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June 2005
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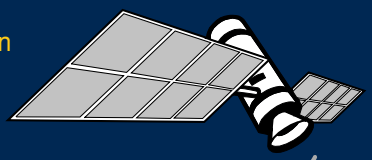
AXTracker

An Inexpensive Satellite Transmitter for Sensing Changes at Remote Locations



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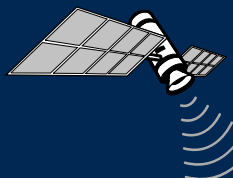

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USDA Forest Service
Technology and Development Program
Missoula, MT

2E22E56—Remote Data Collection System

June 2005

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Contents

Introduction ____ **1**

AXTracker Transmitter ____ 2

Features of the AXTracker ____ **3**

Field Applications ____ **4**

Environmental Monitoring ____ 4

Remote Facility Alarm Notification ____ 5

Vehicle Tracking ____ 5

Configuring the AXTracker ____ **6**

Downloading Transmitted Information ____ **7**

Accessory Hardware and Software Information ____ **8**

Conclusions ____ **10**

Sources and Contacts ____ **11**

Introduction

Remote real-time monitoring of environmental conditions or events is important to the U.S. Department of Agriculture (USDA) Forest Service. For example, silviculturists need to monitor soil or air temperature at remote planting sites. Law enforcement officers may need to monitor remote facilities or other sites for intrusions. Many different types of sensors have been developed to monitor these types of events, but receiving the data or notifications from the sensors in real time sometimes proves difficult or costly. In areas where remote radio transmission and cellular phone coverage are unavailable or impractical, satellite telemetry is the only viable option for transmitting information.

Several satellite service providers offer hardware and services for gathering information remotely. The cost of the equipment and monthly fees may render these systems unaffordable for many tasks.

During a market search for low-cost, real-time remote telemetry systems, the Missoula Technology and Development Center (MTDC) found a low-cost satellite telemetry system called the AXTracker. This device may meet the needs of many Forest Service personnel for relatively low-cost, remote monitoring of a variety of sensors.

Highlights...

- Devices that transmit alarms or environmental information using satellites can be helpful in remote locations.
- At least one such device (the AXTracker) is relatively easy to operate and reasonably inexpensive.
- One potential use might be to monitor snow depth and soil temperature when preparing to plant trees at remote locations.

AXTracker Transmitter

The AXTracker (figure 1) is a battery-operated, self-contained telemetry device designed to communicate using the Globalstar satellite network. It can provide cost-efficient, reliable location and monitoring reports from nearly anywhere. The unit is fully programmable and

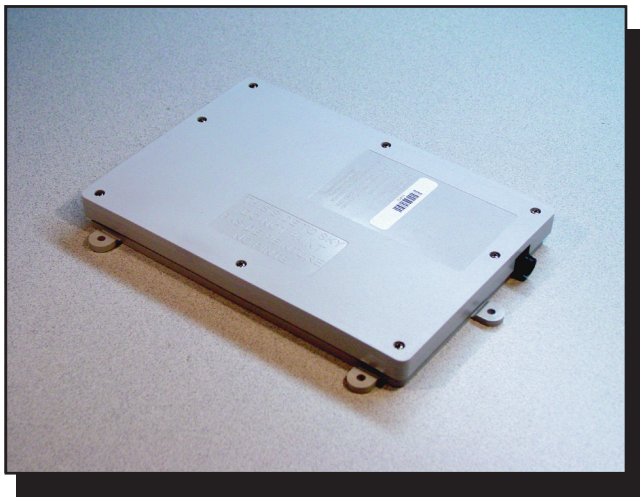

Figure 1—The AXTracker satellite telemetry system manufactured by Axonn LLC can track assets, sense temperatures, and transmit a variety of alarms indicating that a switch is on or off.—*Photo by Scott Quillin, Axonn LLC*

can handle up to four alarm inputs. All the components, including the built-in antenna are in a 6- by 9- by 1-inch environmental enclosure. Battery life can range from 3 to 8 years, depending on how many reports are sent per day. The AXTracker sends information on a user-programmed schedule or when an alarm event occurs.

The information can be communicated in several ways. First, the data are sent over the Globalstar satellite network to a separate service provider (often called a back-office provider) where the information can be displayed on a Web site for viewing or retrieval. Alternatively, the service provider can retransmit global positioning system (GPS), motion, temperature, or alarm data over the Internet as an e-mail message or as a text message to a cellular phone or pager. A second option is to use special service providers that function like burglar- or fire-alarm call centers. They receive data and make regular voice calls to you and others you select on a cascading call list.

The AXTracker transmitter costs $349. Service providers who process information from the AXTracker typically charge fees of $3 to $4 per month plus 20 to 25 cents per report from the AXTracker for processing and displaying the information. Typically, providers charge a $30 to $50 one-time activation fee per unit. Such costs are economical for someone who will receive one or two reports per day or less frequently for an abnormal or alarm situation, such as for an opened door or window, a motor that has turned on or off, or a temperature or water level that is excessively high or low. The AXTracker includes an integrated motion sensor, which is valuable for tracking movement or an unauthorized person trying to move something that has an AXTracker hidden inside (such as a valuable piece of equipment). The AXTracker can send a notification when it crosses a predetermined boundary (known as a geofence).

Features of the AXTracker

- 3- to 8-year battery life (depending on the number of reports per day)
- Operating environment temperature ranges from -40 to 176 °F (-40 to 80 °C)
- GPS position tracking
- Motion detection alarm
- Programmable using a personal computer or Palm personal digital assistant
- Dual- or single-temperature sensor (optional)
- High- or low-temperature alarm
- Weatherproof enclosure meeting the National Electrical Manufacturer's Association 4X standard
- Programmable report intervals (30 minutes to 45 days) or time-of-day schedules (12 sequential triggers)
- Programmable delay before the AXTracker turns on or push-button control to turn it on
- Switch (dry contact) alarm modes (opened or closed)
- On and off indication and alarms
- Geofence operation (signaling an alarm when the unit leaves programmed boundaries)
- Internal antenna (standard), external antenna (optional)
- Transmitter size, 6 ½ inches wide by 9 ½ inches deep by 1 inch tall
- 8.75 bytes of user data without GPS, 2.75 bytes with GPS readout
- Axonn simplex modem, compatible with the Globalstar satellite system
- One-way communication
- I/O port to configure the device

Field Applications

The AXTracker was originally developed to report GPS location and provide alarm notifications for cargo trucks. Besides vehicle location, the AXTracker was designed to have various sensors or alarms to track vehicle conditions, such as temperature and the status of doors (open or closed). These sensors and alarms can serve different purposes. For instance, the AXTracker could be used to monitor environmental conditions, such as water levels and soil, water, and air temperatures or for alarm notifications at remote facilities. Temperature is the only environmental sensor that has been configured for the AXTracker, but any alarm sensor with an on/off contact could trigger the device.

Environmental Monitoring

Monitoring remote sites can be expensive and potentially hazardous. For example, when planting sites are being monitored for reforestation, several trips to the planting site may be needed to ensure that the snow has melted and soil temperature and moisture are optimum for successful planting. Depending on the location of the planting site, these trips may be time consuming and also difficult or dangerous.

The AXTracker system with the dual temperature probe can be an inexpensive method of monitoring planting sites remotely. One temperature probe can be placed just under the soil surface to monitor soil temperature. The other sensor can be mounted just above the soil surface to monitor snowmelt (figure 2). When snow surrounds the upper sensor, the temperature should stay at about 32 °F. As the snow melts, exposing

Figure 2—Two AXTrackers, one measuring temperatures just under the soil surface and another measuring temperatures just above the surface, can provide an inexpensive method for tracking soil temperature and snowmelt in remote regions.

the sensor, temperatures should range above and below 32 °F. MTDC conducted successful field tests of temperature sensors to monitor snowmelt during the winter and spring of 2004.

The AXTracker can be programmed to send a report at specific intervals (from 15 minutes to 45 days) or to send an alarm at a programmed temperature. Either approach can help keep transmission costs low. Figure 3 shows a typical Web page with a temperature table and location information from an AXTracker. This is just one example of using the AXTracker for environmental monitoring. Any environmental sensor with an on/off contact or alarm could be used to monitor conditions in the environment.

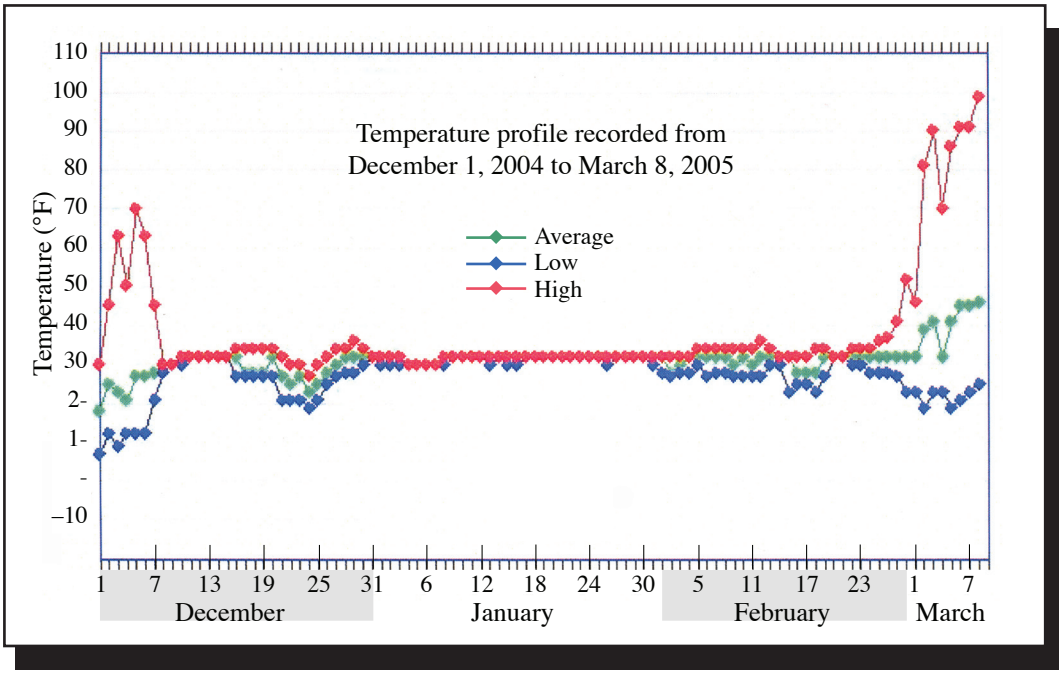

Figure 3—This graph shows the daily low, average, and high temperatures for a temperature probe at the surface of the ground. The sensor was exposed until a snowstorm in early December when the low, average, and high temperatures were essentially equal. The snow melted in late February, exposing the sensor to daily variations in temperature with this installation. The AxTracker did not accurately measure air temperature because the probes were exposed to direct sunlight.

Remote Facility Alarm Notification

Many of the 40,000 buildings and other facilities in the National Forest System are in remote areas where normal very high frequency (VHF) radio or cellular systems are unavailable or unreliable. Such facilities may include municipal watersheds, electronic sites, dams, pipelines, powerlines, tank farms, fee collection sites, bridges, and gates. In remote areas, the AXTracker can provide a relatively inexpensive means for communicating any activity discernible by a sensor back to the appropriate forest office or employee. These activities include intrusions, thefts, broken water pipes—other possibilities are limited only by your imagination.

Vehicle Tracking

Because the AXTracker was developed as a fleet management tool, it is well suited for tracking Forest Service vehicles. A vehicle's GPS coordinates can be transmitted at regular intervals or in connection with a certain event, such as when the back door of the vehicle opens, or when the vehicle starts or stops moving. It is easy to configure one alarm input as a "panic" button that transmits a distress signal, along with GPS coordinates. Another input can be configured to transmit a restore or *All okay* signal.

Configuring the AXTracker

Software provided with the AXTracker (PDA/PC Tool), is used with a personal data assistant (PDA) or personal computer (PC) when configuring the AXTracker. The PC or PDA must be connected to the AXTracker with the proper cable. The PDA/PC Tool software allows the user to configure various transmission modes, start delays, alarm settings, GPS settings, temperature limits, motion sensors, override commands, and various other options. Many programs can be configured and saved for various applications. Once the program is configured on the PDA or PC, it is downloaded to the AXTracker with the program command.

The PDA/PC Tool *Run* button commands the AXTracker to run the downloaded program. The AXTracker also can be activated in the field with the optional field commissioning cable. Programs can be downloaded from the AXTracker to the PDA or PC and saved. Many other configuration options are covered in the AXTracker owner's manual.

Downloading Transmitted Information

Data are transmitted from the AXTracker to a service provider who transforms the information into a new format that is downloadable to the Web, e-mail, or phone. These service providers offer various hardware and downloading services. The providers work with each customer to ensure the transmitted information is downloaded in the required format. Some providers offer a complete package of services and will match the correct hardware to the job at hand. The list of providers (also known as value-added resellers or VARs) is available at *http://www.axtracker.com/VARs/var.html*.

Accessory Hardware and Software Information

Palm PDA Programming Kit—The Palm programming kit (figure 4) allows the user to program and run the AXTracker using a Palm PDA. The price of the kit includes the PDA device and associated cable. The cable can be purchased separately.

Figure 4—The Palm programming package offers a simple method for configuring and running AXTracker programs. The package includes the Palm personal digital assistant and a cable that connects it to the AXTracker.—*Photo by Scott Quillin, Axonn LLC*

USB Serial Programming Cable—The USB cable (figure 5) allows the user to configure and run AX-Tracker programs from a PC. A PC is little more cumbersome in the field, but it may be a cheaper option for users who don't have a Palm PDA.

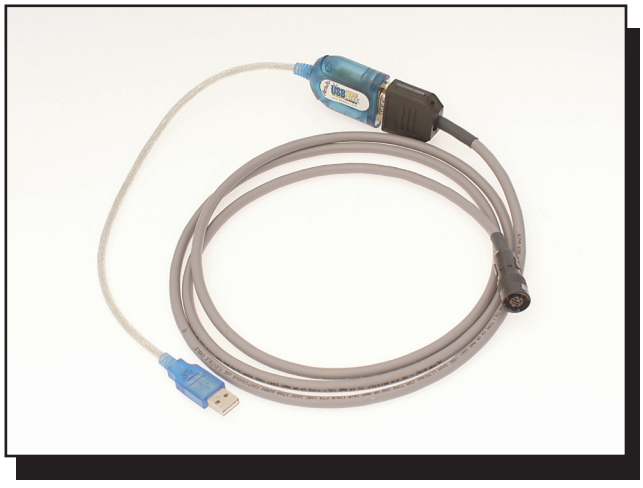

Figure 5—A USB (universal serial bus) cable allows the user to configure and run the AXTracker program from a desktop or laptop PC.

Field Commissioning Cable—The field commissioning cable (figure 6) allows the user to trigger or run the AXTracker without a PC or PDA. This option may be redundant because most Forest Service employees have access to a laptop PC or PDA.

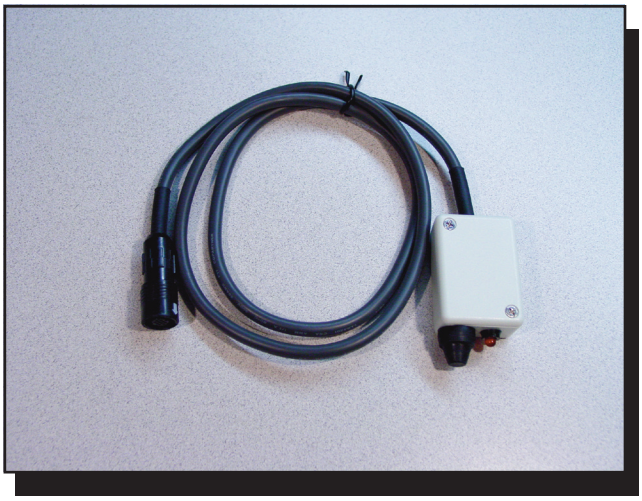

Figure 6—After an AXTracker has been programmed, a field commissioning cable allows an operator to trigger or run the AXTracker in the field.—*Photo by Scott Quillin, Axonn LLC*

Temperature Probe—Temperature probes (figure 7) report a range of –67 to 212 °F (–55 to 100 °C). Temperature

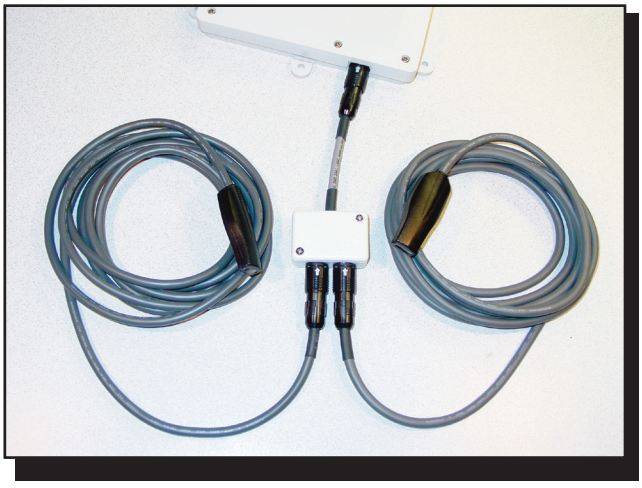

Figure 7—Single- or dual- (shown) sensors record low, high, and average temperatures.—*Photo by Scott Quillin, Axonn LLC*

transmissions can be configured to read temperatures at a specific time and interval (from 15 minutes to 45 days) or to trigger an alarm at a user-defined temperature. The cable is 6 feet long and comes with one or two (dual) temperature sensors. A new temperature probe design is being developed, so the specifications may change.

Magnetic Switch Door Alarm—This magnetic switch (figure 8) allows surveillance of doors or windows, or other things that are either open or closed. The user can program the switch to indicate an alarm when the switch is in the open or closed position.

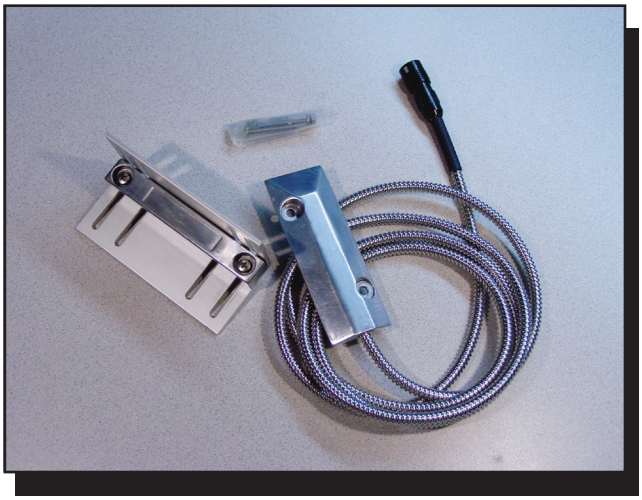

Figure 8—A magnetic switch or another type of on/off switch attached to a bare wire cable (figure 9) can trigger a signal or alarm indicating whether the switch is open or closed.—*Photo by Scott Quillin, Axonn LLC*

Bare Wire Alarm Cable—This 6-foot-long cable (figure 9) allows the user to connect up to four smart sensors that function as on and off switches or other alarm sensors to the bare ends of the cable that attaches to the AXTracker unit. The cable includes a 10-pin connector that attaches to the AXTracker interface port.

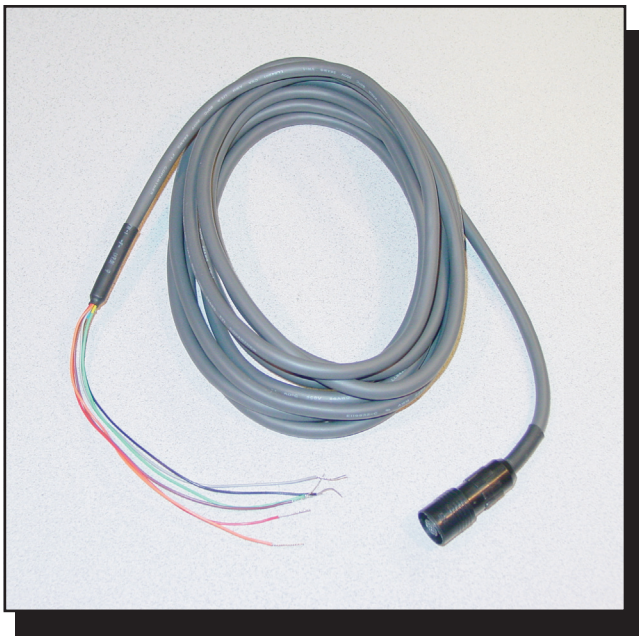

Figure 9—Four smart sensors can be attached to the 6-foot bare wire cable.—*Photo by Scott Quillin, Axonn LLC*

AXTracker Equipment Price List (2004 prices)

Equipment	Part Number	Cost (dollars)
Transmitter	2100–0159–08	349
Palm programming kit (includes PDA)	1800–0102–01	495
USB serial programming cable	1800–0102–02	149
Field commissioning cable	1800–0102–03	69
Temperature probe (single sensor)	1800–0102–14	75
Temperature probe (dual sensors)	1800–0102–15	125
Magnetic switch door alarm (6-foot cable)	1800–0102–06	69
Bare wire alarm (6-foot) cable	1800–0102–07	35
Battery pack (replacement)	1800–0102–08	59

Conclusions

The AXTracker is a relatively low-cost satellite telemetry system that can transmit monitoring information from remote locations. While other satellite telemetry systems may be more robust and handle more sophisticated sensors and larger data packets (to provide more information than the simple on/off data packet), the AXTracker can provide simple monitoring and reporting at a reasonable cost. The range of applications for the AXTracker depends not only on the type of sensors needed, but on user creativity.

Sources and Contacts

The AXTracker and accessories are available from:

Axonn LLC
2021 Lakeshore Drive
New Orleans, LA 70122
http://www.axonn.com
Contact: Scott Quillin, Project Engineer
504–282–8119, ext. 207

Information about service providers is available at:

http://www.axtracker.com/VARs/var.html

Notes

Notes

Notes

About the Authors

Gary Kees is a project leader specializing in reforestation and nurseries, facilities, recreation, and GPS projects at MTDC. He received his bachelor's degree in mechanical engineering from the University of Idaho. Before coming to MTDC in 2002, Gary worked for the Monsanto Co. in Soda Springs, ID, as a mechanical/structural engineer and project manager.

Andy Trent is a project engineer at MTDC. He received his bachelor's degree in mechanical engineering from Montana State University in 1989. Before coming to MTDC in 1996, he worked as a civilian engineer for the U.S. Navy. Andy works on projects in the nurseries and reforestation, forest health protection, and watershed, soil, and air programs.

Library Card

Kees, Gary; Trent, Andy. 2005. AXTracker: an inexpensive satellite transmitter for sensing changes at remote locations. Tech Tip 0524–2802–MTDC. Missoula, MT: U.S. Department of Agriculture Forest Service, Missoula Technology and Development Center. 14 p.

In remote areas, radio transmissions and cellular phone coverage may be unreliable. In such areas, satellite telemetry can be used to monitor environmental conditions, such as temperature, conditions at facilities, and the status of intrusion sensors. Two temperature sensors, one just under the soil surface and one just above the surface, can be used to determine when snow has melted at remote locations and when the soil temperature may be suitable for planting trees. The cost of hardware and monthly fees can make some means of satellite telemetry unaffordable. The AXTracker transmitter, which communicates using the Globalstar satellite network, is a relatively inexpensive device that can be used for reliable location and monitoring reports from nearly anywhere. The unit is fully programmable and can handle up to four alarm inputs. All the components, including the built-in antenna, fit in a 6- by 9- by 1-inch enclosure. Battery life can range from 3 to 8 years, depending on how many reports are sent each day.

Keywords: alarms, Axonn, facilities, Globalstar, GPS, planting, reforestation, remote sensing, surveillance, telemetry, temperature

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Additional single copies of this document may be ordered from:
USDA FS, Missoula Technology and Development Center
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Missoula, MT 59808–9361
Phone: 406–329–3978
Fax: 406–329–3719
E-mail: wo_mtdc_pubs@fs.fed.us

Electronic copies of MTDC's documents are available on the Internet at:
http://www.fs.fed.us/t-d/ (Username: t-d, Password: t-d)

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:
http://fsweb.mtdc.wo.fs.fed.us/search/

For additional information about the AXTracker, contact Gary Kees or Andy Trent at MTDC.

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