Service Manual of Marine Gearbox Model GW Series

© Hangzhou Advance Gearbox Group Co., Ltd
(Hangzhou Gearbox Works)
The marine gearbox GW series manufactured by Hangzhou Advance Gearbox Group Co., Ltd. The People’s Republic of China, has been approved by the classification societies such as ABS, LR, GL, CCS etc. with good selling at home abroad.

Thanks to their compact design and wide matching range, GW gearboxes’ rated input speed is 400-1800r.min⁻¹, ratios 2:1 ~ 6:1 and rated transmission capacity (N/n1) 0.257 ~ 9.25 kW/r.min⁻¹.

GW gearboxes have 6 series, each of which has 10 models. The GWC, GWD, GWS and GWH have the function of reverse and reduction, and the GWL and GWK without reversing function. Input and output shafts can be arranged coaxial or offset (vertically, horizontally or diagonally). The gearboxes have adapted to combined design, and all running parts have been carefully designed and machined to the highest standards for less wasted fuel, smooth operation which can be fitted to most engine models.

Gearbox controller can be selected pneumatic or electrical operation with manual emergency control device. Gearbox and engine are connected by a highly flexible coupling which may be ordered on request. In generally a stand-by pump set should be prepared. When fitting to the engine, please refer to the main transmission data and the instructions in the manual. For special requirements, contact with sales and design departments.

A thorough understanding of this manual will result in lengthy and satisfactory service from the gearbox, please carefully read the manual before putting the gearbox into operation and install, operate and maintain according to stipulated requirements in the manual.
Important Note:

The gearbox cannot be held responsible for torsional problems arising from the drive system. We therefore recommend that a calculation and adjustment for the vibrational data of the ship’s entire drive system should be performed including the torsional compatibility of the gearbox.

No liability is accepted for the gearbox damage arising from wrong matching, operating or other parts of the drive system caused by such vibrations.

The manual is applicable to the standard gearbox version. Variations are possible on special customer requirements.

Technical modifications revised.
Contents

. List of Technical Data.................................................................( 5 )
. Description of Gearbox ............................................................. ( 7 )
. Instructions .................................................................................. ( 10 )
  1. General Information ............................................................ ( 10 )
  2. Instructions ............................................................................ ( 11 )
. Mounting .................................................................................... ( 15 )
. Gearbox Alignment .................................................................... ( 18 )
. Gearbox control and Remote-Control .........................................( 21 )
  1. Control types .......................................................................... ( 21 )
  2. Requirements of the control system .........................................( 22 )
  3. Pneumatic remote control and design example .......................( 24 )
  4. Electrical remote control design example ...............................( 26 )
. Initial operation ...........................................................................( 27 )
. Lubrication and oil pressure instructions ....................................( 28 )
  1. Lubrication oil specifications ..................................................( 28 )
  2. Rated values for oil pressure ................................................... ( 29 )
. Maintenance ................................................................................( 30 )
. Special Notes .............................................................................( 31 )
  1. Monitoring equipment .............................................................( 31 )
  2. Basic explanation of pumping unit motors ...............................( 31 )
  3. Replacement of the segment thrust pads, output end ............( 32 )
  4. Emergency control of the gearbox ...........................................( 33 )
  5. When taken in tow ...................................................................( 33 )
  6. Sealing strips ..........................................................................( 34 )
. Trouble-Shooting .......................................................................( 35 )
1. Overheating .................................................................( 35 )
2. Lack of oil pressure .....................................................( 36 )
3. Oil leakage ...............................................................( 37 )
4. The engine stalls during reversing ...............................( 37 )
5. The propeller does not reach the corresponding speed of the motor ....( 38 )
6. The propeller does not stop turning in “Neutral” ..................( 38 )
7. Gearbox noise ...........................................................( 39 )

Standard Accessories ....................................................( 40 )
1. Filter and cooler .......................................................( 40 )
2. Geartype oil pump ....................................................( 41 )
3. Filter for control oil circuit .........................................( 42 )
4. Pneumatic controller ................................................( 44 )
5. Electrical controller ................................................( 46 )
6. 2-stage control valve ................................................( 47 )
7. Lubrication pressure regulator valve .............................( 52 )
8. Oil filler neck with sieve ..........................................( 52 )
9. Dipstick .................................................................( 53 )
10. Pressure switch ......................................................( 53 )
11. Temperature switch ................................................( 54 )
12. Clutch release valve ...............................................( 55 )

XII Gear selection information ......................................( 55 )
1. Gear selection and ordering ......................................( 56 )
2. Reduction ratio ......................................................( 57 )
3. Trans capacity diagram ...........................................( 58 )
4. Oil capacities and cooling water requirement .................( 60 )
5. Configurations and rotations .....................................( 61 )
6. Dimension table ......................................................( 62 )
I. List of Technical Data

1. General data

   Engine manufacturer:

   Engine type:

   Engine output: \( P = \) kW

   Output speed: \( n = \) r/min

   Direction of engine rotation (facing the flywheel):

   Classification society:

   Shipyard:

   Hull no:

2. Gearbox data

   Product no:

   Type and size:

   Input speed:

   Gear ratio:

   Control type:

   Oil grade:

   SD/CC30 or SAE30 (in summer of the torrid zone for SD/CC40 or SAE40

   Lub. Oil quantity:

   Max. lub. Oil temperature \( 80^\circ C \)

   Cooling water inlet temperature \( \leq 32^\circ C \)

   Cooling water inlet pressure \( \leq 0.6MPa \)
Cooling water requirement: \( m^3/h \)

Reversing time: \( t \leq 15s \)

Mechanical efficiency: \( \eta \geq 97\% \)

Rated propeller thrust: \( P_s = N \)

Permissible angle of inclination: Longitudinal 10\(^\circ\), Transverse 15\(^\circ\)

Overhaul: 10000h

Net weight: 1

3. Technical documents (standard)

Service Manual

Certificate

Assembling drawing

Outlook and installation drawing

Part list

List of torque vibrational data

Diagram for clutch thermal load limited (Switching frequency)

Maintenance Card
Marine Gearbox GW series cover six models. There are the GWC, GWD, GWH reverse reduction gears and the GWL and GWK reduction gears (without reversing function). The six models differ as follows:

**GWC design**

The GWC reverse reduction gear has a primary stage, a reduction stage and a reverse stage. Input and output are coaxial and have same sense of rotation.

**GWD design**

The GWD reverse reduction gear has no primary stage but a reduction and a reverse stage, either one of the clutch shafts is driven directly. Input and output are diagonally offset and have opposite sense of rotation.

**GWS design**

As the GWD model, the GWS reverse reduction gear has no primary stage, but a reduction and a reverse stage. Input and output are vertically offset and have opposite sense of rotation.
GWH design

The GWH reverse reduction gear, as GWD and GWS, has a reduction and a reverse stage, but no primary stage.

Input and output are horizontally offset and have opposite sense of rotation.

GWL design

The GWL reduction gear without reverse function corresponds to the GWC model in that it has a primary and a reduction stage.

Input and output are coaxial and have the same sense of rotation.

GWK design

The GWK reduction gear has no reverse function and is of single stage design.

Input and output are vertically offset and have opposite sense of rotation.
Power flow and shaft rotations for GWC
(Fold out section)

Power flow and shaft rotations for GWL
(Fold out section)

Power flow and shaft rotations for GWD
(Fold out section)
III. Instructions

1. General Information

   The gearbox is delivered without oil.

   The gearbox is protected internally with preservation oil, effective against corrosion for a period of six months when the gearbox is stored in a dry area at an even temperature.

   The gearbox is painted externally. Flanges, shaft ends and flanging surfaces outside the gearbox have a preservation paint.

   The connections for the air pipes, oil tubes and water pipes to be assembled at the site are sealed by means of blanking flanges or plugs.

   Pipelines, pipe connections etc., to the gearbox which have to be installed, modified or renewed after having left our works, must be carefully acidified and cleaned off any obstructions before they are mounted.

   The direction of rotation is shown by an arrow.

Intermediate Storage

   If the gearbox is stored outside, it must be protected from the atmospheric conditions by a protective cover or canopy.

   Our liability is invalid when the gearbox is opened without our authorization.
2. Instruction
Service Manual of Marine Gearbox Model GW Series
1. **Output shaft**
   Align the gearbox acc to the requirements, then fasten the output flange and the propulsion flange with reamer bolts.

2. **Pressure switch**
   When the lub. Oil pressure reduces to 0.04MPa, the switch is on.

3. **Pressure switch for ahead**
   When the working oil pressure reduces to 1.5MPa the switch is on.

4. **Pressure switch for ahead**
   When the working oil pressure reduces to 1.5MPa, the switch on.

5. **Shift handle for lub. Oil filter.**
   (1) When gearbox running, the handle is placed horizontally.
   (2) It is necessary to turn the handle 90° clockwise, while the gearbox is running continuously, the oil flows directly into the system. After cleaning the filter, be sure to return the handle in horizontal position.

6. **Lub. Oil filter**
   Periodically clean the filter acc. To the maintenance instructions.

7. **Pressure gauge**
   Indicate working oil pressure.

8. **Oil temperature indicator**
   Show the oil temperature.

9. **Pressure gauge**
   Indicate lub. Oil pressure.

10. **Temperature switch**
    When oil temperature reaches 72~75℃, the switch is on.

11. **Working oil filter**
Be cleaned regularly acc to the maintenance instructions.

12. Oil pump (with pressure limiting valve)

13. Input flange
   Special order acc. To differential types of high flexible couplings.

14. Oil filler neck with sleeve
   Fill oil into gearbox from here.

15. Dipstick
   Periodically check oil level acc. to the maintenance instructions.

16. Cooler

17. Water inlet

18. Water outlet

19. Controller
   Pneumatic or electrical controller are available in required.
   (1) When use pneumatic controller, the air pressure is 0.5~1MPa.
   (2) When use electrical control, the voltage: D. C. 24V Permissible voltage fluctuation: \( \leq 15\% \)

20. 2-stage control valve
   The valve regulates initial pressure, working pressure, pressure raising time.

21. Non-return valve
   From here to connect stand-by pump set.

22. Installation bracket

23. Pump suction

24. Drain plug

25. Stand-by pump suction
Connect to stand-by pump pipes.

26. Back pressure valve
   Regulate lub. Oil pressure.

27. Working oil pipe, ahead
28. Spare adapter (M14 × 1.5)
29. Spare adapter (M10 × 1)
30. Working oil pipe, astern
31. Spare adapter (M14 × 1.5)
32. Spare adapter (M10 × 1)
33. drain plug for cooler

IV. Mounting
Transportation

The gearbox is suitably suspended on cables for transportation. Therefore, all cables taking the gearbox weight should be clear of the fittings. Slowly lift the gearbox and place in position. The lifting lugs on the upper part of the gearbox serve only to remove the upper section. To lift the complete gearbox the transportation lugs are to be used. To avoid accidents cables are to be used with shackles.

Installation in the engine room

The aligning screws are to be inserted into the tapped holes in the mounting bracket. Via the aligning screws the gearbox rests on the top plates.

Maximum permissible permanent installation angle fore and aft \( \alpha = 5^\circ \)

The foundation

In order to facilitate the changing of oil and washing-out of the gearbox, the foundation has been constructed so that there is sufficient space for the installation of an oil-collector below the drain plug.

The fitting of couplings

If couplings have to be fitted onto the gearbox input shafts, the calibers of the bore holes in the coupling hubs have to be adapted to the diameters of the shaft ends according to our assembly drawings. When the couplings are fitted the hub must be
heated. For this, the temperature of the hubs has to be 40° higher than that of the shaft, in the case of a taper fit. Thus driving-on shocks or impacts will be avoided and the gear wheels protected.

**Gearbox is fixed to the foundation**

If the gearbox is fixed to the foundation with bolts, then all bolts must be reamed bolts. The holes are pre-bored and must have a larger clearance for together ream.

Use bolts of strength specification 8.8
- Tensile strength: 758N/mm²
- Ductile strength: 630N/mm²

**Foundation Drawing of Gearbox**

If the gearbox is mounted and fixed with stoppers against the foundation, normal bolts can be used.

The sizes in the Assembly Drawing can be taken for clearance holes. The bolts can now be chosen to fit. 8 stoppers must be used, the principle of which can be seen on the drawings.

The required chocks must conform to the classification societies’ requirements.
Stand-by pump

In the case of an installation with a separate stand-by oil pump, the oil must be pumped through the system for approximately 2 hours before the first start. For this a close meshed strainer must be inserted at the oil inlet to the gearbox, in order to catch dirt particles coming from the pipeline system installed after delivery. If the diameter of the pipe exceeds NW 25 (1”), the strainer has to be supported by a perforated disc of 2mm thickness with holes of approximately 8mm diameter, in order to prevent the strainer from being crushed and getting into the interior pipeline system, which may happen if the dirt accumulation is too heavy. During this pump test, the exterior pipeline system can be checked for leaks.

V. Gearbox Alignment

The propulsion unit shall only be aligned when the vessel is afloat and it is definitely ensured that it is not in contact with the ground.

The completely assembled propeller shaft shows a deflection between the supporting bearing and the flange. The extent of the deflection in relation to the shaft
overhang and diameter can be seen in the diagram. This deflection is to be compensated.

**Bending checking on the propeller shaft**

The right illustration shows how the deflection is eliminated for gearbox alignment. A roller block is placed underneath the end flange of the propeller shaft and raised by the amount of deflection ascertained.

There are, however, cases where the free end of the propeller shaft due to additional loads is bent more than is required by natural deflection. In this case, an additional dial gauge can be installed near the bearing which indicates the amount of lift required at the shaft end to ensure that the shaft in the bearing is evenly raised.

The reading thus taken at the shaft flange dial gauge is twice the value of the actual deflection. Raising the roller block by half of this value corrects exactly the position of the propeller shaft flange.

**Aligning the gearbox axial parallelism**

The illustration shows how this is to be done with the help of feeler gauges. It is important for this measurement that the shafts be turned in one direction only. The accuracy of axial parallelism should be no more than 0.01mm for 100mm of flange diameter.
Aligning the gearbox axial displacement

When the gearbox is arranged parallel to the propeller flange, the axial displacement is to be aligned.

In the illustration it shows the procedure to be followed. Here, turning must also be in one direction only. A dial gauge can as well be mounted in a suitable manner on the propeller shaft flange to ensure correct and true measurements.

Propeller shaft flange and gearbox flange are turned simultaneously so that the dial deflection can be read. The required accuracy is 0.025mm (i.e. 0.05mm deflection on the dial gauge).

Align gearbox and engine acc to the requirements of the highly flexible coupling.

Compensation for thermal expansion

Since as a rule gearboxes are aligned when in cold condition, the amount of vertical thermal expansion between the support and propeller flange center must be compensated for. The following diagram shows the degree of compensation required for various types and sizes of the GW gearbox series. With the help of the aligning screws on which the unit rests during aligning the gearbox is raised by the dimension indicated, to bring it to the position which exists when the gearbox has reached its operating temperature.

The Compensation diagram considers not only the thermal expansion but also the bearing play.
If tanks are to be found underneath the gearbox foundation, which have varying temperatures during the ships operation, the diagram is not suitable.

The Compensation diagram takes into account only the position changes of the gearbox shafts.

Deflections for the engine are to be observed.

Compensation diagram

VI. Gearbox Control and Remote-Control

1. Control types

A dependable remote control is of great importance for a ships drive system.

The gearboxes of the GW Family are supplied, as standard, with a pneumatic gearbox switch.
Electrical gearbox controllers are available. The gearbox controllers, whichever type of operation, have exactly the same base plate connections.

To this base plate are all pipelines connected.

The base plate is separately screwed to the gearbox housing.

Through having separate base plates, the replacement of a controller can also mean changing the type of operation without having to change the pipe work system.

2. Requirements of the control system

Even through the running of the motor governor, gearbox coupling and, if supplied, shaft brake is difficult, it is necessary to perform the following steps to check the system:

The switching sequence for all switching systems should conform to the following specifications.

Bridge control

Controller positions Full Ahead onto Astern

or

Full Astern onto Ahead

or

Full Ahead onto Full Astern
or
Full Astern onto Full Ahead

**Sequence**

1. Control unit onto low speed
   Let the propeller shaft speed drop to a minimum of 60% of the rated speed
2. Coupling in zero position
   2.1 Propeller shaft brake engages
   2.2 Propeller shaft stops
   2.3 Open propeller shaft brake
      (In case without brake the controller should be retained at zero position for approx. 2～3 sec.)
3. Engage coupling
4. Retain switch position for approx. 1 sec.
   (In case without brake, the controller should be retained at engaging position for approx. 1.5～2 sec. then increase speed).
5. Increase speed
   The control system must be carefully maintained.
   Any faults must be immediately repaired. The control units must be handled very carefully.

**Switching rate of the Gearbox**

When the switching rate is high and or if engine speed is high when switching, the diagram “Engagement speed/Number of Engagements” must be considered.

The diagram is based on the heat regenerating ability of the multiple disc clutch and determined according to the service condition as specified in the order. It shows the admissible number of engagements in relation to the engagement speed.
The “Number of engagements/minute” is to be understood to be a uniformly divided switching rate per minute. “Engagement speed” is the switching is initiated.

A copy of the diagram must be available at the bridge.

3. Pneumatic remote control and design example

When the gearbox is equipped with the standard controller, the remote control is via pneumatics.

When planning the remote control system attention should be payed to:

The engine speed when reversing should not amount to more than 60% of the motor rated speed. An agreement between the supplier of the control system and Hangzhou Gearbox Works must be made for the requirements of the “Crash-Stop” manoeuvre design.

Design example for the pneumatic control of the ships drive.

1. Pressure reducing station
2. Air reservoir
4. Stopcock
6. Control valve
13. Pressure reducing valve
14. Double non-return valve
15. Double non-return valve for oil
16. Non-return choke valve
17. 3-way valves
19. 3-way valve, adjustable
24. Multi-way valve, hydraulic-pneumatic
27. Control unit

Circuit diagrams for systems with multiple control points, as for ships with multiple systems, can be provided.

**Description for a design example of a pneumatic ships propulsion control.**

The example shows the pneumatic remote operation consisting of motor, reversing gearbox and fixed propeller, within the ships drive system. With the single-lever operation of the control valve 6, the desired value for the motor speed and the directional rotation of the propeller will be given.

The control air supply is via a pressure reducing station 1, whereby the doubled supply of air is filtered and from 3 MPa to the operating pressure of 0.6 MPa is reduced. In the air-reservoir 2 the air is stored and if necessary, the water drained off.

The control air desired value is over control valve 6 which then goes to control unit 27 and then the pneumatically/mechanically multi-way valve 24 for the motor and gearbox to be adjusted into the required operating condition. Also dependent on the switching oil pressure of the clutches can only be changed at a low motor speed. The motor speed is raised slightly by the combination of units 13, 17, 19 and 14 when the
gearbox is in a reversed procedure, so that the motor governs the propeller inertia.

4. **Electrical remote control design example**

When the gearbox is equipped with the electrical controller, the remote control is via electrical system.

When planning the remote control system attention should be payed to:

The engine speed when reversing should not amount to more then 60% of the motor rated speed. An agreement between the supplier of the control system and HC must be made for requirements of the “Crash-Stop” manoeuvre design.

**Wiring diagram of the main operating position.**

1. Stop
2. Ahead
3. Astern
4. Main selector
5. Erase link
6. Control lamp
VII. Initial operation

All gearboxes are given a test-run and checked by the manufacturer in the workshops. The control units and control valves are all adjusted in the workshops.

By delivery the gearbox is without oil and is internally protected by a preservation oil. This oil has the quality to mix without any problem or detriment to the gearbox oil.

Turn the engine and propeller shaft, with the unit in “Neutral” position.

The sequences of initial operation describe in brief as follows:

1. Fill the gearbox with lub oil acc to oil specification table, a meshed strainer should be used to avoid foreign matter entering into.

   Check whether the lever of the filter is put to “working” position, and the gauges, as well as pipelines are correctly mounted.

2. In the case of an installation with stand-by pump, at first turn on the stand-by pump for reading on lub oil gauges (If there is no reading on the gauges within one minute about, the stand-by pump should be stopped for inspecting), running for half an hour (a little more in winter), then turn off the stand-by pump and start the engine.

3. In case of no stand-by pump installation, at first start the engine running at idling speed for reading on oil gauges (If there is no reading on the gauges within one minute, the engine should be stopped for inspecting), running half an hour (a little more in winter) then engage “Ahead” and “Astern” for a short period.

4. Check the oil level.

   The oil level can be taken from the dip-stick. The dip-stick has marks for “stationary” and “running”. When taking the oil level reading with a “stationary” gearbox, the oil level must be between the marks “stationary” and with a “running” gearbox between the “running” marks.
5. The gearbox should be slowly run-in until the operating temperature is reached under a partial loading. Then all joints and connections of the oil pipelines should be checked for leakage and if necessary, re-tightened. The cooling system must be adjusted so that the operating temperature is kept constant at a full load. After a total 10 operating hours the foundation bolts must be checked and, if required, tightened. All renewed pipe connections must also be checked.

VIII. Lubrication and Oil pressure instructions

1. Lubrication oil specifications

Following lubrication oil are to the used:

API-Classification: CA, CB, CC
Respectively MIL-L-2104A
Viscosity grade: SAE30

This is mineral oil without an EP additive. This oil brand specification must be strictly adhered to, since GW family gear units, incorporate also multiple plate friction clutches which, in addition to the gearwheels, take part in power transmission.

Extreme pressure additives negatively effect the functioning of these clutches.

Preferred lubrication oils:

Mineral oils of group SOU 63 or HQ-10 GB485-72; HC-11 SY1152-71 (china) are to be used for the running-in and later operations.

Oil group

SOU O II s without additives influencing friction and wear.
Viscosity group 63
Viscosity from 50 to 80 cSt corresponding to 6.6 to 10.5E by 50°C

Firma/Oil Type

FINA
- FINA Dorano 30
- FINA Dilano 30
- FINA Stellano 30
- FINA Cirkan 100
- FINA Solna 30
- FINA Purfinaol 30

Fuchs
- Renolin LTA 30
- Renolin 20B

Mobil
- Mobil D.T.E. Oil Heary

Shell
- Shell Tellus OIC100
  - Shell Turbo OIT100
  - Shell Vitrea Oil100

Texaco
- Regal Oil R&0 150

Ursa Oil P 100

2. Rated Values for oil pressure

<table>
<thead>
<tr>
<th>Switching oil pressure (MPa)</th>
<th>Starting</th>
<th>Normal running</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gearbox oil temperature</td>
<td>15° ~ 30°</td>
<td>40° ~ 60°</td>
</tr>
</tbody>
</table>

Idling:

- Pre-Pressure: $0.3^{+0.15}_{-0.1}$ $0.2^{+0.15}_{-0.05}$
- Switch-pressure: $1.8^{+0.2}_{-0.1}$ $1.8^{+0.2}_{-0.2}$

Rated speed:

- Pre-pressure: $0.6^{+0.2}_{-0.1}$ $0.6^{+0.15}_{-0.1}$
Switch-pressure: \[ 2^{+0.2}_{-0.1} \]

<table>
<thead>
<tr>
<th>Lubrication oil pressure (MPa)</th>
<th>[ 2^{+0.3}_{-0.1} ]</th>
<th>[ 2^{+0.2}_{-0.1} ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idling * :</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Min:</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>Max:</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Rated speed:</td>
<td>0.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Switching time of the 2-stage-valve

\[ 2.5 ~ 3.5 \text{ sec} \quad 1.5 ~ 2.5 \text{ sec} \]

* appropriate 1/3 nominal rotation speed

If the actual values differ from the rated values the Service Dept should immediately be informed.

**IX. Maintenance**

**Daily:**

- Check oil level.
- Turn gap-type filter in the switch line 2～3 times.
- Check the gearbox for leakages.
- Check the oil pressures and temperatures.

**Monthly:**

- Clean the gap-type filter.
- Clean the lubrication oil filter.
- Check the remote control operation.
- Check oil for water contact.

**Yearly:**

- Check all exterior screw connections.
- Check the protection covering of the sea water cooler if used.

**Oil change:**

Under normal service conditions, the first oil change must be after approximately 250 working hours.
Further oil changes must be completed after approximately 2000 service hours, however, not longer than 12 months.

In special conditions consult a mineral oil company.

Before filling with new oil, in accordance with the enclosed lubricant specifications, the gearbox must be cleaned with flushing-oil.

X. Special Notes

1. Monitoring equipment

If monitoring equipment has been installed by the shipyard and maximum permissible value sensors (pressure and temperature controls) fitted then the following information must be observed:

When engaging the clutches the total oil quantity. For a short period, is required to fill the clutch cylinder. This produces that for a short period there is no oil pressure. The warning or cut-off system manufacturer has taken this particular feature into consideration. An override mechanism is included in the warning or cut-off system and conforms to the classification society for maneuver operations.

2. Basic explanation of pumping unit motors

Together the suction and pressure lines may contain no more than four 90° elbows. The maximum suction pipeline length may not exceed 1.5 metres and the pressure line length 2.5 metres.

The electric motors have to be designed for long term operation and conform to the classification rules with consideration of the room temperature. By an unknown room temperature, 45°C is a good basis. Isolation is of normal design.
None of the motors has an explosions class. The terminal box has the type of enclosure. The motor is normally of construction; spark suppression has not been provided for. Content following is only valid for GW with Segment thrust bearings.

3. Replacement of the segment thrust pads, Output end

After removing the bolts, lift the bearing cover vertically.

Remove upper part of the radial bearing. Lift the upper part of the supporting disk together with the thrust pads.

Turn the lower part of the supporting disk by means of the holes at the circumference and lift the disk.

Re-assembling is in the reverse sequence. When installing new pads, take care of the direction of rotation (sketch).

![Diagram showing direction of rotation](image)

- c. p. propeller anti-clockwise rotation
- c. p. propeller clockwise rotation
- Fixed propeller anti-clockwise rotation
- Fixed propeller clockwise rotation
- c. p. propeller and reversible engine
4. Emergency control of the gearbox

If for any reason the hydraulic control of the gearbox is not possible, then there is always the possibility to block the clutch mechanically.

Remove the inspection hole cover (part. 141) of the upper section of the housing. Remove the locking device of the emergency screw and firmly tighten. Fix the inspection hole cover by means of the screws. The gearbox is now ready for emergency operation.

Leave the gearbox switch in the stop position when in emergency operation.

When emergency switching, pay attention:

Put the gearbox selector in the stop position after the unit stands still.

Add filling with lub oil, the oil level must be the mark “stationary”.

The engine speed is at 60% or less of the rated speed.

Regularly inspect the temperature on housing surfaces where the hearings were fixed inside.

5. When taken in tow:

When the ship is being towed and therefore the gearbox is being driven by the propeller the lub oil supply must be assured. (The stand-by pump must be running and the oil pressure existing).
In case of no stand-by pump installation, make the intermediate shaft disengaged by means of brake installed on boat tailshaft or other measures.

6. Sealing strips

1. General Information

It is absolutely necessary to observe, that the colour marking on the side of the sealing strip lies on the bottom of the sealing strip groove. When the sealing strip is incorrectly inserted with the fabric side to the shaft can this fabric sealing strip be damaged, thus is the sealing inoperative.

If there is no colour coding then the assembly is arbitrary.

To cut the sealing strip a good sharp knife is required. The cut must be at right-angles to the length.

2. Measuring and fitting

The measurement of the sealing strip must be done with great care.

There must exist a slight compression between the two butting ends so as to give a good seal.

When the sealing strip is measured for separable parts the amount that stands “Proud” of the joining surfaces, must be equal. The amount that the sealing strip is compressed can be seen in previous notes.

3. Running-in conditions

The sealing area of the sealing strip must be lubricated before the first run. It must be continuously lubricated to avoid the strip drying up.

When systems have an adjustable speed, the running-in of the sealing strip must always be at the lowest possible speed.

4. Treatment of Sealing Strips

Store in a cool room
During storage the strips must not be exposed to a highly humid atmosphere nor must they come into contact with any kind of liquid.

If the sealing strip is wound then the beginning of the winding must be located away from the shaft.

The start of the winding can be determined by the frontal cut edge.

With plaited sealing strips the assembly is arbitrary.

Apply oil to the slideway of the sealing strip prior to installation.

Press the sealing strip uniformly into the receiving groove using the handle of a hammer.

After pressing in the sealing strip, cut off the ends at the joint leaving 1.5～2mm proud.

The special notes of the manufacturers are to be observed.

**XI. Trouble-Shooting**

1. Overheating

**Possible cause:**
- Oil level is too high
- Lubricating oil pressure too low (insufficient cooled oil)
- Gearbox is overloaded

**Remedy:**
- Correct oil level
- Re-set operating oil pressure to the lowest permitted value
- Reduce input power

_Hangzhou Advance Gearbox Group Co., Ltd._
### Operating oil pressure is too low
- **Regulate operating pressure**

(clutch is slipping)  

- **Regulate operating pressure**

(see 2-stage valve)

### Excessive pump pressure
- **Clean the filter**

### Oil does not flow back from the outer bearing sides
- **Installation of end covers or seal covers in such a way that the oil can flow back**

### Bearings damaged
- **Replace damaged bearings**

### Seal too tight
- **Loosen**

## 2. Lack of oil pressure

### Possible cause:
- Wrong direction of rotation  
  - **After engine rotation or gearbox rotation direction clean filter**

- Filter obstructed  
  - **Refill with oil and trace cause of oil loss**

- Oil level too low  
  - **Change to an oil conforming to the “recommended lubricants”**

- The viscosity of the oil is too low  
  - **See “Excessive gearbox temperature”**

- Oil temperature too high  
  - **Clean suction pipe**

- Suction pipe obstructed  
  - **Replace defective parts or the complete valve**

- 2-stage valve is defective  
  - **Renew the pump drive**

- Pump drive is defective  
  - **Install new pump**

- Pump wear  
  - **Adjust remote control operation**

- Selector position is not correct  
  - **Renew oil supply**

- Wear of the oil supply  
  - **Clean quick release valve**

- Quick release valve does not close  
  - **“Recommended lubricants”**
### 3. Oil leakage

<table>
<thead>
<tr>
<th>Possible cause</th>
<th>Remedy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain plug is not tight</td>
<td>Replace the gasket and tighten drain plug</td>
</tr>
<tr>
<td>Dipstick connector not tight</td>
<td>Replace dipstick gasket and tighten</td>
</tr>
<tr>
<td>High pressure system leaking</td>
<td>Tighten all fittings</td>
</tr>
<tr>
<td>Oil loss through the air-vent</td>
<td>Install a plate under the air-vent</td>
</tr>
<tr>
<td>Mating faces of the housings are not sealed</td>
<td>Seal with new compound and tighten all bolts</td>
</tr>
<tr>
<td>Leakage of the shaft seals</td>
<td>a) Renew seals</td>
</tr>
<tr>
<td></td>
<td>b) Install sealing cover in such a manner</td>
</tr>
<tr>
<td></td>
<td>that the passage is free from the outer</td>
</tr>
<tr>
<td></td>
<td>bearing side</td>
</tr>
<tr>
<td>Oil cooler is leaking</td>
<td>Replace the cooler stem</td>
</tr>
</tbody>
</table>

### 4. The engine stalls during reversing:

When switching over, the engine threatens to stall, at this manoeuvre the engine must be “caught” by fuel admission so that the power taken from the propeller will not be larger than the engine power at this moment.

<table>
<thead>
<tr>
<th>Possible cause</th>
<th>Remedy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The idling speed is too low</td>
<td>Increase the idling speed</td>
</tr>
<tr>
<td>The operating pressure is too high, therefore, engagement is too quick</td>
<td>Reduce the operating pressure to normal value</td>
</tr>
<tr>
<td>The gearbox controller is defect (uncontrolled at flow to one clutch)</td>
<td>Replace gearbox controller</td>
</tr>
<tr>
<td>Clutch plates are damaged</td>
<td>Replace damaged clutch plates</td>
</tr>
<tr>
<td>The splines of the clutch are damaged</td>
<td>Re-work the splines or renew the part (check at critical speed ranges)</td>
</tr>
</tbody>
</table>
The release springs do not work
   Clean the clutch. Replace the springs if necessary
Pistons of the clutch are jammed, seals damaged
   Renew damaged seal

5. The propeller does not reach the corresponding speed of the motor.

Possible cause:
Pressure gauge defect, higher pressure shown than in reality
Control oil pressure too low
Gearbox controller is not exactly in the “Ahead” position
Gearbox controller defect
Damaged propeller shaft bearings
Linings of the clutch in the incorrect sequence
Clutch plates broken
Sealing rings of the clutch damaged
The splines of the clutch are worn

Remedy:
Change pressure gauge and re-adjust oil pressure
1. Clean filter
2. Check the control operation
Adjust the remote control operation
Replace controller
Replace worn bearings
Mount the clutch plates correctly
Exchange damaged plates
Replace with new sealing rings
Re-work the teeth or renew the part. Check the installation at critical speed ranges

6. The propeller does not stop turning in “Neutral”

Possible cause:
The vessel is still moving
The propeller is being driven by a current
Gearbox controller is not directly on the

Remedy:
Wait until it’s at a complete standstill
Adjust the remote operation
“stop” position

Defect gearbox controller (uncontrolled oil to one clutch)

Clutch plates broken
Seal damaged, sticking piston
Splines of the clutch damaged
Release springs not working

Replace gearbox controller
Renew clutch plates
Renew seal
Re-work the teeth or renew the part
Clean clutch and if required, replace springs

7. Gearbox noise

Possible cause:

Idle speed is within a critical range
Gearbox runs within the critical speed range.
(The noise is not to be observed throughout the whole speed range)
Input flange loose
The oil level is too low (Suction noise of the pump)
Suction pipe not tight. (Pump sucks in air)
Filter choked. (Excessive pump pressure)
Pump drive not in order. Gearwheel damaged or loose
Extreme bearings damaged
Gearbox bearings damaged
Gear wheels are damaged by foreign matter
The gear rims are loosened by overloading

Remedy:
Increase idling speed
Avoid running the gearbox continuously in the critical range
Tighten the flange or replace when damaged
Correct oil level
Tighten all fittings on the suction line
Clean filter
Repair damaged parts, or replace
Re-align-The whole installation
Renew damaged bearings
Grind damaged area and, if necessary, replace the gear wheel
Re-tighten the gear rims
Gear wheels are loose on the shaft due to overloading

Propeller damaged

Output flange is loose

Extreme misalignment on the output side

of the gearbox

XII. Standard Accessories

1. Filter and cooler

Cleaning of the filter: After approx. 200~300 hours of operation, the filter package has to be removed and cleaned. With a large dirt accumulation and when on the first run, the filter must be more frequently cleaned. Differential pressure may not exceed 0.2MPa as otherwise the filter package can burst.

Remove the plate “r” with filter cartridge “p”, then remove the nut “s” and the filter cartridge. The filter can be a multi-baged one of which consists of several round disc or a
star-sieve cartridge. The filter web is to be rinsed in an acetone bath and blown out with compressed air.

Care must be taken not to damage the web. After cleaning, re-assemble the filter on the plate “r” and mount into the filter housing.

Generally, the filter has to be cleaned when the machine set is stopped.

In special cases, it is allowed for cleaning the filter during the set is running, firstly switch the lever to the “u” position for oil flows directly into the cooler, then clean the filter cartridge. After cleaning, the lever must be switched to the “t” position.

**Cleaning of tube bundle:**

Water side: After cutting off the water and oil flow, the oil should be emptied at the bottom chamber socket cover. After the removal of the reverse covers the cooling tubes are to be cleaned by means of wire or nylon brushes and the remains blown out with compressed air. The covers can now be re-assembled.

2. **Geartype oil pump**

![Geartype oil pump diagram]

Filling: Normally when putting into operation the filling of the pumps is not necessary, but dry operation must be avoided.
Direction of rotation: Pumps must only rotate in the given direction, but it is possible to alter the direction of rotation. To check the direction of rotation the motor can be switched on and off for short periods, only so long as the pump is filled and has no load.

Pressure limited: The pump and hydraulic system have to be protected by the pressure

Limiting valve, when ex-works, the valve discharge pressure set of 2.5MPa, normally without re-adjustable.

Temperature: After having reached the operating values, the temperature of the units especially that of the bearings and shaft seals has to be checked.

Bearing temperatures taken on the surface may exceed the oil temperature by 10°C.

3. Filter for control oil circuit
Mode of operation and maintenance

The liquid to be cleaned flows from the outside towards the inside of the filter element, whereby the dirt particles are left on the element. Dirt collects on the filter element and by means of a special unit, operated by turning the T-handle or setting in motion the electrical or hydraulic spindle drive, is scraped-off and allowed to drop into the sediment chamber. This must, from time to time, be drained. No other maintenance of any kind is necessary.

Cleaning instructions:

1. According to operating conditions the filter must be cleaned regularly. It is advisable to clean the filter when new liquid is to be renewed. The pictures show the cleaning procedure.

2. Shut-off feed; release the sediment drain plug A and allow the sediment to flow out. Take care of sealing washer D.

3. Undo the fixing nuts F and remove the washers G.

4. Lift the filter element carefully from the housing L and take care of seal
5. Clean the filter element J in washing petrol and dry with compressed-air. Do not damage the coil or cleaning brushes.

4. Pneumatic controller

Gearbox controller with by air return device
Pneumatic controller is a 3-position and 4-way valve, its control air pressure is 0.5～1MPa. The connection “Z” is always with air pressure, and the connections “V” and “W” are connected with the valve which set in control air piping.

**Control principing:**

Stop position: The “V”、“W” are opened into the atmosphere via the control valve. With the air pressure acting in “Z”, the pneumatic controller is in the neutral position and the working oil is cut off, “A” + “B” with “T” are connected with oil sump. Both ahead and astern clutches are disengaged.

**Ahead position:** Compressed air comes into “V” via the control valve, and pushes the controller moving left, the working oil enters “A”, ahead clutch is engaged.

**A stern:** Compressed air comes into “W”, and pushes the controller moving right, the working oil enters “B”, astern clutch is engaged.

**Hand control:**

When without air pressure, hand control is available to realize exchanging of ahead-stop-astern.
Control air piping connections:

V—to control air piping valve (ahead) M14 × 1.5
W—to control air piping valve (astern) M14 × 1.5
Z—to compressed air (stop) M14 × 1.5

5. Electrical controller

The gearbox can also be controlled with electrical solenoid valve. The valve is a 3-position and 4-way valve.

Voltage: D.C. 24V
The voltage permissible fluctuation ≤15%

I_{max} = 0.94A

On the both sides of the valve there are mechanic hand bottoms, which can be used for the emergency controlling in case of that electricity is cut off.

When the electrical control buttom turns to the “Ahead” or “Astern” position, the relevant solenoid has electricity, pushes the valve moving and makes the working oil enter the corresponding clutch for engaging.

When the control buttom is in the “stop” position, both two solenoids have no electricity and the ahead and astern clutches are all disengaged.
6. 2-stage control valve

Control and lubrication oil circuit*

![Diagram of the 2-stage control valve](image-url)
Control and lubrication oil circuit
2-stage Control valve description

Idling of the gearbox. Clutch not engaged.

The gearbox selector is in the stop position.

The clutches 1 and 2 are connected via the gearbox selector connections A+B with the return flow R, to the gearbox oil sump.

The connections C+D of the 2-stage valve are also pressureless and connected via the clutch connections on the gearbox selector A+B with R and the oil sump. The same happens to connection E of the 2-stage valve.

Oil from the oil pump flows to the 2-stage valve via connection “F” to connection “G”.

In this selector position the connections “C”, “D” and “E” are pressureless and it is the spring assembly which is lightly stressed and produces the pre-pressure.

After the 2-stage valve the oil comes into the lubrication oil circuit.

Engaging the gearbox. Clutch engaged.

When operating the gearbox selector the connection “A” (or “B”) is connected with the clutch 1 (or 2). The connection “C” (or “D”) of the 2-stage valve is likewise with the connection “A” connected. Thereby, oil reaches the clutch and 2-stage valve at the same time.

The oil which enters connection “C” (D) moves the checking piston in the direction of connection “D” (C).

The checking piston serves to separate the clutches 1+2, the function being like that of a double return valve. The oil from connection “C” (D) reaches the time adjustment “H”.

The time adjustment consists of the receiving hole with jet needle and the chamber. Screwing in the jet needle (clockwise) makes the pressure build-up time longer.

Unscrewing the jet needle (ant-clockwise) shortens the pressure build-up time.

Attention! See control times. The given control time must be adhered to. Not
conforming to these times can lead to multiple plate damage.

The oil that flows via the time adjustment “H” into the chamber actuates the pressure raising piston, which the spring assembly strongly stresses.

Through this measure the pressure rises before the regulator piston and therefore in the complete clutch operating system.

At the same time the remaining oil at the time adjustment “H” flows via the connection “K” passed the quick drain piston and thereby blocking return flow “E”.

Disengaging the clutch

The connections are the same as in “idling of the Gearbox”. However, draining of the chamber is additionally required. Through cessation of the pressure at connection “K” the quick drain piston is not held in position.

Because of the return force of the spring assembly via the pressure raising piston on the oil in the chamber the quick drain piston rises and the oil flows to the oil sump.

Because of this, the 2-stage valve is also suitable for high control frequencies.

Drain period-max. 1 sec.

Pressure adjustment

1. The 2-stage control valve is adjusted in the works.

A re-adjustment is normally not necessary.

2. Adjustment ring: The pre-pressure of the valve is adjusted by this ring.

Lengthening the ring = raising pre-pressure

Shortening the ring = lowering pre-pressure

3. Adjustment washer: The final pressure is adjusted by this washer = Clutch control pressure is adjusted.

(Normally, no adjustment washer is provided!)

Adding or strengthening of the washer produces a rise in the final pressure.
Removing or making thinner, respectively shortening the spring reduces the final pressure.

4. Ascertain the control pressure at operating temperature and nominal speed. Check when idling and with cold gearbox.

5. For values see Control and Lubrication Oil Pressures.

**2-Stage Control Valve pressure adjustment**
Pressure-time relationship in the clutch control pipeline after the gearbox controller, during engaging and disengaging phases.

The illustration shown is valid for operation at nominal speed and operating temperature.

7. Lubrication pressure regulator valve

Characteristics:

Sealing by a 90° cone sealing washer made from rubber.

Restricted stroke, therefore, ensures free opening, shock absorbing and silent.

Opening pressure: Approximately 0.1Mpa.

8. Oil filler neck with sieve

Sieve as above measurements with 3-4mm mesh size
9. Dipstick

10. Pressure Switch

Type: YWK50 - C, aluminum casting case, water-resistant; untivibration acc. To standard GB5010-85

Wiring:

Double pole mini switch, working process:

Terminal 1, 2 and 3:
When the pressure lowers to the
shift point, terminal 1 has connected with terminal 3, and terminal 1 and terminal 2 are disconnected.

Electrical cable: φ12 marine class or φ7.5, 3-core.

Shift point:
Ahead: 1.5Mpa
Astern: 1.5Mpa
Lubrication oil: 0.04Mpa

11. Temperature Switch

Type JWC-K-A

1. Working Voltage: D.C. 27～110V
2. Charge on the contact point: 2A (resistance)
3. Shift temp. regulated value: 72～75℃

When the temperature reaches at 72～75℃, the switch is on.
12. Clutch release valve

The release valve has the task of putting the clutch into a renewed working phase as quickly as possible after being disengaged.

After the disengagement of the clutch, the retaining pressure on the piston is removed and by centrifugal and spring force the piston is put into the limiting position.

The clutch space is then discharged into the gearbox.

13. Notes:

If the structure or type of these standard accessories should be modified, the manual will be corrected in new issue.


VIII. Gear selection information

Gear selection

The gear model selection based on rating, input speed and required ratio is made from rating diagrams on the manual.

Ordering date

When ordering please state: gear specification, reduction ratio, design number, i.e.: Marine reverse reduction gear GWC42.45, reduction ratio i = 3, design No, B02 and the following data:

Engine maker:
Engine type:
Engine output:
Input speed: (Engine speed)
Output speed: (Propeller speed)
Direction of engine rotation: facing flywheel
Direction of propeller rotation: facing flywheel
Control valve type:
Cooling water temperature (inlet):
Classification society:
Kind of survey:
Shipyard:
Yard no:
Special order, contact the maker.
Precise reduction ratios GWC/GWL

<table>
<thead>
<tr>
<th>gear model</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
<th>nominal</th>
<th>reduction</th>
<th>ratios</th>
</tr>
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<tbody>
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<td>4.5</td>
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</table>

Precise reduction ratios GWD/GWS/GWK/GWH

<table>
<thead>
<tr>
<th>gear model</th>
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<th>2.5</th>
<th>3</th>
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</table>
### Selection diagram GWC/GWL'

#### Maximum permissible input speed

<table>
<thead>
<tr>
<th>Gear</th>
<th>2:1 2.5:1 3:1 3.5:1 4-6:1</th>
</tr>
</thead>
<tbody>
<tr>
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<td>28.30-36.39</td>
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<td>39.41-42.45</td>
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<td>700 875 1050 1230 1400</td>
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<tr>
<td>49.54-60.66</td>
<td>600 750 900 1050 1200</td>
</tr>
</tbody>
</table>

#### Remarks

* N = rated power, in HP (metric)

Input speed in rpm

The selection curves are based on following conditions:

- the above mentioned input speeds are not to be exceeded
- special order on request
- inline engines with more than 5 cylinders
- Veeine engines with more than 6 cylinders
- engine and gearbox to be connected by hightly elastic coupling

(In case of different conditions please contact us.)
maximum permissible input speeds

<table>
<thead>
<tr>
<th>gear models</th>
<th>r/min</th>
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Remarks
* N = rated power in HP (metric)
* n_i = input speed in rpm

The selection curves are based on the following conditions:
- the above mentioned input speeds are not to be exceeded
- special order on request
- inline engines with more than 5 cylinders
- vee engines with more than 6 cylinders
- engine and gearbox to be connected by highly elastic coupling

(In case of different conditions please contact us.)
## Oil capacities

<table>
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<tr>
<th>Gear model</th>
<th>GWC (i = 2.6)</th>
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1) With GWS and GWK gears having ratios above 4:1, oil capacities are on request.

### Cooling water requirements

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Cooler selection based on:

- Water inlet temperature (max): 32°C
- Oil cooler inlet temperature (max): 65°C
Water pressure at cooler inlet (max): 0.6Mpa

1) Rotations stated refer to ahead movement facing engine flywheel

*) Available as special design for models GWK, GWD, GWS and GWH only.
Service Manual of Marine Gearbox Model GW Series

GWC = reverse reduction gear
GWL = reduction gear with clutch

dimensions table $i = 2:1$ up to $6:1$

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HANGZHOU ADVANCE GEARBOX GROUP CO., LTD.

6 2
# Service Manual of Marine Gearbox Model GW Series

<table>
<thead>
<tr>
<th>Gearbox Model</th>
<th>Input Dimensions</th>
<th>Output Dimensions</th>
<th>Casing Dimensions</th>
<th>Weight with Cooler</th>
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* Dimensions and weights for gears with reduction above 4:1 are on request.

HANGZHOU ADVANCE GEARBOX GROUP CO., LTD.
Service Manual of Marine Gearbox Model GW Series

dimensions table i = 2:1 up to 4:1 only

| gear model | d | l | q | k | J | P | Q | q | A | B | E | F | H | H1 | h | h2 | L | GWS | GWK |
| GW28.30   | 82| 100| 134| 250| 32| 300| 174| - | 557| 1050| 300| 450| 1020| 1370| 100| 235| 968| 1230| 1130|
| GW30.32   | 85| 105| 149| 270| 32| 320| 191| - | 680| 1110| 320| 500| 1070| 1420| 100| 250| 1140| 1465| 1300|
| GW32.35   | 95| 115| 147| 290| 35| 340| 190| - | 718| 1220| 350| 560| 1140| 1480| 120| 290| 1189| 2035| 1870|
| GW36.39   | 105| 130| 169| 300| 40| 360| 218| - | 718| 1330| 390| 600| 1240| 1580| 120| 280| 1256| 2245| 2145|
| GW39.41   | 115| 140| 182| 330| 45| 400| 227| - | 821| 1400| 410| 650| 1290| 1630| 130| 320| 1393| 3230| 2960|
| GW42.45   | 130| 160| 189| 400| 46| 470| 198| - | 848| 1560| 455| 700| 1290| 1630| 140| 335| 1425| 3690| 3630|
| GW45.49   | 135| 165| 194| 420| 58| 500| 272| - | 934| 1590| 490| 710| 1420| 1800| 150| 410| 1594| 5725| 3835|
| GW49.54   | 145| 180| 214| 440| 65| 530| 301| - | 960| 1750| 540| 870| 1690| 2130| 170| 470| 1684| 6900| 6310|
| GW52.59   | 155| 190| 220| 460| 70| 550| 319| - | 1036| 1870| 590| 1080| 1750| 2320| 180| 480| 2038| 8920| 8120|
| GW60.66   | 180| 225| 254| 500| 75| 600| 370| 1146| 2080| 660| 1200| 1950| 2520| 200| 500| 2540| 12100| 11100|

* Dimensions and weights for gears with reduction above 4:1 are on request
Data for vibration calculation

Each system including the auxiliary system driven by the power-take-off (PTO) must be calculated regarding the torsional vibrations.

The following table contains all necessary data for GWC calculation for reference. The data for other series and variations will be made available on request.

**Moments of inertia**

- $I_1$: part of input shaft without coupling
- $I_2$: input wheel with part of input shaft
- $I_3$: Clutch wheel
- $I_4$: turning wheel with clutch disks external
- $I_5$: clutch disks internal with part of pinion shaft
- $I_6$: shaft pinion
- $I_7$: output wheel with part of shaft
- $I_8$: output flange with part of shaft

**Torsional rigidity**

- $C_1$: input shaft
- $C_2$: shaft pinion
- $C_3$: output shaft
<table>
<thead>
<tr>
<th>gear model</th>
<th>ratio</th>
<th>moment of inertia</th>
<th>torsional rigidity</th>
<th>shaft diameters</th>
</tr>
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<td>i2</td>
<td>i3</td>
<td>i4</td>
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**Service Manual of Marine Gearbox Model GW Series**

**Hangzhou Advance Gearbox Group Co., Ltd.**
# Service Manual of Marine Gearbox Model GW Series

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<th>Torsional rigidity 10^6 Nm/rd</th>
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1) absolute values not reduced
2) hollow shaft

HANGZHOU ADVANCE GEARBOX GROUP CO., LTD.

67