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Power

Maintaining Full Station Keeping Capabilities During a Blackout

Keith Hebert

Global Industries, Ltd., Carlyss, Louisiana

SLIDE ONE, TITAN II PRE-UPGRADE (click to view)

In July of 2001 Global Industries initiated the project of converting the Titan II, which at the time was a self-propelled / anchored heavy lift vessel, to a DNV class AUTR DP vessel. The Titan was self propelled with four thrusters, two main zee drives of 2200HP each and two tunnel thrusters at 200HP each. Global entered into a long term lease for the vessel with a Ukraine based company with the intention of converting it to DP. Although not one of the original goals, one result of the conversion method [to DP] was a vessel that could maintain station for at least 30 minutes during a complete electrical blackout.

The project was designed to reduce delivery time by minimizing modifications to the hull and existing shipboard systems, so alternatives to standard thruster installations were investigated. Thrustmaster of Texas produces 1000 HP hydraulic azimuthing thrusters, which mount to the outside of the vessel. Minor structural support modifications to the hull are required to mount these thrusters. Each thruster unit has its own dedicated diesel engine powering two hydraulic pumps, one for propulsion and the other for azimuthing. The engine / pump set is installed in a standard 20' ISO container, one container per thruster. The hydraulics are run from the container to each thruster unit by either piping or hoses. This thruster design seemed ideal for our situation, as it would require very little hull work, no dry-dock time, and minimal interfacing to the vessel's electric power plant (the only requirement being a feed to the battery charger in each diesel/pump container unit). The only other impact to the existing vessel's systems was a fuel line from the main diesel fuel tank to each diesel/pump container unit. An added benefit of using these thrusters was that, if needed, Global could quickly, easily, and cheaply move the entire DP conversion to another vessel. We chose to install eight of the Thrustmaster units; six on the bow end of the vessel and two on the stern. The existing vessel controls were modified such that the new DP system could control the original thrusters without affecting the original controls. Two 2200HP zee drives and two 1000HP Thrustmaster units for a total of 6,400 HP aft pretty evenly balances the 6,000 HP from the six 1000 horsepower Thrustmaster units forward. Although the existing tunnel thrusters were interfaced to the DP system, we anticipated only using them in extreme environmental or job conditions.

SLIDE TWO, THRUSTER LAYOUT OVERVIEW (Click to view)

SLIDE THREE, VIEW OF TITAN BOW (Click to view)

SLIDE FOUR, DP SYSTEM ON-LINE (Click to view)

The DP system chosen for this installation was a Kongsberg Simrad SDP21, along with a Kongsberg Norcontrol Monitoring and Alarm System. Sensors for the DP system included a Seatex DPS100 DGPS, a C&C Technologies C-Nav DGPS, an MDL Fanbeam laser ranger, a Bandak taut wire unit, and a Kongsberg HiPAP acoustic system. Environmental sensors include two Seatex MRUs, two Gill wind sensors, and two C. Plath gyrocompasses. The new DP system also provided inputs for two survey-supplied DGPS inputs and the existing ship's gyro. The system also includes two 3KVA UPSs which provide up to a half hour of battery supplied power to all DP hardware shown here.

The installation was done at Bollinger Calcesieu Shipyard, located near Global's headquarters in Carlyss, Louisiana. The shipyard installed all of the DP equipment, Thrustmaster thrusters and containers. The shipyard also performed all required hull modifications to accept the new thrusters, with no dry-dock time required.

SLIDE FIVE, THRUSTER CONTAINER (Click to view)

Here we see one of the thruster containers just prior to its installation on the vessel. The containers were installed on the main deck in close proximity to its associated thruster unit. To shorten the delivery time by several weeks, we chose to run the hydraulics from the containers to the thrusters by hose. This had the added benefit of costing 80% less than the stainless pipe option.

SLIDE SIX, HOSES RUNNING FROM CONTAINER (Click to view)

We see here the container mounted on deck, with the hoses run through the deck. Each container houses a 1050 HP Caterpillar diesel engine, which in turn drives a 1000 HP hydraulic pump for thruster RPM and a 30 HP hydraulic pump for thruster azimuth. This particular container was mounted on a pedestal to avoid interferences on the deck, with the bottom of the container about five feet above the deck. The thruster package design avoids the need for accurate RPM control or coordination between multiple engines. Individual diesels only need to take care of their individual thruster. Controls are greatly simplified compared to a bussed diesel-electrical power plant. Any failure in a diesel engine or associated hydraulics cannot cause the loss of more than one thruster. Single point failures are inherently avoided by the system design using these thruster packages. Also, troubleshooting is greatly simplified, further reducing downtime.

SLIDE SEVEN, VIEW OF THRUSTERS (Click to view)

Two of the forward thrusters are shown in their retracted position in this slide. You can also see the hydraulic power supply hoses covered with anti-chafing material running down to the thruster.

In order for the DP system to control the ship's existing propulsion system, the controllers for both sets of original thrusters were modified. The main thrusters were originally built by Aquamaster. The tunnel thrusters were originally built by Kamewa. Rolls Royce has since acquired both of these companies, or acquired companies that acquired these companies, so Rolls Royce was contracted to install the controls upgrades for both systems. One of the most difficult problems we encountered in the project was

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sorting out the new interface between the existing thruster controls and the new controls. The difficulty arose from the age and surprising complexity of the original thruster controls, inadequate shipboard documentation, and the effects of multiple corporate relocations within the Rolls Royce family of companies. After a few days, Rolls Royce sorted out the interface, but it turned out to be more difficult than originally estimated. It is worth mentioning that this thruster interface problem very likely would not have been noticed on most DP conversions. However, this conversion project went so smoothly overall that relatively minor interface problems quickly became critical path items. The other major problems encountered on this project were slipping feedback potentiometers on the Thrustmaster units, corroded wiring harnesses on the Cat engines, elderly shaft couplings on the main zee drive units, which required replacement, and reversed azimuth display meters, none of which would qualify as MAJOR problems on a normal DP conversion project.

Although not one of the major design goals, one of the biggest benefits of having the thrusters with each its own self-contained power unit was the fact that the vessel could continue to maintain station after a total blackout of the ship's electrical plant. Except pressure to fill the fuel tanks every so often, the new thrusters do not require the main power plant to operate. The only reason station keeping during a blackout is limited to a half hour is because that's how long the DP System UPS batteries last. If desired, additional power could be supplied to the UPS batteries to extend blacked-out DP capability indefinitely. The Titan II does not require long term blacked-out station keeping capability, so there is no need or plan to extend beyond the existing 30 minute rating. The thrusters have enough fuel in each container to run at full load for twelve hours, and much longer during normal operations. Another advantage of this design became increasingly apparent during the early stages of the FMEA development. Because of the multiple redundancies inherent in the system design, many power-related failure tests that are normally performed on DP vessels are immaterial on this vessel. The DNV ERN (Environmental Regularity Number) for this vessel was barely affected by most failure modes.

In summary, our original goals with this project were to find a solution to our tight schedule constraints, one that would require minimal impact to the existing vessel structure, and have a system that is easily and cheaply movable to another should it be required. Although not one of the major design goals, one of the biggest benefits of having the thrusters with each its own self-contained power unit was the fact that the vessel could continue to maintain station for up to a half hour after a total blackout of the ship's electrical plant.