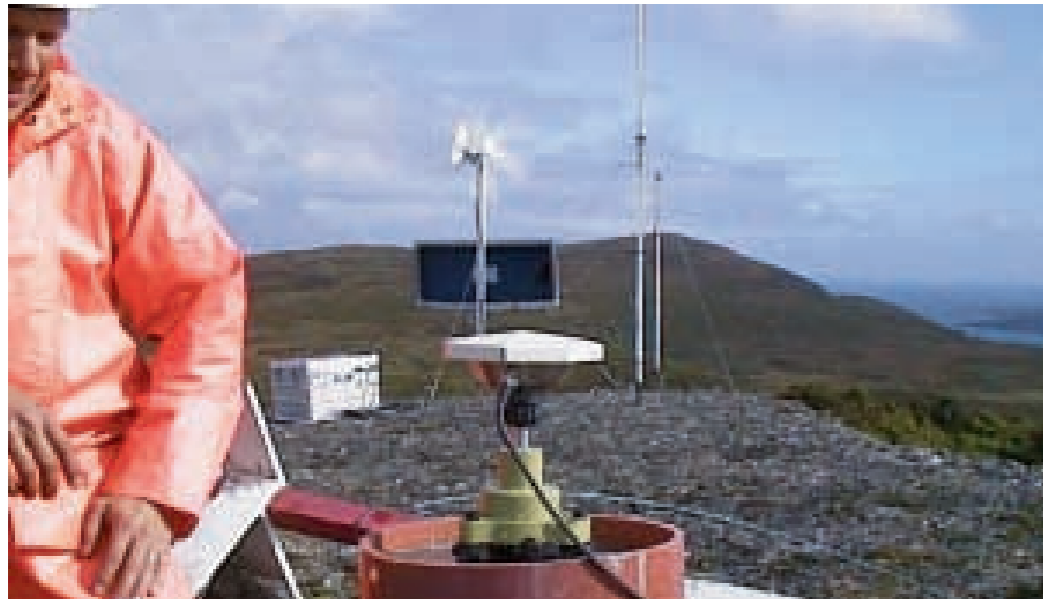


Leica GPS for the biggest Gas Pipeline Project in Norway



Four Leica MC1000 GPS base stations transmit real-time data in RTCM format via a radio modem.

In the midst of harsh terrain, surveyors in astronaut-like garb stake out the route for a new gas pipeline. Determining their position in real-time with the aid of satellites and the Leica MC1000 and SR 9500, they perform the groundwork for one of the largest-ever land based pipeline projects.

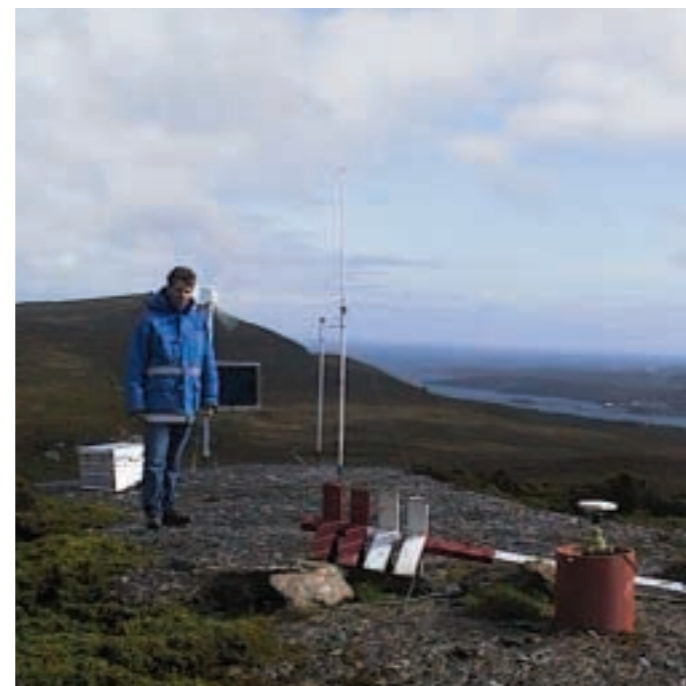
Åsgard and Europipe II. Åsgard is the name of the new gas pipeline that will run from Kalstø to Kårstø, where it will join Europipe II to carry gas via the Bokn islands to Germany. The steel pipeline, with a diameter of 105 cm and wall thickness of 4 cm, will be buried on land at a depth of 0.9 to 2.0 metres below the surface. Statoil chose the joint venture Kårstø Pipeline Contractors as the prime contractor for the stretch from Kårstø to the western side of Vestre Bokn. Selmer ASA has a 50% stake in the joint venture, with the remainder shared between two German companies, Ludwig Freitag and Bohlen & Doyen, and a Danish company, Per Aarsleff AS. The contract is worth 100 million EURO, making it one of the largest onshore contracts ever awarded. Not only are the costs enormous, the joint venture also faces some mammoth challenges. The pipeline will be laid not only on land, but also under four sections of sea. In total, an approx. 40 km stretch needs to

be completed in 22 months. Once construction is complete, the landscape must be restored to its original state.

Real-time surveying with GPS

Trond Pettersen Valeur of Selmer is responsible for surveying and GIS: "Given the project's magnitude, and the vital importance of surveying to its successful

completion, we felt compelled to adopt innovative methods right from the start." No tacheometers have been used on this project, only GPS instruments. Four Leica MC1000 GPS receivers have been installed as base stations. Three of these base stations are self-powered by their own small wind generator and a system of solar panels. The base station coordinates and the parameters for transforming these into the local Norwegian coordinate system were defined by static measurements to nearby reference points. The base stations transmit real-time data in RTCM format via a radio modem with a power output of 0.5W. The GPS rover units can select measurements from different base stations by setting the corresponding radio channel. After



Solar and wind generators provide electricity.



Some forty kilometres of 1.05 m gauge steel piping will be buried up to 2 m deep or routed across straits. The entire survey effort makes exclusive use of GPS technology; the picture shows a Leica SR9500 in action.



initialisation (determination of phase ambiguities), the rover operates with centimetre accuracy. Precision is affected by factors such as the number of satellites, satellite geometry, multipath signal propagation, etc. Five or more satellites with good geometry are needed for effective, precise working. Positioning precision is typically 10 mm ±2ppm. Height precision is somewhat lower (by a factor of approximately 2). To verify results after resolving phase ambiguities, a known point is often used to perform a calibration, then the coordinates are compared. Two initialisations are normally performed with data from two different base stations. A total of seven Leica SR9500 rover units are deployed on the project. Transformation parameters allow work to be performed directly in the Norwegian NGO48 map system (height = 54 AMSL). The field computers are equipped with routing software that provides

information on the current position with respect to the pipeline at any time. Detailed surveying knowledge is not necessary to be able to mark out pipelines using this method. However, some experience with satellite-based surveying is advantageous.

"In practice, this is not a big problem for us as our 'shore leave' is limited anyway. Also, we need to know in advance when we will be needed so we can prepare ourselves appropriately", says Bjørn Willy Larsen of GEFO AS, responsible for quality management on this project. Trond Pettersen Valeur estimates that the time needed for surveying and marking out can be reduced by 50% compared to traditional methods. However, he emphasises that the area around Karmøy and Bokn are particularly well suited to GPS surveying because the terrain is open, without obstructions from tall trees or buildings.

Norkart V/G software is used for checking and documentation. All surveying is performed using GPS; the surveyors send their field results directly to the V/G system software via the databank manager on a daily basis.

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