GENERAL TECHNICAL SPECIFICATION

PT. Marine Propulsion Solutions

Model ZM SERIES

THROUGH-HULL AZIMUTHING Z-DRIVE
TOP PULLOUT WITH NON BUILT-IN CLUTCH

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1. General Description

1.1

PT. Marine Propulsion Solutions through-hull azimuthing Z-drives are designed for main propulsion of heavy duty workboats and tugs. In most applications, two units are installed in wells located in the stern section of the vessel. They are normally directly driven by diesel engines. They use fixed pitch propellers in nozzles that can be steered through 360º, without stops. The units are usually individually controlled by full follow-up combination joysticks that control engine speed, clutch and steering angle all in the same handle.

1.2 Design

PT. Marine Propulsion Solutions through-hull azimuthing Z-drives are engineered products of European design based on the latest marine propulsion technologies, ANSYS Finite Element Analysis and the most modern manufacturing technologies available. They are of very heavy duty design and incorporate many unique features to optimize reliability, longevity and easy maintenance.

1.3 Low Profile Design

MPS Propulsion's unique design features a very low input shaft height. In most applications, the diesel engine crank shaft is at a much lower elevation than the input shaft of the Z-drive. MPS's low input shaft elevation facilitates reduced cardan shaft angles resulting in longer life of cardan shafts and pedestal bearings and less vibration in the event of minor inaccuracies in cardan shaft alignment. Moreover, the low input shaft elevation facilitates lower main deck elevation.

1.4 Top Pull-Out Design

The Z-drives are for installation in wells. The wells are large enough to allow top-side installation and removal of the completely assembled thruster unit. Installation and removal takes place through soft patches in the main deck. If practical, the top flange of the well is at an elevation slightly above waterline in light ship condition. This allows removal and installation of the Z-drive while the vessel remains in the water, i.e., without dry docking. The thruster mount is provided with a top flange for bolting to the well flange. It is also provided with bottom closure plating that follows the lines of the vessel bottom. The well flange is also provided, along with the flange gasket and bolting, allowing easy and accurate installation without the need for any machining on the vessel well structure.

2. Azimuthing Thruster

2.1 Gear Transmissions in the Upper and Lower Gear Box

Both sets of right angle spiral bevel gears are HPG - machined or lapped in pairs Klingelnberg design Cyclo-palloid gears with crowned teeth. The gears are made of 17CrNiMo6 material and are designed for continuous operating at maximum torque condition. They are either integrated with the shaft or keyless fitted to the shaft thus avoiding local stress concentrations.

2.2 Bearings of Main Power Transmission Shafts

Bearings used for main power transmission are Anti-Friction roller bearings. The highest quality bearings such as Timken and SKF are applied for these applications. The design life of the bearings exceed the Classification Society requirements.

2.3 Shafts of Main Power Transmission

The main power transmission shafts are made from heat treated high strength 4140 alloy steel. Each dynamic sealing surface of the shaft is pre-machined, special coated and surface hardened to above HRc50 and ground to a mirror finish.

A pair of crowned teeth gear couplings transfer torque from the upper vertical shaft to the lower vertical shaft. This "floating shaft" compensates for misalignment resulting from dynamic deflection under load. Shafts are rifle-drilled and provided with integral pump to circulate lube oil from lower gear box to upper gear box.

2.4 Seals

A special design mechanical face seal is mounted on the propeller shaft and a positive oil pressure at the seal is provided by a gravity tank to prevent ingress of sea water.

The steering seals are two spring energized seals made from low friction and low wear polymer material mounted in tandem to prevent sea water ingress and lube oil egress. Corrosion resistant springs compensate for any dynamic runout under any loading condition. The dynamic sealing surface is hardened to above HRc60 hardness and is ground to a mirror finish. The steering seals are monitored by level switches in a gravity tank to indicate any leakage.

2.5 Upper Housing Assembly

The upper housing assembly consists of upper gear set, built-in clutch, auxiliary drive and steering mechanism.

2.5.1 Steering Mechanism

Steering of the Z-drive is facilitated by a large diameter slewing ring which supports the lower azimuthing body. This is a 4-point contact bearing provided with internal spur gearing on the inner race. Two top-mounted steering drives control steering of the Z-drive, which is through 360º, without stops. Each steering drive features a hardened spur gear pinion which is integral with the output shaft of a planetary gear drive, driven by a plug-in style hydraulic motor. These integrated slewing drives are bolted into flanged seats on the thruster deck.

2.5.2 Feedback Indicator

An independent angle position indicator is mounted on the upper housing assembly. Electric steering angle feedbacks are provided for the steering control system and for the remote angle position indicator in the wheelhouse.

2.6 Lower Housing Assembly

Lower housing assembly consists of a set of spiral bevel gears, propeller and nozzle. A high quality, ISO 484/2-1981 Class I, propeller is hydraulically mounted on the propeller shaft through a keyless friction joint. The propeller is made from high strength nickel-aluminum bronze.

The modified Kort 19A nozzle is made from primed steel plate. The inner surface of the nozzle around the propeller is made of stainless steel. Nozzle is slotted and welded to the lower housing to reduce the steering torque.

Sacrificial zinc anodes are welded to the nozzle against electrolytic corrosion.

Line cutters and a rope guard are provided at the lower housing for protection of the propeller shaft seal.

2.7 Thruster Mount and Well Flange

The thruster mount is provided with an upper flange to connect the thruster to the well flange. The well flange is provided by MPS Propulsion and is match drilled. It needs to be welded to the well by the shipyard. A thick gasket made from polymer material is provided between the two flanges to prevent sea water leakage. Minor distortions from welding the well flange to the well can be compensated for by the gasket. The bottom of the thruster mount is designed to fit flush along the vessel hull lines.

3. Hydraulic Power Take off

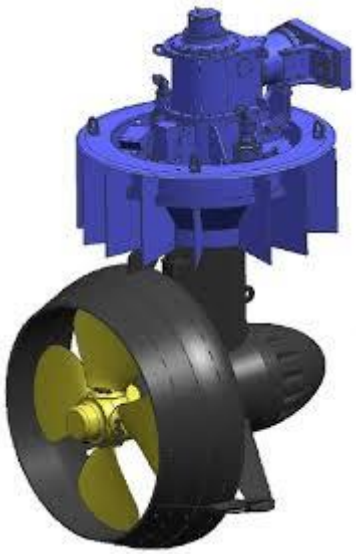
A range of compact and lightweight power take offs and incorporating a hydraulically operated clutch made from Twin Disc is directly mounted to engine flywheel housing. A built-in flexible coupling for engine flywheel is located at the input side of the hydraulic power take offs (HPTO). An output flange of the HPTO is ready for a cardan shaft connection.

An internally mounted oil pump provides pressure oil for clutch engagement and oil flow for clutch cooling and lubrication. The HPTO hydraulics uses an independent oil and reservoir system to keep any wear from clutch plates out of the main transmission system and the hydraulic steering system.

The HPTO is remotely controlled with the control level in the wheelhouse. In case of sudden electric power loss, the clutch can be manually kept in engaging condition.

4. Drive Line

Due to a very low input shaft height, the connection between the thruster and the HPTO mounted to diesel engine is a single cardan shaft. The cardan shaft compensates for misalignment resulting from the installation of the thruster and the engine. One set of cardan shaft installation tool is provided for initial alignment of the cardan shaft.



5. Hydraulic and Lubrication Systems

All components of the hydraulic systems are installed on the thruster, tested and adjusted at our factory for easy and time saving installation in the shipyard with the exception of the parts mentioned in the delivery list as ship loose items.

The hydraulic systems are the power source to steer the thruster unit, to lubricate and cool the propulsion unit and to engage and disengage the clutch.

5.1 Steering Hydraulics

Steering hydraulics are designed to accomplish 360 degree steering motion of the thruster unit in both steering directions. The steering hydraulic system is complete with pump, motors, valves, filters and heat exchanger. The system is independent from the electric power other than 24 VDC control power. The system can be manually operated even when the electric control signal is out. The steering hydraulic system has its own hydraulic reservoir and is entirely separated from the lubrication or clutch system.

The steering pump is a variable displacement axial piston pump controlled electrically.

The steering speed is proportional to the angular displacement of the thruster and is independent from engine running speed. The maximum steering speed is 3 rpm.

5.2 Clutch Hydraulics

The purpose of the clutch hydraulic system is to supply the oil flow required for engaging the clutch and dissipating heat generated during the clutch engagement, to maintain the working pressure required by the clutch and to filter the clutch hydraulic oil. The clutch hydraulic system has its own hydraulic reservoir, which is entirely separated from the lubrication or steering hydraulic system. Any wear from the clutch friction plates will not get into the gear and bearing system and neither into the steering hydraulic system.

A two stage engagement circuit is used on the clutch to ensure a very smooth clutch engagement.

5.3 Lubrication System

Lubrication of the power transmission components is accomplished by filling the thruster unit with lube oil. The lube oil is circulated from the lower housing to the upper housing both by nature of physics and with the help of an internal pump element. An external pump is used for filtering and cooling of the oil. Lube oil in the head tank gives a positive pressure to the lube oil inside the unit for maintaining a positive pressure on the propeller shaft seal.

6. Control System, Pilothouse

Pilot house controls consist of joysticks, steering angle indicators, switches and indicator lights mounted in a panel for customer installation. A dimmer is provided for illumination level control.

6.1 Primary Control (Full Follow-up)

The illuminated primary control head controls propeller speed, clutch and direction of thrust in one joystick. The propeller speed is controlled by advancing the bail handle, first engaging the clutch, then increasing the engine speed. Thrust direction is selected by rotating the control head to the desired angle. The thruster will steer to the selected position and maintain that position. This control head has detents at 0 position (directly ahead) and at engine idle (clutch engaged). Illumination level is controlled by the panel dimmer.

6.2 Secondary Control (Non Follow-up)

In the non-follow-up mode, the spring-centered steering joystick commands the direction of rotation, and the thruster rotates as long as the command is given. Clutch engagement and engine speed are controlled by a turning knob. Rotating clockwise engages the clutch, and then increases engine speed.

6.3 Steering Angle Indicator

The Steering Angle Indicator displays the thrust direction of the unit. The propeller insignia on the gauge indicates the direction of the propeller wash. The indicator operates independently of the controls, and is active in full follow-up and in non follow-up modes.

6.4 Clutch Engaged Indicator

A green light indicates clutch engagement. Illumination level is controlled by the panel dimmer.

6.5 Engine Room Controls

Prime mover speed control is available in the machinery space by selecting "Local" control. The clutch actuation and the prime mover speed are then locally controlled by a rotary knob. A clutch engaged light is also provided in this panel.

6.6 Local Thruster Controls

Clutch control valves can be manually actuated at the thruster for maintenance and troubleshooting and in the event of an emergency.

6.7 Control System Features

Control Voltage — 24 VDC Nominal.

Enclosures — NEMA 1 in pilothouse, NEMA 4X in engine room and thruster room.

7. Alarms and Indicators

Control system/power failure alarm.....Making contact
Lubrication oil level low alarm.....Making contact
Lubrication oil temperature alarm.....Making contact

Steering hydraulic
Charge pressure low alarm.....Making contact
Hydraulic oil tank level low alarm.....Making contact
Hydraulic oil tank temperature alarm.....Making contact
Steering control fault.....Making contact and local indication
Loss of steering input signal.....Making contact and local indication

Clutch control oil pressure low alarm.....Making contact
Clutch oil tank oil level low alarm.....Making contact
Clutch oil tank temperature alarm.....Making contact

Steering seal oil tank oil level low alarm.....Making contact
Steering seal oil tank oil level high alarm.....Making contact

8. Interface, Prime Mover

Speed control to the prime mover is 24 VDC at 0-20 mA (based on a standard 250· load). This signal can be provided by the full follow-up control head or either of the speed control knobs.

9. Interface between Thruster and Vessel

Installation of the Z-drive uses the top pull-out through hull mounting method. The well flange provided by MPS is machined and is ready to be welded to the top of the well by the shipyard. The detail well construction drawing is provided. The well strengthening gussets are preferably located to align with the gussets inside the thruster mount and should extend into the vessel longitudinal and transverse structural members.

An integrated structure for supporting the pillow block bearings is strongly recommended. The structure shall be attached to the vessel longitudinal and transverse structure. A robust structure design is a key to minimize the lateral vibration introduced from the drive line.

Hydraulic reservoirs shall be placed as close to the thruster unit as possible. The location of thruster lube head tank shall be placed approximately 15 ft. above the water level. Final installation height will be given in installation drawing or manual.

10. Quality Control System

PT. Marine Propulsion Solutions is committed to producing products and services at a level of superior quality and reliability. MPS Systems complies with all Classification. Quality control consists of routine inspections, random spot component testing and functional testing of all systems prior to final delivery. In addition, full torque and full speed testing is performed, verifying full load gear tooth contact patterns, vibration levels and smoothness of operation. When choosing components, the most important criteria are reliability, long service life, easy maintenance and availability. We use leading industry standard component manufacturers with a strong preference towards domestic made products.