Roaming Free for Precision

Field Surveyors in California Save Time with StarFire

Along a particular 385-kilometer stretch of land from Phoenix, Ariz. southwest to El Paso, Tex. lies a respectable swath of challenging terrain - from low desert sands and shrubs, to dry, steep rocky outcrops, to lush tree-lined riverbeds and streams to looming mountain ranges. Scenes that can change as quickly as the peaks and valleys of the blips on an electrocardiogram screen.

By Mary Jo Wagner

The SPEC team used the StarFire system to pinpoint and to set the location of about 300 aerial survey control panels.

Snow and Sandstorms

Pat Donohoe and Steve Razo, field surveyors at SPEC Services, an engineering firm in Fountain Valley, Calif., are used to navigating both manmade and nature's elements throughout the multitude survey projects they have carried out. However, this particular survey project was a bit different. It was to be SPEC's largest-ever pipeline-survey project through one of the most challenging settings its staff had ever experienced. And it was to be the trial run for its new, virgin survey tool from Torrance, Calif.-based NavCom Technology – the StarFire Global Satellite- Based Augmentation System (GSBAS) GPS solution.
Fitting circumstances to try out a new tool? Not generally, but Jeff Allsbrook, SPEC's manager of surveys, says it was the right time to purchase and apply an emerging technology that they had been monitoring for over two years. "We have traditionally used real-time kinetic (RTK) GPS for our pipeline-route surveying projects but we have always been on alert for systems that could offer very similar accuracies without the need for a base station," he explains. "A few years ago we began hearing murmurs in the industry that manufacturers were working on GPS systems that could offer decimeter-level solutions. That got our attention and we monitored the growth of this new capability for over two years. When we were confronted with the challenging realities of our biggest pipeline survey, we were even more eager to obtain a more efficient, highly accurate system. So when NavCom came to the market with StarFire and its offer of achieving decimeter-level accuracy without needing a base station, we bought it quickly and expressly."
The assignment came from SPEC's long-time client, Kinder Morgan Energy Partners (KMP), one of the largest pipeline and terminal companies in the U.S. based in Houston, Tex. Although very familiar and comfortable with these types of assignments, KMP was handing SPEC a project that called for a whole new set of tools to apply in a whole new kind of geographic environment.

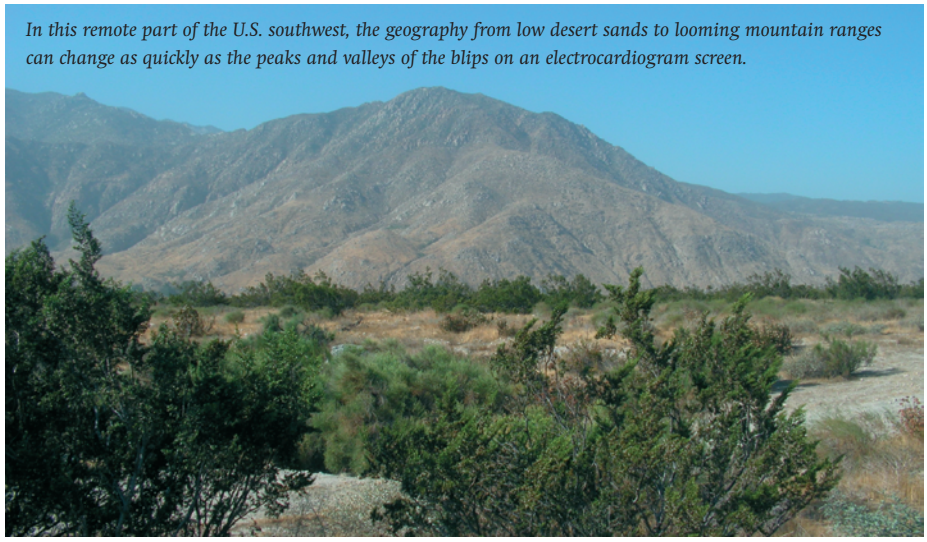
Assessing the Project Details

KMP's scattered assets include more than 40,000 km of pipelines and more than 140 terminals. Each day its pipelines transport over 2 million barrels of gasoline and other petroleum products and up to 8.7 billion cubic yards of natural gas. Its terminals handle over 80 million tons of coal and other dry-bulk materials annually.
As part of KMP's robust asset-maintenance program, the company noted that a 385-km stretch of its underground gas pipelines from Phoenix, Ariz. to El Paso, Tx., needed to be upgraded and expanded. At issue was where to place the new pipeline. KMP commissioned SPEC to survey and to locate the existing pipelines, to create a planimetric map based on aerial photography and to design the route for laying this substantial expanse of new pipeline.
In addition to the daunting size of the survey area and the tight deadline required by KMP, SPEC also faced another challenging reality – construction on parts of the new pipeline route would have to exactly parallel and closely border the existing pipeline route.
"We needed to have a high level of confidence that when KMP contractors started construction on the new pipeline, they would closely parallel the existing pipelines," says Allsbrook. "That meant we had to deliver a highly accurate position of the existing pipeline and proposed new route. That requisite, along with the sheer length of the survey area – three times the size of any of our previous pipeline surveys - and short deadline, would have been difficult to meet with our traditional RTK system."

StarFire Network

NavCom, a provider of precision GPS and wireless communications solutions, launched its StarFire Network in 1999 initially to the agricultural market and then diversified the product line into wider applications over the following years. A departure from standard RTK DGPS systems, the StarFire GSBAS uses a global network of dual frequency receivers and does not require local base stations. Both features, says Philip Morris, manager of product support and product validation & verification at NavCom, enable the system to greatly augment real-time

Network



In this remote part of the U.S. southwest, the geography from low desert sands to looming mountain ranges can change as quickly as the peaks and valleys of the blips on an electrocardiogram screen.

positioning accuracies (typically sub-decimeter) for users.

"The use of dual frequency receivers allows us to directly remove the two largest error sources in previous wide area DGPS systems – ionospheric refraction effects and multipath effects which can substantially impact positioning accuracy," he explains. "And by removing the need for a base station, users can eliminate the struggle to maintain communication links to continually receive a source of local corrections. In short, they are no longer tethered to a base station for precise positioning."

First Challenge

To adequately prepare for the survey project, Allsbrook and colleagues first researched the existing available maps of KMP's pipelines, which connected them to their first challenge. The KMP pipeline maps showing the exact location of their pipelines were tied to the United States Rectangular Public Land Survey System. But to create the new pipeline design in a digital grid system, SPEC engineers required a map based on the NAD 83, Universal Transverse Mercator coordinate system. That meant that not only the entire existing pipelines would have to be surveyed and digitized. The position of each section corner referencing the recorded pipeline easements would have to be surveyed as well.

So in mid-January, 2004, Donohoe and Razo headed to the site to both locate and survey the existing pipelines and set the aerial photography targets for survey control to ultimately create a planimetric background map.

Donohoe: "We mounted the NavCom StarFire system on our truck every morning, and while driving to the job site, it would gain its corrections from the land-based systems in the StarFire Network. By the time we reached the site, it had resolved its position down to the level of accuracy we needed and we could start surveying immediately."

Target Survey

Using a combination of a British-made underground utility locator and the StarFire SF-2050G backpack unit, Donohoe and Razo located the position of the existing 385 km of pipeline and surveyed its position at 152-meter intervals.

They also used the StarFire system to pinpoint the location of the aerial survey control points, and with some help from two additional colleagues, they laid about 300 aerial panels – each of which is about 4.5-m wide – at 1.6-km intervals.

The entire pipeline and aerial target survey took ten weeks to complete. Once the survey was complete and the aerial targets were set, a third party flew the site and collected a series of aerial photos using the large panels as a guide. Planimetric/topographic mapping was then compiled from the photography. Based on the position of the aerial panels and existing pipeline, SPEC's staff used Autodesk's AutoCAD to create a series of "alignment" sheets, detailed drawings to indicate the proposed route for KMP's new pipeline. The drawing of the entire 385-km pipeline was then segmented at 1.6-km increments to create 240 sheets of drawing plans, one kilometer at a time. The complete drawing package topped 400 sheets. With route in hand, KMP contractors began digging a new pipeline trench in early August 2005.

Roaming Free

With construction underway, it was time for Allsbrook and co. to assess the StarFire's first foray into the field. All were in agreement that the unit performed much better than expected, but what they seemed to like the best was the ability to roam free.

Allsbrook: "Typically, if you are 8 kilometers or more from the station, the correction signal will be lost, you will lose your accuracy completely and you will have to return to the base station to move it and start again. When you are in the remote desert, that trip back to the station could mean a drive over rough roads, over riverbeds, through cattle fences – it is not going to be a quick trip. It could take over an hour just to return to the base station and another two hours to reset it. With the NavCom unit, we could just continually drive the site and survey the pipeline."

"If we had taken on this job with our previous RTK solution we would have had to have a second survey crew on site to meet the project deadline," says Donohoe. Those benefits will be quickly negated however if the required accuracy is not met. After all, base or no base, surveying is all about position precision. And there is no better test to assess how well a system performs than the numbers.

Accuracy Claims

Allsbrook, Donohoe and Razo all admit they were rather skeptical that the StarFire system would live up to its accuracy claims, but Donohoe says the numbers they received just don't lie.

"The average horizontal accuracy we achieved was about 15 centimeters and vertically we achieved well under 30 centimeters," he qualifies. "For a system like this that was outstanding. Those accuracies are not typically achievable with a backpack DGPS unit."

The crew took more steps than usual to check the validity of the numbers, says Allsbrook. "Each day we would check into at least one monument to make sure the numbers we were seeing were indeed true," says Allsbrook. "Sometimes we came to within a couple centimeters horizontally and vertically to the published NGS values." Although there is no guarantee that the next survey project won't take Donohoe and Razo to a similar setting like that of the rugged U.S. southwest, they can be assured, however, that the StarFire unit will help reduce their exposure to the elements the next time they are subjected to nature's four seasons in one day.

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