

# The North American Coal Corporation

## *GPS DOZERS*

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Prepared for:

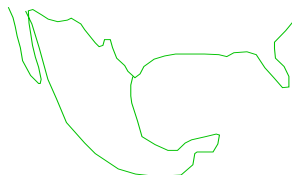
AUSTRALIAN JOURNAL OF MINING  
Open Cut Coal Operations  
Conference



Mackay, Queensland  
June 2001



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## Abstract

Global Positioning System (GPS) Machine Guidance is satellite based system utilizing a dual-frequency Real Time Kinematic (RTK) GPS receiver, specialized software to compare calculated position against a pre-set Digital Terrain Models (DTMs), correction radio and a rugged, touch-screen computer display. In laymen term's, an engineered plan and a computer is used to guide an equipment operator in placement or moving of earth, much like a speedometer tells you your speed in your automobile.

## Introduction

**The North American Coal Corporation**, a subsidiary of NACCO Industries, Inc. (Yale and Hyster Lift Trucks, Hamilton Beach, Proctor Silex, Kitchen Collections), Is engaged in the acquisition, mining, and marketing of coal used by electric utilities for power generation. NACCO is 8th Largest Mining Company in the United States mining 31 million tons of lignite and 8 million tons of limestone annually with 1000 Employees. Corporate headquarters are located in Dallas, Texas, with surface coal mining operations in Texas, North Dakota, Louisiana, Mississippi and also provides dragline mining services for a limerock quarry in Florida.

The Falkirk Mining Company is a wholly owned subsidiary of The North American Coal Corporation. Falkirk supplies about seven million tons of lignite annually to a 1,100 megawatt electric generating station owned and operated by the Great River Energy Cooperative of Minnesota, from two pits near Underwood in central North Dakota, about 100 kilometers north of Bismarck. We are currently working two coal seams, one of them about 1 meter in thickness and the other about 2-3 meters, at depths of 8-40 meters, separated by about 6 meters of clay and sandstone interburden. Overburden consists mostly of sandy shale and glacial material. The pits are about 3 km long and 60 meters wide, and are worked by a pair of Marion 8750 electric-powered walking draglines

## History

Falkirk started investigating the use of GPS for machine guidance in 1997. We set several goals for the system. The system needed to be **Operator Friendly, Accurate, Reliable, Easy to Maintain, Flexible** and **Cost Effective**. After evaluating several potential vendors, we began a demonstration project in April 1998 using specialized software developed by Carlson Software with much input from Falkirk and a MC1000 GPS system from Leica Geosystems. The demo system was installed on one of the Caterpillar D11 bulldozers working primarily in overburden grading. In June, a second system was installed on a supervisor's pickup truck for further evaluation. We took daily feedback reports from the machine operators during the trial period and then we worked closely with Leica and Carlson to fine tune the system and iron out glitches. Leica, much like NACCO, saw the enormous potential for this system and negotiated an exclusive distribution agreement for the guidance software with Carlson. Soon thereafter, Leica named the system "Dozer 2000".

## Regulations create need

As required by the Surface Mining Control and Reclamation Act, the land is being restored to its pre-mining condition. Land reclamation is being accomplished contemporaneous with the mining operations in strict compliance with state and federal regulatory requirements. As the dragline works its way down the pit, a dozer fleet levels and grades the spoil piles of overburden to the approximate desired contour. The post mining contours have been submitted and approved in a mining permit prior to mining. A truck shovel fleet then brings in subsoil from newly uncovered land, followed by tractor-scrapers with topsoil. The land is graded to the approximate original contours, referring to topographic maps created prior to the excavations. In the case of Falkirk, the terrain is mostly flat or gently rolling prairie, used primarily for agriculture or grazing. Falkirk reclaims approximately 500 acres per year.

## How it works

The Dozer 2000 machine guidance system includes a ruggedized high-precision GPS receiver, radio data receiver and touchscreen computer. The GPS antenna is mounted on the top of the cab, where it has a clear view of the orbiting satellites. The GPS receiver calculates its position in three dimensions 10 times per second. The position data is corrected for local-area errors using data transmitted from a fixed differential GPS reference station, consisting of a Leica MC1000 GPS receiver, GPS antenna and one-watt radio transmitter that has been established on top of Falkirk's coal silo. The DGPS data is transmitted via 900 MHz radio frequencies through two repeaters mounted at the tip of the dragline booms to the GPS "rovers" working in both pits. The mobile Dozer 2000 systems use the error correction data to fine-tune the position accuracy to 2-5 centimeters. The touchscreen computer is mounted in the cab. The computer compares the actual GPS position to the desired finished terrain, using grid files created from topographic maps. Files from the office are transferred to the field units by using standard PCMCIA cards. The large, bright display provides visual guidance to the operator for maneuvering the vehicle and positioning the blade to achieve the cut and fill values needed to match the computer model.

## Benefits

Falkirk has achieved important cost savings and productivity gains by reducing rehandling of overburden and subsoil. Our goal is to put the right amount of dirt in the right place the first time. This means handling the material once. Rehandling is very expensive, in terms of labor, machinery maintenance and life-cycle costs for the equipment.

Using the Dozer 2000, the operators can typically bring the surface within 9-12 cm of the design grade without the use of survey stakes, even at night. There is less downtime, since the dozer operators no longer have to wait for surveyors to come to the site and replace stakes that have been knocked down or covered over.

While it is harder to measure, there has been a tremendous upsurge in morale among the machine operators. The operators love the system. It empowers them to do a great job independent of surveyors and stakes. They get a better 'feel' for the terrain model and can better visualize the contours. The topographic files displayed in the cab clearly show drainage, hilltops, valleys, wetlands and other terrain features. We already had the best operators in the industry and this tool enhances their performance.



The machine operators like the touch-screen display with its large graphics and intuitive operating procedures. At a glance, the operator can see the cut and fill values needed to match the topographic design model.

There is a lot less friction between shifts, especially in the morning. The morning shift no longer has to worry about undoing work that had been done during the night. When the new operator climbs into the cab, he simply touches an icon on the screen. When he sees the “target” symbol in the upper right corner, he knows that the surface is within design tolerances.

### **Innovative Uses**

The main applications of the system is spoil reclamation, respread of subsoil and dragline bench building. The Dozer 2000 technology has encouraged more innovation by machine operators, who are constantly seeking out new applications.

For instance, last winter, when freezing temperatures made it impossible to handle topsoil, the truck shovel and tractor scraper fleet was redeployed for final highwall reclamation at another site that was being closed. Because some of these vehicles were not equipped with Dozer 2000 systems, the reclamation supervisor was able to drive his GPS-equipped pickup truck to the site and stake it out quickly for the shovel and tractor scrapers. This resulted in considerable savings.



In another case, one of the bench dozer operators used the Dozer 2000 to map breaks in the dewatering pipes that had been ruptured by bench building for the draglines. This made it easy to guide the pump crews back to the exact location of the buried pipes, to make repairs. And in another, a dozer operator used the slope function in the Dozer 2000 to engineer a runoff slope and drain a large water puddle in the spoil area, allowing work to resume without waiting for pumpout.

Falkirk is really seeing the benefit of constructing roads and ponds using the GPS system in less surveyor staking time and results that accurately represent the engineered plan.

### **Expansion**

Today, Falkirk has a total of 13 systems installed on a variety of vehicles, including eight bulldozers (four Caterpillar D11s, one Caterpillar D8, and three Komatsu D375A's, one motor grader, one tractor scraper and three pickup trucks. The D11s are mostly used for spoil pile leveling and the D8 is used in subsoil respread. Two Komatsu dozers work on the dragline benches and one is a push cat for the tractor-scraper fleet.

North American Coal Corporation has purchased and installed a total of 42 Dozer 2000 rover systems. The Coteau mine in North Dakota has 12, San Miguel lignite mine in South Texas operates 4, the Sabine mine in Texas runs 7 and Mississippi Lignite Mining Company is using 6 units.

## Summary

**Dozer GPS has been one of the best things done in operation in the last twenty years,** according to our operators and supervisors. The system has reduced the surveyors' use of wood stakes and changed the talent a surveyor needs. It is a highly technical system requiring expertise in GPS, radio systems, computer & software operation and digital terrain modeling. Computers can be a great tool, but you only get out the quality that you put in. Our people and the support of Leica and Carlson have been the greatest asset in making the system successful.

If you are in our area, we invite you to stop by and take a tour of our mine.

For more information on this system feel free to contact me with any questions at [gerry.Lannoye@falkirk.com](mailto:gerry.Lannoye@falkirk.com) or check out the following web sites:

<http://www.leica-geosystems.com/news/2000/falkirk.htm>

<http://www.leica-geosystems.com/gps/product/dozer.htm>

[http://www.leica-geosystems.com/news/2000/machine\\_texas.htm](http://www.leica-geosystems.com/news/2000/machine_texas.htm)

[http://www.leica-geosystems.com/news/2001/dozer\\_v3.0.htm](http://www.leica-geosystems.com/news/2001/dozer_v3.0.htm)

<http://www.carlsonsw.com/>

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