GeoLink® For Utilities Mapping
UP THE POLE, DOWN THE LINE:
GPS on the Utilities Circuit

Pole by pole, line by line, across two-thirds of Montana, the Independent Inspection Company of Havre is using GPS and GIS to inspect and evaluate the condition of each of the 330,000 utility poles owned by the Montana Power Company.

Robert T. Bricker
Chris Kemmer
Independent Inspection Company

Photography
Robert T. Bricker

Robert T. "Bob" Bricker founded Independent Inspection Company (IIC) in 1987 in Havre, Montana. He holds a B.S. in Vocational Education from Northern Montana College in Havre. Before founding IIC, Bricker was a power line contractor with Duty Construction Company for nine years, and before that he was employed by Hill County Electric Co-op for eight years. He was most recently recognized in GPS World as the first place winner of the August 1994 Applications Contest. Chris Kemmer is project manager at IIC and holds a B.S. in Design Drafting Technology, also from Northern Montana.

Montana is a state long on scenic beauty and dramatic terrain. It is home to the Rocky Mountains and Glacier National Park; the Gallatin River where the Maclean men fished in A River Runs Through It; and the wide open spaces of Big Sky Country, where the general absence of urban sprawl and polluting industries accentuate the mild presence of electric power poles rhythmically rising across the endless landscape.

The Montana Power Company (MPC), an investor-owned electric and natural gas utility headquartered in Butte, Montana, has a huge territory, spanning approximately 107,000 square
miles, from the Canadian border on the north to the Wyoming border on the south, from the Idaho border on the west to within 150 miles of the North and South Dakota borders on the east. MPC manages nearly 21,000 miles of distribution line with 230,000 poles and 6,000 miles of transmission line with approximately 100,000 poles.

Keeping track of 330,000 poles can be a difficult task. Some companies have linked their databases with computerized field data collection systems to record utility system conditions. Recently, Independent Inspection Company (IIC), an independent company that provides wood pole inspection, utility inventories, GPS and computer aided mapping and drafting services to MPC and others in north-central Montana, has been able to decrease the utility’s costs and increase its system’s reliability using GPS.

ENSURING RELIABILITY

Electric utilities invest considerable sums in facilities and equipment. Some of those funds are spent on management, inspection, and maintenance programs that ensure safe and reliable operations. Electric utilities cannot solve problems late in the game; they must establish measures that prevent problems from arising and methods to limit the damage when problems appear. Preventive management can cut costs incurred by unnecessary overtime, outages, and potential liability, which could very well total more than the initial investment into safeguarding measures.

In 1987, MPC decided to implement its System Integrity Plan, a specialized program that the company developed to inspect, inventory, evaluate, and maintain its system. The company was firmly convinced that such a program would save money and offer greater system reliability. After all, some of MPC’s utility poles have been in place since the early 1900s. Under the System Integrity Plan, MPC, in conjunction with IIC, inspect 100 percent of its system on an annual basis. Each year MPC maintenance personnel inspect 80 percent of the system in a drive-by procedure to locate obvious and immediate hazards, to satisfy Forest Service requirements, and to document any changes adversely affecting safe operation of the lines. The remaining 20 percent is accomplished by IIC in a detailed pole-to-pole inspection procedure. With this 80:20 ratio, the company gets a complete and detailed pole-to-pole inspection every five years.

MPC contracted IIC’s services at the very start of the plan. In conjunction with MPC, we designed a plan to perform the detailed inspection in a consistent manner. The objective of this inspection is to accomplish the same goals as the drive-by inspection, and also:

- evaluate the condition of the poles, stubs, x-arms, and any
On the opening pages, a scenic backdrop near Dillon typifies one of Montana's chiseled landscapes in the southwestern part of the state.

The CAD map (above) details all circuits out of the Thompson Falls substation distribution system; the poles are color-coded for ratings.

From left to right, a series of five power pole problems: hazards encountered with other structures; conductor damage; fractured pole; wood rot; and beaver damage.

On the facing page (top right), a detailed CAD map of Fort Belknap, east of Havre, illustrates the pole-rating system and exact locations.

Below, Chris Kemmer uses a handheld GPS receiver to record a pole's exact location.

equipment attached to the poles
- identify potential code violations
- update maps and engineering records
- verify joint-use attachments
- number or verify numbering of each pole.

The evaluation is correlated to a numerical rating system that is then applied to each structure. Separate ratings are used for the pole, x-arm, and stub, if used. The numbers used for the ratings range from one to five, with "one" indicating a new structure and "five" representing a structure in need of immediate attention or replacement in less than one year. Structures rated "four" or "five" rated are slated for replacement in one to two years. Ratings of "three" to "one" mean the structure should be reevaluated in five years. This rating system provides MPC with an overall view of its system's condition.

In addition to inspecting the structures and attached equipment, we measure conductor clearances, span lengths, and ambient air temperature for possible National Electrical Safety Code (NESC) violations. We take these measurements at crossings over roads, railroad, highways, and typical clearances over land where no roads or trails exist. Clearances between TV, telephone, and primary conductors are also documented as needed. We visually inspect each conductor from pole to pole, documenting any anomalies or hazards that may conflict with the conductor.

Along with the aforementioned evaluation, we collect the following information:
- size, class, and type of wood pole and original treatment
- date of pole installation, if available
- ownership of pole and joint-use attachments
- date of last remedial treatment, type and location of treatment, and whether the treatment meets government requirements
- transformer sizes and the phase to which they are attached (for load studies)
- type of structure (for inventory purposes)
- location of plant (for tax districts)
- miscellaneous codes (for loose hardware, physical damage, and so on)
- location of areas that have tree problems (for tree-trimming crews)
- potential problems that need immediate attention.

We record these physical characteristics on a form, enter them into a database, and generate a report for MPC's review. MPC then analyzes the data and prioritizes the repairs and/or corrections that are
required. In the early days of the program, we handwrote the data for each power pole on a form and sent the completed forms to our office where the information was reentered into a computer, which then generated hard-copy reports. That method was time-consuming and error prone, dependent as it was on the person reentering the data. Later, we turned to GPS to automate this procedure. Not only could one person enter all the data into a handheld receiver and download it into the office computer, but we were also able to obtain an accurate GPS location for each pole.

A GPS OPPORTUNITY
In 1993, MPC’s Missoula division had an old Distribution System Management (DSM) computer system with a database containing information about pole locations, transformer locations, and conductor sizes used for load studies on all of the data. The database information was valuable, but the outdated DSM computer system could not keep up with the division’s rapid growth. MPC’s Missoula division therefore purchased a custom-designed automated mapping/facility management geographic information system (AM/FM GIS) as a first step toward solving the problem. The next step was to transfer all the existing data into the AM/FM GIS format. The division was able to transfer the old information into the new system format, but not to the new “plant” that was recently put into service because the locations of the old power poles and transformers were taken with dated aerial photographs.

MPC turned its computer-incompatibility problem into an opportunity to collect the data in a different format. IIIC implemented a new GPS data collection system to gather MPC’s data and update its old DSM data, plus all the data from the inspection program for its new AM/FM GIS. IIIC purchased two differential GPS six-channel, parallel-tracking, L1, C/A-code receivers with removable 2 MB RAM cards. The base station receiver connects to a laptop computer and uses the computer’s memory to collect the base station file. The field data collection receiver has a removable 2 MB RAM card that can be changed when full. We rely on a battery pack (which lasts at least six hours) when working with the field (rover) receiver because our crews move from pole to pole.

We use the function keys to program 34 different fields into the unit, which enables us to gather the same data that we collect in our inspection program. After we collect a day’s worth of data with the extremely portable units, we download the information from the rover to the base station portable computer; we then use postprocessing software to differentially correct the base station file with the GPS data from the rover file. It generally takes us one to two hours to process eight hours’ worth of data. Each day during the program, we process all the collected data, a valuable step as this allows problems to be corrected as soon as they are detected.

Once the points are differentially corrected, we transfer them
The inspection process.

To a file to be processed on a computer-aided design (CAD) system and/or transferred along with the attributes to MPC's AM/FM GIS. We collect points in a latitude/longitude format that can be converted to a state plane format. For this project and for MPC's AM/FM GIS, we convert the points to state plane coordinates based on the North American Datum of 1927 (NAD27). From this point, we can either print out maps that are color-coded to match the ratings of the structures along with a report with all pertinent information, or MPC personnel can have the information at their fingertips on their AM/FM GIS. To prevent misidentification of power poles on a GIS, we give each circuit a name and file distinct from each substation's name.

FIRST GPS IMPRESSIONS

The transition from inspecting to inspecting and collecting data in a different format was sometimes complicated. We quickly discovered some of the finer operational aspects of a GPS system as well as some of its quirks.

Our first GPS project was to inspect and determine GPS coordinates for a distribution line on the outskirts of Missoula in July 1993. The line was about six miles long, in the mountains, and inaccessible except on foot because of deep canyons and heavy tree cover. We set up our base station in MPC's main office and let it average for 12 hours to establish the base station coordinates. The next day, we set up the base station, got it running, and then headed out to the field to collect our first data using GPS.

Although the tree cover obscured the satellite reception — it took most of the day to collect the data on half the line — we knew we had made the right decision in choosing GPS for our fieldwork. We collected the data with ease, and we were able to receive enough satellites amidst the mountainous terrain. Our enthusiasm flagged, however, when we arrived back at the MPC office to check the base station files. Somebody who had seen the computer running had shut it off to conserve power, inadvertently turning off our base station! Consequently, we had no base station files with which to correct our field files. The next day, we repeated the previous day's work, and on our third fieldtrip, we finished collecting all the data for the entire line and processed them with the base station files.

Our next project was to inspect a line on a hill called TV Mountain, where a heavy concentration of radio, TV, and microwave antennas are located, which extended down to the outskirts of Missoula. This proved to be a most baffling experience. With a clear view of at least four satellites, we were unable to receive any signals. We moved down the mountain to see if we could receive signals at different locations. Changing our location allowed us to receive signals, but the almanac was distorted. After about 30 minutes, we moved back up the mountain to try again. At that point, we again failed to receive signals. After some research, we discovered that the radio-frequency interference was obscuring the GPS satellite transmissions and altering the almanac. To collect these points, we measured from the last power pole that we received signals from to those where we were unable to receive signals and
Power poles in MPC's eastern territory are easy targets for the harsh weather and extreme temperatures that blast through the plains.

The project we have undertaken for MPC have demonstrated that GPS technology can occupy a valuable place in the industry. Whether it is used exclusively for system inventory, for an inspection program, or for a combination of projects, GPS has proven itself an economically sound way to collect data.

The flexibility and diversity of GPS equipment should accommodate the changing needs and requirements of today's utility companies — for example, it can precisely link the consumer's name, electric meter number, and the structure's specifications. The inspection program and data collection system we are now using for MPC represent extremely effective tools for managing facilities. And with the vast territory MPC's system covers and the large number of poles MPC owns, it makes sense to utilize a powerful resource such as GPS.

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