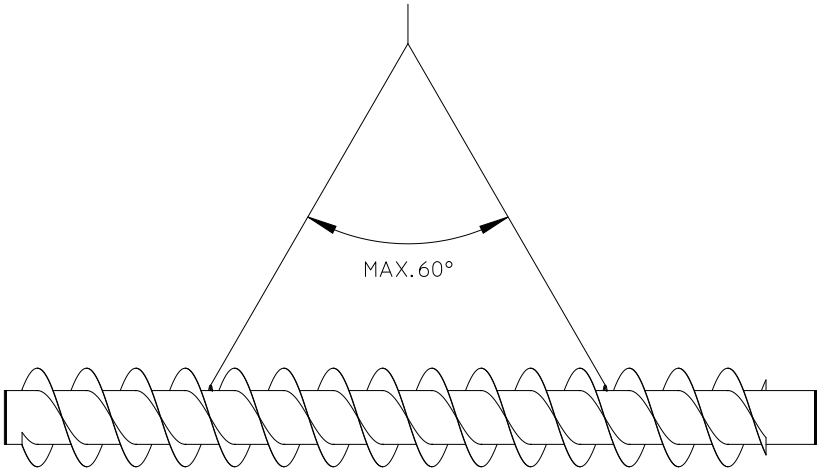
1 Landustrie Archimedean screw installation manual

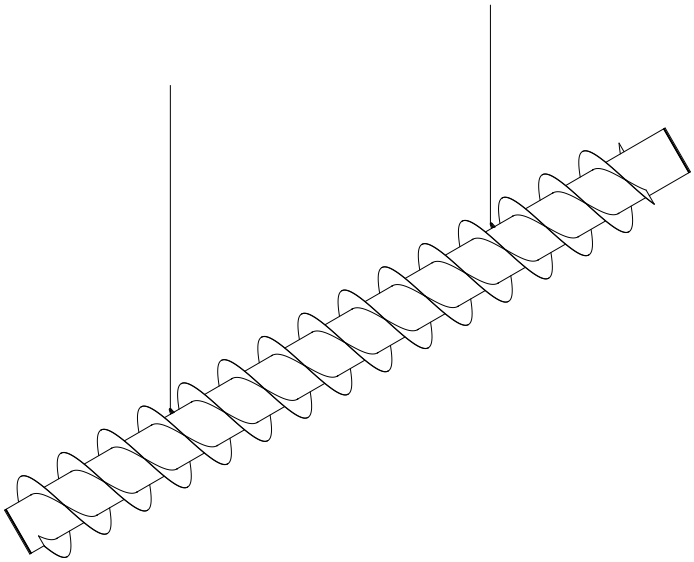
This manual will lead you through the process of handling and installing Landy screws

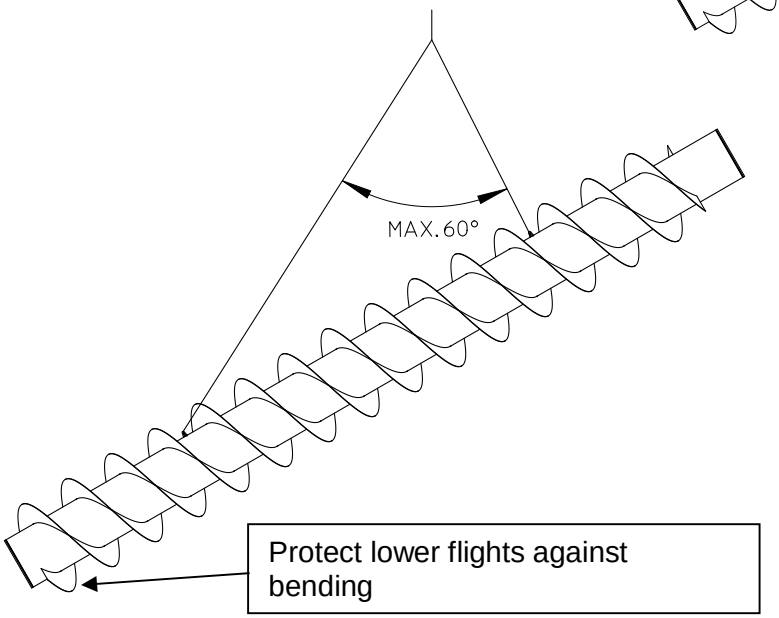
1. Handling:

The screws will be delivered packed on skids, in sea containers or on trucks. There will be lifting lugs welded to the screws suitable for screw, bearings and if applicable, troughs. The slings or chains for lifting the screws must be of a suitable size and length and approved and certified for the purpose.
All lifting operations are to be carried out with suitable equipment by certified & competent personnel.



For positioning the screws in the trough, the screws will have to be lifted in an angle relevant to the installation. The use of 2 cranes is recommended. If the use of 2 cranes is not possible, one crane can be used with great care, different lengths of slings or clutching chains must be used or suitable chain hoists.





In case of using only one crane, great care will have to be taken, not to damage the flights of the screw. When the screw is tilted on the upper side, the screw can be leaning on the lower flights, which might be damaged in doing so.

2. Installation

Landustrie can provide the service of a supervisor, it is highly recommended to make use of this service.
As a source of information, you will be supplied not only with the information in this manual, but also with an operation and maintenance manual, which contains all the suppliers' information together with a set of drawings, consisting of:

- A general layout, which is usually marked no1 in the far bottom right hand corner. This drawing is to be used for all the specific features of the project, like dimensions, weights and position of the machines, and project specific components and their specifications and weights.

Also included are the drawings of, for example :

- Bearings
- Side rails
- Drive units

Every drawing has, as an appendix, a parts list.
The encircled numbers on the general layout correspond with the parts list, which will lead you either directly to a part, or to a sub drawing. The sub drawing will have its own parts list. The parts will be packed in boxes or bags. These will be marked with the drawing numbers and parts numbers. For example: "BL 1 Pos 1" is: BL1= Drawing 1, Pos 1= Number 1.

1. Before the installation can begin, check the civil works for dimensions against drawings.

2. Clean the flanges of the screw and bearings and check for damage. Remove the plastic plugs from the tapped holes in the flanges of the screw and check the thread of the tapped holes; the bolts should screw in by hand. Bolt the lower bearing assembly to the screw using the bolts that have been supplied with the bearing using multi purpose grease on the thread. Tighten the flange bolts to the right torque with a torque wrench and where appropriate a torque multiplier. The torque settings are stated on the drawings. Place the anchor bolts into the designated holes. There is a separate drawing of the lower bearing, follow the numbers on the drawings as mentioned above.

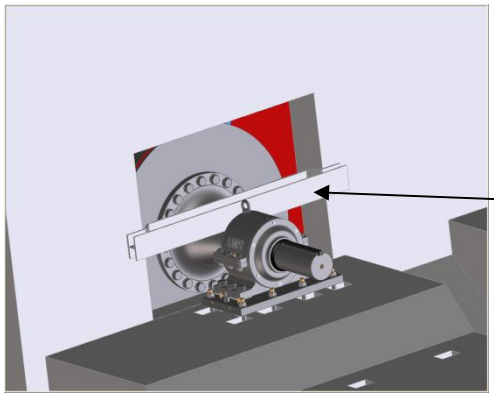
3. Place the upper bearing assembly with anchor bolts on its foundation and support it so it will not slide away. Prepare the bolts supplied with the upper bearing; use a smear of grease on the thread. And use only the bolts supplied with the bearing! These are 8.8 with washers HV.

4. This complete screw pump/ lower bearing assembly can now be carefully hoisted into the concrete construction See Chapter 1 Handling.

5. Position the screw in the civil structure and bolt the screw to the upper bearing while the screw is still hanging from the crane, using the bolts and washers supplied with the upper bearing. The upper bearing flange bolts must be tightened with a torque wrench, to the

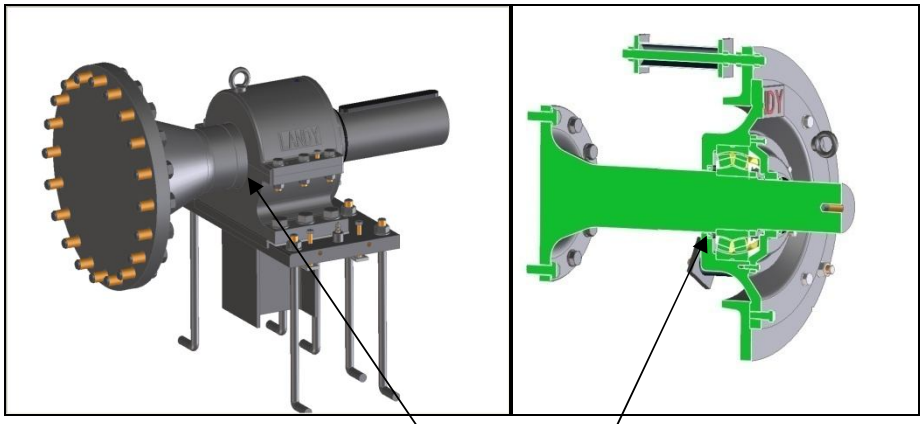
right settings. The torque settings are stated on the drawing.

6. Do the final positioning of the screw pump, trough and bearings while the screw is still partially supported by the crane. See to it, that the upper bearing is supported by the jack bolts in its foundation plate and by a support to prevent the screw from sliding downhill.



Example of a temporary support for the upper bearing (Not necessary for wall mounted bearings).

7. The upper bearing needs to be aligned using feeler gauges between bearing housing and shaft.
   For screws with screeded troughs, the lower part of the screw can be supported by metal plates between the flights and trough.
   Screws with liners can be supported on the liner itself.
   Screws with casting moulds must be supported on the tube of the screw.



Clearance between shaft and housing at least 0.5mm (0.002”) all around the shaft

8. Any lubricators and grease or oil lines can be installed and connected now, if applicable.

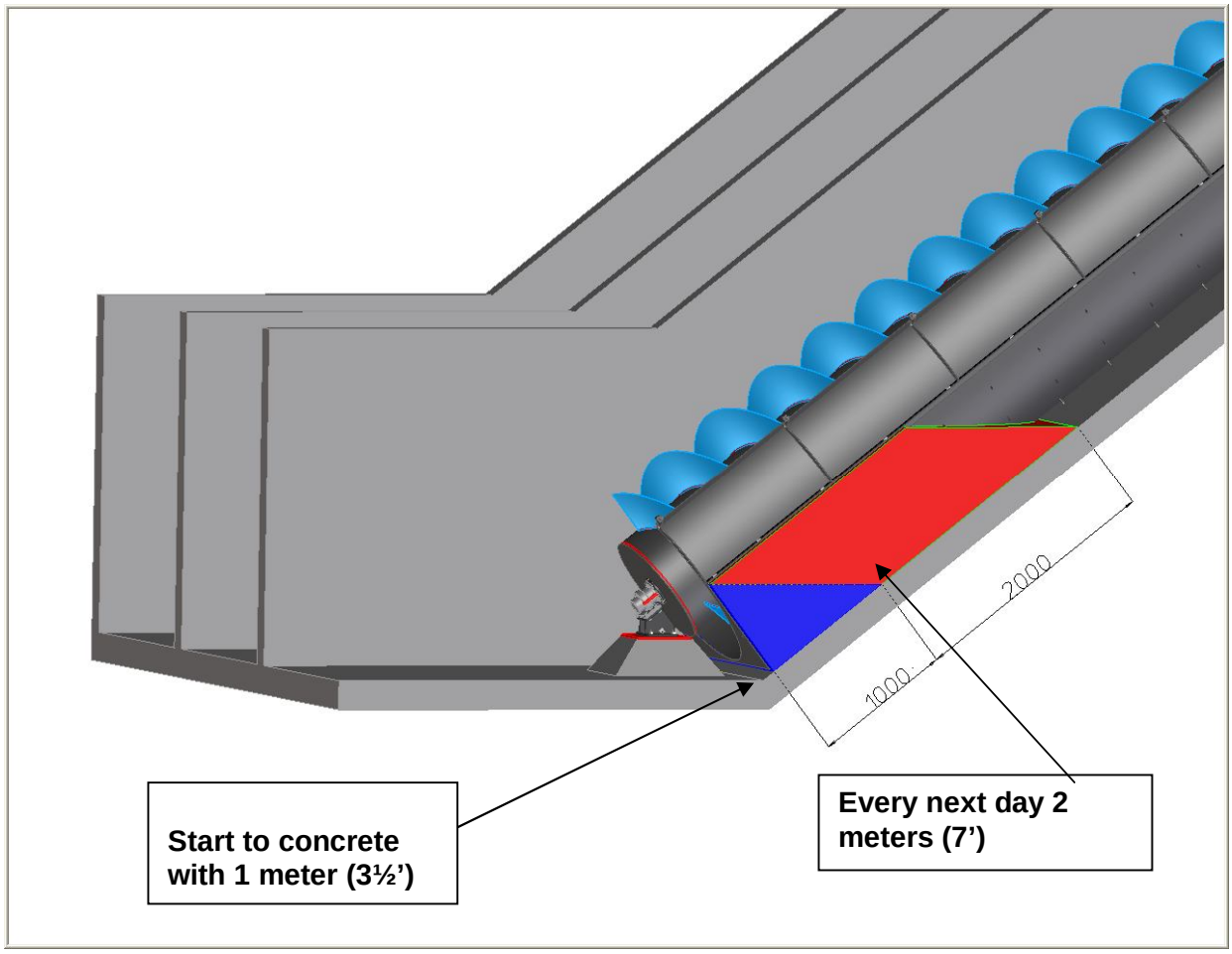
3. Grouting

The grouting is a civil matter, outside the scope of this manual, and the buyers' responsibility. The recommendations in this chapter are to be used as a guideline only.

1. **Bearings:**
   When the screw is positioned, grouting can start. For the grouting of anchor bolts and other machine parts a non shrink mortar is recommended, for example:
   "Pagel V1/50" www.pagel.com/en/index.html or
   "SikaGrout® 300". www.sika.com/const_contr_grouting_cement_grouts_bro
   For grouting of steel liners and casting moulds, a suitable concrete is used.

2. **Troughs:**
   A screw needs to be fitted into a closely fitting trough. This trough can be made in different ways;
   - As metal liners, to be cast in concrete,
   - As screeded concrete troughs,
   - As cast concrete troughs, where a steel casting mould is fitted around the bottom half of the circumference of the screw, and a full concrete trough is cast,
   - As a complete, prefabricated construction where no further civil works are needed.

   a. **In case of screws with steel lined troughs and casting moulds**:
      Only the lower bearing and the anchor bolts of the upper bearing are grouted at this stage. After curing of the bearing grout, the trough can be grouted bit by bit. The grouting is a civil engineering matter and care must be taken, tremendous amounts of pressure and buoyancy can be developed during the concreting of the trough. We recommend to concrete one meter (3½') of trough length to start with, and to do another 2 meters(7') per day.

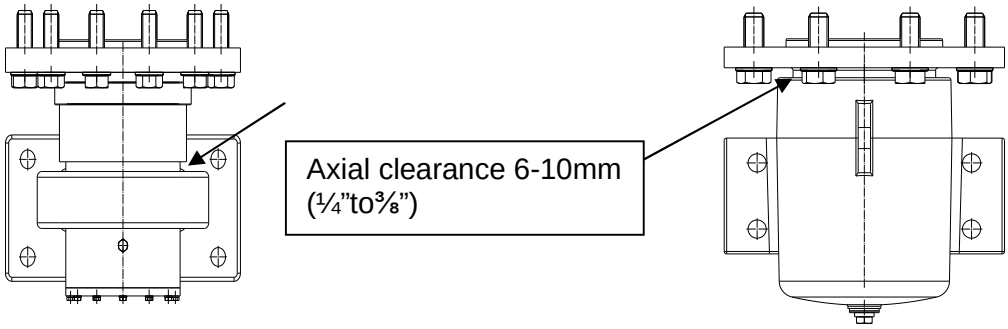


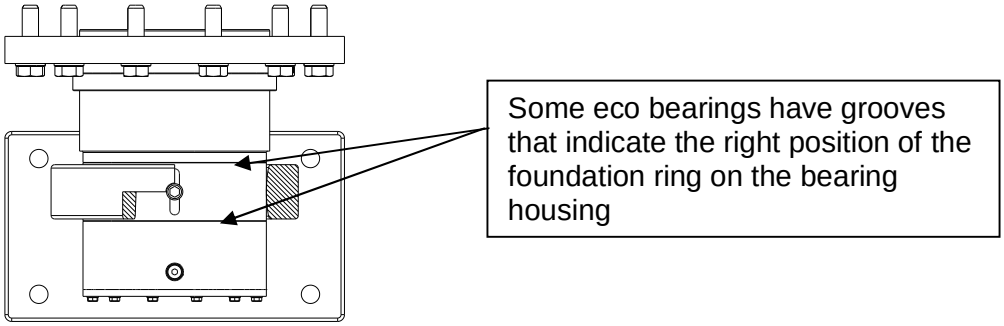
When the trough is finished, the spacers between trough and screw must be removed, the red brackets on the lower bearing must be removed and anchor bolts of the lower bearings must be tightened.
Now the screw must be lifted up and the bearings shimmed to achieve the desired clearance of 4-10mm (5/32"-3/8") between trough and screw. One must be able to turn the screw by hand, rotating backwards. Now the upper bearing foundation plate must be grouted.

Note! The screw must be kept out of direct sunshine. Temporary distortion can occur as a result of one sided heating through the sun, making it impossible to set up the screw with the right clearance. In order to be able to turn the screw, this job can be performed early morning or late in the evening to avoid direct sunshine. Also the fitting of a sunshield can be considered.

b. **In case of screeded troughs:**
When the grouting has cured, all temporary supports and the red brackets on the lower bearing must be removed and the anchor bolts of the bearings must be tightened. Check if the screw turns freely.

4. Finish bearings and drive





1. Check if the lower bearing has the right axial clearance. The forces of the weight of the screw pump and water will be taken by the upper bearing, The lower bearing must only support the screw radially, axial forces will destroy the lower bearing.

2. Now the drive/generator unit can be installed. Check the drawings and the documentation in the manuals for clearances and run out of the couplings. The gearbox is installed on foundation plates provided with jack bolts for alignment, and anchor bolts for securing the unit to the plinth. A clearance of 20-40 mm (¾”-1½”) will be foreseen between the foundation plate and the concrete plinth. When the drive unit is setup, grout in the anchor bolts and foundation plates. An electric motor/generator can be fitted on top of the gearbox, it can be flange mounted, or have its own foundation plinth and the drive can be direct or by

V-belts. In either way, check and follow the manual and the drawings.

3. Fill up the gearbox with the right type of oil. Depending on the make and type of gearbox the type and quantity of oil can be on the type-shield, on the parts list, or in the gearbox manual.

4. After all the grouting has been finished, tighten all the anchor bolts.

5. Lubrication lines to the lower bearing if applicable, must be bled. Grease lines must be disconnected from the lower bearing and grease must be pumped in with a grease gun until clean grease comes out of the disconnected grease pipe. Reconnect the grease line and fill some more grease into the lower bearing with the grease gun. Check for leaks!
In case of oil lubrication, the oil feed line must be disconnected from the lower bearing, and the bearing must be filled with the oil return line from the oil pump.

5. Screeding

1. Now the screeding of the trough can be done. The screeding is a civil matter, consistency of the screeding materials is not in the scope of this manual. For the screeding a gear motor is needed to temporarily replace the drive motor, in order to very slowly rotate the screw, (circumferential speed approx. 0,5 m or 20” per sec). Over the outside of the blades of the screw, parallel to the axis of the screw, a flat strip of steel must be tack welded to create the clearance of the screw. Safety precautions must be taken complying to local law. The screw can now be used as a template to create the finish of the trough. When screeding, plan for a dry, cloudy day. Obviously screeding cannot be done in the rain, and when the screw heats up unevenly through direct sunshine, it might temporarily distort, causing a “bent” screw.

2. When the screeding is finished, the side rail can fitted, take care to fit it to the right side. It must have the same clearance as the trough. Check the drawing of the side rail and general arrangement for the details.

3. The drive motor can be placed back in position and V-Belts and guards fitted.

6. Furthermore:

1. Touch up all the paintwork on the screw. Also paint the flanges and bolts of both bearings, so no moisture can enter between the flanges and bolt holes.

2. Connect the electric motor/ generator and sensors on the electric motor and gearbox. Make sure to comply with local legislation. Use a suitable way of starting up the motor. Motor and gearbox can have a minimum speed. If in any doubt about the suitability of the starting equipment, contact the Landustrie project-or field service manager. Multiple speed motors can be shifted from a lower to a higher speed while running, from a higher to a lower speed however, the motor must be stopped to a full standstill and started up again in the lower speed to avoid serious damage.

3. Next, a trial run can be made. Again, watch out for direct sunshine, which can temporarily distort the screw, making it foul the trough. Check for oil flow in the gearbox if an oil pump is fitted, and check temperatures. The oil in the gearbox is, as a rule, suitable for temperatures up to 80°C(176ºF), if this temperature is exceeded, contact Landustrie, another type of oil might be necessary. The motor/generator temperature in a class F motor can without immediate damage get up to 140°C(285ºF) in the windings. As the winding temperatures are not directly measurable, check the casing temperature of the motor if the temperature gets around 95°C(203ºF). Check power, voltage, connections, cooling fans, other electrical equipment, VFD settings and cable lengths.

4. Carefully read the maintenance manual, specifically about the lubrication, after some time oil and filters may need replacing. This varies with the make and type of the gearbox and motor. Read it now, in order to be able to purchase new oil and filters in time
.

7. Mode of operation for screw pump

The starting of the screw pump must only be done when the screw pump has drained itself after the last run.

1. **Fixed speed continuous;**

Running a screw pump in fixed speed continuous means the screw pump is running in a fixed speed, regardless of flow. No further controls needed.
Used for example for sewage treatment head works, the flow into the plant is equal to the flow towards the head works, or for sludge recirculation.

2. **On-off controlled by level;**

Running a screw pump in on-off mode by level means there is a level control unit in the screw pump sump, that switches the screw pump on and off. A timer must be wired in to allow the screw pump to empty after switching off, before it is allowed to switch back on.

3. **Multiple speed motor controlled by level**

As #2 but with more possibilities of controlling the flow. In this mode there is of course the need for multiple speed motors. For each speed there is a separate level set point. The screw is started at the lowest set point, at the lowest speed, when the flow is greater than the capacity of the screw pump at the respective speed, the screw pump is switched to the next higher speed, no need to stop the screw pump first. When the flow diminishes and the level drops to below the previous set point, the motor can be switched to the next lower speed**.** *The screw has to be stopped and restarted in order to change tot a lower speed.*

4. **Flow control by frequency converter;**

The most efficient way to control a screw pump for changing flows. This is a master-slave control. The master is the proportional level controller in the screw pump sump; the set point is a certain level, above the filling point of the screw. When the offset is below the set point there will be a signal commanding the slave, the frequency converter, to increase the speed of the motor, when there is an offset above the set point, there will be a signal commanding the frequency converter to decrease the speed of the motor. Check for minimum/maximum speeds and powers of motor and gearbox!. In this mode there is the possibility of over speeding the screw, which means the screw pump will pump more than it is designed for. This is no problem, within the limits of motor and gearbox, but the energy efficiency will diminish and more splash will occur.
Contrary to centrifugal pumps, *screw pumps are constant torque machines*. This means that the torque, needed to turn the screw is the same at every speed. Not every frequency converter is suitable for this mode. Make sure only to use frequency converters of the right type!

Mode of operation of Archimedean screw generators:

1. Fixed Speed, fixed level:

The flow through the screw is controlled by a gate or a weir, the generator is connected to the grid, giving the screw a fixed speed. The gate or weir is controlled by a level sensor in order to achieve a constant nominal water level at the intake of the screw. This is the most efficient control, provided there is enough water to maintain the nominal water level.

2. Fixed speed, variable level:

There is no level control, the generator speed is controlled by the grid. The efficiency depends on the variation of the water level.

3. Variable speed, fixed level:

The level is controlled by the speed and thus the flow through the screw, in this way the intake level, and the fall can be maintained, improving the efficiency. Also mechanical losses are reduced. Power is synchronized with the grid through a VFD. A level sensor controls the level in the intake, by controlling the VFD.

A brake is fitted to the drive unit to lock the machine when switched off, the brake must be adjusted following the instructions of the brake manufacturer. The controls of the brake must be designed fail safe.

8. Archimedean Screw Maintenance

An Archimedean screw, in general, needs very little maintenance.

Every machine however, needs some care, in order to give the best and efficient service as possible.

Before working on any screw, make sure the installation is safe to work on; make sure the screw cannot be driven in any way; by a drive system or through backflow of water!

1. General

It is recommendable to do periodic checks on machines running in continuous operation. Get used to the sound, temperature and appearance of the machine and look further if there is any change in either of these. Keep everything clean and tidy and make sure no safeties are removed. Have a look out for rubber dust of couplings and belts and check for leaks. Be aware of smells (overheating).

2. Lower bearing:

The lower bearing is either a plain bearing or a low maintenance ECO Bearing. Both have a nodular cast iron or stainless steel stub shaft, and a cast iron, or stainless steel housing.
They are bolted to the screw with pre tensioned, high tensile steel bolts. In some cases, in very aggressive environments, that also require stainless steel screws, special arrangements for the bolts are required.

The plain bearing will be lubricated with an automatic lubricator. It is driven by a V-belt from the main drive, or a separate electric motor.

The bearings are only suitable for radial forces, all axial forces are taken by the upper bearing. Expansion, contraction and all other longitudinal movement is compensated by the lower bearing.

If the screw is in continuous or near continuous use, daily checks have to be done to ensure the lubrication is maintained.
A yearly check of the bearing is recommended.

The ECO bearing is a fully enclosed roller bearing. It is lubricated by running in an oil bath.
A check every year is recommended. For further, detailed information about bearing maintenance, check the appropriate instructions for lower bearings.

3. Upper bearing:

Upper bearings consist of a nodular cast iron or forged steel stub shaft, bolted to the screw body with pre-tensioned, high tensile bolts., and a foot- or wall mounted cast Iron housing with either a spherical roller bearing, or a combination of a spherical roller bearing and thrust roller bearing. Lubrication is by lithium base grease.

It is important to keep the upper bearings greased. This is done manually with a grease gun. For the right amounts of grease check the manual. One method is, to look behind the bearing, keep on pumping grease, until fresh grease comes out from between the shaft and the bearing housing, do this at least once a year.

4. Screw:

A good time to check the screw is when doing maintenance on the lower bearings.
Check the screw and side rail for bent flights, corrosion, and wear. Also check the clearance between screw pump and trough.
Decreased clearance between screw and trough mostly means a worn lower bearing,
Increased clearance means wear in the trough or screw.

5. Gearbox:

The gearbox takes care of a reduction in shaft speed between drive motor and screw pump.
Lubrication of the gearbox is either by oil circulation or oil bath or sometimes a combination of oil bath and grease.
In general, oil changes must be made every 10.000 hrs, or every 2 years whatever comes first.
This is at an oil temperature of around 75°C(167ºF), every increase of 10°C (18ºF) in temperature will reduce the oil change intervals by 50%.
At high temperatures PAO oils are a good alternative.
If in doubt about the oil change intervals, take regular samples and have them analyzed. This is particularly advisable for larger gearboxes because this can save much money in oil.
Carefully read the user's manual of the gearbox manufacturer.
Regular checks on gears and bearings and keeping logbooks are recommended on the bigger gearboxes. In general, gearboxes, with the right maintenance can be made to last forever. Gears do not normally wear out, when bearings are kept in good order. The amount of checks and maintenance one gives a gearbox more or less depends on the price of a replacement gearbox.

6. Motor:

The motor is coupled to the gearbox by means of V-belts, an elastic coupling or coupled directly.
The bearings are lubricated by grease, smaller motors are greased for life, larger motors can be regreased.
Daily maintenance is keeping the fan cover and cooling fins clean.
Carefully check the manual on the greasing of electric motors. Certain amounts of grease have to be used, sometimes in a specific way, and most motors have provisions to remove the old grease.

7. V-Belts:

V-belts have to be kept at the right tension, and regularly checked for cracks. Be careful for over tightening v-belts on small motors, the v-belt transmission can be over engineered on small motors. On large motors, keep the belt tension tight. When changing v-belts, check for wear on the pulleys. The belts must not bottom out in the groove.

9. Lower bearing maintenance:

1. **Plain bearings**:

Traditionally, screw pumps have been supplied with plain lower bearings, lubricated with grease from an automatic lubricator, switched on and off parallel with the main drive of the screw, or even driven from the main drive of the screw.

This has proven to be a reliable construction, provided the necessary maintenance is carried out by suitably qualified personnel.

The lubricator must be set so, that the right amount of grease will be applied to the screw pump at all times.
The right amount of grease is depending on the size of the bearing and is stated in the table below. This amount of grease is suitable for screw pumps that are in operation continuously or semi continuously.

Bearing size	Amount of Grease
60	0,9 cc or 0,03 oz/hr
80	1,7cc or 0.06 oz/hr
100	2,5cc or 0.085 oz/hr
120	3,6cc or 0.122 oz/hr
140	5,5cc or 0.185 oz/hr
160	7,7cc or 0.26 oz/hr
180	8,8cc or 0.30 oz/hr
200	11 cc or 0.37 oz/hr
240	16 cc or 0.54 oz/hr

Some screw pumps are only used in extreme weather situations, and sometimes will only run a few hours a year. For these screw pumps the lubricators should be set at maximum flow.
We recommend using calcium based grease viscosity 1, preferably without EP dopes because of the low bearing strain.
In cold climates or when grease return lines are fitted, lower viscosity grease may prove necessary. This does not affect lubrication, lubrication only depends on the base oil of the grease.

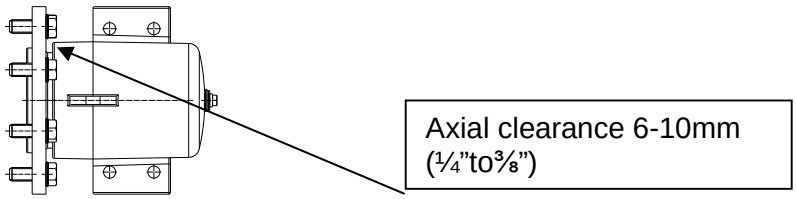
To make sure the right amount of grease is applied, regular checks must be made on the grease reservoir. The level in the reservoir must come down, but must never be empty, or air bubbles will enter the grease line, thus disturbing the grease flow.

Periodical checks of the bearings:

These bearings must be checked yearly.

- Check the screw to trough clearance, diminishing clearance might mean that the bearing is worn.
- The clearance on the bearing can be checked by lifting the screw with a hydraulic jack while using a dial gauge to measure the up and down movement in the bearing. As a rule the bearing must be renewed if the clearance exceeds 1% of the diameter of the bearing.

- Check for irregularities around the screw in the lower bearing area, like rope, or wire which can be wound around the screw quite tightly and can damage coatings and even the metal of the screw and bearing,
- Check the grease supply to the bearing.
- Check for corrosion.
- Check for damage to the construction, like cracks in concrete foundations.
- Check for axial clearance of the bearing
- Check all bolts

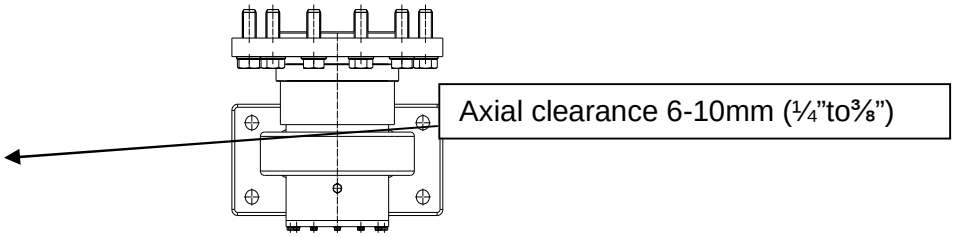


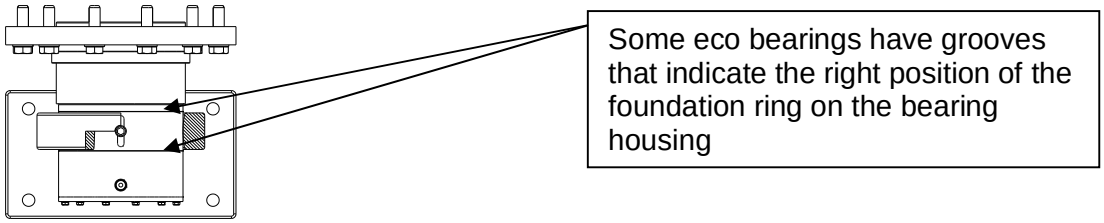
2. Eco bearings

To minimise maintenance and to cut back on lubricant emissions in screw pumps, the eco bearing was developed.
The eco lower bearing consists of a stub shaft running on a pair of tapered roller bearings, in a stainless steel housing. The stainless steel housing is supported in a cast, non corroding ring.
The bearing is 3 dimensionally self aligning.
The housing has a number of seals, making the bearing fully enclosed for a long period of time.
The bearing has oil bath lubrication.

We recommend a yearly check;

- for damage on the bearing and screw pump,
- for irregularities like wire, ropes, or any other debris that might be able to damage the screw or bearing.
- for damage to the construction, like cracks in concrete foundations.
- Check for axial clearance of the bearing housing in the support ring.





The oil in the bearing must be changed once every 5 years or 25000 hours, whichever comes first, the used oil must be checked for metal and water, metal indicates wear to the bearing.
Water can indicate leakage. It is normal, that small amounts of water will be inhibited in the oil. When free water is found inside the bearing, the seals have to be renewed.

The bearing can easily be drained through the cover of the housing, which is sealed by an o-ring and can be used again as long as it is not damaged.
New oil, Shell Rimula R3+ SAE30, a single grade engine oil, must be used and filled through the filling/ level plug in the top of the housing. On refitting the fill/drain plug, make sure to apply a sealant.

Some bearings are fitted with an oil circulation system, which circulates the oil through the bearing and a reservoir, by means of a small oil line by a few cc's a minute. The oil level in the reservoir needs to be regularly checked, as well as the quality of the oil. When too much water becomes inhibited in the oil, the oil must be changed. If the oil becomes water inhibited again very quickly, or oil levels will drop repeatedly, there will obviously be a leak somewhere, which will have to be located and repaired. After filling up the system with oil, the level in the reservoir can drop through air locks, it will obviously have to be topped up if it does, after some time the level will stabilise.

As an extra, a water in oil monitoring alarm can be fitted (also retrofitted). When this alarm comes on, the bearing must be checked as soon as possible; the bearing must be drained and checked for metals. If there is no excessive metal in the drained oil, and there are no obvious leaks, the bearing can be suitable for further use. If the water in oil alarm returns within a short period of time, the bearing must be disassembled and the seals and bearings must be renewed.

10. Water in oil warning system for Landy Eco bearings.

All Landy Eco bearings can be fitted with a water in oil alarm system.
This system gives an alarm when a certain amount of water or some other conducting medium has polluted the oil in the bearing housing.
The system can be fitted to new bearings as well as be retrofitted to existing bearings.

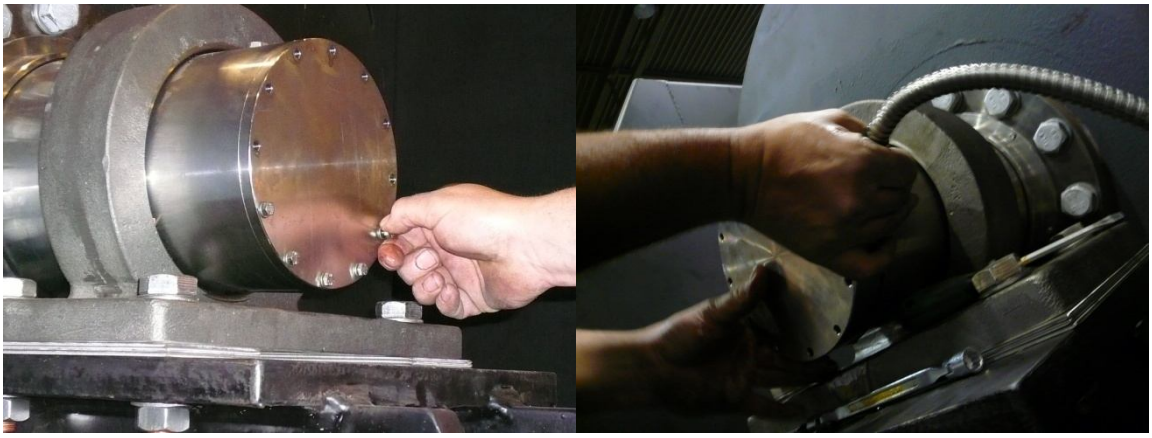
The system comprises:

- A sensor, that is to be changed with the existing end plate/inspection cover of the bearing housing,

- About 20 meters of cable, of which one end is connected to the sensor,
- A control box with the conductivity monitor, a relay, a terminal block and a combined alarm light/reset button

1. **Retrofit of the sensor:**

The existing end plate/inspection cover of the bearing must be removed, check the oil for water and metal. The sensor can now be screwed in place of the end plate, using the new, longer bolts, that were supplied with the sensor. Do not omit the O-Ring, this is vital for the water tightness of the bearing.

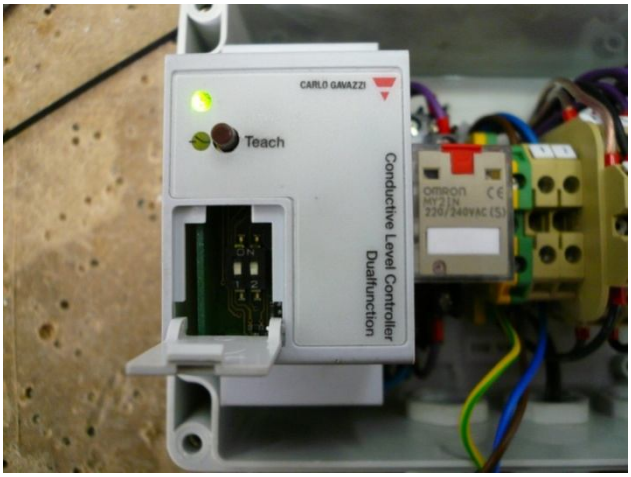


2. Cable routing:

The first part of the cable protected by a flexible cable conduit, and can with no further protection be led towards the floor of the sump, from where further protection will be needed to where the control box is to be located. The cable is sewage water resistant, but will need conduit if laid underground.

3. Calibrating the conductivity monitor:

The conductivity monitor must be calibrated before use. The switch point is to be set at 150-200 KΩ.



Power must be on, and the two toggle switches behind the lid in the front of the conductivity monitor must be in the down position. The “teach” button must be given a short push, the light should extinguish on pushing and light up again immediately after releasing the button.
Next, the test button on the cover of the control box and the teach button must be pushed and held. On pushing the teach button the light will extinguish, a blink can occur straight after extinguishing, but after 2 seconds, a steady blink will start and the light next to the tech button will light up. Also the alarm light will be on. Now the calibration has been done. The alarm light can be reset by pushing the alarm light/button combination. Close the control box and push the test button, the alarm should come on now.

4. **Remote controls:**

A remote alarm and reset can be connected to the terminal block inside the control box. Check the wiring diagram for connections.

5. **Alarm:**

When an alarm is given, an inspection of the bearing should take place.
For inspection of the bearing see Chapter **Lower Bearing maintenance.**

11. Recommended spare parts

The need for spare parts is subject to the risk involved in the failing of a machine. The risk is the product of the likelihood of problems occurring and the consequence of these problems.
Besides that there is the lead time of the parts. The table below is an example of how this decision can be made.
3 kinds of installations are used as an example:
A=crucial installation with no reserve,
B=crucial installation with reserve.
C=non crucial installation

* Recommended spare part

Item	A	B	C	Lead time(est)
Upper bearing	*			2-20 weeks
Lower bearing	*	*		2-13 weeks
Gearbox	*			6-26 weeks
Motor	*			3-13 weeks
Gearbox oil	*	*	*	2 weeks
Lubricator	*			2 weeks
Pump element for lubricator		*		2 weeks
Lower bearing oil	*	*	*	2 weeks
Repair set upper bearing	*	*		2-20 weeks
V-Belts	*	*		2-3 weeks
Rubber elements for coupling(s)	*	*		2-3 weeks
Grease	*	*	*	2 weeks
Lubricant filters	*	*	*	4 weeks