Shinko DMG turbo feed pumps have been developed for LNG carriers designed with a 3-stage, double suction impeller for the 1st stage and a single suction impeller for the 2nd & 3rd stages to improve pump efficiency and suction performance.

### GENERAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>DMG 100-3</th>
<th>DMG 125-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of stages</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Max. capacity (m³/h)</td>
<td></td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>Max. discharge press. (MPaG)</td>
<td></td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>Max. suction press. (MPaG)</td>
<td></td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Max. suction temp. (°C)</td>
<td></td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Suction bore of strainer (mm)</td>
<td></td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Discharge bore (mm)</td>
<td></td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>Rotational direction</td>
<td></td>
<td></td>
<td>Clockwise when viewed from turbine</td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td>Velocity compound impulse</td>
</tr>
<tr>
<td>Max. output (kW)</td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Max. inlet steam press. (MPaG)</td>
<td></td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Max. inlet steam temp. (°C)</td>
<td></td>
<td>530</td>
<td></td>
</tr>
<tr>
<td>Max. exhaust steam press. (MPaG)</td>
<td></td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Steam inlet bore (mm)</td>
<td></td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Steam exhaust bore (mm)</td>
<td></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Lubrication system</td>
<td></td>
<td>Forced lubrication (turb. oil ISO VG68)</td>
<td></td>
</tr>
<tr>
<td>Governor</td>
<td></td>
<td>Woodward governor UG-10D</td>
<td></td>
</tr>
<tr>
<td>Total weight (kg)</td>
<td></td>
<td>4500</td>
<td>4900</td>
</tr>
</tbody>
</table>
■ PERFORMANCE CHART

● Selection
Pump model selection can be made in accordance with the chart on the right classified by capacity and total pressure.

● Pump Efficiency
The efficiency of each pump varies between 65 ~ 74%, based on the capacity, as shown in the chart on the right.

● NPSH
The NPSH of each pump varies according to the capacity and speed, as shown in the chart on the right.

● Steam Consumption
If inlet steam pressure is between 5.5 ~ 6.0 MPaG, steam consumption of the turbine can be determined by the speed and the exhaust steam pressure, and calculated by the correction factor based on output, as shown in the charts below.
**OPERATION SYSTEM**

The turbo-feed pump is equipped with various equipment for safe operation, auto change-over operation, and remote starting/stoppage.

**Start Up in Cold Conditions**

A turbo-feed-pump cold start can be carried out locally with the following procedure:

1. Open the drain valve \( \bullet \) on the main steam line.
2. Condensate water is fed to the pump stuffing boxes as seal water after adjusting the pressure with the control valve \( \bullet \).
3. Set the starter switch to MANUAL mode, and start the priming LO pump.
4. Open the inlet steam valve \( \bullet \) slightly to warm up the pump, and widen the opening degrees for startup.
5. When the main LO pressure reaches 0.1 MpaG, the turbo feed pump enters normal operation mode automatically at the constant pressure.

**Pump Overheating Prevent System**

The system is designed to prevent casing overheating during normal operation. The recirculation control valve \( \bullet \) is opened to send part of discharge flow back to the deaerator by detecting the differential pressure on flow-meter orifices \( \bullet \) and \( \bullet \).

**Warming Up the Pump & Turbine**

The stand-by pump and turbine can be warmed up using the discharge flow and steam flow and steam from the working pump and turbine through orifices \( \bullet \) and \( \bullet \).

**Auto Change-Over Operation**

When the select switch on the main console is set to AUTO mode, the stand-by pump starts automatically and reaches normal operation levels within 10 seconds, whenever the discharge pressure on the working pump drops abnormally due to some trouble.

**Remote Starting & Stopping**

When the select switch on the main console is set to REMOTE mode and the start button has been pushed, the necessary equipment is activated sequentially, enabling the stand-by pump to start in order to maintain normal discharge pressure. After that, the working pump can be stopped by pushing the stop button.
**DESIGN & MATERIALS**

The turbo feed pump is designed so that the DMG pump and the turbine are connected by a gear coupling installed on a common base plate. The pump is a horizontal three-stage centrifugal type. The stainless-steel casing is cast with sufficient heat treatment. Since the casing is split horizontally into two halves and the suction and discharge nozzles are cast as an integrated unit, lower casing disassembly can be carried out easily without disturbing the piping.

The stem turbine is a horizontal single-stage velocity-compound impulse type. The turbine casing and bearing housing are both split horizontally. Thus, overhaul inspection can be carried out easily. Each bearing, gear coupling, and other components for both the pump and the turbine are forcibly lubricated via the main LO pump located on the opposite of the coupling from the turbine. The discharge pressure, regardless of capacity, is continuously controlled by our most economical constant pressure governing system.
● Casing
The casing is split horizontally into 2 halves in the way that the suction and discharge nozzles and the lower casing are an integrated casting unit. So, disassembly can be carried out without disturbing the piping.
Since the casing is supported on the center line, thermal expansion by high water temperature does not affect the alignment. The casing is firmly secured to the pedestals at the coupling with a king pin and bolts, and fitted to the pedestals at the opposite end with a key and bolts with conical spring washers, so that it can move axially toward the opposite coupling side.
Therefore, expansion of the casing from high temperature water can be sufficiently absorbed.

● Impeller
The impeller is designed and finished to maintain stability and high efficiency throughout the capacity range. It is perfectly balanced dynamically and statically.
Since the impeller is positioned on a shaft and firmly secured by a key and split ring, the shaft does not bend, and is free from axial expansion by high temperature water.

● Bearing
Bearing housings are equipped on both sides of the casing, and are split into the upper and lower parts. In order to support the radial load, a horizontally-split journal bearing is employed.
A Mitchell-type thrust bearing is equipped on the opposite side of the coupling to absorb the axial thrust.

● Thrust Balance
In order to balance axial thrust which occurs in the second-and-third impellers, a balance piston acting against discharge pressure is placed at the opposite side from the coupling.
Floating Ring for Pump Shaft Seal
Both ends of the pump casing, through which the impeller shaft passes, are equipped with the stuffing boxes where floating rings are fitted. Some of the condensate water is led to the inside of the floating rings as sealing water to prevent the high temperature water from leaking.
To minimize the amount of sealing water, the pressure is adjusted by a sealing control valve to stay 0.1 ~ 0.25 MPaG higher than the suction pressure. The narrow clearance between the sleeve and the floating rings also reduces water leakage.

A jacket is installed around the stuffing box, and sealing water is led to the floating rings after cooling the stuffing box.

Axial Movement Trip
When the turbine rotor moves abnormally in an axial direction for some reason, the moving and stationary blades may come into contact and may cause severe damage.
This trip is fitted in place with a 1 mm clearance (C) from the shaft end. When the thrust bearing wears down by 0.7mm and clearance (C) becomes 0.3mm, the turbine is tripped.

Tachometer (Patented)
This tachometer, having three functions showing the number of revolutions, the running indications, and the overspeed trip, is a patented electronic system. As shown in the figure below, this system is composed of a transmitter, receivers, and speed relays, and needs no external power source.
### Constant Pressure Governing System

The turbine is equipped with a constant pressure governing system, which consists of a Woodward speed governor, a pressure controller, and a transmitter. Pump discharge pressure is converted into a DC 4 ~ 20mA current by means of the transmitter and is used as an input signal for the pressure controller. The pressure controller issues an ON-OFF pulse signal according to the deviation between the input signal and preset value. Turbine speed is controlled by the speed-setting motor in the governor via this pulse signal so that the pump discharge pressure becomes equal to the preset pressure.

### Lubrication System

During operation of the turbine, the LO is supplied to the bearing metal, gear couplings, and other components through the main LO pump.

Besides, in order to maintain safe operation, an independent electric motor driven priming LO pump is utilized. When the turbine starts, it is inter-locked so as not to start even if the inlet steam valve is open until the pressure of the LO line reaches between 0.02 ~ 0.03MPaG. On the contrary when the turbine stops, the priming LO pump stays operating to keep the LO pressure at 0.02 to 0.03MPaG until the turbine stops completely.

<table>
<thead>
<tr>
<th>Actuation</th>
<th>P.O. pump</th>
<th>M.O. pump</th>
<th>LO pressure MPaG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch on (P.O. pump)</td>
<td>start</td>
<td>start</td>
<td>0.02 ~ 0.03</td>
</tr>
<tr>
<td>Main steam x. open</td>
<td>stop</td>
<td>start</td>
<td>0.1</td>
</tr>
<tr>
<td>Normal operation</td>
<td>stop</td>
<td>stop</td>
<td>0.1 ~ 0.15</td>
</tr>
<tr>
<td>Main steam x. close</td>
<td>start</td>
<td>down</td>
<td>0.045</td>
</tr>
<tr>
<td>Turbine stop</td>
<td>run</td>
<td>stop</td>
<td>0.02 ~ 0.03</td>
</tr>
<tr>
<td>Switch off (P.O. pump)</td>
<td>stop</td>
<td>stop</td>
<td>0</td>
</tr>
</tbody>
</table>

### Turbine Gland

The turbine glands, where the turbine shaft passes through the casing, are sealed with labyrinth packing to prevent steam leakage. Each of the labyrinth packing is split into 4 segments and suspended by a plate spring on their back sides, so that the turbine shaft does not get damaged even if the shaft makes contact with the labyrinth packing from excessive vibration.

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**Diagram:**

Diagram showing the control system of the turbine with various components labeled. The diagram includes the control panel, pump station, and various piping connections.

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**Figure:**

Figure of turbine glands illustrating the labyrinth packing system.
### ACCESSORIES [per pump]

- **For Pump**
  - Suction strainer: 1 set
  - Sealing pressure control valve: 1 set
  - By-pass orifice: 2/ship
  - Warming orifice: 1/ship
  - Thermometer for bearings: 3 sets
  - Gauge root valve: 3 sets

- **For Turbine**
  - Priming LO pump: 1 set
  - LO cooler: 1 set
  - LO Thermometer: 2 sets
  - Thermometer for bearings: 2 sets
  - Tachometer transmitter: 1 set
  - Tachometer indicator: 1 set
  - Pressure gauge: 6 sets
  - Gauge root valve: 3 sets
  - Gauge board: 1 set
  - Main feed pump starter with constant discharge pressure control device: 1 set

### SPARE PARTS [per ship]

- **For Pump**
  - Journal bearing metal: 1/set
  - Thrust bearing: 1/set
  - Floating ring for shaft seal: 1/set
  - Coupling bolts and nuts: 1/set

- **For Turbine**
  - Journal bearing metal: 1/set
  - Thrust bearing metal: 1/set
  - Each kind of spring: 1/set
  - Gasket and packing: 1/set
  - LO cooler cooling tube: 2.5% of total amount/set
  - Ball bearings for priming LO pump: 1/set
  - Turbine starter auxiliary relay: 4/set
  - Turbine starter pilot lamp: 10% of total amount/set
  - Turbine starter pilot lamp globe: 2/set
  - Turbine starter fuse element: 1/set
  - Solenoid valve coil: 1/set
  
  (set* = all units of the same application and model)

| Model | A   | B   | C   | D   | E   | F   | G   | H   | J   | K   | L   | M   | N   | P   | R   | S   | T   | U   | V   | W   | X   | Y   |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| DMG-100-3 | 3048 | 434 | 625 | 974 | 395 | 350 | 325 | 900 | 1477| 990 | 730 | 665 | 2425| 95  | 1030| 1160| 1260| 1180| 315 |
| DMG-125-3 | 3101 | 434 | 625 | 992 | 420 | 400 | 400 | 370 | 900 | 1477| 990 | 710 | 665 | 2530| 95  | 1030| 1260| 1260| 1180| 315 |

**Dimensions:** mm

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**SHINKO IND. LTD.**

[Details of the company and its products are included here, but not transcribed.]