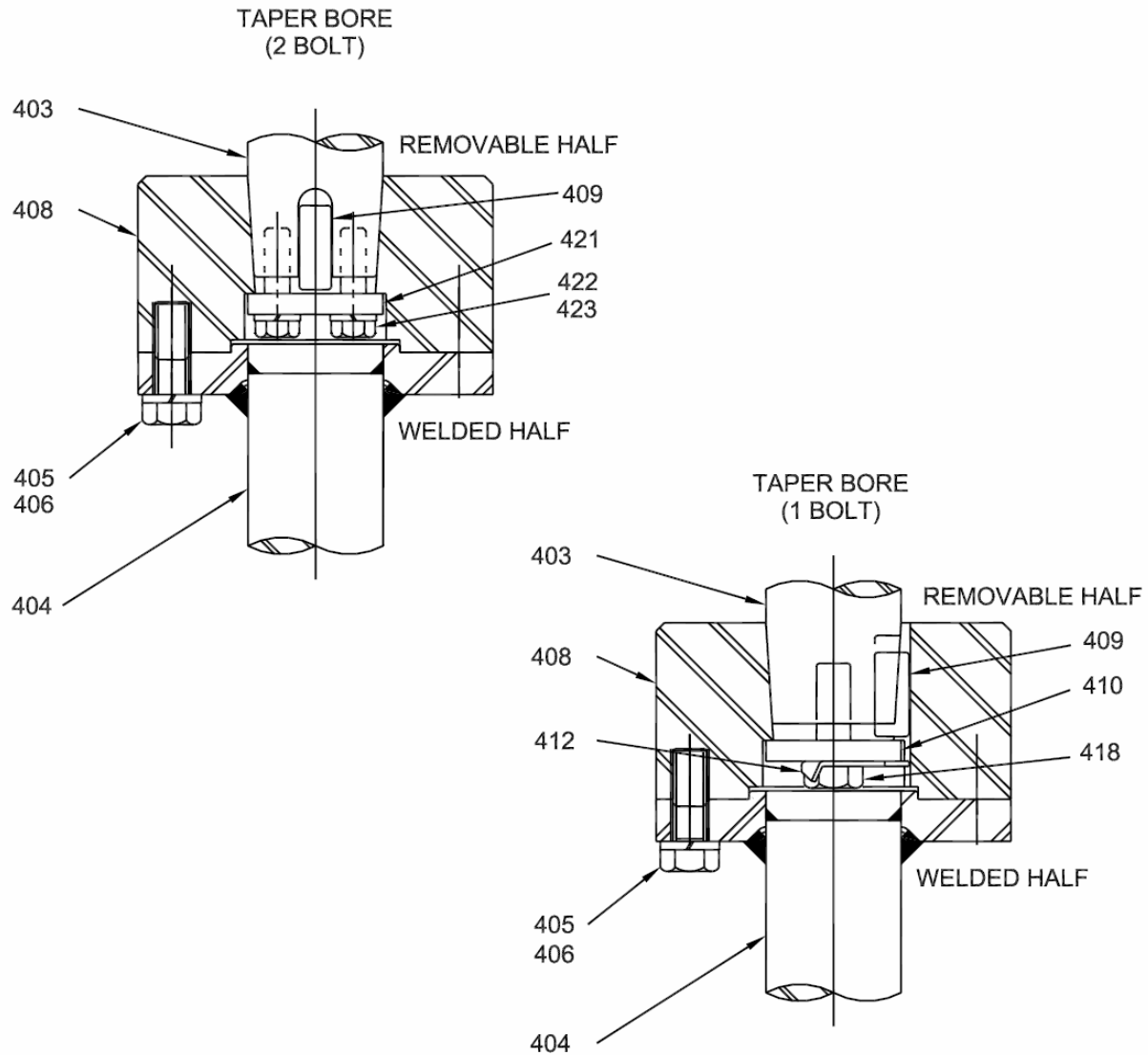


Figure 28. In-Tank Couplings

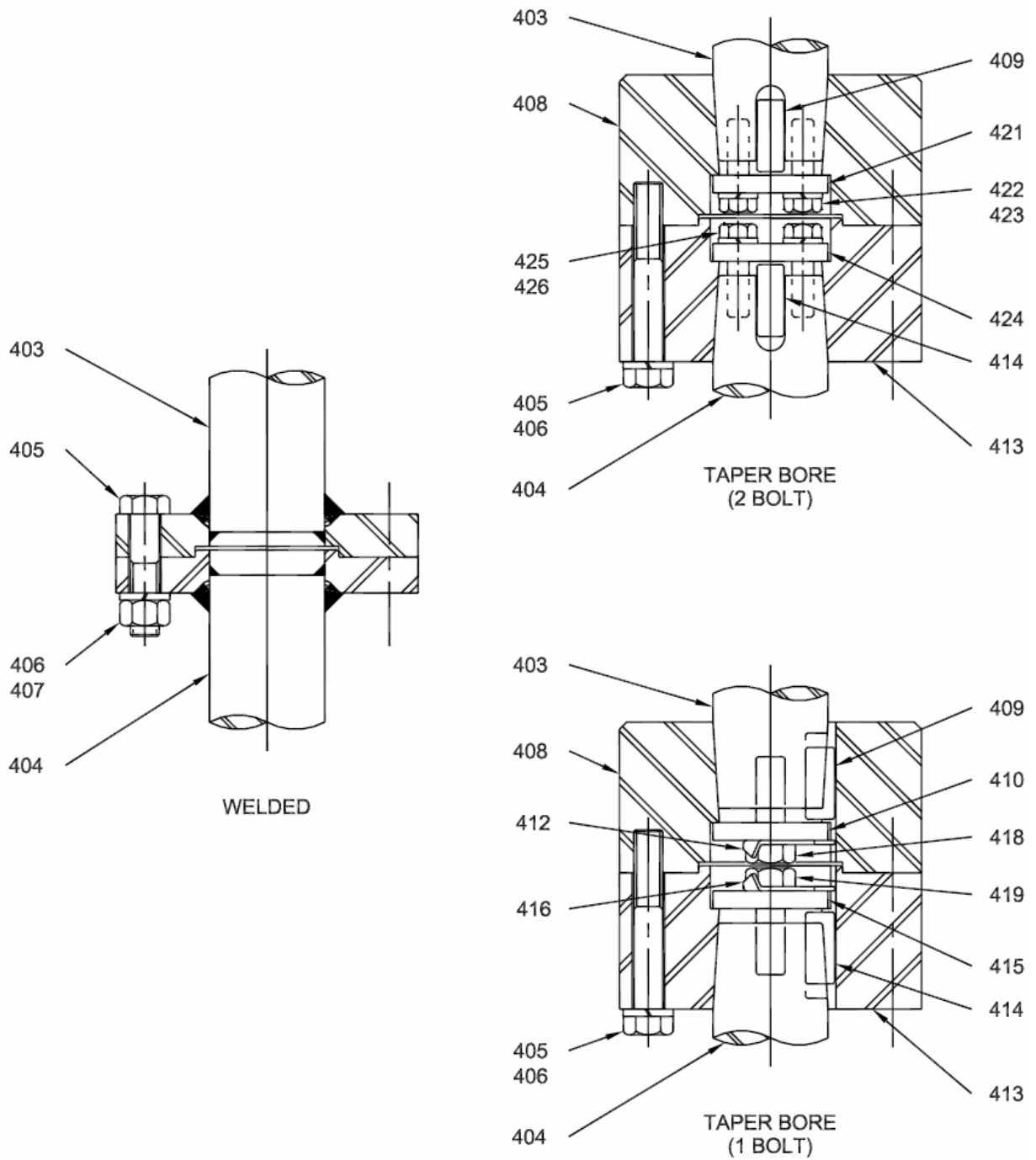


Figure 29. In-Tank Couplings (Continued)

O.2 STEADY BEARINGS

MR agitators may include an optional in-tank steady bearing. See the unit assembly drawing for the steady bearing style, type of mounting, and vessel installation requirements.

Proper steady bearing operation requires the agitator extension shaft to be straight and the steady bearing to be centered on the shaft. Refer [Shaft Runout Section](#), page 36, for checking and straightening the shaft. Steady bearing mountings should be located from the installed agitator extension shaft.

O.2.1 Bracket Steady Bearing

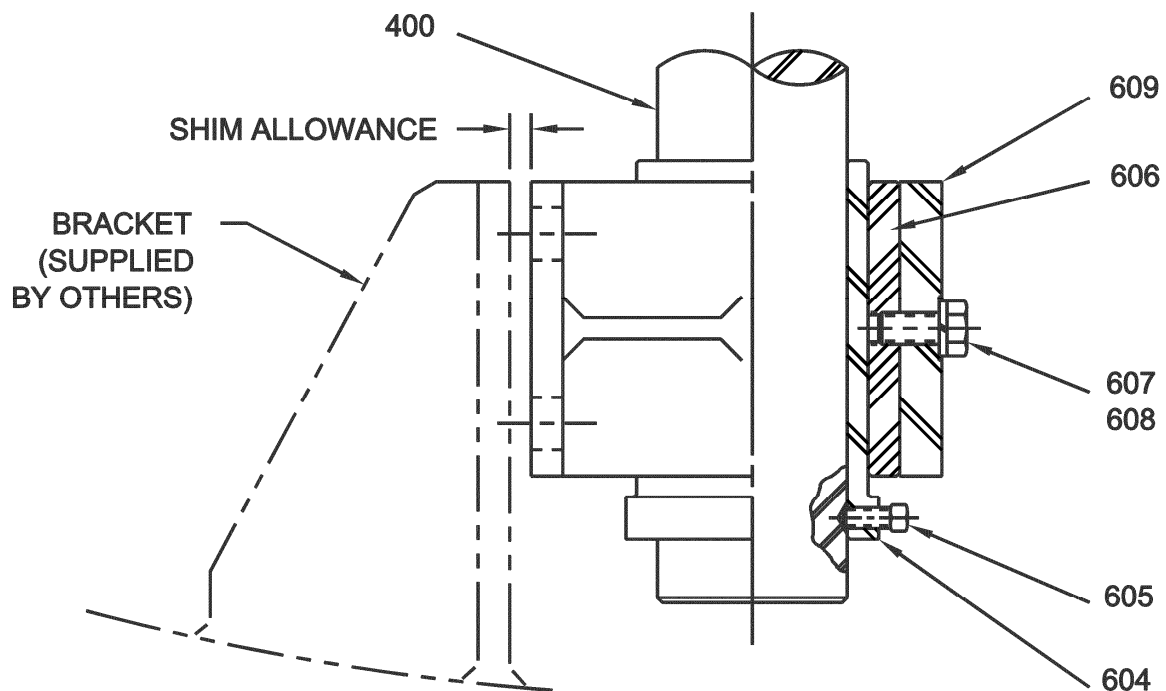


Figure 30. Bracket Steady Bearing


1. Place the steady bearing assembly on the end of the shaft and attach it to the support bracket (supplied by others). The support bracket should be located such that the steady bearing assembly is centered on the shaft. Bolt the steady bearing housing [609] to the support bracket. Tighten the bracket bolts (supplied by others) to 25% of specified torque per the APPENDIX, Page 98.
2. Loosen setscrews [605] and remove wear sleeve [604]. Remove bushing retaining bolt [607] and bushing [606] from steady bearing housing [609].
3. Attach a dial indicator to the shaft and set it so the point of the indicator extends inside the steady bearing-housing bore.

4. Manually turn the gear drive flexible coupling half to rotate extension shaft one turn. Shim the steady bearing housing until it is located concentric to the shaft centerline within .050" (1.25 mm) FIM (Full Indicator Movement).
5. Install bushing, bushing retaining bolt, lock washer, wear sleeve and setscrews [606, 607, 608, 604, 605]. See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten the bushing retaining bolt and the setscrews.
6. With a feeler gauge check the clearance between the wear sleeve and the bushing at the top and bottom in 90° increments. For proper angular alignment, the gap at all locations (from top to the bottom) must be within .010" (0.25 mm) of each other.
7. If the angular alignment needs correction, repeat *Steps 1 through 6*.
8. Once the final steady bearing housing location has been determined, drill the steady bearing housing and its support bracket at two locations and install roll or dowel alignment pins (supplied by others). Torque the bracket bolts to the value shown in the APPENDIX, Page 98.
9. Remove the wear sleeve setscrews one at a time and transfer punch a center into the agitator shaft. Take the wear sleeve off the shaft. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.
10. Reinstall the wear sleeve with the setscrews over the drill spots located in Step 9. Torque the setscrews and the bushing-retaining bolt to the value shown in the APPENDIX, Page 98. The tapped holes for the setscrews are usually a self-locking thread form. When an auxiliary fastener locking is required, screws will be drilled and lock-wire will be attached..


**Attention!**

Do not operate the agitator without the steady bearing being submerged.


1. Install the coupling [620] onto the end of the extension shaft [400] with key [623] and bolts, lock washers, and coupling washer [625, 626, 624]. Refer to Installation, page 52 for in-tank coupling installation.
2. Assemble the stub shaft [630], stub shaft housing [634], and retainer plate [631] with bolts [632] and lock washers [633]. Torque bolts to the value shown in the APPENDIX, Page 98.

	Note!
	Be sure to assemble the stub shaft [630] to the retainer plate [631] before inserting into the stub shaft housing [634]. Alignment of the stub shaft [630] to the retainer plate [631] is crucial to future maintenance.

3. Attach legs [635] with bolts, nuts, lock washers, and two flat washers [636, 637, 638, 639]. Do not torque the bolts at this time. Locate the steady bearing assembly so that it is centered with the extension shaft.
4. Adjust the leg angle and steady bearing assembly height. Torque the leg bolts [636] to value shown in the APPENDIX, Page 98. Refer to the steady bearing assembly drawing for the proper steady bearing set dimensions.


	Note!
	Later in the procedure, the stub shaft housing will need to be adjusted for shaft concentricity and parallelism. Be sure to leave room in the leg and housing slots for future adjustment.

5. Attach the legs [635] to the vessel bottom.


	Attention!
	The stub shaft [630] will need to be removed periodically for future maintenance. Be certain that there is no obstruction below the steady bearing assembly that would hinder the stub shaft removal.

6. Attach an indicator to the coupling [620] and set the point of the indicator on the top of the stub shaft housing [634]. Manually turn the extension shaft [400] one full turn. Loosen the leg bolts [636] and nuts [637] and adjust the stub shaft housing [634] to obtain 0.010" (0.25 mm) FIM (Full Indicated Movement) maximum.
7. Place the indicator point on the outside diameter of the stub shaft [630] and rotate the extension shaft one turn. Loosen the leg bolts [636] and nuts [637] and move the stub

- shaft housing [634] until the stub shaft is located concentric to the shaft centerline within 0.050" (1.25 mm) FIM.
8. Torque the leg bolts [636] and nuts [637] to the value shown in the APPENDIX, Page 98.
 9. Recheck the steady bearing alignment with the dial indicator. If the alignment needs correction, repeat steps 6 through 8.
 10. Once the final steady bearing housing location has been determined, drill the stub shaft housing and install the dowel alignment pins [640].
 11. Loosen and remove bolts and lock washers [632, 633] anchoring the retainer plate [631] to the stub shaft housing [634]. Re-install bolts into tapped holes at 90° in the retainer plate. Progressively tighten these bolts around the bolt circle to remove the stub shaft [630] from stub shaft housing.

	Attention!
	Tapers can disengage with a great deal of force. On larger units, the stub shaft/retainer assembly can be very heavy. It may be advantageous to only remove half of the retainer plate to housing bolts and use those removed to break the stub shaft taper as described above. This will allow the stub shaft to still be held in position when it disengages.

12. Install bushing [606] into bushing housing [627] and secure with bushing retaining bolt [628] and lock washer [629]. With bushing installed, assemble bushing housing to coupling [620] using bolts and lock washers [621, 622]. Torque the bolts to the value shown in the APPENDIX, Page 98.
13. Install the stub shaft [630] through the stub shaft housing [634] and into the bushing [606]. Attach the retainer plate [631] with bolts [632] and lock washers [633]. Torque bolts to the value shown in the APPENDIX, Page 98. The retainer plate has been drilled and tapped for a NPT pipefitting, be sure to orient the plate so that the larger end of the tapped fitting hole is facing downward.
14. The tripod steady bearing has an optional flush feature for lubrication and cooling. If the flush is utilized, attach the flush piping to the flush hole in the retainer plate [631]. Keep the flush plug [641] in place on the bushing housing [627]. Note: The flush inlet pressure should be 15 to 20 psi over the vessel pressure.
15. If the flush is not utilized, remove flush plug [641] from the bushing housing [627].

	Attention!
	Do not operate the agitator without the steady bearing flush and bearing assembly fully submerged.

O.2.2 Tri-Pod Steady Bearing

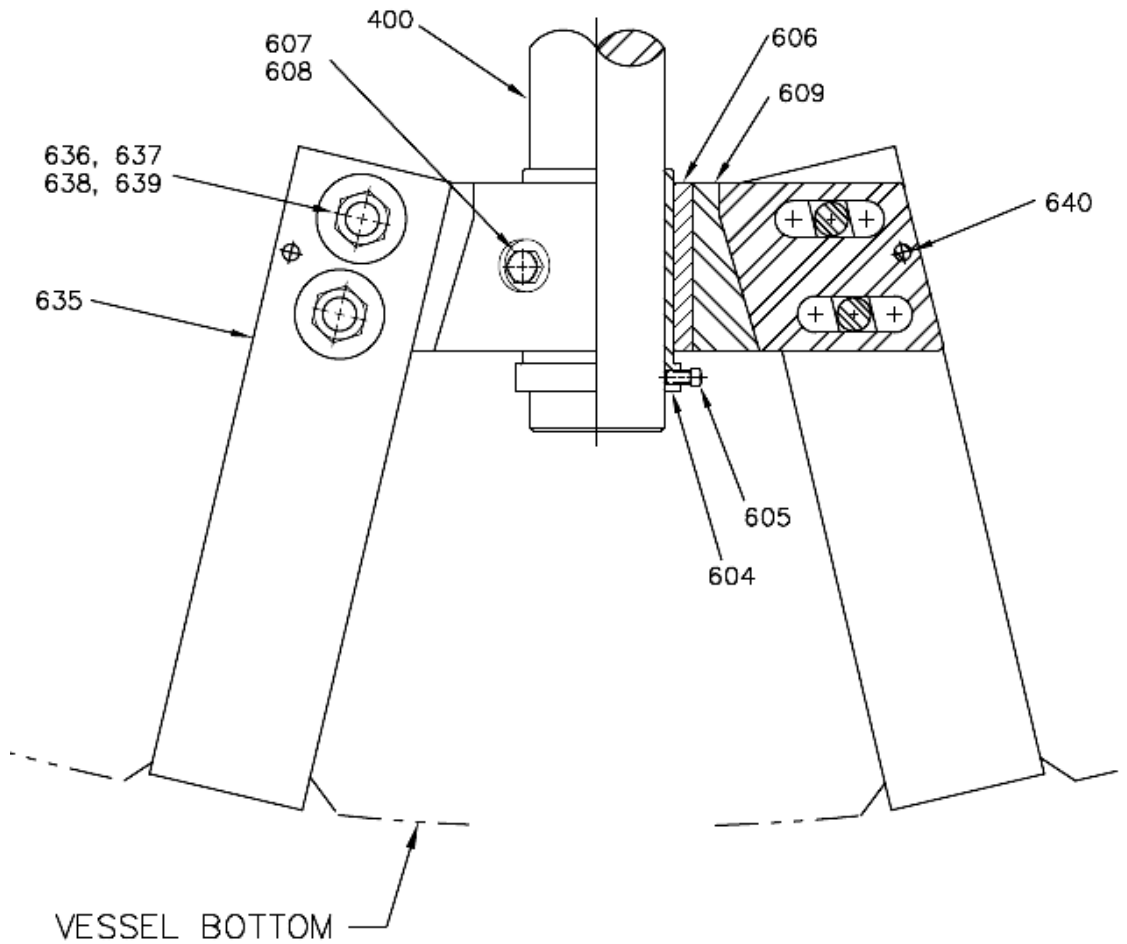



Figure 32. Tripod Steady Bearing


1. Attach legs [635] with bolts, nuts, lock washers, and two flat washers [636, 637, 638, 639]. Do not torque the bolts at this time. Locate the steady bearing assembly so that it is centered with the extension shaft [400].
2. Adjust the leg angle and steady bearing assembly height. Torque the leg bolts [636] to value shown in the APPENDIX, Page 98. Refer to the steady bearing assembly drawing for the proper steady bearing set dimensions.

	Note!
	Later in the procedure, steady bearing housing will need to be adjusted for shaft concentricity and parallelism. Be sure to leave room in the leg and housing slots for future adjustment.

3. Attach the legs [635] to the vessel bottom.

	Attention!
	The wear sleeve [604] and bushing [606] will need to be removed periodically for future maintenance. Be certain that there is no obstruction below the steady bearing assembly that would hinder their removal..

4. Attach a dial indicator to the shaft [400] and set it so the point of the indicator extends inside the steady bearing housing bore and rotate the extension shaft one turn. Loosen the leg bolts [636] and nuts [637] and move the housing [634] until the housing bore is located concentric to the shaft centerline within 0.050" (1.25 mm) FIM.
5. Install bushing, bushing retaining bolt, lock washer, wear sleeve and setscrews [606,607,608, 604, 605]. See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten the bushing retaining bolt and the setscrews.
6. With a feeler gage, check the clearance between the wear sleeve and the bushing at the top and bottom in 90° increments. For proper angular alignment, the gap at all locations (from top to the bottom) must be within 0.010" (0.25mm) of each other.
7. If the angular alignment needs correction, repeat steps 1-6.
8. Torque the leg bolts [636] and nuts [637] to the value shown in the APPENDIX, Page 98.
9. Recheck the steady bearing alignment with the dial indicator. If the alignment needs correction, repeat steps 6 through 8.
10. Once the final steady bearing housing location has been determined, drill and install the dowel alignment pins [640].
11. Remove the wear sleeve setscrews [605] one at a time and transfer punch a center into the agitator shaft [400]. Take the wear sleeve [604] off the shaft. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.
12. Reinstall the wear sleeve [604] with the setscrews [605] over the drill spots located in the previous step. The tapped holes for the setscrews are usually a self-locking thread form; auxiliary fastener locking is not necessary. Torque the bolts to the value shown in the APPENDIX, Page 98. When auxiliary fastener locking is required, screws will be drilled and lock-wire will be attached.

	Attention!
	Do not operate the agitator without the steady bearing assembly fully submerged.

O.2.3 Pad Steady Bearing

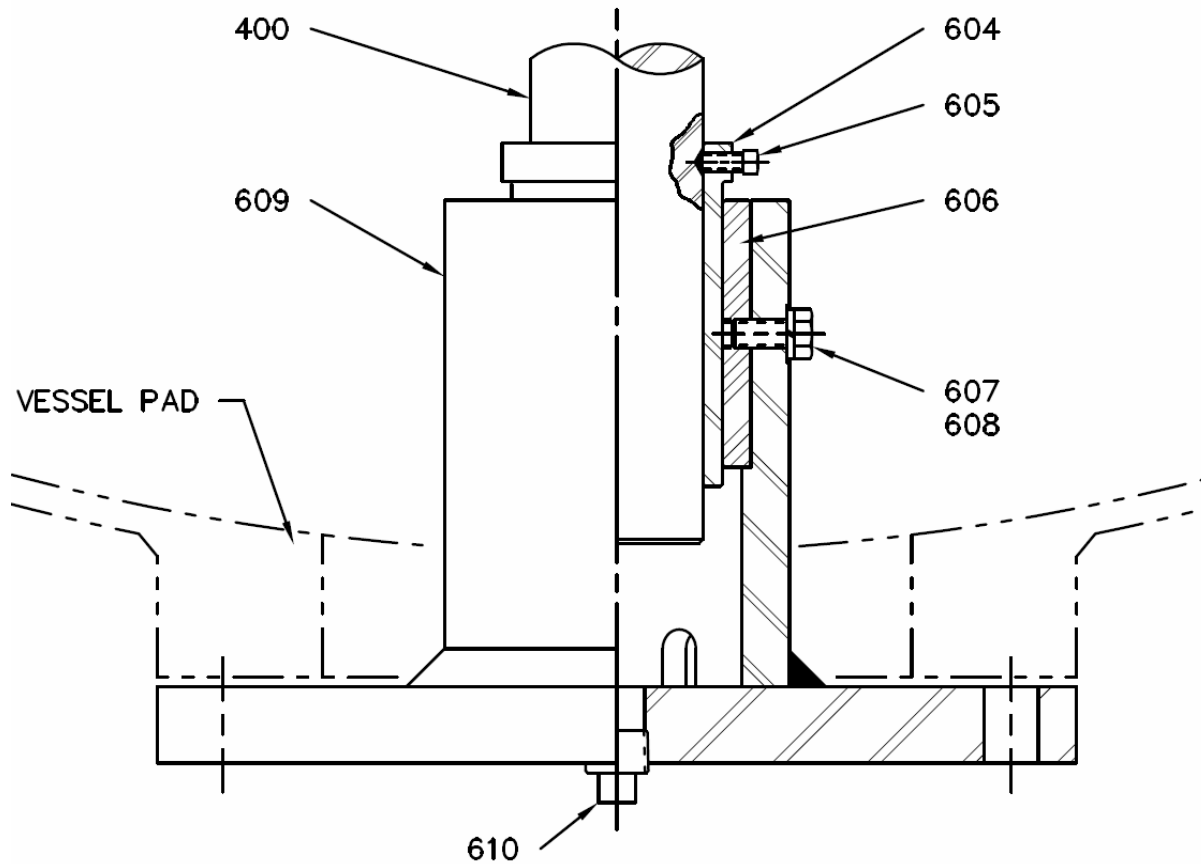




Figure 33. Pad Steady Bearing

1. Assemble steady bearing housing [609] to the vessel pad with the proper gasket and flange bolts (supplied by others). Tighten the flange bolts to 25% of specified torque shown in the APPENDIX, Page 98.
2. Slide wear sleeve [604] up the extension shaft to disengage from bushing [606].
3. Attach a dial indicator to the shaft and set the point of the indicator on the top face of housing hub [609].
4. Manually turn the flexible motor coupling to rotate the extension shaft one turn. If the runout exceeds .010" (0.25 mm) FIM (Full Indicator Movement) maximum, a tapered adapter (supplied by others) should be installed between the housing mounting flange and the vessel mounting pad. Call Chemineer Field Service for assistance.
5. Place the indicator point on the outside diameter of the housing hub and rotate the extension shaft one turn. Loosen the flange bolts and move the steady bearing housing

- until it is located concentric to the shaft centerline within .050" (1.27 mm) FIM. Torque the flange bolts to the value shown in APPENDIX, Page 98.
6. In extreme cases, the agitator drive may have to be shimmed to correct for angular misalignment. Call Chemineer Field Service for assistance.
 7. If the angular alignment needs correction, repeat the previous steps.
 8. Once the final steady bearing housing location has been determined, drill the steady bearing housing flange at two locations on or outside of the bolt circle and install roll or dowel alignment pins (supplied by others).
 9. Slide the wear sleeve down the shaft into the bushing. See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten setscrews [605].
 10. Remove the wear sleeve setscrews one at a time and transfer punch a center into the agitator shaft. Slide the wear sleeve up the shaft and retain. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.

	Attention!
	Cover the opening between the extension shaft and the bushing to prevent drill chips from getting into the housing.

11. Reinstall the wear sleeve with the setscrews over the drill spots located in *Step 10*. Torque the setscrews to the value shown in APPENDIX, Page 98. The tapped holes for the setscrews are a self-locking thread form. Auxiliary fastener locking is not necessary.

	Attention!
	Do not operate the agitator without the steady bearing flush on or the steady bearing assembly fully submerged.

O.3 ANCHOR BOLTS

Anchor bolts [901] are to be located on centers as specified on the unit assembly drawing or Figure 3 on page 14 or Figure 4 on page 15. Mount the agitator drive on the anchor bolts and install flat washers, lock washers and nuts [904, 903, 902]. Torque bolts to the value shown in the APPENDIX, Page 98.

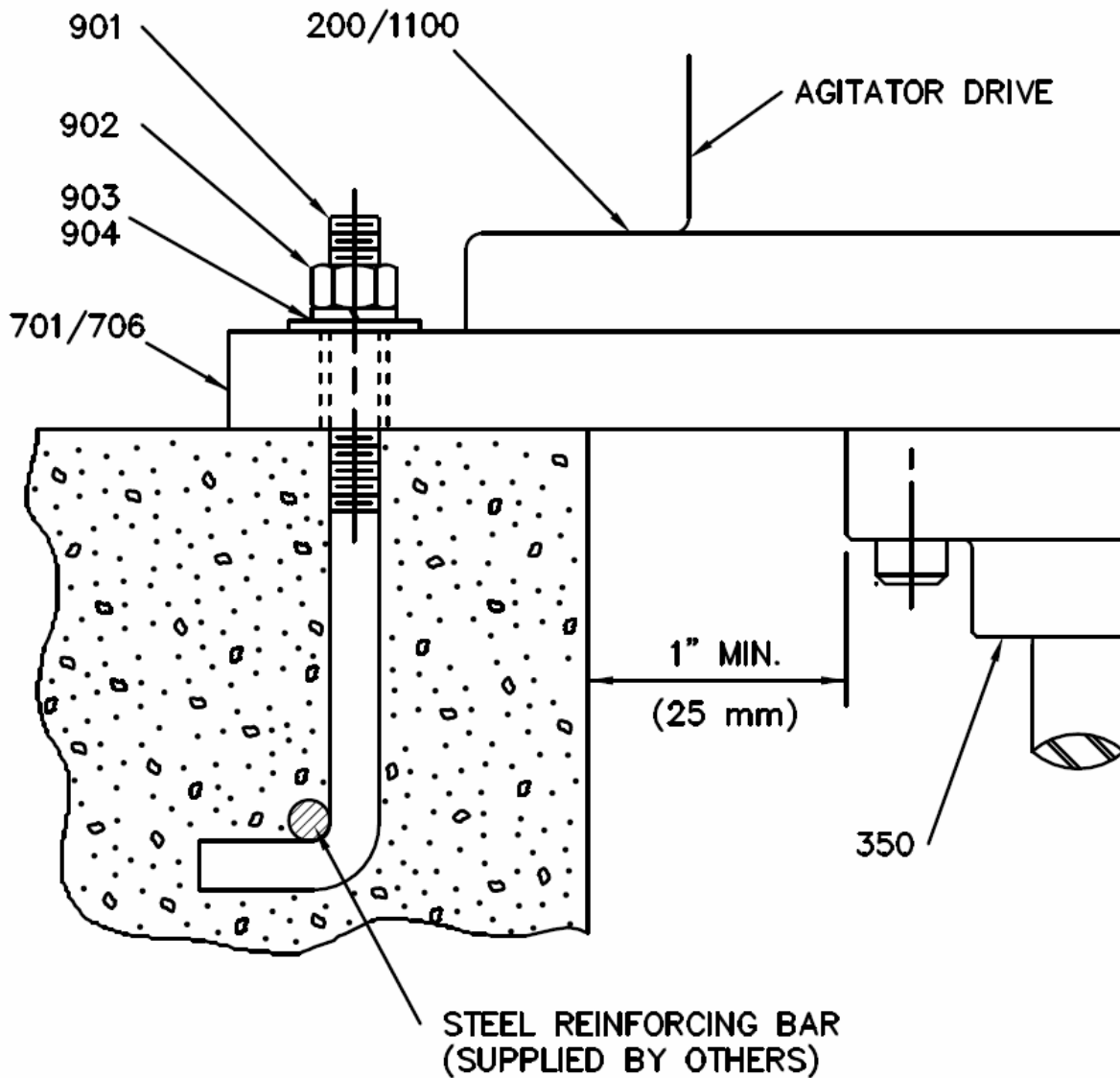


Figure 34. Anchor Bolt Assembly

0.4 COOLING SYSTEM

Cutting ring screw threads (see Item 1, Figure 35) are located at the casing cover for the connection of a pipe with an external diameter of 10 mm according to DIN 2353.

1. **Remove the drain plug from the screw neck prior to assembly to avoid any contamination of the cooling system.** The screw necks should be connected with the coolant circuit, which must be provided by the operator. The flow direction of the coolant is irrelevant.
2. **Make sure not to twist the screw necks during or after assembly** as the cooling coil may be damaged (see Item 3, Figure 35). You must ensure that no external forces act on the cooling coil.

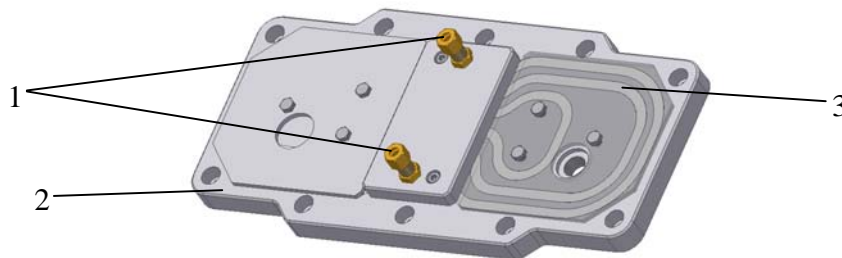




Figure 35. Cooling Cover

	Danger!
	Ensure that the pressure has been released from the cooling circuit before carrying out any work on the gear unit.

P. LUBRICATION


This section defines the proper oils and greases that must be used with this equipment.

	Attention!
	Check the gear drive for proper oil fill before operating.

P.1 MOTOR - LUBRICATION

The motor bearings are properly greased by the manufacturer. Motor bearings should be re-greased at 12-month intervals when installed in clean, dry environments, or every six months for heavy duty and dusty locations. Any good quality general-purpose grease consisting of a refined base oil stock and a lithium, calcium, or polyurea (preferred) complex based soap, with an NLGI No. 2 classification, will work satisfactorily. **However, different greases are not always compatible. Hence, check for compatibility of greases before you replace one with the other.** Most major oil companies offer such products, usually with extreme pressure (EP) additives for additional protection. Table 4, page 67 lists some commonly available greases.

When re-greasing, stop the motor, remove the outlet plug and add grease according to motor supplier's recommendations with a hand lever gun only. Run the motor for about ten minutes before replacing the outlet plug. Certain TEFC motors have a spring relief outlet fitting on the fan end. If the outlet plug is not accessible at the surface of the hood, it is the spring relief type and need not be removed when re-greasing.

	Attention!
	Over-greasing is a major cause of bearing and motor failure

The following actions can be taken to correct or prevent motor over-greasing and related problems¹:

1. Review motor lubrication procedures to ensure that they identify the type and quantity of grease to use, the specific fill and drain nozzles to uncap, and the length of time motors should be run with drain plugs off after greasing the bearings.
2. To prevent foreign materials from contaminating the grease, ensure that grease containers are covered during periods of storage and that the nozzles and grease fittings are cleaned.
3. Determine the optimum quantity and correct type of grease required for each motor by examining the manufacturer's recommendations and by monitoring the behavior of grease added to motors.
4. Consider using pre-lubricated sealed bearings in applications where re-lubrication is difficult, where contaminants can adulterate the grease, or where over-greasing might damage safety systems.

¹US Nuclear Regulatory Commission, Information Notice No. [88-12](#)









P.2 GEARBOX - LUBRICATION

All gear units are filled with lubricant ready for operation when delivered. This initial filling corresponds to a lubricant from the column for the ambient temperatures (normal version) in the lubricant table.

P.2.1 Roller bearing greases

Table 4 shows comparable roller bearing greases from various manufacturers. The manufacturer can be changed for a given grease type. Chemineer Field Service must be contacted in case of change of grease type or ambient temperature range, as this may change the warranty status for the functionality of our gear units.









Table 4. TYPICAL NLGI NO. 2 GREASES

Lubricant type	Ambient temperature								
Grease (mineral oil based)	-30 ... 60°C (Normal version)	Aralub HL 2	Enegrease LS 2	Sheerol AP 2 LZV-EP	Mehrzweckfett Beacon 2	Renolit FWA 160	Klüberplex BEM 41-132	Mobilux 2	–
	-50 ... 40°C	Aralub SEL 2	–	Spheerol EPL 2	–	Renolit JP 1619	–	–	Alvania RLB 2
Synthetic grease	-25 ... 80°C	Aralub SKL 2	–	Product 783/46	Beacon 325	Renolit S2 Renolit HLT 2	Isoflex Topas NCA 52 Petamo GHY 133 N	Mobiltemp SHC 32	Aero Shell Grease 16 or 7
Biodegradable grease	-25... 40°C	Aralub BAB EP 2	Biogrease EP 2	Biotec	–	Plantogel 2 S	Klüberbio M 72-82	Schmierfett UE 100 B	Alvania RLB 2
Food compatible grease	-25 ... 40°C	Eural Grease EP 2	Enegrease FM 2	Vitalube HT Grease 2	Carum 330	Renolit G 7 FG 1	Klübersynth UH1 14-151	Mobilgrease FM 102	Cassida RLS 2

P.2.2 Lubricant table

Table 5 shows comparable lubricants from various manufacturers. The manufacturer can be changed within a particular viscosity or lubricant type. Chemineer Field Service must be contacted in case of change of viscosity or lubricant type, as this may change the warranty status for the functionality of our gear units.

Table 5. TYPICAL LUBE OILS

Lubricant type	Ambient temperature								
	ISO VG 220 -10 ... 40°C (Normal version)	Degol BG 220 Degol BG 220 plus	Energol GR-XP 220	Alpha SP 220 Alpha MW 220 Alpha MAX 220	Spartan EP 220	Renolin CLP 220 Renolin CLP 220 Plus	Klüberoil GEM 1-220	Mobilgear 630 XMP 220	Omala 220
	ISO VG 100 -15 ... 25°C	Degol BG 100 Degol BG 100 plus	Energol GR-XP 100	Alpha SP 100 Alpha MW 100 Alpha MAX 100	Spartan EP 100	Renolin CLP 100 Renolin CLP 100 Plus	Klüberoil GEM 1-100	Mobilgear 627 XMP 110	Omala 100
Synthetic oil (Polyglycol)	ISO VG 220 - 25 ... 80°C	Degol GS 220	Enersyn SG-XP 220	Alphasyn PG 220	Glycolube 220	Renolin PG 220	Klübersynth GH 6-220	Glygoile HE 220	Tiveal S 220
Synthetic oil (hydrocarbons)	CLP HC ISO VG 220 -40... 80°C	Aral Degol PAS 220	–	–	–	Renolin Unisyn CLP 220	Klübersynth EG 4-220	Mobil SHC 630	Omala 220 HD
Bio-degradable oil	ISO VG 220 -5 ... 40°C	Degol BAB 220	Biogear SE 220	Carelub GES 220	–	Plantogear 220 S	Klübersynth- GEM 2-220	–	Naturelle Gear Oil EP 220
Food compatible oil as per regulation H1 / FDA 178.3570	ISO VG 220 - 25 ... 40°C	Eural Gear 220	–	Vitalube GS 220	Gear Oil FM 220	Geralyn AW 220 Geralyn SF 220	Klüberoil 4UH1-220N Klübersynth UH1 6-220	Mobil DTE FM 220	Cassida Fluid GL 220
Synth. Synthetic liquid grease	- 25 ... 60°C	Aralub BAB EP0	–	Alpha Gel 00	Fließfett S 420	Renolit LST 00	Klübersynth GE 46-1200 UH1-220N Klübersynth UH1 14-1600	Glygoile Grease 00	Tivela GL 00

Note!

After changing the lubricant, and in particular after the initial filling, the oil level may change during the first few hours of operation, as the oil galleries and hollow spaces only fill gradually during operation. The oil level is still within the permissible tolerance.

If at the express request of the customer, an oil inspection glass is installed at an additional charge, we recommend that the customer corrects the oil level after an operating period of approx. 2 hours, so that when the gear unit is at a standstill and has cooled down, the oil level is visible in the inspection glass. Only then is it possible to check the oil level by means of the inspection glass.

The stated filling quantities are guide values. The exact quantities vary according to the exact gear ratio. When filling, always observe the oil level screw hole as an indicator of the precise quantity of oil.



P.3 SHAFT SEALS - LUBRICATION

Some units are furnished with auxiliary mounted stuffing boxes with six rings of self-lubricating packing. This packing does not require any additional lubrication for the life of the packing. Please refer to agitator assembly drawings for seal style and packing type.

P.4 STEADY BEARINGS - LUBRICATION

Steady bearings are lubricated and cooled by the process fluid. Do not operate agitator unless the steady bearing is submerged or there is a flush to the steady bearing.

If a Clean-In-Place (CIP) system is present, it will generally put enough liquid into the steady bearing to ensure the bearing is adequately lubricated, during cleaning cycle.

Q. OPERATION

Q.1 AGITATOR OPERATION

Chemineer agitator has been designed for your specific application. Proper operating procedures will allow maximum performance.



The following list will aid in the safe operation of your unit.

- **Do not** operate the unit before reading and following the instructions on all tags and nameplates attached to the unit.
- **Do not** operate the unit in a fluid with a specific gravity or viscosity higher than that for which the unit was designed.
- **Do not** attempt to start a unit with the mixing impeller buried in solids or a "set up" fluid.
- **Do not** operate mechanical shaft seals at temperatures or pressures higher than those for which the unit was designed. Refer to unit assembly drawing.
- **Do not** locate large pump discharges, other agitators, down comers, coils, baffles, or other vessel internals close to the agitator impellers and extension shaft.
- **Do not** make any changes in the field (i.e. motor horsepower, agitator speed, shaft length, impeller diameter, impeller blade width, etc.) without reviewing the change with your local Chemineer office or Chemineer Field Service. Minor changes could upset the dynamics and result in dramatic and potentially dangerous failures.

Should there be problems operating the unit; review the installation and the [Troubleshooting Guide](#), Table 7, page 75. If you are unable to resolve the problem, contact your [local Chemineer office](#).

Q.2 MOTOR - OPERATION

Electric motors furnished on Chemineer agitators are designed to deliver their rated output when properly installed and maintained.

Air circulation is very important to get full performance and long life from an electric motor. Do not block the suction inlets on fan-cooled motors. Life of the motor will be decreased if its temperature exceeds its thermal rating. The allowable temperature is stamped on the motor nameplate.



Prior to permanently wiring the electric motor:

- Check nameplate data on motor to assure that the available power supply agrees with the motor requirements. Protective devices should be the proper size and rating to safely carry the load and to interrupt the circuit on overloads.
- If motor has been stored in a damp location, the windings may require drying.
- Do not obstruct the normal flow of ventilating air through or over the motor.
- Identify motor auxiliary devices such as space heaters or temperature sensors. Connect them in proper circuits and insulate them from motor power cables.
- Check motor leads with connection diagrams on motor nameplate and/or conduit box so that the proper connections are made. All motors should be installed in accordance with the National Electric Code and local requirements.
- Check the gear drive output shaft rotation against the proper rotation indicated on the unit nameplate. For standard three-phase electric motors, the rotation can be reversed by switching any two power leads.
- Check operating motor amperage against motor nameplate amperage.

The motor should start quickly and run smoothly. If the motor should fail to start or make abnormal noise, immediately shut motor off, disconnect it from the power supply, and investigate the cause. If the problem cannot be corrected, contact your [local Chemineer office](#) for assistance.

Q.3 SHAFT SEALS - OPERATION

Q.3.1 LIP SEALS

This gearbox is sealed on the output shaft [244] by two lip seals. These seals are greased at the factory, so no service is necessary at start up for these seals.

The extension shaft lip seal or v-ring does not come pre-greased. While it is not mandatory to grease these seals, the seals will have a lower running temperature and thus a longer life if grease is applied prior to operation. If the process conditions allow, process-compatible grease should be applied to the sealing surface.

All rotary lip seals will eventually need replacement as they are wearing components. Wear rates depend on agitator input and output speeds, frequency of service, and environmental factors. A “typical” life cannot be predicted, so periodic inspection is highly recommended.

Q.3.2 AUXILIARY STUFFING BOXES

Some units are furnished with auxiliary mounted stuffing boxes. The standard stuffing box is a six (6) ring design with self-lubricating packing suitable for 100 psig (689 kPa) at 400°F (204°C).

At start-up, the packing should be “run-in” by tightening the hex adjusting nut one flat at a time, allowing 15 minutes between each take-up for the packing to reseal itself before further tightening. Repeat these adjustments at 15-minute intervals until the desired leakage is obtained.


Make periodic inspections for leakage, but do not pick up the gland unless necessary. Over tightening wears out packing prematurely, and causes scoring and damage to the shaft.

Q.4 STEADY BEARINGS - OPERATION

If a steady bearing is supplied, do not operate agitator unless it is properly installed. Failure to install a required steady bearing will cause severe damage to the agitator assembly if operated. Do not operate agitator unless the steady bearing is submerged.

The pad and cup-tripod steady bearings have been supplied with an optional flush feature for lubrication and cooling. If the flush is utilized, the pipe plug [641] must remain installed on the bushing housing [627] and the inlet pressure should be maintained at 15 to 20 psi over the vessel pressure. If the flush is not utilized, the pipe plug [641] must be removed.

Q.5 LUBRICANT WATER COOLING - OPERATION

	Caution!
	The drive may only be commissioned after the cooling spiral has been connected to the cooling circuit, and the cooling circuit has been put into operation.

The coolant must have a similar thermal capacity as water (specific thermal capacity at 20°C $c=4.18$ kJ/kgK). Industrial water without any air bubbles or sediments is recommended as a coolant. The water hardness must be between 1° dH and 15° dH, and the pH value must be between pH 7.4 and pH 9.5. No aggressive liquids should be added to the coolant!

The **coolant pressure** must not exceed **8 bar**. The required **quantity of coolant** is **10 litres/minute**, and the **coolant inlet temperature** should not exceed 40°C; we recommend 10°C. We also recommend fitting a pressure reducer at the coolant inlet to avoid any damage due to excessive pressure.

If there is a danger of frost the operator should add a suitable anti-freeze solution to the cooling water.

The **temperature of the cooling water** and the **cooling water flow rate** must be **supervised and ensured** by the operator.

Q.6 CHECKLIST**Table 6. START UP CHECK LIST**

<i>Object of the check</i>	<i>Checked on:</i>
<i>Is the vent plug activated or the pressure vent screwed in?</i>	
<i>Are contact guards fitted to rotating components?</i>	
<i>Is the cooling cover connected to the cooling circuit (if applicable)?</i>	
<i>Is mounting per recommendations?</i>	
<i>Are impeller bolts properly torqued?</i>	
<i>Are impellers submerged in any settled solids?</i>	
<i>Has shaft runout been checked?</i>	
<i>Has shaft rotation direction been verified?</i>	
<i>Does gearbox have proper lubrication?</i>	

Q.7 TROUBLE-SHOOTING**Table 7. TROUBLE-SHOOTING GUIDE**


OBSERVATION	POSSIBLE CAUSE	ACTION
Noisy Operation	Worn or damaged parts	Check bearings and gears for excessive wear. Replace worn parts. Try to find cause of wear. Check for water and/or abrasives in oil, overload, incorrect rotation, excessive shock, etc.
	Overloading	Overloading can cause excessive separation of gear teeth and loud operation. Check process fluid (specific gravity and viscosity) vs. design conditions. Check agitator speed and impeller diameter against unit assembly drawing information.
	Worn or improperly installed motor coupling	Couplings can generate noise, which seems to emanate from gear drive. Check for worn parts.
	Structural vibration and sound amplification	Steel mounting structures often amplify small amounts of normal noise into excessive noise. This can be corrected by adding stiffness or sound deadening material to the structure.
Abnormal Heating	Incorrect Oil	Review Lubrication section of manual. Replace with proper oil.
	Unusual ambient	Units installed in a hot area of a plant where airflow is restricted can overheat. Remove obstruction and if necessary force circulate air.
	Improper oil level	Add or remove oil.
	Cleanliness	Remove dirt and/or product buildup from motor/gear drive.
Leaking	Worn oil seals	Replace defective seals.
	Oil escaping from pressure vent	Incorrect oil level or incorrect, contaminated oil or unfavourable operating conditions. Change oil.
Drive shaft does not rotate although motor is running	Fracture in gear unit or defective motor coupling or shrink disc slippage	Consult Chemineer Engineering

R. MAINTENANCE –AUXILIARY SEALS

R.1 MAINTENANCE – INTEGRAL-TO-FLANGE STUFFING BOX


The stuffing box is generally furnished with self-lubricating packing. If this is the case, it does not require any additional lubrication for the life of the packing. Routine maintenance consists of periodic inspections for leakage and tightening of gland nuts [1353]. Repacking is required when satisfactory control over leakage is not attainable. Check to ensure your packing is self-lubricating or is otherwise sufficiently lubricated.

R.1.1 Stuffing box Removal

	Attention!
	<p>Prior to removing the agitator drive, review the agitator installation to assure that all safety issues are resolved.</p>

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove stuffing box packing:

Remove hex adjusting nuts [1353] and lock washers [1354]. Slide gland plate [1355] toward the gear drive. Remove split gland [1356]. With packing tools (supplied by others), remove three rings of packing [1357], lantern ring [1358], and the remaining three rings of packing. The lantern ring is provided with two #8-32 tapped holes to aid in removal.

	Attention!
	<p>Never add new packing on top of the old packing, as this will cause accelerated wear and scoring of the shaft.</p> <p>Refer to the unit assembly drawing for the number and composition of the packing rings supplied originally with your agitator.</p>

R.1.2 Stuffing box repacking

1. Install three packing rings [1357], lantern ring [1358], three more packing rings, split gland [1356] (holes at top), gland plate [1355], lock washers [1354] and gland nuts [1353]. Stagger each packing split 90°. Seat each packing ring as it is installed.
2. Tighten the gland nuts until the lock washers are compressed. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten.

The stuffing box will require adjustment at start-up. Always strive for satisfactory sealing with the least gland force possible. Tighten the hex adjusting nuts uniformly and gradually (no more than one flat on the nuts every 15 minutes) until the leakage rate is acceptable. Do not over tighten. Make sure the split packing gland remains square with the shaft. Once the packing has been "run in", the hex adjusting nuts should be retightened on a regular basis. This can vary from weekly to monthly depending upon the desired level of sealing and the frequency of operation.

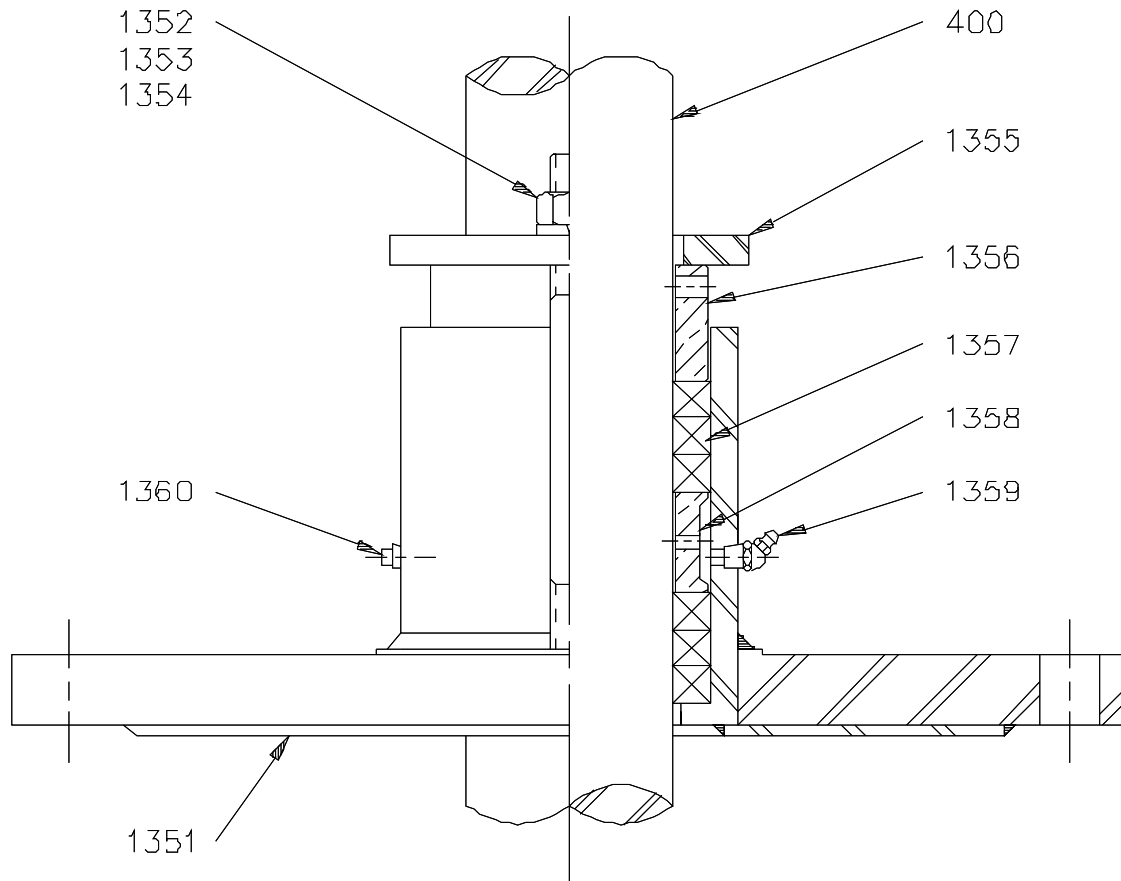



Figure 36. Auxiliary Stuffing Box

R.2 MAINTENANCE – BOLT-ON STUFFING BOX (CAST HOUSING)


The stuffing box is generally furnished with self-lubricating packing. It does not require any additional lubrication for the life of the packing. Routine maintenance consists of periodic inspections for leakage and tightening of hex adjusting nuts [1301]. Repacking is required when satisfactory control over leakage is not attainable.

R.2.1 Stuffing box Removal

	Attention!
	<p>Prior to removing the agitator drive, review the agitator installation to assure that all safety issues are resolved.</p>

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove stuffing box packing:

Remove hex adjusting nuts, lock washers, flat washers and gland clamps [1301, 1302, 1303, 1304]. Remove split packing gland [1312]. With packing tools (supplied by others), remove packing [1313].

	Attention!
	<p>Never add new packing on top of the old packing, as this will cause accelerated wear and scoring of the shaft.</p> <p>Refer to the unit assembly drawing for the number and composition of the packing rings supplied originally with your agitator.</p>

R.2.2 Stuffing box repacking

1. Install packing rings [1313]. Stagger each packing split 90°. Seat each packing ring as it is installed. Install split packing gland and gland clamps [1312, 1304]. Retain with hex adjusting nut, lock washer and flat washer [1301, 1302, 1303].
2. Tighten the hex adjusting nuts. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten.

The stuffing box will require adjustment at start-up. Always strive for satisfactory sealing with the least gland force possible. Tighten the hex adjusting nuts uniformly and gradually (no more than one flat on the nuts every 15 minutes) until the leakage rate is acceptable. Do not over tighten. Make sure the split packing gland remains square with the shaft. Once the packing has been "run in", the hex adjusting nuts should be retightened on a regular basis.

This can vary from weekly to monthly depending upon the desired level of sealing and the frequency of operation.

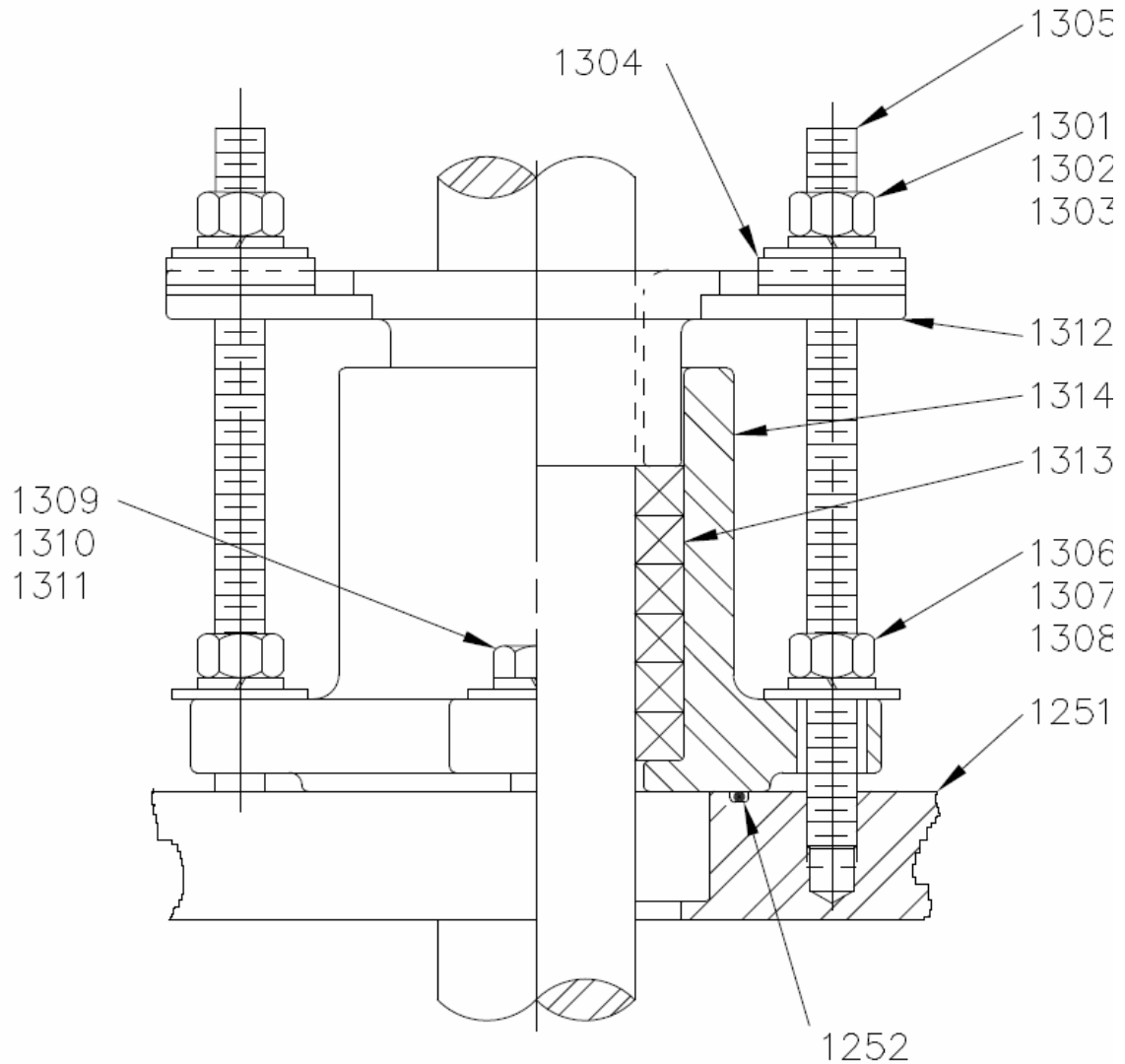



Figure 37. 6 – Ring Stuffing Box (cast housing)

R.3 MAINTENANCE – BOLT-ON STUFFING BOX (FABRICATED HOUSING)


The stuffing box is generally furnished with self-lubricating packing. It does not require any additional lubrication for the life of the packing. Routine maintenance consists of periodic inspections for leakage and tightening of hex adjusting nuts [1301]. Repacking is required when satisfactory control over leakage is not attainable.

R.3.1 Stuffing box Removal

	Attention!
	<p>Prior to removing the agitator drive, review the agitator installation to assure that all safety issues are resolved.</p>

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove stuffing box packing:

Remove hex adjusting nuts [1301] and flat washers [1303]. Slide gland plate [1355] toward the gear drive. Remove split gland [1356]. With packing tools (supplied by others), remove packing [1313].

	Attention!
	<p>Never add new packing on top of the old packing, as this will cause accelerated wear and scoring of the shaft.</p> <p>Refer to the unit assembly drawing for the number and composition of the packing rings supplied originally with your agitator.</p>

R.3.2 Stuffing box repacking

1. Install packing rings [1313]. Stagger each packing split 90°. Seat each packing ring as it is installed. Install split gland [1356] (holes at top) and gland plate [1355]. Retain with hex adjusting nut and flat washer [1301, 1303].
2. Tighten the hex adjusting nuts. Let the packing set for five to ten minutes so that it can cold flow and adjust to the gland pressure. Loosen the hex adjusting nuts, then finger tighten.

The stuffing box will require adjustment at start-up. Always strive for satisfactory sealing with the least gland force possible. Tighten the hex adjusting nuts uniformly and gradually (no more than one flat on the nuts every 15 minutes) until the leakage rate is acceptable. Do not over tighten. Make sure the split packing gland remains square with the shaft. Once the packing has been "run in", the hex adjusting nuts should be retightened on a regular basis. This can vary from weekly to monthly depending upon the desired level of sealing and the frequency of operation.

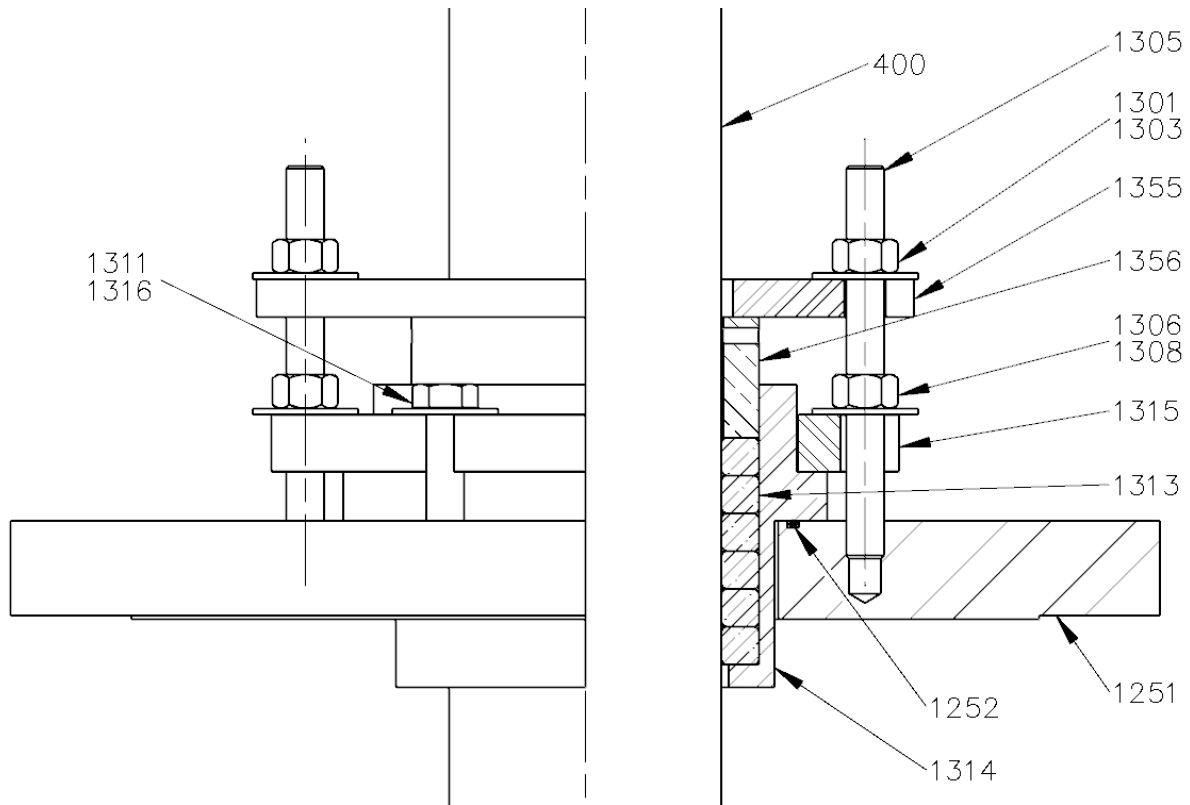


Figure 38. 6 – Ring Stuffing Box (fabricated housing)

R.4 MAINTENANCE – AUXILIARY LIP SEAL

The lip seal, like any rotary shaft seal, will eventually wear and require replacement. Routine maintenance consists of periodic inspections for leakage. Replacement is required when a satisfactory shaft seal is no longer attainable.

R.4.1 Lip seal removal

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove snap ring [1852] and lip seal [1853] from flange [1851].
4. Lip seal will need to be cut for removal from shaft. Snap Ring Can remain on the shaft until the new lip seal has been installed.

R.4.2 Lip seal replacement

1. Place the new pre-split lip seal into the flange.
2. Reinstall the snap ring [1852] into flange [1851].
3. Auxiliary lip seals do not require any adjustment or lubrication.

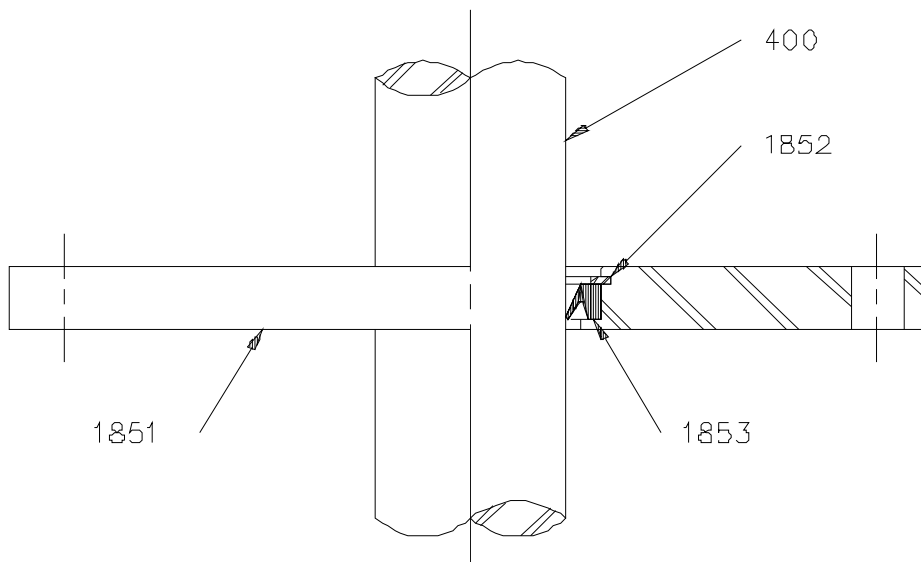


Figure 39. Auxiliary Lip Seal


R.5 GEAR DRIVE

R.5.1 Maintenance Intervals

Table 8. MAINTENANCE INTERVALS FOR GEARBOXES

Service and Maintenance Intervals	Service and Maintenance Work
At least every six months	<ul style="list-style-type: none"> – Visual inspection – Check for running noises – Check oil level – Re-grease
Every 10000 operating hours, at least every 2 years	<ul style="list-style-type: none"> – Change oil (if filled with synthetic oil, this period is doubled) Reduction of lubricant replacement interval under extreme operating conditions (high humidity, aggressive environment and high temperature fluctuations) – Check the cooling coil for deposits
At least every 10 years	<ul style="list-style-type: none"> – General overhaul

R.5.2 Maintenance Work

	Attention!
	Service and maintenance work must only be performed by qualified personnel.
	Installation and maintenance work must only be performed when gear units are at a standstill. The drive must be isolated and secured to prevent accidental start-up.

R.5.2.1 Visual inspection

The gear unit must be checked for leaks. In addition, the gear unit must be inspected for external damage and cracks in the hoses, hose connections and rubber buffers. Have the gear unit repaired in case of leaks, e.g. dripping gear oil or cooling water, damage or cracks. Please contact the Chemineer Field Service department.


R.5.2.2 Check for Running Noises

If the gear unit produces unusual running noises and/or vibrations, this could indicate damage to the gear unit. In this case the gear should be shut down and a general overhaul carried out.

R.5.2.3 Check the Oil Level

1. The oil level may only be checked when the gear unit is **at a standstill and has cooled down**. The gear unit must be secured to prevent accidental switch-on.

2. The oil level screw corresponding to the version must be screwed out.

	Note!
	At the first oil level check a small amount of oil may escape, as the oil level may be below the lower edge of the oil level hole.


3. The maximum oil level is the lower edge of the oil level hole. The minimum oil level is 4 mm below the oil level hole. If the oil level is too low, this must be corrected using the correct type of oil. An oil level glass is available instead of the oil level screw
4. Cap screw with dipstick (optional) and all other loosened screws must be correctly re-tightened.

R.5.2.4 Re-greasing

For some IEC adapters, the outer roller bearing must be re-greased with approx. 20-25g of grease via the grease nipple provided

R.5.2.5 Changing the Oil

1. Place the drip tray below the oil drain screw or the oil drain cock
2. Completely remove oil level screw, screwed sealing plug with dipstick if an oil level tank is being used and oil drain screw.

	Danger!
	Warning: Hot oil!

3. Drain all the oil from the gear unit.
4. If the screw lock coating of the oil drain screw or oil level screw is damaged in the thread, a new oil level screw must be used or the thread cleaned and coated with securing lubricant, e.g. Loctite 242, Loxeal 54-03 prior to inserting. The seal ring must be replaced if damaged.
5. Support the seal ring, insert the oil drain screw into the hole and tighten to the correct torque! (See Appendix, Page 98 for torque values)
6. Using a suitable filling device, refill with oil of the same type through the oil level hole until oil emerges from the oil level hole. (The oil can also be filled through the pressure vent screw or a sealing plug located higher than the oil level).
7. Wait at least 15 minutes, or at least 30 minutes if an oil level tank is used, and then check the oil level.

R.5.2.6 General Overhaul

The gear units must be completely dismantled. The following work must be carried out:

- Clean all gear unit components
- Examine all gear unit components for damage
- All damaged components must be replaced
- All roller bearings must be replaced
- Replace all seals, radial seals and Nilos rings
- Replace plastic and elastomer components of the motor coupling

The general overhaul must be carried out by a specialist workshop with appropriate equipment and qualified specialist personnel.

R.5.3 MRP Agitator drive removal

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove hand hole covers.

Remove mounting bolts, lock washers, and nuts [1102, 1103, 1104]. With a hoist or crane system, lift the agitator drive assembly (Figure 15, page32) above the pedestal [1101] sufficiently to allow the shaft to be blocked in place.

4. Figure 14, page 31.
5. Remove the agitator drive to a suitable service area

R.5.4 MRD Agitator drive removal

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.

Remove mounting bolts, lock washers, and nuts (supplied by others). With a hoist or crane system, lift the agitator drive assembly (Figure 15, page32) above the mounting structure sufficiently to allow the shaft to be blocked in place.


3. Figure 14, page 31.

4. Remove the agitator drive to a suitable service area


R.5.5 Preparation for disassembly

1. Clean external surfaces and drain the oil.
2. Remove motor [100] from gearbox.

R.5.6 Removing the taper fit output shaft coupling

	Attention!
	Do not subject the gear unit to harmful axial forces or shock loads when fitting the hubs.

1. Bend down the tabs on the locking tab (if present) and loosen the coupling bolt, but do not remove completely.
2. Use an appropriate puller to pull the coupling from the output shaft (Figure 40). Apply force against the end of the exposed output shaft while pulling on the coupling. If necessary, a gentle tap on the side of the coupling with a hammer will help loosen the self-locking taper from the shaft.

	Attention!
	WARNING: The release of the taper fit can cause the coupling to suddenly pop off the shaft and fall to the floor if not adequately restrained..

R.5.7 Installing the taper fit output shaft coupling

1. Re-installing the taper coupling to the gearbox is the same as installing the taper coupling onto the extension shaft. See section J.3 on page 31 for instructions.

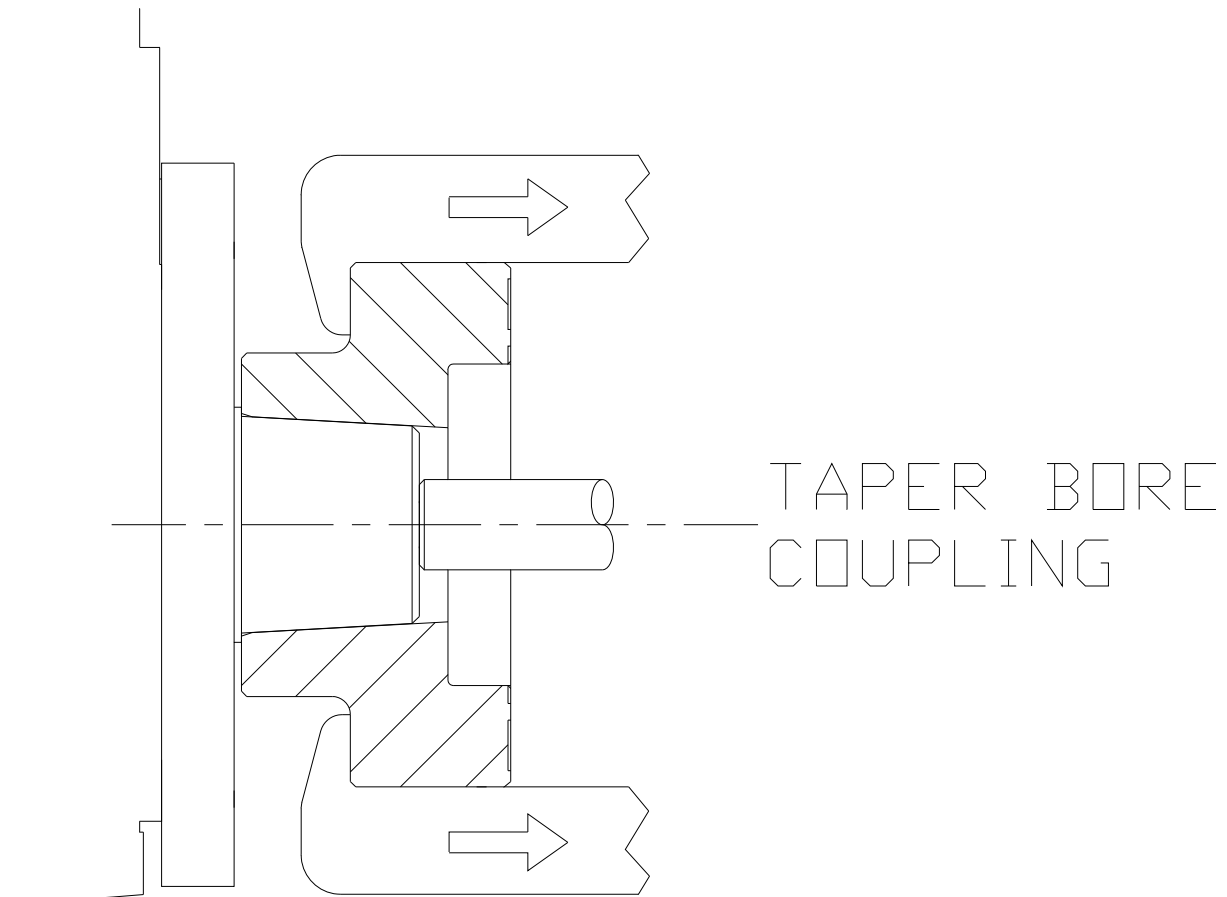


Figure 40. Simple Disassembly Device

R.6 MAINTENANCE - STEADY BEARING

R.6.1 BRACKET, TRIPOD AND PAD STEADY BEARINGS


In-tank steady bearings will require periodic inspection and replacement of bushing and wear sleeve [606, 604] (Figure on page 55)

It is recommended that the steady bearing fasteners be checked for tightness and the bushing and wear sleeve for wear after the first two weeks of operation. Unless otherwise specified the recommended wear allowance is:


Table 9. BRACKET, TRIPOD AND PAD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES

SHAFT DIAMETER	UP TO 3" (76.2mm)	LARGER THAN 3" (76.2mm)
WEAR SLEEVE	.040" (1mm)	.060" (1.5 mm)
BUSHING	.120" (3mm)	.180" (4.5 mm)


The wear sleeve and bushing should be replaced in sets.

	Attention!
	Lock out and disconnect all power to the gear drive motor, any optional devices, and depressurize vessel before servicing this equipment.

1. Loosen setscrew [605] and slide wear sleeve [604] off the shaft.
2. Unbolt the housing from the bracket or tripod (Not applicable to pad style).
3. Remove bushing retaining bolt and lock washer [607, 608]. Remove the bushing from the steady bearing housing.
4. Press a new bushing into the steady bearing housing. Install the bushing retaining bolt and lock washer.

	Note!
	Line up the clearance hole in the new bushing with the tapped hole in the housing prior to pressing the bushing into the housing.

5. Reinstall the wear sleeve and housing/bushing assembly. Torque all fasteners to the value shown in APPENDIX, Page 98.

	Attention!
	Do not operate the agitator without the steady bearing being submerged.

R.6.2 CUP TRIPOD STEADY BEARING

In-tank steady bearings will require periodic inspection and replacement of bushing and stub shaft [606, 630]. (Figure 31, page 57)


It is recommended that the steady bearing fasteners be checked for tightness and the bushing & stub shaft for wear after the first two weeks of operation.

Unless otherwise specified, the recommended wear allowance is:


Table 10. CUP TRIPOD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES Figure 1

SHAFT DIAMETER	UP TO 3" (76.2mm)	LARGER THAN 3" (76.2mm)
WEAR SLEEVE	.040" (1mm)	.060" (1.5 mm)
BUSHING	.120" (3mm)	.180" (4.5 mm)


The stub shaft and bushing should be replaced in sets.

	Attention!
	Lock out and disconnect all power to the gear drive motor, any optional devices, and depressurize vessel before servicing this equipment.

1. Remove the retainer plate [631] and the stub shaft [630] from the stub shaft housing [634]. Remove the retainer to housing bolts and install them into the threaded holes on the retainer plate. Progressively tighten these bolts around the bolt circle to remove the stub shaft.

	Attention!
	Tapers can disengage with a great deal of force; also the stub shaft/retainer assembly can be very heavy on larger size agitators. In order to hold the stub shaft when it disengages use half of the supplied retainer plate bolts threaded into the stub shaft housing.

2. Unbolt the bushing housing [627] from the coupling [620]. Remove the bushing retaining bolt [628] and lock washer [629]. Press the bushing [606] out of the bushing housing [627].
3. Press a new bushing into the bushing housing. Install the bushing retaining bolt and lock washer.

	Note!
	Line up the clearance hole in the new bushing with the tapped hole in the bushing housing prior to pressing the bushing in place.

4. Reinstall the bushing housing, new stub shaft, and retainer plate as described in the *Steady bearings installation section*. Torque fasteners to the value shown in Table 11, page 98.
5. Re-attach the flush piping (if used).

S. ITEMS LIST

Item#	Description	Qty.
100	Motor	1
200	Gear drive	1
244	output shaft	1
350	Low Speed Coupling Assembly	1
351	gear drive coupling half	1
352	key	1
353	coupling washer (1 bolt)	1
354	coupling washer (2 bolt)	1
355	lock washer	1
356	bolt	1
357	lock washer	2
358	bolt	2
361	bolt	
362	bolt	2
363	lock washer	2
364	coupling washer	1
365	key	1

Item#	Description	Qty.
400	Extension shaft assembly	1
402	pin key	1
403-001	drive shaft (welded coupling)	1
403-002	drive shaft (removable coupling)	1
404-001	extension shaft (welded coupling)	1
404-002	extension shaft (removable coupling)	1
405	bolt	
406	lock washer	
407	nut	
408	rigid, removable, taper bore coupling half	1
409	key	1
410	coupling washer	1
412	locking clip	1
413	rigid, removable, taper bore coupling half	1
414	key	1
415	coupling washer	1
416	locking clip	1
418	shaft bolt	1
419	shaft bolt	1
420	key	1
421	coupling washer	1
422	bolt	2
423	lock washer	2
424	coupling washer	1
425	bolt	2
426	lock washer	2

Item#	Description	Qty.
500	Impeller assembly	
501	impeller assembly P-4	
502	impeller assembly S-4	
503	impeller assembly HE-3	
504	hub	
505	setscrew	
506	extension blade	
507	bolt	
508	lock washer	
509	nut	
510	stabilizer fin	
511	bolt	
512	lock washer	
513	nut	
514	impeller assembly D-6, CD-6, BT-6	
515	split disc	
516	bolt	
517	flat washer	
518	bolt	
519	flat washer	
520	locking clip	
521	nut	
522	gasket	2
523	snap ring	1
524	thrust plate	1
525	gasket	1
526	mounting bolt	1
527	impeller assembly SC-3	
528	impeller assembly Maxflo W	
529	bolt	
530	lock washer	
531	nut	
532	impeller assembly XE-3	

Item #	Description	Qty.
533	Impeller assembly RL-3	1
534	Bottom hub cap	1
535	Top hub cap	1
536	Bottom hub cap bolt	3
537	Top hub cap bolt	3

Item#	Description	Qty.
600	Steady bearing assembly	1
601	bracket steady bearing	1
602	pad steady bearing	1
603-001	cup tripod steady bearing	1
603-002	tripod steady bearing	1
604	wear sleeve	1
605	setscrew, square head	
606	bushing	1
607	bushing retaining bolt	1
608	lock washer	1
609	steady bearing housing	1
610	drain plug, NPT	1
620	coupling	1
621	coupling bolt	4 to 6
622	lock washer	4 to 6
623	key	1
624	coupling washer	1
625	shaft bolt	2
626	lock washer	2
627	bushing housing	1
628	bushing retaining bolt	1
629	lock washer	1
630	stub shaft	1
631	retainer plate	1
632	retainer plate bolt	4 to 8
633	lock washer	4 to 8
634	stub shaft housing	1
635	leg	3
636	leg bolt	6
637	leg nut	6
638	lock washer	6
639	flat washer	6
640	alignment pin	3
641	pipe plug (flush)	1

Item#	Description	Qty.
700	Mounting plates	1
701	plate	1
702	bolt	8
703	lock washer	8
704	bolt	8
705	lock washer	8
706	plate	1
707	eye bolt	4
708	flat washer	4
900	Anchor bolt assembly	1
901	anchor bolt	4
902	nut	4
903	lock washer	4
904	flat washer	4
1100	Pedestal assembly	1
1101	pedestal	1
1105	hand hole cover	2
1106	bolt	8
1107	lock washer	8
1109	bolt	8
1110	flat washer	8
1111	well nut	8
1124	eye bolt	4
1125	flat washer	4

Item#	Description	Qty.
1250	Mounting flange assembly	1
1251	mounting flange	1
1252	o-ring	1
1300	Auxiliary stuffing box assembly (bolt-in)	1
1301	hex adjusting nut	2
1302	lock washer	2
1303	flat washer	2
1304	gland clamps	2
1305	stud	2
1306	nut	2
1307	lock washer	2
1308	flat washer	2
1309	bolt	2
1310	lock washer	2
1311	flat washer	2
1312	split packing gland	2
1313	packing	6
1314	packing housing	1
1315	clamping gland	1
1316	bolt	4
1350	Auxiliary stuffing box assembly (integral)	1
1351	flanged stuffing box (6 ring)	1
1352	stud	2
1353	gland nut	2
1354	lock washer	2
1355	gland plate	1
1356	split gland	1
1357	packing (2 sets of 3 rings)	6
1358	lantern ring	1
1359	grease fitting	1
1360	pipe plug, NPT	1
1850	Auxiliary lip seal assembly	1
1851	lip seal flange	1
1852	snap ring	1
1853	lip seal	1

T. APPENDIX I

Tighten all fasteners to values shown unless specifically instructed to do otherwise. Lubricate all fasteners at assembly with thread lubricant or an anti-seize material. Bolt threads and contact surfaces of bolt heads and nuts should be lubricated. Note that stainless steel and alloy fasteners can gall while being tightened. The risk of galling or thread seizing is reduced by using lubrication, by tightening fasteners with low rpm's and without interruptions, and applying only light pressure. Dry fasteners, components with dirt or dust, bolting faces with rough finish, or even some environmental factors such as heat or moisture can effect the torque readings, and require values different than those listed in the table below.

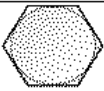
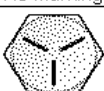

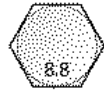
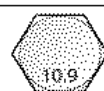
Table 11. BOLT TIGHTENING TORQUE

BOLT SIZE	SAE J429 CARBON STEEL						STAINLESS STEEL	
	GRADE 2 METRIC GRADE 4.6		GRADE 5 METRIC GRADE 8.8		METRIC GRADE 12.9		300 Series Stainless Steel (e.g. 304, 316)	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4 - 20	-	-	6	8.1	-	-	4.1	5.6
5/16 - 18	-	-	13	18	-	-	8	11
3/8 - 16	-	-	23	31	-	-	15	20
1/2 - 13	38.0	52	55	75	-	-	38	52
9/16 - 12	50.0	68	79	107	-	-	50	68
5/8 - 11	68.0	92	110	149	-	-	68	92
3/4 - 10	120.0	163	195	264	-	-	95	129
7/8 - 9	122.0	165	314	426	-	-	153	207
1 - 8	184.0	250	470	637	-	-	230	312
1-1/8 - 7	260.0	353	587	796	-	-	326	442
1-1/4 - 7	368.0	499	828	1123	-	-	460	624
1-3/8 - 6	482.0	654	1085	1471	-	-	602	816
1-1/2 - 6	640.0	868	1440	1953	-	-	800	1085
M6 x 1.00	3.8	5.1	6.9	9.4	9.7	13	4.3	5.8
M8 x 1.25	8	10	17	23	24	32	10	14
M10 x 1.50	15	20	34	45	47	63	21	28
M12 x 1.75	26	35	58	79	81	110	36	49
M16 x 2.00	64	87	145	196	202	274	89	121
M20 x 2.50	126	170	282	383	394	534	174	236
M24 x 3.00	217	295	489	664	537	728	300	407
M30 x 3.50	434	588	971	1316	1073	1455	598	811

Table 12. BOLT TIGHTENING TORQUE (CONTD)

BOLT SIZE	ALLOY 600 (UNS#N06600), ALLOY C4 (UNS#N06455), ALLOY G30 (UNS#N06030), ALLOY 2205 (UNS#S32205)		ALLOY C276 (UNS#N10276), ALLOY C2000 (UNS#N06200)		ALLOY 20 (UNS#N08020), ALLOY 400 (UNS#N04400), ALLOY 825 (UNS#N08825)	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4 - 20	4	5.4	5	6.8	3.4	4.6
5/16 - 18	8	11	10	14	7	9
3/8 - 16	15	20	18	25	12	17
1/2 - 13	36	49	45	61	30	41
9/16 - 12	52	70	65	88	43	59
5/8 - 11	72	97	89	121	60	81
3/4 - 10	127	172	159	215	106	143
7/8 - 9	205	277	256	347	170	231
1 - 8	307	416	383	520	256	346
1-1/8 - 7	435	589	543	737	362	491
1-1/4 - 7	613	832	767	1040	511	693
1-3/8 - 6	804	1090	1005	1363	670	908
1-1/2 - 6	1067	1447	1334	1809	889	1206
M6 x 1.00	3.7	5.0	4.9	6.6	3.1	4.2
M8 x 1.25	9	12	12	16	7	10
M10 x 1.50	18	24	24	32	15	20
M12 x 1.75	31	42	41	56	26	35
M16 x 2.00	77	104	102	139	64	87
M20 x 2.50	150	203	200	271	125	169
M24 x 3.00	276	374	345	468	216	292
M30 x 3.50	548	743	682	925	430	583

Table 13. Bolt grades and mechanical properties

Head Marking	Grade and Material	Nominal Size Range (inches)	Mechanical Properties		
			Proof Load (psi)	Min. Yield Strength (psi)	Min. Tensile Strength (psi)
US Bolts					
 No Markings	Grade 2 Low or medium carbon steel	1/4 thru 3/4	55,000	57,000	74,000
		Over 3/4 thru 1-1/2	33,000	36,000	60,000
 3 Radial Lines	Grade 5 Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
		Over 1 thru 1-1/2	74,000	81,000	105,000
 6 Radial Lines	Grade 8 Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. Most stainless is non-magnetic	18-8 Stainless Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		40,000 Min. 80,000 – 90,000 Typical	100,000 – 125,000 Typical
		3/4 thru 1		40,000 Min. 45,000 – 70,000 Typical	100,000 Typical
		Above 1			80,000 – 90,000 Typical
Head Marking	Class and Material	Nominal Size Range (mm)	Mechanical Properties		
			Proof Load (MPa)	Min. Yield Strength (MPa)	Min. Tensile Strength (MPa)
Metric bolts					
 8.8	Class 8.8 Medium Carbon Steel, Quenched and Tempered	All Sizes below 16mm	580	640	800
		16mm - 72mm	600	660	830
 10.9	Class 10.9 Alloy Steel, Quenched and Tempered	5mm - 100mm	830	940	1040
12.9	Class 12.9 Alloy Steel, Quenched and Tempered	1.6mm - 100mm	970	1100	1220
Stainless markings vary. Most stainless is non-magnetic. Usually stamped A-2	A-2 Stainless Steel alloy with 17- 19% Chromium and 8-13% Nickel	All Sizes thru 20mm		210 Min. 450 Typical	500 Min. 700 Typical
Tensile Strength: The maximum load in tension (pulling apart) which a material can withstand before breaking or fracturing. Yield Strength: The maximum load at which a material exhibits a specific permanent deformation Proof Load: An axial tensile load which the product must withstand without evidence of any permanent set. 1MPa = 1N/mm ² = 0.2248 pounds/mm ²					

(Source: www.boltdepot.com)



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