Marine Solutions:
AC Induction Motors

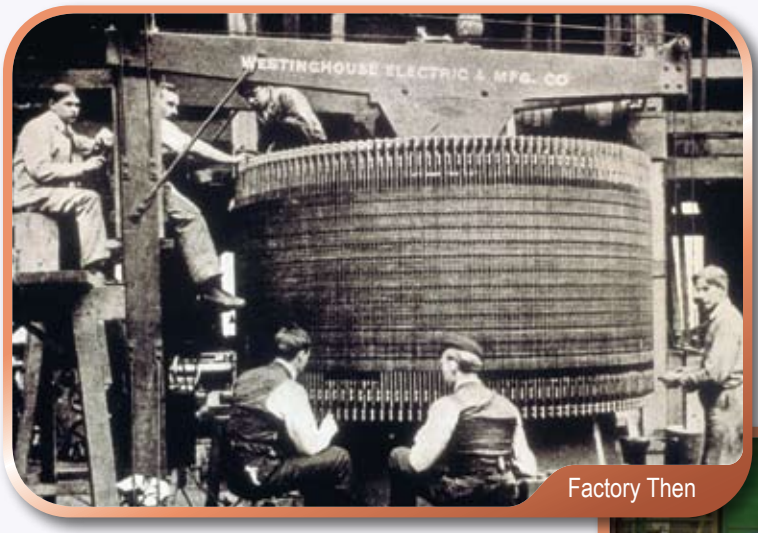
TECO Westinghouse

ABS ANAB SGS

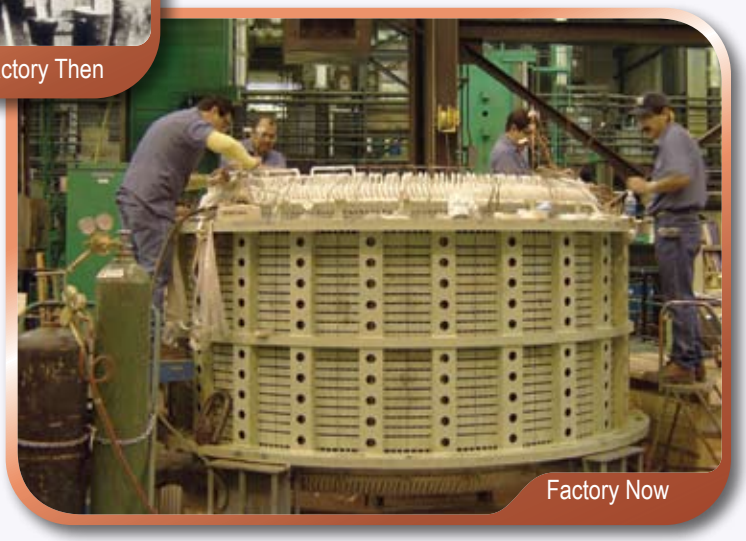
Marine Induction Motors

A Proud Tradition of Leadership

TECO-Westinghouse Motor Company began a tradition of industry leadership in 1884 when company founder George Westinghouse and Nicola Tesla introduced the world's first line of commercially practical polyphase induction motors. This pioneering achievement launched a new era in the utilization of electrical energy and we have continued to be an industry leader in electric motor design and manufacturing. Responding to the growing demands of industry, we have developed several generations of large-scale induction motors, each setting new standards for performance and reliability. These advances, along with the advent of the adjustable frequency drive, have culminated with our modern Marine family of motors.



Factory Then


Factory Now

A Distinguished Record of Innovation

TWMC's position as a world leader in the design and manufacture of large induction motors is secured by an unfailing commitment to engineering excellence and technological innovation. Among our most notable pacesetting advances, in addition to the induction motor itself, are the Thermalastic® Epoxy Insulation system, refinements in copper bar rotor construction, and high frequency induction brazing. Much of our success results from an emphasis on computer-aided design as a tool for engineering excellence. Drawing on more than four decades of design related computer analysis techniques, we optimize the design of every motor. These experience-based computer capabilities account for the high levels of performance and refinement that characterize the marine series induction motors.

TWMC marine application motors are specifically designed to meet IEC 60034-18-41/42 and can be used with any quality adjustable frequency drive. These motor designs also meet any of the major marine classification specifications, including ABS, DNV, LLOYDS, etc.

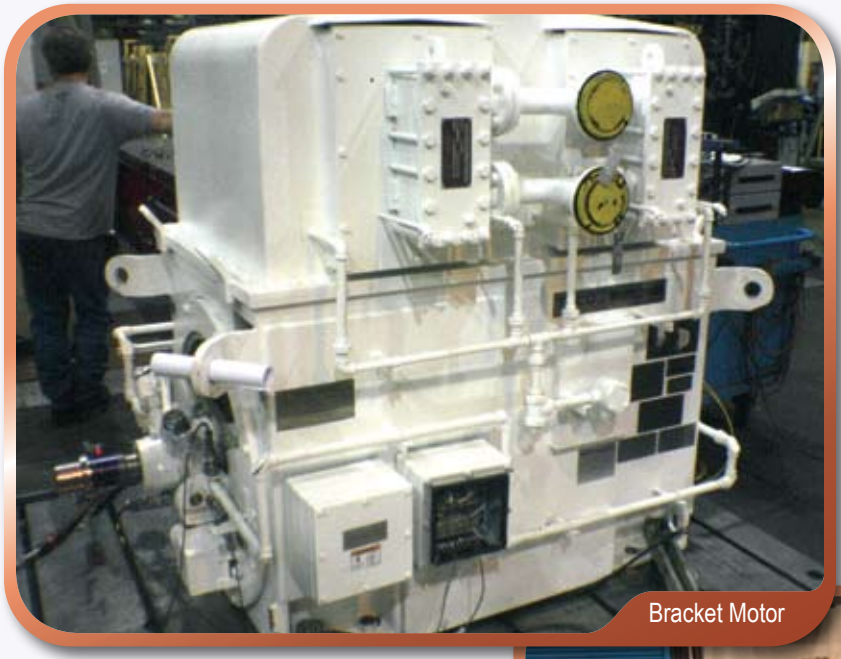
Marine Induction Motors

Propulsion Drive System Options

Our induction motors are typically used for the following marine applications: direct drive, geared drive, thruster drive, water jet drive, and pod drive. They can also be used in a hybrid drive where the motor drives into a gearbox and is in parallel with a mechanical propulsion prime mover such as a large diesel or gas turbine. This motor provides efficient low power for slower ship speed operation.

Motor Configurations

TWMC induction marine motors can be either bracket type or pedestal type. Bracket type motors feature a common rugged fabricated steel housing for the stator and bearing assemblies. Pedestal type motors have a free standing stator assembly and free standing bearing assemblies that are mounted on a common base plate structure which is mounted to the ship's hull. Larger motors are typically pedestal type. In either configuration, the motor ventilation system is a subassembly mounted on top of the motor.



Bracket Motor

Pedestal Motor

Excellence in Design & Manufacturing

TWMC has worldwide engineering, manufacturing, and R&D capabilities. The key to high efficiency levels of our marine motors is our ability to draw on our cumulative past experience to determine the precise combination of design variables that best meet customer specifications. Our engineers are able to review hundreds of design configurations in minutes, making it feasible to explore a complete range of possibilities and ultimately to optimize each design. State-of-the-art software capabilities also enable us to provide superior designs, drawings, complete quotations, and accurate performance data. TWMC also has an experienced R&D engineering team to support our design engineering staff for optimizing electromagnetic designs, mechanical designs, ventilation design, stress analysis, and vibration analysis.

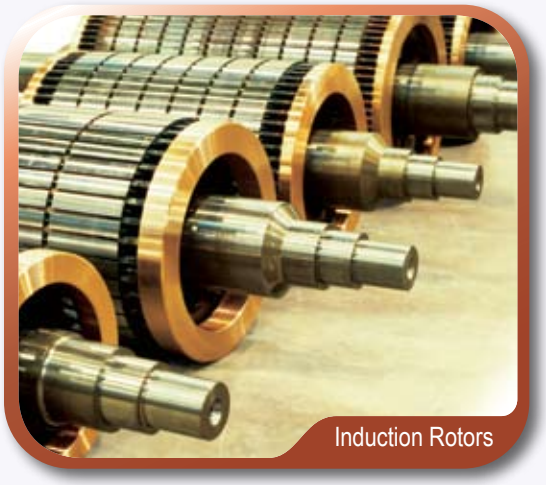
TECO-Westinghouse has three large modern manufacturing facilities in addition to our factory headquarters in Round Rock, Texas. Each of these factories has the ability to manufacture the same large motor designs at the same quality level.

Round Rock Headquarters

Engineering Design Center

Factory View

Heavy Duty Rotor Construction


Induction Rotors

One of the keys to the reliability of TWMC's marine duty motors is our emphasis on superior rotor design and construction.

The shaft is machined from a carbon steel forging designed for the rigors of marine propulsion service and to meet the marine codes. It features a smooth finish and specific contours to assure minimum stress concentrations. Smaller motors have radial arms that are integral with the shaft for transmitting torque from the laminated core. Larger motors have a fabricated steel spider structure that is shrunk to the shaft with heavy interference.

Swaged Rotor

Motor rotor laminations are thin sheets of precoated electrical steel. Each lamination is coated with a special insulating material that forms a molecular bond with the lamination metal to achieve interlaminar resistance. Core losses are minimized because the coating will not flow at any operating temperature, will not interact with other insulating materials, varnishes, or paints, and is not affected by moisture. The lamination bore, OD, and slots are punched utilizing special dies to assure accuracy and minimum burr height.

Special vent plates and fingerplates are used to allow ventilating air to pass radially through the laminations, thus assuring optimum heat transfer. These components also act like fans to assure uniform distribution of ventilating air within the motor.


Rotor Brazing

The rotor core is clamped between endplates and core pressure is maintained with thru studs. The core mechanical integrity does not rely on any electrically active component. The rotor core assembly is then shrunk onto the spider arms.

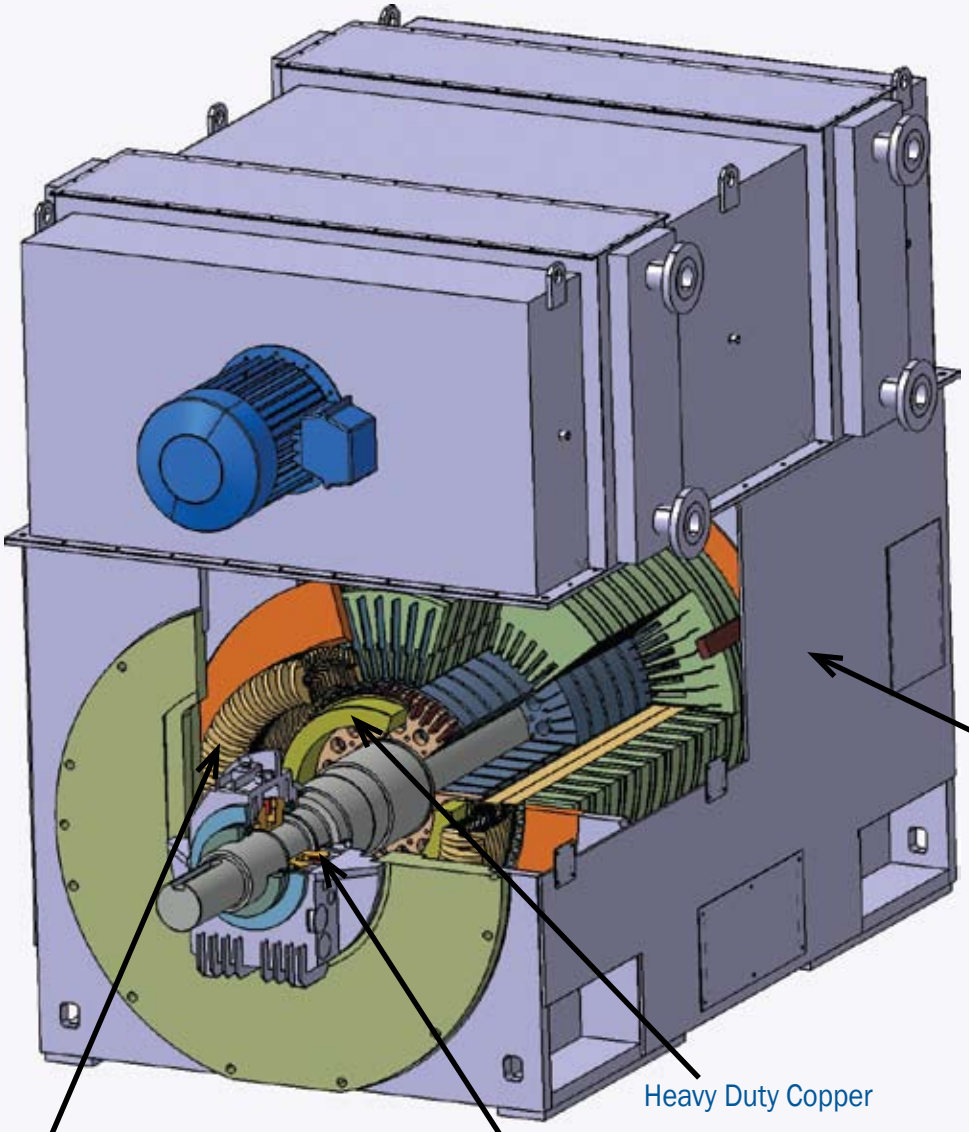
The rotor bars and end rings are made of copper, which has high conductivity and thermal capacity. The bars and end rings are sized similar to those used on "across the line start" motors, providing high strength and stiffness for marine service. End rings are centrifugally cast to assure purity and a void-free cross section. The bars and rings are machined to provide a special joint configuration and then joined together with a high frequency induction brazing process to assure high strength, reduce stresses, and eliminate hot spots in the joint. The rotor bars are then swaged with a special process that eliminates bar movement and vibration that can result in bar fatigue and failure.

Stator Construction

TWMC induction motors are available in two types of stator construction. Smaller motors utilize bracket type construction which features a heavy duty steel fabricated box with the stator frame and bearing assemblies integral with it. The fabricated steel frames are braced by steel plate bulkheads for lateral and torsional stability. End brackets are reinforced to give the bearings rigid support and to reduce vibration. Overall frame strength also minimizes vibration and virtually eliminates the need for realignment. The motor mounts directly to the hull.

For larger motors, the stator frame and bearing pedestals are mounted to a bedplate, which is mounted to the hull of the ship. For both pedestal and bracket construction motors, the ventilation package is typically mounted on top of the motor as a subassembly. The air ventilation subassembly can be mounted remotely from motor when there is restricted engine room space.

The stator core is assembled from stacks of individual thin laminations made of precoated electrical steel and clamped by large end rings with thru studs providing the clamping force. The core is welded into the frame for rigidity. Stacked into the core are vent plates which provide radial flow paths around the stator coils to transfer their heat to the ventilating air.



Windings

The TWMC Thermalastic® Epoxy Insulation system is a patented process that ensures the unsurpassed dielectric strength and voltage endurance for marine motors. Mica is the key to the Thermalastic® insulation system and is used for all stator coils. The coils fit in the slots of the stator and are then wedged. The end turns are braced to prevent coil motion both from motor magnetic forces and against dynamic ship motion forces.

Coil Bracing and Wedging

When the stator winding components are fully installed, including the insulated coils, coil-to-coil connections, and winding supports, the entire stator is post-impregnated with solventless epoxy resin in a vacuum pressure tank. The stator is then transferred to an oven for polymerization. This vacuum pressure impregnation (VPI) cycle is repeated for the elimination of corona-generating voids. The result is a reliable insulation system capable of withstanding prolonged voltage stresses, thermal cycling, moisture, and dirt.

VPI Process

Bearings

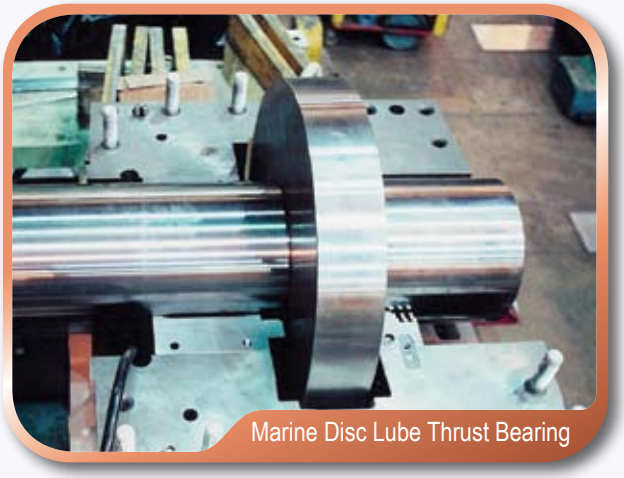
Two types of bearings are available with our marine motors. Most smaller motors are supplied with long life antifriction bearings that are grease lubricated. The aft bearing has limited end float and maintains rotor position. This can be either a split roller bearing or a deep groove ball bearing with preloading springs. The upper bearing on vertical motors supports not only the rotor weight but also the dynamic ship motion forces. Antifriction bearings can also be oil lubricated.

Large motors are typically supplied with sleeve bearings that are disc lubricated and self contained. In some cases, it may be necessary to provide a lubrication system for the bearings. For applications requiring very low speed operation for an extended period of time, hydrostatic lift can be supplied at each bearing.

TWMC can also provide a heavy duty thrust bearing as one of the main motor bearings. This bearing can handle the propeller thrust in both directions.

Renk Sleeve Bearing

Motor with Anti-friction Bearing



Marine Disc Lube Thrust Bearing

Ventilation


Force Ventilated Enclosure


TEWAC Enclosure

A variable speed propulsion motor must be capable of operating with full torque at zero speed. As a result, marine motors require a ventilation system independent of the main motor speed.

There are three types of ventilation systems normally used for marine motors:

- Type one has the ventilation air piped into the motor from a separate source.
- Type two has a separate fan with a motor mounted on top of the marine motor. The fan can obtain its air from another compartment in the ship or from the engine compartment.
- The third type is commonly used and is known as the totally enclosed water to air cooled (TEWAC). The requirement of a TEWAC is to have a separate complete ventilation subassembly mounted on top or along side the motor. This subassembly includes an air to water heat exchanger and separate motor driven blowers. This system provides a closed loop system independent of the environment. The heat exchanger can use either fresh water or sea water and is typically fitted with a water regulating valve in the water piping. This valve controls the water flow as a function of the air temperature in the motor which assures that condensation will not occur in the motor.

Vertical Motors

TECO-Westinghouse marine vertical motors reflect the same high quality construction and insulation processes that distinguish all the various components of our horizontal motors. Our vertical motors are readily adaptable to a variety of specific needs.


Vertical Motor

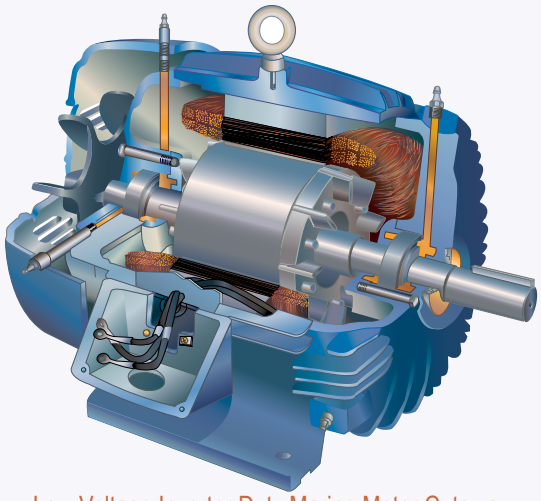

Vertical Motors

Low Voltage Motors

In addition to large propulsion motors, TWMC stocks a complete line of auxiliary inverter duty motors from 1 HP to 800 HP. These motors are used for propulsion fans, pumps, compressors, and other applications aboard the ship. All low voltage motors are rugged duty motors specifically designed for marine applications (above and below deck requirements) and meet the major marine codes, such as ABS. In addition they meet IEEE45 marine duty specifications.

Low voltage motor features include:

- Totally enclosed fan cooled construction
- Premium efficiency
- 1.15 continuous service factor
- Class B temperature rise- Class F insulation
- Bi-directional rotation
- 2 – Part Epoxy paint system
- Stainless steel nameplates, hardware and breather drains
- Noise level less than 85 db (A) at 1 meter
- INPRO seals on both ends



Low Voltage Inverter Duty Marine Motor Cutaway

Drives

TECO-Westinghouse Motor Company supplies low voltage AC drives from 5 HP to 500 HP (3 to 373 kW) for your marine duty applications. These drives comply with the major world marine codes, including ABS, etc.

Marine Duty Low Voltage AC Drive Features:

- Remote Analog Operator
- Either LED or LCD Digital Operators
- Output Card
- PID Relay Card
- Various Communication Cards Available
- Energy Saving Software
- Computer Link Software
- PID sleep Mode Function

Marine Duty Low Voltage Drive

Marine Standard Capabilities

3 Phase Windings

< 1000 VAC	500 – 5000 HP	100 – 1800 RPM
2400 - 4160 VAC	1000 – 14,000 HP	100 – 1800 RPM
6000-13,800 VAC	2000 – 26,000 HP	100 – 1800 RPM

Multi - Phase Windings

< 1000 VAC	500 – 8000 HP	100 – 1800 RPM
2400 - 4160 VAC	1000 – 20,000 HP	100 – 1800 RPM
6000-13,800 VAC	2000 – 35,000 HP	100 – 1800 RPM

Other Voltage, Rating and Speed combinations are available.

Service

At TECO-Westinghouse Motor Company, we pride ourselves on service. Our valued customers are able to tap into the strength of our resources for superior front end services, including engineering support, computer studies, product information and quotation assistance. Once your marine motor is in place, you can rely on our worldwide field service and engineering network to service and protect your investment.

Induction motor testing

TECO Westinghouse

5100 North IH-35
Round Rock, Texas 78681
1-800-451-8798

www.tecowestinghouse.com

LM-MSAC 02/08