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## Switch Position Monitoring Systems in Nonsignaled Territory

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### Summary

The railroad industry is interested in switch-position monitoring systems that will improve the safety and reliability of switch operation in nonsignaled railroad territory. Train dispatchers currently rely on verbal communication with train or ground crews to determine if switches are positioned properly for the main track. To reduce the potential for human error, better technology for switch position monitoring systems is needed. BNSF has developed and implemented two new systems in 51 nonsignaled switch locations. The Federal Railroad Administration is overseeing the development of the project and has provided partial funding.

One system allows dispatchers to monitor and issue movement authorities over the switch. It has been in operation since November 2005 in 49 locations between Avard and Tulsa, Oklahoma.<sup>1</sup> In case of improperly lined switches or lost communication, the dispatcher notifies the train crew to inspect and correct the switch position. Since this system has been installed, few issues have arisen. There have been occasional commercial telecommunication outages and occasional maintenance needed on switches. Railroads experience these normal anomalies, however, in their typical daily operation.

The other system allows dispatchers to monitor and position the switch before authority is given.<sup>2</sup> It has been in operation since November 2006 in two locations, within a nonsignaled territory, in Finney, Texas. This system has proven to be safe and reliable, and according to BNSF Railway, there has been a cost reduction in constructing and maintaining track and facilities since its implementation.

The switch position monitoring only system investigated is an overlay system connected to a Track Warrant authority system. Systems that provide remote control in addition to switch monitoring can provide additional capacity. Either type of system will provide a safety benefit over nonsignaled operation. And there are cost reductions possible, especially when compared in terms of installation and maintenance of a signal infrastructure.

Other systems have also been developed and will be discussed briefly in this digest. This project is part of the Association of American Railroads' Strategic Research Initiatives Program.



## INTRODUCTION

Transportation Technology Center, Inc. (TTCI), a subsidiary of the Association of American Railroads funded by the Strategic Research Initiatives Program, has reviewed demonstration systems for monitoring position of switches in nonsignaled territory in the rail industry. The objective of switch position monitoring system development is to provide most of the switch-related safety and operating benefits of a traditional track circuited signal system at a lower cost. The systems are communications based and can be applied in a modular or phased implementation. This strategy will allow more rapid implementation of communication-based train control systems, as well.

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Train dispatchers currently rely on verbal communication with train or ground crews to determine if switches are properly positioned for the main track. To reduce the potential for human error, the railroads have been interested in acquiring better technology for switch position monitoring systems. BNSF has developed and implemented two new systems in 51 nonsignaled switch locations. The Federal Railroad Administration who is overseeing the development of the project has provided partial funding.

Two monitoring systems are being evaluated by the TTCI. One system has been implemented in 49 locations between Avard and Tulsa, Oklahoma, and the other has been implemented in two locations in Finney, Texas. These types of systems can be implemented without requiring an expensive Centralized Traffic Control (CTC) dispatcher office.

US&S, MeteorComm, and Global Rail Systems are other companies that have produced these types of monitoring systems and are briefly described here.

### System Methodology

The general idea of the switch position monitoring system (Figure 1) consists of the following four major subsystems:

1. Hand-Operated Switch
2. Monitoring or Indicating System
3. Wireless Communication System
4. Application Software
5. Power Source – AC or Solar System

In addition to the four subsystems, a vital controller is added for a switch position monitoring and controlling system. In this case, a hand-operated switch will be replaced with an electric switch. This electric switch can be hand-operated in case it fails to throw.

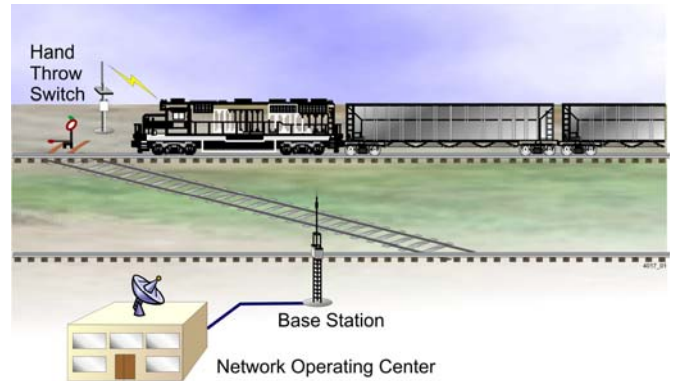


Figure 1: Illustration of a Switch Position Monitoring System

## DEMONSTRATION SYSTEMS AND RESULTS

### Development of a Switch Point Monitoring System (SPMS) in Nonsignaled Territory (Avard Subdivision)<sup>1</sup>

The SPMS has been in service since November 2005 on BNSF's Avard Subdivision, which runs between Avard and Tulsa, Oklahoma. There are currently 49 SPMS locations installed and being monitored. Most locations were installed using solar power, which was less expensive and more expedient to install. AC power was used on locations that had AC power readily available or where the sun was blocked by trees or hills. The SPMS automatically relays information about switch integrity to the train dispatching system in the Network Operations Center located in Fort Worth, Texas. The ability to determine the switch position automatically allows the dispatcher to issue movement authorities over those properly lined switches without the need for the train crew to stop the train at the switch. A track warrant will not be issued through the switch in case of communication loss and improperly lined switches. Such a situation is treated as an out-of-correspondence switch, and the train is stopped short of the switch.

The infrastructure required to support SPMS is comprised of the following:

- Wayside Switch Monitoring Equipment: US&S U-5 Switch Circuit Controller
- Office Dispatch System Software: Innovative, low-cost, closed-loop technology that safeguards against loss of communication from the wayside to the office computer systems and assures that the switch position reported from the wayside is timely and not latent information.
- Data Communication Equipment: Existing MeteorComm's 545C packet data radio network operating at 44.58 MHz. (This wireless network was installed to support the hi-rail compliance system that monitors the position of on-track maintenance vehicles and compares their reported GPS position against their authority to occupy the track.)

This system only monitors the switch position. If the switch is improperly lined or the communication is lost, the train crew has to stop short of the switch and manually correct the switch position.

Since this system has been installed, few issues have arisen. There have been occasional commercial telecommunication outages and occasional maintenance needed on switches. These are normal anomalies, however, that the railroads experience in their typical daily operation. Very infrequently, a wayside radio locked itself out (corrected with software) from communicating with the network until it had been reset. In this case, the crew was instructed to stop the train before reaching the switch, inspect the switch points visually, and, if needed, correct the switch position before proceeding.

This SPMS allows for its migration into other technologies. The components that are used at the switch location can be used to provide power remote control switching in nonsignaled territory. In Illinois, the switch position monitoring system is integrated into BNSF's pilot Electronic Train Management System, currently in test.

#### **Switch Position Monitoring System with Remote Control Power Switch<sup>2</sup>**

The operation and concept plan was developed to start implementation of a nonsignaled remote control power (RCP) switch in nonsignaled track warrant territory. The concept is for the dispatcher to control the power switch directly through the Track Warrant System. BNSF installed two nonsignaled remotely controlled power switch locations within nonsignaled track warrant territory in Finney, Texas, in November 2006. These locations provide the ability to control nonsignaled main track switches remotely from the BNSF train computer-aided dispatch system known as Train Management & Dispatch System.

The infrastructure required to support SPMS with RCP switch is comprised of the following:

- Switch Machine:  
US&S M23 mainline power switch machine
- Wayside Switch Monitoring and Control Equipment:  
US&S Object Controller (OC), the vital programmable logic controller allows the switch to be electrically locked to prevent the switch from moving.
- US&S Peer Protocol:  
Used between the office and the wayside vital OC, which gives the capability to handle latent, duplicate, and corrupt signals, and the pacing of messages.
- OS Overlay Circuit:  
To lock the switch during train movement over the switch.
- Wayside Application Software:
- CTC-like logic for use in Track Warrant Control territory.

- Data Communication Equipment:  
An existing MeteorComm 6100 SDR data radio network. (This wireless network was installed to support the Hy-rail Compliance System that compares the reported GPS position and the indicated track.) The SDR is a multi-band data/voice radio. This installation used 45 MHz and GPS capabilities.

BNSF reported that this system achieved cost reduction in constructing and maintaining track and facilities due to fewer track insulated joints required and lower installation costs. Reliability was improved by direct indication to the dispatcher of the current switch position. Switches are positioned for trains before authority is given. Dispatchers are notified of an out-of-correspondence switch if the signal is lost. In this case, train crews stop short of the switch and manually correct or check the switch position.

#### **OTHER SYSTEMS**

In addition to the two demonstration systems by BNSF and FRA, Global Rail Systems has developed a monitoring controlling system called FAS-PAS<sup>TM</sup>, which has been implemented by NB Southern Railway under harsh Canadian winter conditions.<sup>3</sup> The system has proven to be dependable, accurate, and relatively maintenance free. The final report on this implementation is pending.

The Railway Technical Research Institute of Japan has developed a monitoring system for an electric switch machine.<sup>4</sup> This system has proven to have a precise locking mechanism and can also be used under extreme weather conditions. The system withstands track vibration from passing trains and electromagnetic noise. Development continues to make it more functional and practical. See references 3 and 4 for more details on these systems.

#### **COMMERCIAL SYSTEMS**

##### **Solar Powered Switch Monitors by MeteorComm<sup>5</sup>**

This system, through the base station by MCC-545C Packet Data Radio, can report the hand-thrown switch position to locomotives equipped with a MeteorComm radio and to dispatchers. Interfacing does not require use of circuit controllers.

##### **FAS-PAS<sup>TM</sup> (Failsafe Audible Signal-Power Assisted Switch) by Global Rail Systems<sup>6</sup>**

FAS-PAS provides visual and audio indications of switch position. It is capable of remote switch controlling and position monitoring, and is compatible with any switch machine. It consists of communication, zone occupancy, indication, and control systems. The switch can be controlled from locomotive by voice radio (UHF-VHF) and from dispatchers by data radio. FAS-PAS can also utilize telephone modems or fiber optic modems as other means of integration into a communications network. It requires two insulated joints to be installed on the turnout side of the control point. This system has been implemented by NB Southern Railway

in a track segment near Westfield, NB, Canada, since May 2005, as part of a project funded by Transport Canada. Global Rail Systems reports FAS-PAS to be dependable, accurate, and relatively maintenance free. A final report of the results of this system is pending.

#### **Power Switch Monitoring and Control by Union Switch and Signal Inc.<sup>7</sup>**

Union Switch and Signal (US&S) Inc. designs, manufactures, and provides systems and products that signal, automate, control, and manage rail-based traffic. US&S also provides solutions for nonsignaled territory switch monitoring. The first system, Switch Monitoring and Control System, is comprised of the MicroLok® Object Controller, Dual Tone Multi-Frequency (DTMF) Controller and Annunciator, a mainline switch machine, optional switch position indicators, and audio frequency (AF) track circuits. This system allows train crews to control switches by entering two series of numbers using a DTMF-capable radio to request the switch in normal or reverse position. Another system, Island of Train Control, is comprised of the MicroLok® II, a mainline switch machine, switch position indicators, insulated joints, DC OS track circuit, and track interface panels. This system works in the same manner as a CTC dispatch office. Neither system has been implemented by any railroads.

#### **CONCLUSION**

Several switch-position monitoring systems have been developed and implemented, which are capable of improving the track safety and switch operation in nonsignaled territory. However, some of the newer systems need further evaluation for safety, durability, and life-cycle performance before widespread implementation.

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