



COMMAND FOR LONGWALL

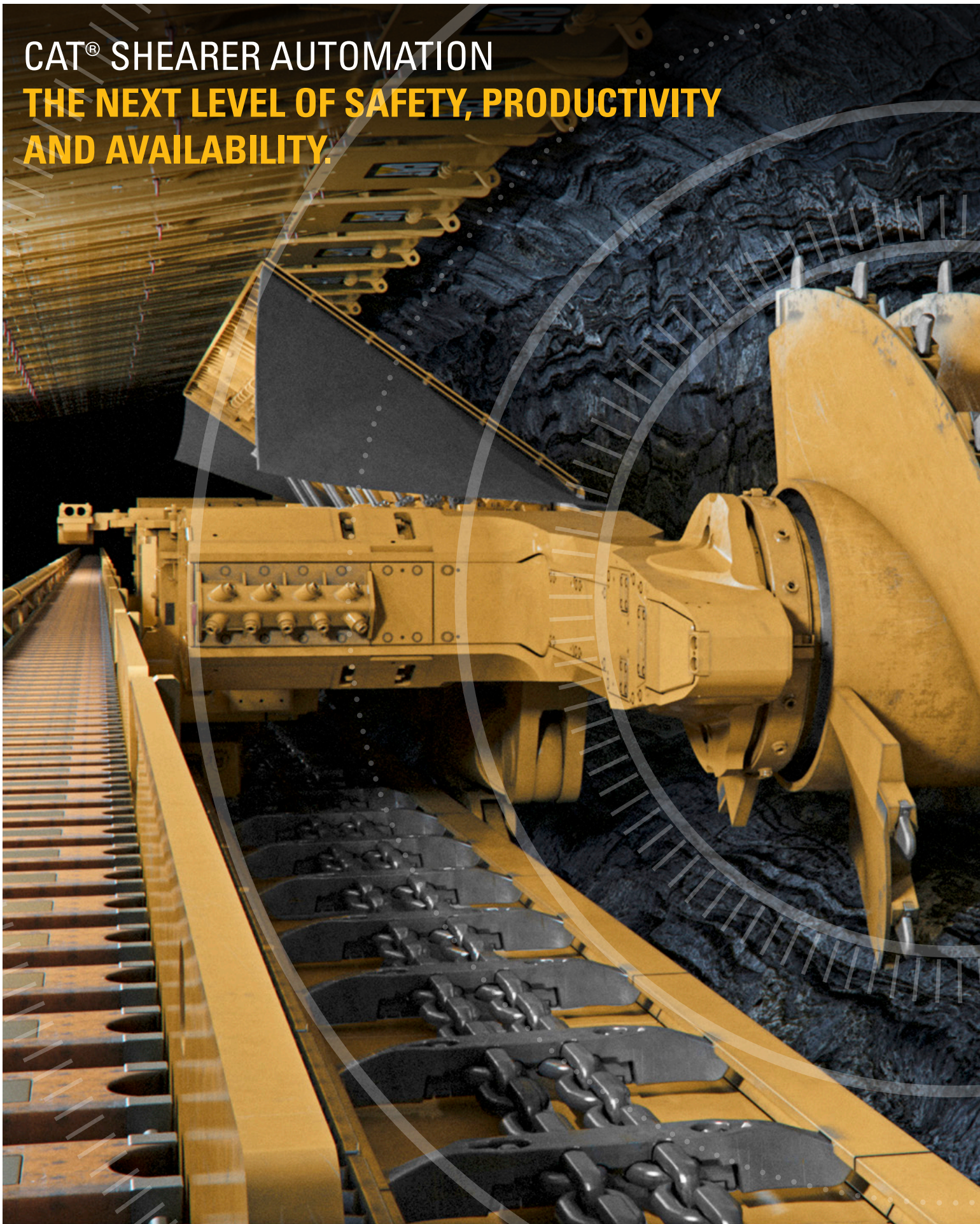
CAT[®] SHEARER AUTOMATION

PHONE LOCKOUT

Standard Machine Control
Basic Automation
Advanced Automation



CAT® SHEARER AUTOMATION
**THE NEXT LEVEL OF SAFETY, PRODUCTIVITY
AND AVAILABILITY.**





PUSHING THE LIMITS

High-performance longwall mining operations demand cutting machines which deliver highest productivity, availability and reliability. Cat longwall shearers are designed to meet these requirements.

To fully exploit the potential of Cat longwall shearers and to further increase safety, productivity and efficiency of the cutting process, Caterpillar developed powerful automation technologies which are taking your Cat shearers to the next level: basic or even advanced automation of the cutting process which is decisive for your productivity and indispensable for the correct alignment of the entire longwall.

COMMAND FOR LONGWALL

Command for Longwall, a Cat MineStar™ technology capability set, delivers significant improvements in safety, productivity and availability at your longwall operation. It offers remote control, semi-autonomous and autonomous systems for your longwall shearer and provides the following operational benefits:

- + OPTIMIZATION OF LONGWALL MINING PRODUCTION CYCLES
- + LOWERING PRODUCTION COST
- + IMPROVED CONSISTENCY AND CONTINUITY OF THE CUTTING PROCESS
- + ENHANCED SHEARER PERFORMANCE
- + IMPROVED OPERATOR SAFETY AND HEALTH
- + EXTENDED SERVICE LIFE OF ALL LONGWALL SYSTEM COMPONENTS



SELECT THE DEGREE OF AUTOMATION YOU NEED

SAFETY AND EFFICIENCY RIGHT FROM ENTRY LEVEL.

ADAPTABLE TO YOUR OPERATIONAL CHALLENGE.

When it comes to safe and efficient longwall mining operation, Command for Longwall offers the right level of automation for your shearer – from operator assistance to full autonomy.

Every longwall operation is different, and each mining company defines its own requirements and objectives with regards to safety, productivity and performance. This has a direct impact on the needs for longwall automation. Therefore, three different levels of Cat shearer automation are offered:

- + **STANDARD MACHINE CONTROL** WITH RADIO REMOTE SYSTEM AND BASIC MONITORING AND VISUALIZATION OF THE MAIN SHEARER COMPONENTS AND FUNCTIONS
- + **ADDITIONAL BASIC AUTOMATION** INCLUDING GATE END COMMUNICATION AND BASIC STATE TABLES
- + **ADDITIONAL ADVANCED AUTOMATION** FEATURING FACE ALIGNMENT AND HORIZON CONTROL

Longwall mining customers can select the automation package that best matches their job, and when required, they can perform software updates to expand their automation capabilities.

Because hardware upgrades can be time-consuming and costly, Cat dealers assist customers in ordering their shearers with the hardware required to meet their longterm automation goals.

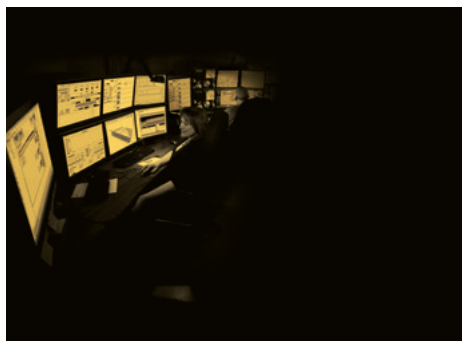




TAKE CONTROL

WITH CAT SHEARER AUTOMATION

- + CHOOSE THE AUTOMATION CAPABILITIES THAT MAKE SENSE FOR YOUR LONGWALL OPERATION
- + ADAPT WHAT'S WORKING WELL IN OTHER MINES TO BOOST SAFETY, EFFICIENCY AND EQUIPMENT AVAILABILITY AT YOUR LONGWALL MINE
- + KEEP YOUR SHEARER OPERATORS IN CONTROL BUT OUT OF HARM'S WAY – THROUGH REMOTE-CONTROLLED OR SEMI-AUTONOMOUS COAL EXTRACTION
- + FINALLY, AUTOMATE YOUR SHEARER CUTTING CYCLES



CAT SHEARER AUTOMATION PACKAGES

KNOW YOUR OPTIONS



STANDARD MACHINE CONTROL

FEATURES

- + STANDARD MACHINE CONTROL
-

HARDWARE

- + PROGRAMMABLE LOGIC CONTROLLER
 - + ENCODER FOR FACE POSITION
 - + INFRARED RECEIVER (OPTIONAL)
 - + POWER LINE MODEM (OPTIONAL)
 - + SHEARER END DISPLAY (OPTIONAL)
-

SOFTWARE

- + VSHEARER (OPTIONAL)



BASIC AUTOMATION

FEATURES

- + STANDARD MACHINE CONTROL
- + GATE END COMMUNICATION
- + BASIC STATE TABLE
- + *REMOTE OPERATION CONTROL (OPTIONAL)*

HARDWARE

- + PLC (PROGRAMMABLE LOGIC CONTROLLER)
- + IPC (INDUSTRY PC)
- + ENCODER FOR FACE POSITION
- + INERTIAL MEASUREMENT UNIT (IMU)
- + RANGING ARM POTENTIOMETERS
- + POWER LINE MODEM (PLM)
- + *INFRARED-TRANSCEIVER (OPTIONAL)*
- + *WIRELESS LAN (OPTIONAL)*
- + *FIBRE CONNECTIVITY (OPTIONAL)*
- + *SHEARER END DISPLAY (OPTIONAL)*

SOFTWARE

- + VSHEARER

ADVANCED AUTOMATION

FEATURES

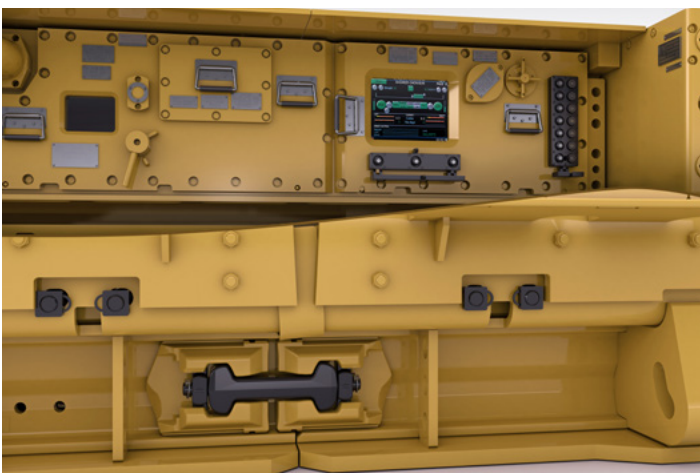
- + STANDARD MACHINE CONTROL
- + GATE END COMMUNICATION
- + BASIC STATE TABLE
- + ADVANCED STATE-BASED AUTOMATION
- + LONGWALL NAVIGATOR
- + *REMOTE OPERATION CONTROL (OPTIONAL)*

HARDWARE

- + PROGRAMMABLE LOGIC CONTROLLER (PLC)
- + INDUSTRY PC (IPC)
- + ENCODER FOR FACE POSITION
- + INERTIAL MEASUREMENT UNIT (IMU)
- + RANGING ARM POTENTIOMETERS
- + POWER LINE MODEM (PLM)
- + *PAMS – PAN ANGLE MEASUREMENT SYSTEM (OPTIONAL)*
- + *INFRARED-TRANSCEIVER (OPTIONAL)*
- + *WIRELESS LAN (OPTIONAL)*
- + *FIBRE CONNECTIVITY (OPTIONAL)*
- + *SHEARER END DISPLAY (OPTIONAL)*
- + *CAMERAS (OPTIONAL)*

SOFTWARE

- + VSIELD
- + VSHEARER
- + LONGWALL NAVIGATOR



CAT SHEARER AUTOMATION FEATURES

STANDARD MACHINE CONTROL

MANUAL OPERATION OF THE SHEARER

The basic machine operation is controlled by push buttons at the machine and a radio remote system (e.g. haulage control, hydraulic control, motor control).



VISUALIZATION OF OPERATIONAL VALUES AND PARAMETERS

The main display unit on the shearer provides all required process data and parameter settings to commission and operate the machine.



CONDITION MONITORING OF MAIN SHEARER COMPONENTS AND FUNCTIONS

The on-board control system permanently monitors all required sensor data and device information to operate the machine in a safe manner. If device information or sensor data are not within pre-defined limits, the system turns into a safe mode.

SHEARER OPERATION WITH TWO RADIO CONTROLS (including radio tilt, drop and impact detection and radio guard signal monitoring)

The shearer can be controlled with up to two radio remotes. The remote handsets detect whether the unit has been dropped, tilted or an impact has occurred. If so, the machine will turn into a safe mode.

DETECTION OF UNREQUESTED MOVEMENTS IN THE HAULAGE AND HYDRAULIC SYSTEM

Movements in the haulage or hydraulic system that are not initiated by the operator are detected by the system and as a result the machine is turned into a safe mode.



HAULAGE SPEED CONTROL (based on cutter motor load)

The shearer control system can relate the haulage speed to the actual cutter load. If an increased load on the cutter motors is detected, the haulage system will slow down automatically. This will reduce loads on the cutter drums and will increase the average performance of the machine.

ONBOARD SYSTEM DIAGNOSTICS FOR TROUBLESHOOTING

An onboard fault diagnostic system will guide the operator to troubleshoot a system issue. Direct links to sensor data, and flowcharts will support the fault analyses.

SYSTEM PARAMETER MANAGEMENT

The system parameters of the shearer can be managed onboard and off-board. The system provides the ability to save complete machine setups on- and off-board. Parameter sets for operation can be saved and uploaded as backups and they can be downloaded and installed again to restore previous machine configurations.

DATA LOGGING (7 days)

The system stores machine data online for later fault analyses and diagnostics. Data will be stored for seven days and can be retrieved by USB or gate end communications.

HAULAGE SPEED ZONE CONTROL

Haulage speed zones can be commissioned with the system for up to 10 zones in each direction of travel. Haulage speed zones will adapt shearer speeds to production requirements and geology (PLC based speed control).

MACHINE POSITION DETECTION

The shearer machine position is calculated by an absolute position encoder. This allows the control system to detect the exact machine position, even in the event of an interruption in the exchange of data.

SHEARER HAULAGE SPEED CONTROL BY METHANE LEVEL DETECTION

The shearer haulage speed is adjusted according to the measurement of the methane levels at the shearer. If a critical limit is detected and rises toward the set trip point, machine speed is reduced accordingly.





GATE END COMMUNICATION

DATA EXCHANGE WITH OTHER LONGWALL COMPONENTS

The control system can communicate machine data and interact with external longwall components such as PMC-Rs, PMC-Ds and Gate End PLCs.

ROOF SUPPORT ANTI-COLLISION DETECTION

Shearer roof support anti-collision detection allows the operator to control the shearer haulage system (speed limitation on anti-collision prewarning, haulage stop on anti-collision event).



SHEARER REMOTE STOP/PAUSE MODE

The shearer can be stopped from the longwall (via PMC-R) and can be set to a pause mode by the gate end PLC. During pause mode the shearer can automatically stop all motors and re-energize them if the pause mode is disabled by the gate end controller. The machine operation will then continue.

EXTERNAL SHEARER HAULAGE SPEED LIMITATION

External longwall controls PMC-R, PMC-D and Gate End PLCs can control the shearer speed limit if it becomes necessary due to ongoing production.

FLEXIBLE SETTING OF ELECTRICAL TAIL GATE STOP POSITION

The control system will exchange data with the AFC system in the longwall and will receive the status of the AFC tensioning cylinder stroke and thus the actual current length of the AFC. This information will be used to recalculate the commissioned electrical tail gate stop position.

GATE END MESSAGING TO REMOTE CONTROL

The Gate End controller sends general longwall system information to the machine operator's radio handset display. The types of messages are either predefined or can be customized.



BASIC STATE TABLE

RADIO HANDSET DISPLAY SUPPORTS PROCESS DATA VISUALIZATION AND INTUITIVE MINER-MACHINE INTERACTION

Several status pages are available indicating the current machine status, such as motor currents, drum heights, machine positioning etc. They are shown on the color display of the operator radio handset.

DRUM AUTOMATION – PAN FOLLOWING, FIXED EXTRACTION, IDLE

Drum automation methods are available for the individual cutting drums. They make the ranging arms steer to cut a defined shape. This can be either a pan follow, a roof follow or an idle method.

ZONED DRUM HEIGHTS

Drum heights and method can be set up to specific zones along the face. There are up to 40 zones onboard the shearer commissionable.

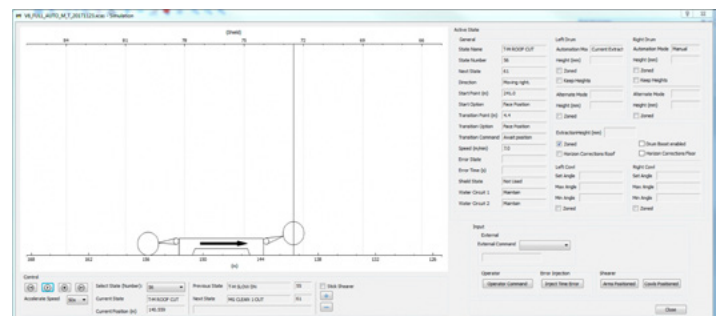
ADVANCED STATE-BASED AUTOMATION

CUSTOMIZABLE STATE TABLE

Customized state tables allow the operator to define complete cutting cycles/sequences with the automation of direction, speed, different cutting methods, ranging arm heights etc. for up to 200 individual states and an additional 50 exceptional states.

STATE TABLE SIMULATOR

The simulation of state tables allows the operator to verify a defined cutting sequence in the state table editor by testing it in a simulation environment which is integrated in the tool.



LONGWALL NAVIGATOR

CALCULATION AND CONTROL OF HIGH ACCURACY HORIZON PROFILES

The desired floor and roof cutting profiles can be defined, controlled and monitored.

HORIZON CONTROL VIA VSHEARER INTERFACE

It allows the operator to define the desired floor and roof cutting profiles within the visualization tool and then send the adjustments to the shearer from a remote location (gate end or control room at the surface).

HORIZON CONTROL ADJUSTMENT VIA ROOF SUPPORT CONTROL INTERFACES

The operator can define desired floor and roof corrections from each roof support control unit within the longwall. The corrections can then either be directly sent to the shearer or be visualized and reviewed within the VSshearer software before being applied.

CALCULATION AND CONTROL OF FACE ADVANCE PROFILE

The shearer controls can steer the machine to a desired face advance angle. These angles can be defined in a profile along the longwall.

FACE ALIGNMENT VIA VSHIELD INTERFACE

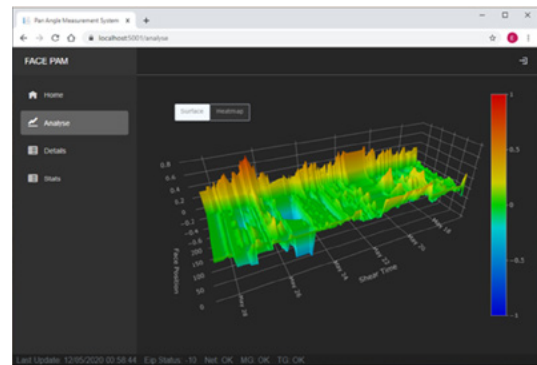
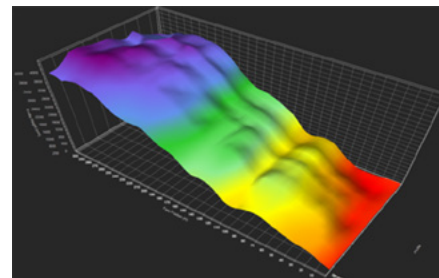
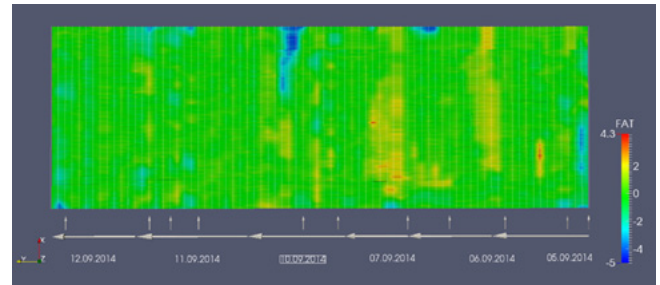
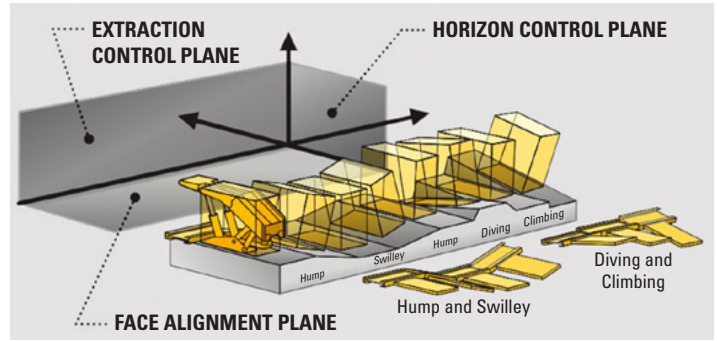
The shearer calculates the conveyor profile from actual position data and sends corrections to the VShield system where they are translated to the relay bar's extension. This feature allows the operator to keep the longwall straight for consistent production and minimal wear of the conveyor system.

3D NAVIGATION INTERFACE (for CSIRO Landmark System)

The shearer control system is capable to communicate with the third-party CSIRO Landmark System that controls face alignment and floor profiling. *One-time royalties and license fee for the first year are included.*

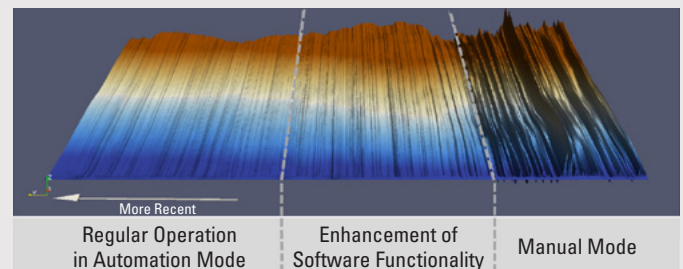
PAN ANGLE MEASUREMENT SYSTEM (PAMS) INTERFACE

This feature allows to communicate with gate end inclinometers installed on the last five conveyor pans on each gate end. With this information the system can determine the pan profile in front of the shearer in the gate end sections.



HORIZON PROFILE IMPROVEMENT

Increased degree of automation constantly reduces the period of manual overrides.



Enrollment of advanced shearer automation over 3 months in two major steps.

REMOTE OPERATION CONTROL

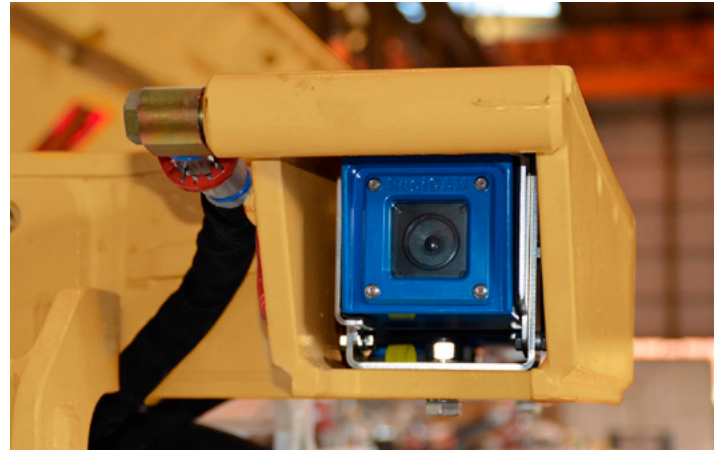
SHEARER OPERATION FROM REMOTE LOCATIONS

The shearer can be controlled either from the gate end/roadway area from a cabin or from a control room at the surface. Complete machine functionality is available with this feature. Additional equipment is required to operate the machine from a remote location.



MULTIPLE CAMERAS INSTALLED ON THE SHEARER

Multiple cameras can be installed on the shearer communicating the video streams to the longwall and remote-control locations.



REMOTE CONTROL ENABLES HIGHER PRODUCTION

This technology provides remote control of all shearer and roof support functions that are operated by radio control – either from the surface control room or from a safe area underground not in the line of sight of the longwall equipment. All hydraulic functions and group functions that are typically initiated by a roof support operator at the face can now be done remotely. This advanced technology also offers the capability of controlling production while keeping operators in a safe zone.

ENHANCED OPERATOR SAFETY

The remote operation reduces the presence of miners at the face during longwall operation, which lowers health and safety risks and aids compliance with dust exposure regulations.

HIGHER PRODUCTION OUTPUT

The Cat remote system incorporates increased automation for smoother, more continuous longwall operation, resulting in lower equipment wear rates and less mechanical downtime within the production cycle. A remote operator can also execute corrections quickly, further decreasing downtime by eliminating the need to travel across the face. Shorter cycle times, less downtime and an increase in the number of shearers per shift all contribute to a higher overall production output.



INCLUDED HARD- AND SOFTWARE

HARDWARE

MACHINE CONTROL

- + **PROGRAMMABLE LOGIC CONTROLLER (PLC)**
For basic machine functionality in coal production
- + **INDUSTRY PC (IPC)**
For advanced automation features



POSITION AND FACE ANGLE MONITORING

- + **ENCODER FOR FACE POSITION**
- + **INERTIAL MEASUREMENT UNIT (IMU) OPTIONS**
 - **IMAR**
 - **LN-270 (NORTHROP GRUMMAN)**
 - **OCTANS (IXBLUE/IXSEA)**
 - **PHINS (IXBLUE/IXSEA)**
- + **PAMS FOR ENHANCED GATE END HORIZON CONTROL**
- + **RANGING ARM POTENTIOMETERS FOR STEERING/RANGING ARM POSITIONING**

DATA COMMUNICATION

- + **INFRARED-TRANSCIVER**
- + **POWER LINE MODEM (PLM)**
- + **WIRELESS LAN**
- + **FIBER CONNECTIVITY**

SHEARER END-DISPLAYS

- + **INTEGRATED SHEARER END DISPLAY TO DISPLAY SELECTED MACHINE PARAMETERS**

SOFTWARE

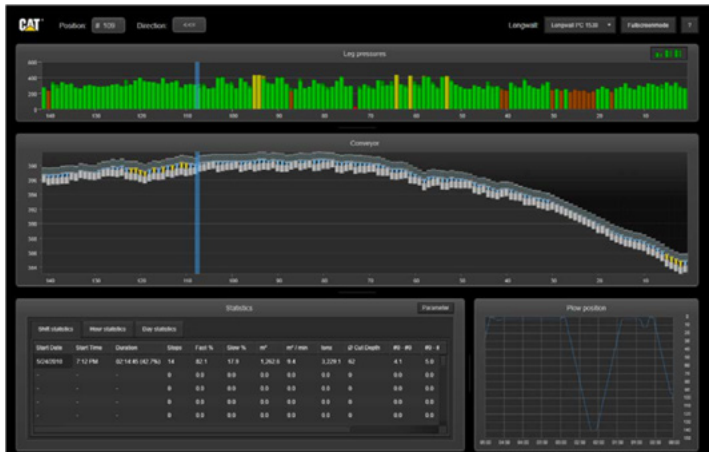
VSHEARER SOFTWARE (Health for Longwall)

- + **VISUALIZATION TOOL FOR MACHINE HEALTH MONITORING AND DATA LOGGING**
- + **RADIO KEYSTROKE LOGGING**



VSHIELD-SOFTWARE (Health for Longwall)

- + **VISUALIZATION TOOL FOR MACHINE HEALTH MONITORING AND DATA LOGGING**
- + **DATA VISUALIZATION FOR AUTOMATED FACE ALIGNMENT CONTROL**



SHEARER AUTOMATION PACKAGES

Command for Longwall

FEATURE	DESCRIPTION	STANDARD	BASIC	ADVANCED
Standard Machine Control	<p>Allows manual operation of the shearer</p> <p>Visualization of the operation related values and parameters on main display</p> <p>Monitors all important shearer components and functions permanently and turns into safe mode in case of exceeding defined limits</p> <p>Allows to operate the shearer via two radio controls with radio tilt, drop and impact detection and radio guard signal monitoring (no handset display support)</p> <p>Unrequested movement monitoring for haulage and hydraulic functions</p> <p>Controlled haulage speed reduction depending on cutter motor load</p> <p>Onboard system diagnostics for troubleshooting</p> <p>Parameter management allows to save, upload, download parameter settings of the machine configuration</p> <p>Data logging for seven (7) days, retrievable with USB or gate end communications</p> <p>Zoned haulage control with PLC based speed control</p> <p>Shearer position via encoder or other method</p> <p>Interface for haulage speed control by methane level detection</p>	•	•	•
Gate End Communication	<p>Allows data exchange with other longwall components (PMC-R, PMC-D, Gate End PLC)</p> <p>Enables roof support anti-collision detection*</p> <p>Provides Shearer remote stop/pause mode</p> <p>Provides Shearer haulage speed limitation from external systems (PMC-R, PMC-D, Gate End PLC)</p> <p>Flexible setting of electrical tail gate stop position depending on AFC tensioning cylinder stroke</p> <p>Provides messaging from Gate End to remote control display</p>	○	•	•
Basic State Table	<p>Radio Handset Display supports process data visualization and intuitive miner-machine interaction</p> <p>Drum Automation – pan following, fixed extraction, idle</p> <p>Zoned drum heights (idle, pan follow, roof follow)</p> <p>Fixed state table – configurable by dealer or Caterpillar</p>	X	•	•
Advanced State-Based Automation	<p>Customizable state table – allows to define complete cutting cycles/sequences with automation of direction, speed, different cutting methods, ranging arm heights etc. for up to 200 individual states and additional 50 exception states</p> <p>Includes state table simulator</p>	X	X	•
Longwall Navigator	<p>Calculation and control of high accuracy horizon profile (roof and floor profiles)</p> <p>Horizon Control via VShearer Interface for Floor and Roof Profiles from Gate End or Surface</p> <p>Horizon control adjustment via PMC-R interface possible from the longwall*</p> <p>Calculation and control of face advance profile</p> <p>Face Alignment capability via VShield interface from Gate End or Surface*</p> <p>Interface for 3D Navigation with CSIRO Landmark System</p> <p>Interface for Pan Angle Measurement System (PAMS) gate end floor control</p> <p>One-time royalties and license fee for the first year included</p>	X	X	•

SHEARER AUTOMATION PACKAGES

Command for Longwall

FEATURE	DESCRIPTION	STANDARD	BASIC	ADVANCED
Remote Operation Control	Allows operation of the shearer from outside the longwall Multiple cameras installed on the shearer Tele-remote shearer operation (drive by cameras)	X	○	○

HARDWARE AND SOFTWARE

Hardware and Software included in the packages respectively optional available:

HARDWARE	DESCRIPTION	STANDARD	BASIC	ADVANCED
Machine Control	Programmable Logic Controller (PLC) for basic machine functions to produce coal	●	●	●
	Industry PC (IPC) for features like advanced automation	X	●	●
Position and Face Angle Monitoring	Encoder for face position	●	●	●
	IMAR – Inertial Measurement Unit (IMU)	X	●	●
	LN-270 (Northrop Grumman) – Inertial Measurement Unit (IMU)	X	○	○
	Octans (iXblue/IXSEA) – Inertial Measurement Unit (IMU)	X	○	○
	Phins (iXblue/IXSEA) – Inertial Measurement Unit (IMU)	X	○	○
	PAMS for enhanced gate end horizon control	X	X	○
	IS Switches in each gate for PAMS integration	X	X	○
	Ranging Arm Potentiometers for steering/ranging arm positioning	X	●	●
Data Communication	Infrared-Transceiver	○	○	○
	Power Line Modem (PLM)	○	●	●
	Wireless LAN	X	○	○
	Fibre Connectivity	X	○	○
Shearer End-Displays	Integrated shearer end display to display selected machine parameters	○	○	○
SOFTWARE	DESCRIPTION	STANDARD	BASIC	ADVANCED
VShearer–Software	VShearer visualization tool for health monitoring and data logging	○	●	●
	Radio Keystroke Logging	○	●	●
VShield–Software	Roof support visualization for automated face alignment control	X	X	●

● standard ○ optional X not available

* PMC-R roof support control system required

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