Building a Tough Tug
When a Carnival Cruise Ship Was Stranded off the Mexican Coast in November 2010, a Special Drive and Control Design on a Tugboat’s Winch Was Integral in Successfully Towing it to Safety

Background
In November last year, the Carnival cruise ship Splendor left Long Beach, California headed for a tour of the Mexican Riviera. The luxury trip was cut short, however, by an engine fire that caused the ship to lose electricity and become stranded 55 miles off the coast of Mexico. One of the six tugboats that brought it to shore used a powerful winch specially designed for the challenges of the open sea environment.

The winch design came from the collaboration between Markey Machinery, a major marine winch manufacturer, and Systems Interface Inc. (SII), a Rockwell Automation Solution Provider.

When Markey Machinery first contacted SII to build its control and drive systems for winches to be installed on four newly-designed tugboats, SII knew it would have to make the impossible, possible.

The project provided SII with a challenging prospect: Develop winch controls that could sustain the rough, high seas off the Pacific Coast of Mexico.

Solutions
Twin Allen-Bradley® PowerFlex® Drives
• Operating in tandem provided required redundancy
Separate Allen-Bradley CompactLogix™ Controller
• Provided the controls for additional backup for this critical system

Services and Support
• The collaboration between Systems Interface Inc., Markey Machinery and Rockwell Automation is a hallmark of the Rockwell Automation® PartnerNetwork™. Working with simulators, Markey Machinery and SII collaborated to design a winch drive system needing lower horsepower requirements

Results
Proven Performance
• The winch controls are able to sustain the rough, high seas off the Pacific Coast of Mexico
Remote Access Benefits
• The ability to remotely access and upload line tension data and diagnose problems off-ship allowed the crew members to stay focused bringing the ship into port

The SMBC Monterey tugboat (center, front) helps pull the disabled Carnival Splendor into the San Diego harbor after the cruise ship was stranded without power 55 miles off the Mexico coast.

Source: Michael Torres
Most tugs operate in ports and harbors with calmer waters, but these tugs would be working in open water, maneuvering through large, energetic waves, which makes tethered escorting of ships extremely difficult.

To make the project even more challenging, the tugboats would be tasked with safely escorting large liquefied natural gas (LNG) tankers into a new LNG terminal in Baja California, Mexico.

**Operating in a Tough Environment**

To keep the tug’s Hawser Line (a large, heavy rope used for towing) at a constant tension in protected water isn’t typically a challenge, but conventional drive and control systems couldn’t handle the sea’s power in the open ocean. The machine also needed enough horsepower to keep up with the demands at sea.

“As you can imagine, you don’t want the line to go slack and come back and snap tight when it’s attached to the ship while the tug is being tossed around on the ocean’s 10 ft. seas. The forces generated could destroy line attachment points on the ship or part the line and break the connection with the ship,” says deMers.

“It was a huge challenge. We did initial simulations on what it would take for the equipment, and the numbers were immense for a Hawser winch application – 2,000-3,000 Hp of machinery drive systems were required to keep that line under control in the anticipated sea conditions,” he adds.

The larger the horsepower required, the larger the on-board power generation needed. But with tug applications like this one, power generation capacity has practical limitations. This made the drive and control system design even more challenging, inspiring an innovative solution.

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“The unique test was to design a piece of equipment that could handle being tethered to a large LNG tanker and escort them in under very dynamic ocean conditions and safely berth the ships at the terminal. In the event there’s a rudder or engine failure on the ship, the tugs and winch must be able to control the speed and direction of the ship, and keep it off the coastline,” says Scott deMers, president, SII.
The controls would also play a fundamental role in the winch’s unique Render/Recover™ technology in which the winch handles the line’s tension automatically without the operator actively involved – a key component in the tugs’ ability to operate in these waters.

With the severe environment and sensitive cargo on-board the ship, the tugs had to have as much redundancy as possible to eliminate potential on-board problems.

A lot was riding on the project, says deMers. “These tugboats and the winches needed to handle the application, and if we couldn’t come up with a solution, then the shippers’ and terminal operator’s investment in the construction of this LNG facility would have been basically all for naught. So really, there was a huge amount of design pressure to come up with a solution,” he says.

In fact, all eyes were on Markey and SII to see if the new technology would work. If the winch was successful, it would set the standard for other tugboats used to escort LNG vessels in open water.

**Redundant Drives**

Working with simulators, Markey Machinery and SII designed an Asymmetrical Render/Recover™ winch drive system in which the drives work electrically for the recovery of the line, but power is reduced during rendering of the line using water-cooled slip brakes.

“Doing that, we were able to get the horsepower requirements down into the 1,000 Hp range, allowing us to use a more conventional dedicated generator system on board the tugs,” says deMers.

SII set up a dual-drive system, providing redundancy with two 500 Hp Allen-Bradley PowerFlex 700S drives from Rockwell Automation operating in tandem. If one were to fail, the tug workers still could operate the equipment, but at reduced performance.

For further backup, the controls use a separate Allen-Bradley CompactLogix controller (www.rockwellautomation.com/go/tjcompactlogix) to help if the main processor were to fail. Operator interface is provided by an Allen-Bradley PanelView™ HMI and 800H and 800F operators.

SII also installed data logging, remote diagnostics and winch troubleshooting abilities via the internet.

“We used a redundant Rockwell Automation EtherNet/IP™-based network system for reliability, but also to facilitate winch system diagnostics to compliment our internet access for data collection and remote troubleshooting. The tug operators wanted us to be able remotely access and upload line tension data and diagnose problems without having to dedicate their personnel directly,” he explains.
High-Profile Mission

While these tugs’ sole mission is the docking of LNG tankers, one tug, the SMBC Monterrey, received another high-stakes mission in early November 2010: to rescue the stranded Carnival Splendor, a cruise ship that lost power in open water after an engine room fire.

SII also played a key role in assisting the mission. While the tug was in transit with the Splendor, the tug’s on-board display detected a fault condition. The winch’s remote diagnostics technology allowed the tug operators to focus on bringing the ship to port, while SII remotely logged into the winch control and drive system on-board and diagnosed a cooling fan overload trip.

The remote troubleshooting effort resulted in finding some loose motor t-lead wiring that was tightened by the on-board engineer, and the issue resolved.

Thanks to Markey Machinery and SII’s unique design, the powerful high-tech winch allowed for safe towing and docking of the Splendor and her passengers in San Diego.

The results mentioned above are specific to Systems Interface’s use of Rockwell Automation products and services in conjunction with other products. Specific results may vary for other customers.