Detect Personnel for Longwall Adding a New Safety Feature

Dr. S. Mundry & J. Weßelmann
Caterpillar Global Mining

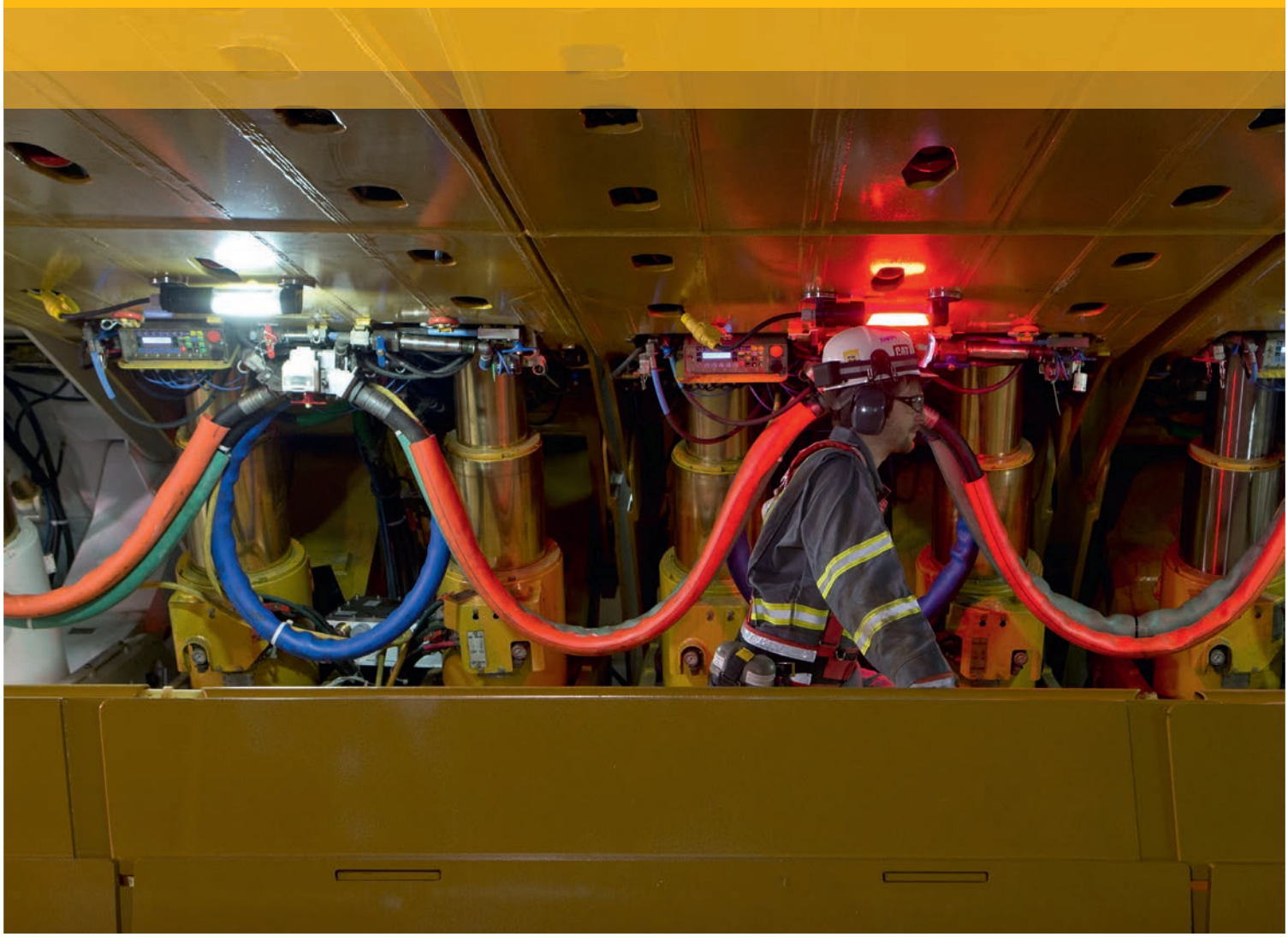


Table of Contents

1 Abstract

Longwall mining is one of the most extreme environments. To serve and protect the mines most valuable asset, the operator, is at the center of this latest technology. For longwalls, this requires a system that protects the miner even when distracted or incapacitated. Detect for longwall adds another layer of safety to longwall systems along with typical lock-out procedures.

The new personnel proximity detection (PPD) system enables mine operators to control machine motion as well as detect and track personnel on the longwall face. The technology can differentiate between operators and control machine motion up to and including inhibiting automated machine advancement if an operator is in a hazardous area. Working in conjunction with advanced automation features found within normal operation of longwall systems, PPD enhances machine control, allowing mine operators to continue meeting production demands with the utmost safety.

2 Changing Safety Awareness

Since years we recognize a continuous global trend that authorities and industry reaches out to higher level of safety. Perhaps with different speed, but almost in all countries and regions, we see higher awareness and a change in culture dealing with safety aspects and proactive measures.

The trend started about a decade before with Mine Safety and Health Administration - MSHA introducing the Miner Act for US mines, demand for increased "post-accident communication and electronic tracking systems". The process continued by updating the European Machine Directive (Directive 2006/42/EC on machinery) and introducing standards like IEC61508, EN13849, EN62061. All these standards show the efforts towards more responsibility on the part of the operator and the supplier for proactive initiatives relating to safety.

Australia introduced regional MDG regulations (Millennium Development Goals) especially MDG 15 transferring more responsibility to the industry (here mines) operating machines and equipment.

All in all this caused a changing safety culture both at mine operations as well as at original equipment manufacturers (OEM) in general.

Changing customer perception of safety as a culture is involving all employees at site but also OEMs to provide and demonstrate their safety measures.

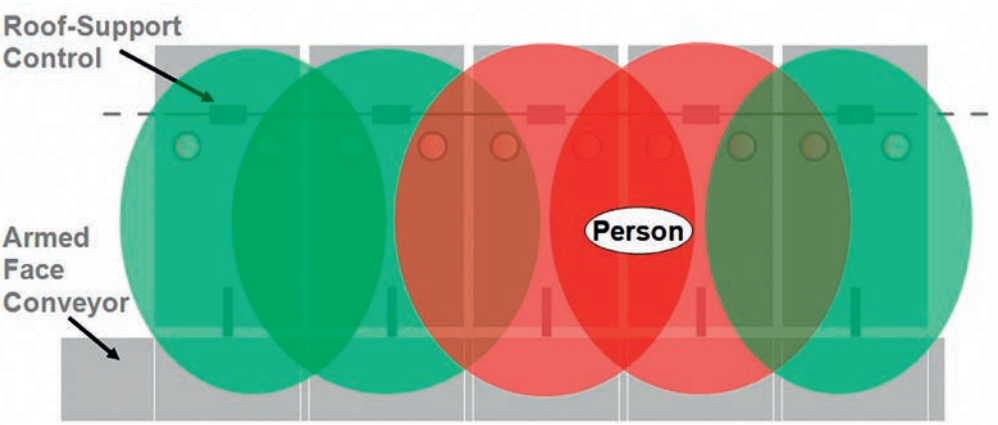
3 The Idea of a “New Safety Feature”

The answer to the increased safety awareness with regard to Longwall operation is a personnel tracking system, as supplement to the existing measures like emergency stop and local lock out buttons.

Detect for Longwall represents a quantum leap in safety for Longwall Systems. Common safety procedures, such as lock-out, tag-out, in conjunction with the detection technologies in Personnel, provide multiple, redundant layers of safety for the miners. Detect for Longwall does not replace manual lock-out and emergency stop systems of roof supports. It adds another means of keeping workers safe underground by automatically ceasing movement of shields on both sides of the detected, tagged employee.

4 Detecting the Presence of a Person

A longwall equipped with PPD detects the presence of the person wearing a tag and if the tag is appropriately programmed – their employee ID, location and/or role – and it reports this tag interaction directly to the local controller, which then responds in real time, preventing motion while the person is present. Since operator roles are configurable within the system, the roof supports could be programmed to respond differently based on operator role. For example: it may be desired for a roof support to advance as scheduled for maintenance personnel to troubleshoot problems, while it also may be desired for the roof support to stop if a visitor is detected.



Picture 1: Readers send electromagnetic signals that generate a marker field.

Radio Frequency Identification (RFID) technology utilizes a reader to send electromagnetic signals that generate a marker field. A transponder tag, worn by workers, receives the signal and sends data back to the reader. The reader interprets the data and passes it on to the Programmable Mining Control for roof supports (PMC®-R), which initiates the appropriate response.

If several tags are detected in the same field and the system is programmed to differentiate responses by the role of the tag wearer (operator, maintenance crew, visitor etc.), the "safest" control response is selected.

Readers located at the surface give a visual indication to personnel entering the mine (hazardous underground area of the mine) whether their tags have sufficient power and are set up correctly.

Gate readers located at the ends of the longwall give a visual indication to personnel entering the longwall whether their tags are functioning correctly and the miner is registered.

Picture 2: Longwall miner working at the face are detected and relating roof support control is interacting with appropriate response.

5 Features and Benefits

Value for the operation

PPD provides operators with peace of mind while working around a Longwall system. The system also allows the mine management the flexibility to optimize the system for their specific needs.

The system inherent reliable detection provides a high level of safety for longwall personnel. The system tracks location of each individual in the operating longwall area, while visualization software allows presenting the information in control rooms at the gate end and at surface. All data is logged together with all other time variant data from the face.

Each tag has a unique identifier and is software-configured. This is allowing an individual adaptation to mine specific regulations and type of worldwide usage. Direct communication connection to local controls allows real-time response of the system without any delay due face wide communication of gathered data. It is possible to set up the control response dependent on person's role by application programming.

An unique dual-frequency system and special antenna is used to setup enhanced reception in steel-laden environments. A flexible mounting of the reader on the roof support lessens installation time, while readers are preconfigured for easy installation.

The overlap of marker fields ensures tags are still detected during shield transitions. Constant communication between readers and tags including condition information ensure detection of tag failure.

Complete System Integration Improves Control

Each roof support in the longwall is equipped with its own reader, which is connected directly to the local roof support controller, enabling real-time response. Other systems on the market send signals to a control center and/or gate-end computer for processing, which can create delays until the signal reaches the roof support control unit. PPD has local control, multiple redundancies of detection and communication. Any problem with a reader or a roof support control is immediately detected by the neighboring controls.

Operators are automatically recognized by the system as they pass through gate readers at the entry points of the longwall. While on the longwall, their position is constantly monitored. In the unlikely event of a tag failure while the tag was detected at least once before, the system will recognize the absence of the operator and alarm the head gate, reducing your overall risks and enhancing safety at your operations.

(Remark: the technology presented, is no safety technology acc. to IEC 61496-1 but supports already safe operation of a Longwall with one more hazard suppressing layer. This equals a safety belt in cars, while the driver is still responsible for its behavior within a traffic environment.)

6 System Components

As mentioned before the system mainly consist of three elements providing personnel functionality in continuous cooperation: The reader, the tag and the roof support control PMC®-R (not being described here in more detail):

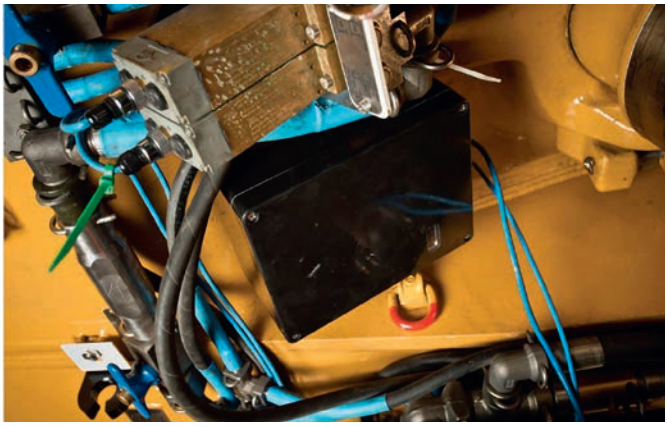
Readers

One reader is mounted on each roof support and connected directly to the local Caterpillar PMC®-R roof support controller. Installation is relatively easy and existing PMC®-R control systems can be upgraded. The reader software is pre-installed and the marker field is adjusted by varying the field strength. Once this has been done, the reader detects the exact position of any tag in its marker field. Marker fields are set to overlap allowing tags to still be detected in the unlikely event of one reader failure. Operating at 12V and less than 250 mA, the intrinsically safe reader demands little of the power supplied at the face. Readers could optional be fed by roof support controller power groups or preferred by an additional power group over spanning several roof supports.

Characteristic	Value
Dimensions	200 × 250 × 120 mm
Weight	5.5 kg
Input Voltage	(DC) 9.5V – 13.2V (typical 12V)
Power Consumption	<= 250 mA
Connectors	OS4 and OS8 (O-ring sealed)
Operating Temperature	–20° C to +70° C
Frequency Low-Frequency High-Frequency	 125 kHz 2.4 GHz
Sealing	IP 67
Type of Certification	Intrinsically safe
Approvals	ATEX, MSHA, IECEx
Features	Direct serial communication to roof support control unit

Table 1: Reader – Technical details.

The robust housing allows easy mechanical integration into the roof supports along with a special antenna configuration for flexible positioning and safe and easy access.



Picture 3: Reader situated below a canopy to best generate a Roof Support wide marker field.

Tags

Each miner or visitor wears an intrinsically safe battery-powered tag.

This compact unit can be mounted on a helmet or worn on clothing or a belt. The tags are active and can store up to 2 KB of data. Comprised of a chip, antenna and enclosed battery, the tag is about the size of a deck of cards.

The tag has low power consumption and a guaranteed one-year battery life. Under typical use, most batteries will have a two-year life span. Battery status information routinely transmitted by each tag is captured by the visualization software, allowing mine staff to be warned when their tag needs replacing.

Picture 4: Belt and helmet equipped with tags.

Each tag is delivered as a "blank device" with only its unique identifier. In this "factory" state the tag will have the highest safety configuration. Only when the tag is programmed with specific personnel parameters (subject to local regulations) will the longwall system react differently. The first time a new tag enters the longwall the PMC-R will ask for the name and the role to be assigned to the tag. Information can be assigned to the tag or it may be left blank to simply recognize the presence of a person. For mines that establish a company-wide set-up standard this enables the use of tags across mine sites utilizing Caterpillar PMC®-R control systems and PPD.

For example: A mine manager can carry one tag across multiple sites. If all mine sites are properly equipped, he can expect the same level of safety at each site. The Caterpillar PPD tag uses two frequencies: low and high. Low frequency is used for standard RFID identification as described above. High frequency is used for detailed communication back to the reader, including providing data on battery status and marker field number.

Characteristic	Value
Dimensions	80 × 60 × 40 mm
Weight	200 g
Input Voltage	(DC) 3.6V (± 15%)
Estimated Battery Lifetime	1 years under typical underground use
Operating Temperature	–20° C to +40° C
Frequency Low-Frequency LF-Range High-Frequency HF-Range	 125 kHz Up to 6 m 2.4 GHz Up to 50 m
Sealing	IP67
Type of Certification	Intrinsically safe
Approvals	ATEX, MSHA, IECEx
Features	Different mounting versions available (belt, helmet, or safety vest)

Table 1: Tag – Technical details.

7 Visualization and Administration

Visualization

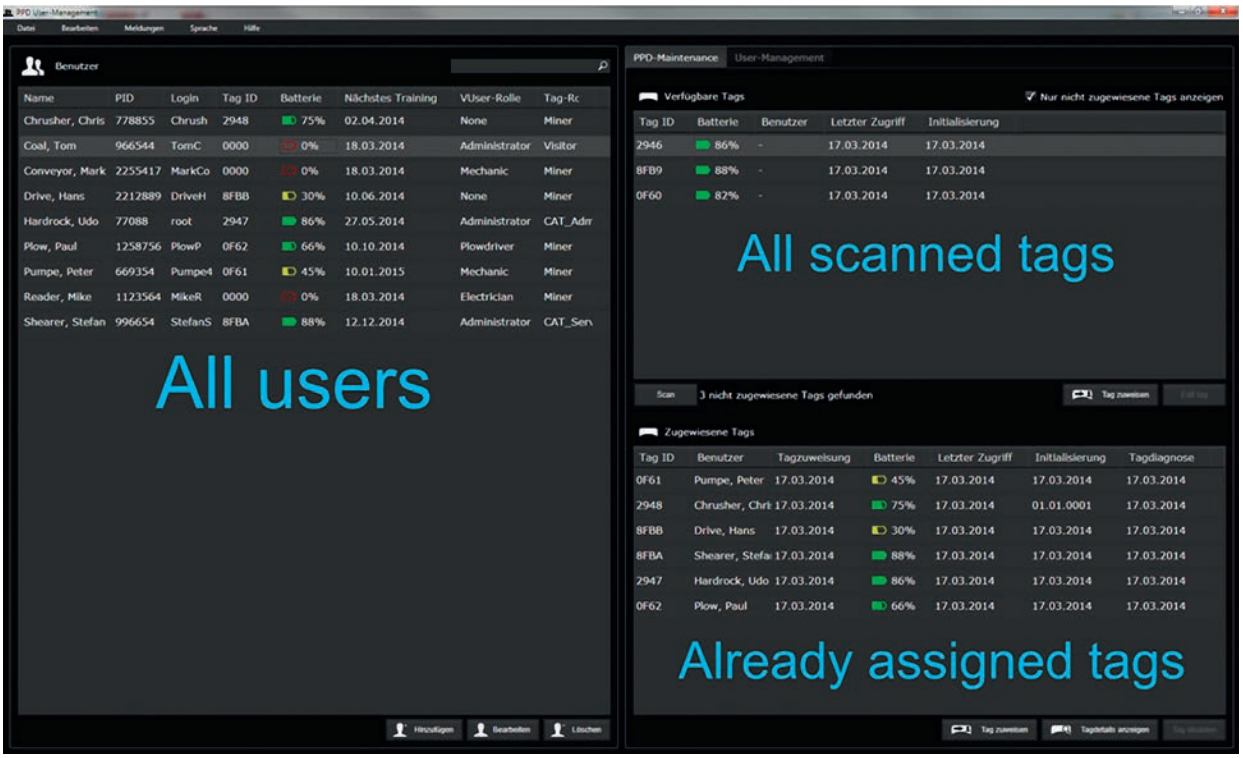
The information about personnel moving within the longwall is fully integrated in the existing visualization and analysis tools for the roof support system. The locations of personnel detected by the system can be displayed at the surface mine control center and/or gate end using advanced Caterpillar visualization software.

As all other parameter and process data from the Longwall system, also the tag related data can be shared via various communication interfaces within a mine's local area network (LAN) to be integrated into third party or mine specific visualization systems to allow for a comprehensive, site wide tagging solution.

The software allows data to be replayed along with reporting capabilities that can be used for continuous improvement towards safety.
If a maintenance need arises, the system provides information to the person at the underground control center (if available) or surface control room that will aid in locating the nearest specialist that can fix a technical issue such as a hydraulic or electrical problem.

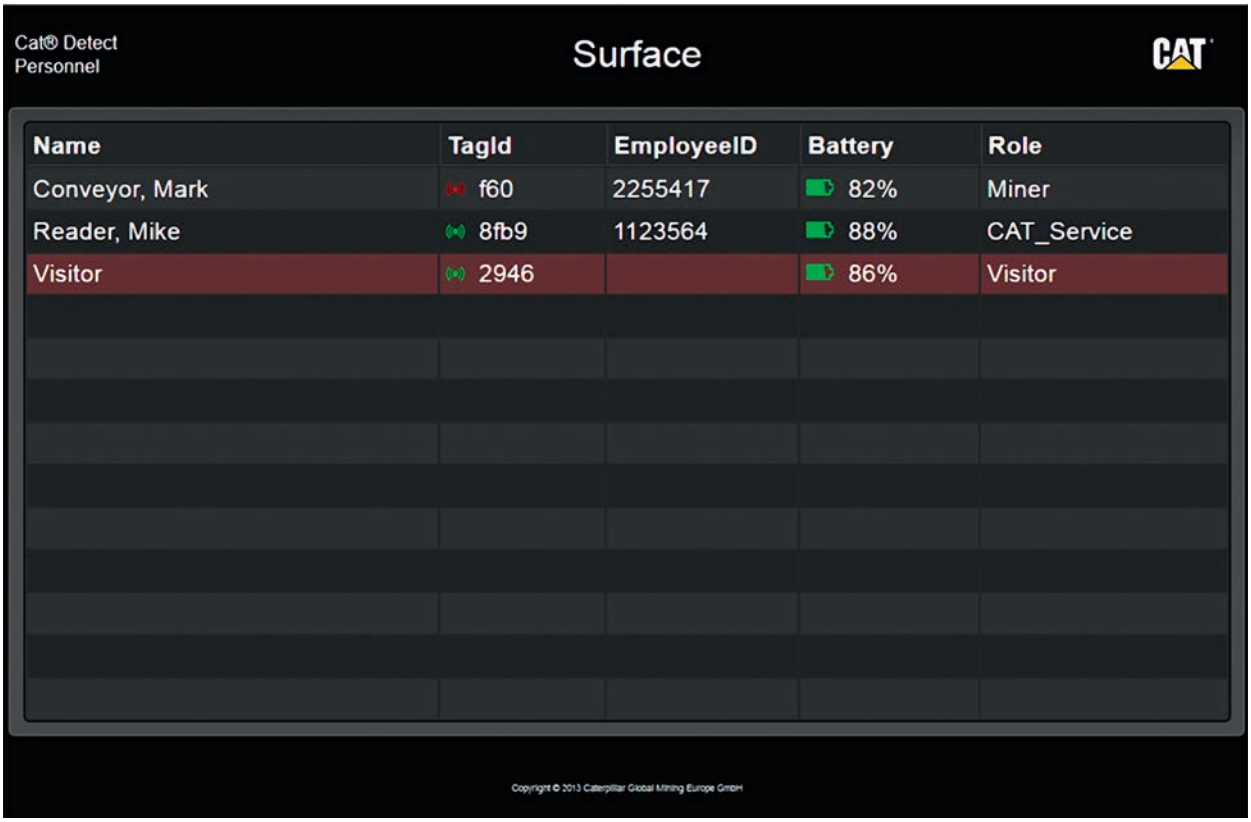
Administration Tools

As miners with the allowance to enter the Longwall area have to use tags daily and on every shift, easily more than hundred tags will be in operation at the mine. As a nature of regularly used equipment in mining environment, the assignment of tags to personnel is necessary on a regular basis. Therefore a database with and relating administration software needs to be operated at the mine site, preferably at an administrative building at the surface, e.g. goods output.
In combination with a reader type unit administrative personnel is able to assign tags referring its unique ID to a miner. Change assignments, miner's name and function or education. This information is thereby loaded into the tag. As well the general functionality of the Tag could be checked here, allowing exchanging tags proactively if necessary.



Picture 5: VUserManagement providing administrative functions.

Before a miner enters the hazardous mine area, e.g. before entering the shaft area, he and his tag is checked by another administrative system set from a reader type unit and a off the shelf PC. The tag is identified in a certain area and all information from the tag is shown on a wide screen. This enables the miner to check both, does he carry the right tag and is the tag status and data proper set up like the battery power status is sufficient for an underground visit.



Picture 6: VPersonnelSurface providing last check of tag status and correct assignment before entering the underground mine area

8 Conclusion

Cat® MineStar™ System is a broad suite of integrated mine operations and mobile equipment management technologies configurable to suit your operation's needs on top of the regular machine control technology.

Detect, a capability set within Cat® MineStar™ System, provides equipment operators with enhanced awareness of the environment around their equipment, resulting in increased safety and greater operator confidence.

PPD enables enhanced safety during the operation of Caterpillar longwall systems. Protecting the most valuable asset on a site, the operator, PPD reduces the potential for operator injury through seamless integration into critical machine control functions. It adds to overall Cat longwall system value through maximum machine utilization and continual safe operation of the system.

Keeping operators safe and out of harm's way is a top priority for you and Caterpillar. Controlling potentially hazardous working conditions such as automatically moving shields helps you achieve this goal. PPD protects operators from these hazards to allow continuous, safe operation of Cat Longwall Systems.

9 Internetlinks

[1] http://www.msha.gov/techsupp/PEDLocating/CommoandTrackingMINERActCompliant.pdf, Last access 03/2014

[2] http://www.msha.gov/MinerAct/2006mineract.pdf, Last access 03/2014

[3] http://www.resources.nsw.gov.au/__data/assets/pdf_file/0006/412197/Nuts-and-Bolts-of-MDG15-Compliance-Ray-Wilton.pdf, Last access 03/2014

[4] http://www.resources.nsw.gov.au/__data/assets/pdf_file/0006/444192/Matt-Willoughby-MDG15-Compatibility-Mode.pdf, Last access 03/2014

[5] https://mining.cat.com/products/underground-mining, Last access 03/2014

[6] https://mining.cat.com/detect, Last access 03/2014

Notes

Detect Personnel for Longwall
Adding a New Safety Feature

For more complete information on Cat products, dealer services, and industry solutions, visit us on the web at **mining.cat.com** and **www.cat.com**

AEXQ1532