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# Canadian Coast Guard Boosts Marine Survey Accuracy and Productivity With Thales Navigations DGPS Solutions

System takes tide effects and 'squat' into consideration in crucial depth measurements - By Louis Maltais

The St. Lawrence River, the busy North American waterway that flows 3,800 kilometers to connect the Great Lakes to the Atlantic Ocean, is a vital component in the commerce and economy of Canada and the United States. Some 36 million metric tons of cargo moved through the Montreal-Lake Ontario section of the river in the nine-month navigation season of 1999, while the U.S. locks at Messina, New York saw nearly 3,167 vessel transits during the same period.

Because it's a limited-depth waterway carrying as much traffic as it does, the St. Lawrence needs to be managed in a way that takes into consideration the dual priorities of safety and efficiency. That means figuring out the optimal uses for the river in terms of vessels, speeds and traffic scheduling without permitting unnecessary safety hazards.

In the heavily navigated, 300-kilometer Laurentian section of the river between Montreal and Quebec, where large-ship traffic is exceptionally congested, dredging operations are essential and are conducted regularly. Ice formed during the winter flows downstream in spring and displaces huge amounts of rock and debris that, in turn, significantly alter water depth in some spots. Those depth changes require constant vigilance to ensure ships' safety.

## FINDING A NEW MARINE SURVEY SOLUTION

The Canadian Coast Guard has long worked together with the Canadian Hydrographic Service in conducting bathymetric surveys to accurately determine water depth, prepare for dredging operations, and determine the effectiveness of those operations after they've been completed.

Until recently, we used a combination of technologies for these surveys: a differential global positioning system (DGPS) for horizontal positioning and a network of tide gauges to determine the vertical position of the survey vessel with reference to the chart datum. The method presented a few problems, however. For one, the tide gauges give local measurements



taken close to shore on the assumption that the water at the vessel's location is the same as that indicated by the nearest tide gauge. Unfortunately, currents, tidal effects and other hydrodynamic phenomena acting on the vessel cause hollows and swells at the water surface. "Squat," the tendency of a ship's draft to increase as it moves through water, is a good example of this. It's a hydrodynamic phenomenon in which displaced water creates an increase in current velocity past a ship's moving hull. That, in turn, causes a reduction in pressure resulting in a localized reduction of the water depth—an important factor in determining precise depths for navigation.

In addition, the system was impractical, relying as it did on a series of 80 tide gauges, from which cumbersome data collection was an ongoing process. Matters were further complicated by the need to interpolate measured depths from several gauges at some points along the river.

Nearly four years ago, we began to look for a real-time kinematic GPS solution that would give us vessel positioning data and greater overall accuracy, and would take into account the hydrodynamic effects the old system couldn't measure.

## **THE THALES NAVIGATION SOLUTION: STABLE AND ACCURATE POSITIONING DATA**

We considered several options and, after an impressive demonstration that achieved real-time kinematic (RTK) initialization at 65 kilometers from the base station, selected Thales Navigation's Long Range Kinematic (LRK™) solution. The system takes full advantage of dual-frequency GPS technology while reducing initialization times to just a few seconds. Importantly for us, the system maintains optimal real-time positioning accuracy to within a centimeter at a range of up to 40 kilometers, even with a reduced number of available satellites. For our purposes, the system gives us a real-time three-dimensional positioning of the survey vessel – something we never had under the old system. Positioning is expressed in the WGS84 (World Geodetic System 1984) datum and can be converted to the chart datum with the help of a "seamless" datum, a grid model that gives the differences between the WG884 datum and the chart datum.

The LRK positioning of the survey vessels is done by Thales Navigation's Aquarius™ 5502 MK receivers, using DGPS signals from the on-the-fly OTF network deployed by the Canadian Coast Guard in the Laurentian region.

After selecting the Thales equipment, the next step was to work with Thales to build our St. Lawrence OTF network and monitor its stability over an 18-month period. The validation studies were conducted with Aquarius 5002 SK station and a 6000 RK™ relay station. The network was up and running in September 2001.

Later, our topographical department decided to invest in three Thales Navigation 6502 SK/MK™ systems for use by its land survey teams, the SK station to be used only when surveyors are outside the OTF network's range.

## **NEXT UP: STUDYING 'SQUAT' EFFECTS**

This year, we plan to begin experiments to analyze and quantify the effect of squat on various vessels' draft depth. We currently use a physical model to determine those effects based on vessel speed, vessel load and waterway depth. Our OTF network will allow us to verify the model's validity through full-scale experiments.

In the experiments, a small vessel with little squat exposure serves a reference and navigates just ahead of a larger vessel being monitored. The larger vessel will be fitted with as many as six DGPS receivers that provide a real-time LRK position. Those highly accurate positions will give us the data for calculating the fore and aft squat measurement as well as the torsion movements of the vessel.

The LRK technique, with its stable and accurate positioning readings, is an ideal means of conducting these experiments. Centimeter-level accuracy is essential in assuring the relevance of the of the experiments' conclusions.

Most important, of course, is our ability to provide accurate and reliable charts of the channel's depth characteristics, taking into account the tidal effects, during the busy navigation season. The Thales Navigation system is accomplishing just that, along with the welcome phasing-out of the old tide gauge system.

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