Mobile Control
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GNSS accelerates world speed record

Ed Shadle, driver, co-owner, project manager

In the summer of 2010, an all-volunteer team of 44, led by Seattle-area aerospace and computer experts, wants to attempt to break the world land speed record of 763 miles per hour and reach 800 mph. To ensure that the North American Eagle car operates as efficiently and safely as possible, the team is capturing reams of performance data from numerous sensors mounted on the car's body and a Topcon Global Navigation Satellite System (GNSS).

Steve Wallace, the team's data-acquisition engineer, and the team have to ensure that the 56-feet-long, 13,000-pound converted Lockheed F-104 Starfighter does not burrow into the ground or lift any of its wheels while in motion, for example, either of which would be detrimental to both record-breaking efforts and driver safety.

Analyzing the impacts of speed and sound on the car requires an enormous quantity of data. Wallace obtains the data from two separate information systems:

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Company: North American Eagle, Inc.
Location: Seattle, Washington area

Project: World land speed record
Location: Black Rock Desert, Utah/TBD
Scope: Existing record 763 mph; project goal 800 mph; GNSS system collects position data 20 times per second

Topcon Products:
- Euro 160T mobile control board
- GB-1000 receiver
- Topcon Tools software

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'[GNSS] is a great way of getting information I need fast without looking at accelerometer data. I can't think of a more valuable tool to understand what's happening from a sense of motion of the vehicle in general.' – Steve Wallace, data-acquisition engineer, North American Eagle, Inc.

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a data-acquisition system and GNSS.

The data-acquisition system collects data from as many as 70 sensors mounted on the car on critical components. Twenty times a second, a dual-frequency, dual-constellation Topcon PG-A1 antenna and Euro 160T OEM receiver located behind the cockpit collect positioning signals from GPS and Russian GLONASS satellites; Wallace says that signals have been captured from as many as 14 satellites at a time. The manufacturer says that it designed the antenna for rugged applications, making it a fit for the car's high speeds and vibration. The antenna and a base station set up near the track simultaneously receive satellite positioning signals and work together to provide real-time kinetic (RTK) position information, revealing the car's three-dimensional location.

A Euro 160T mobile control board, which Topcon Positioning Systems donated to the project, is mounted inside the vehicle's electronics bay. A GB-1000 dual-constellation receiver is positioned close to the test track for the purpose of collecting static reference data.

According to Charles Rihner, vice president, planning, for Topcon's Emerging Business Unit, the board is designed according to the Eurocard standard format, i.e., its interface is designed as a very rugged, industry-standard adapter for computing products that withstands acceleration up to 30 G-forces. The board withstands operating and storage temperatures of minus-40 degrees Celsius (minus-104 degrees F) to 75 degrees C (167 degrees F). Rihner adds that a compact "flash" card can be used to transfer data from the board, which has a total storage capacity of 1 Gigabyte, to a personal computer.

Although Wallace can access the data in real time, the data are collected on board. After a test run, he downloads the data to his computer and uses Topcon Tools software to correlate the time and location data. Then he exports the data to a Microsoft Excel spreadsheet. Each row of data in the spreadsheet reveals the interval (as time-stamped by the data-acquisition system 20 times every second) for the car to reach a GNSS coordinate (as obtained by the GNSS) within a three-dimensional Cartesian coordinate system. Elapsed time is converted into mph for each dimension and then the data are merged into "three-vector velocity" showing the car's direction and speed. Wallace can use the data to generate charts showing acceleration, which may indicate how numerous components and systems on the car are performing.

ABOVE: Precise measurement of actual vehicle speed requires the use of onboard sensors and a Global Navigation Satellite System.

LEFT: As the North American Eagle was prepared for a run at the world land-speed record, the car was displayed to the public at the Redding, CA Air Show in early fall 2009.

RIGHT: Topcon's precision dual-frequency, dual-constellation antenna, PG-A1.