

CAT® MINESTAR™

COMMAND FOR DRILLING

AUTONOMOUS
DRILLING SYSTEM





CAT® MINESTAR™ COMMAND FOR DRILLING

SET THE TONE FOR YOUR DOWNSTREAM OPERATIONS



More consistent drilling. Greater accuracy. Higher utilization. Increased productivity and production. Lower operating costs.

These are just a few of the outcomes you can expect when implementing remote and autonomous drilling into your mining operation. However, not all autonomous drilling systems are the same. To get these benefits — and many more — the ideal solution is Cat® MineStar™ Command for drilling.

Caterpillar combines a proven technology solution, decades of implementation experience, deep system integration with Cat machines and the global support of the Cat dealer network to deliver an autonomous drilling solution that can take your operation to the next level of efficiency, consistency, safety and availability — maximizing outputs and reducing costs.

OPERATORS REMOVED FROM HAZARDOUS JOBSITE CONDITIONS

LESS RELIANCE ON OPERATOR INPUTS = MORE DRILLING TIME

HIGHER UTILIZATION

OEM AGNOSTIC

REDUCED OPERATIONAL COSTS

- » Fewer re-drills, reduced drill wear, damage and consumable costs

GREATER ACCURACY & CONSISTENCY

ONE OPERATOR. MULTIPLE DRILLS

IMPACTS THE BOTTOM LINE

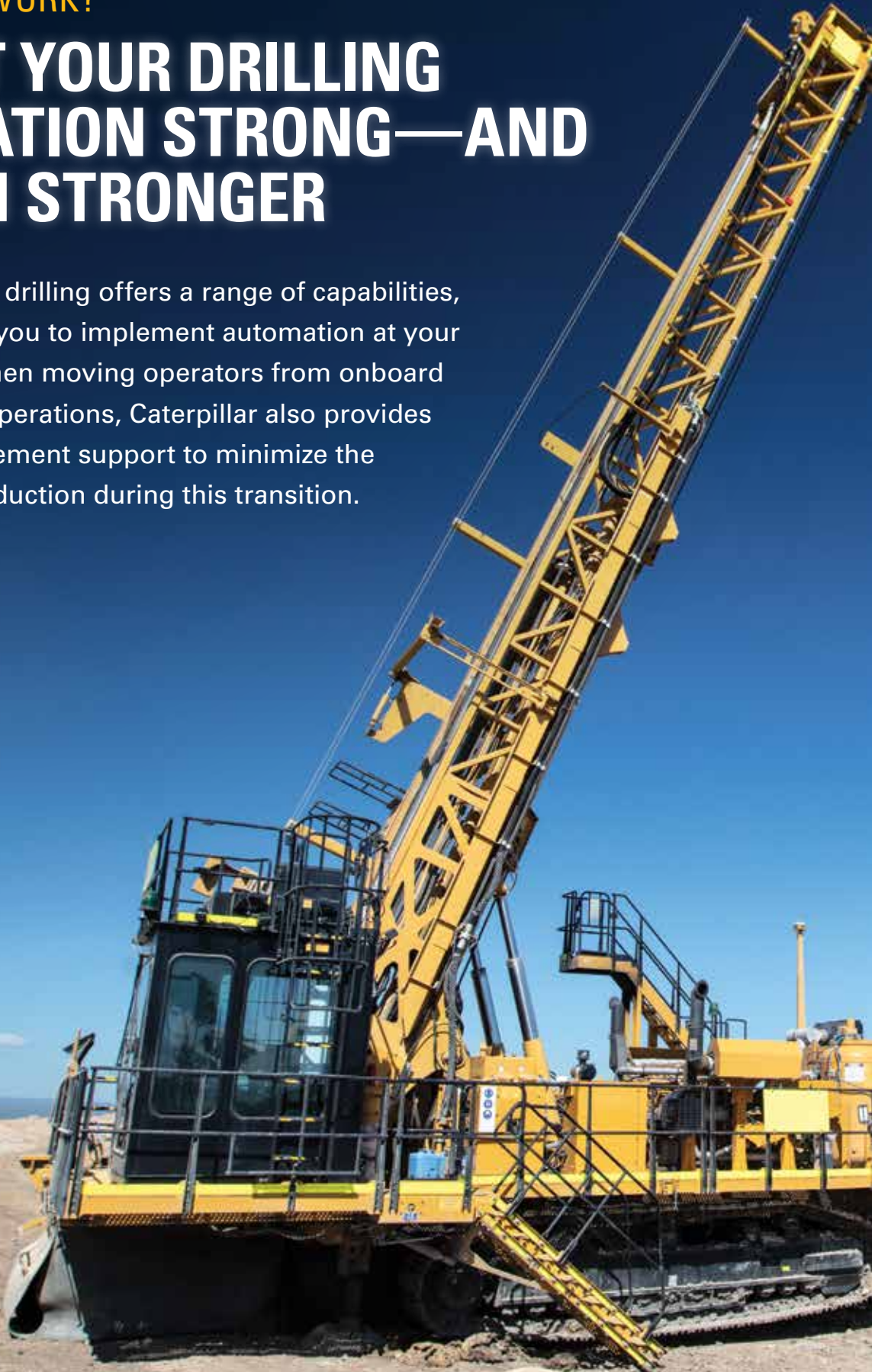
- » Better fragmentation and execution of blast plan
- » Optimized loader bucket fill and truck load accuracy
- » Proper subdrill provides smoother benches

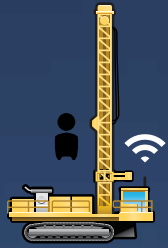
MORE METERS DRILLED PER LITER AND MORE HOLES DRILLED PER HOUR

HOW DOES IT WORK?

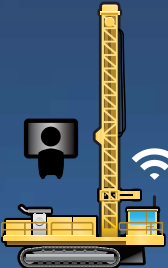
START YOUR DRILLING OPERATION STRONG—AND FINISH STRONGER

Command for drilling offers a range of capabilities, which allows you to implement automation at your own pace. When moving operators from onboard to off-board operations, Caterpillar also provides change enablement support to minimize the impact to production during this transition.

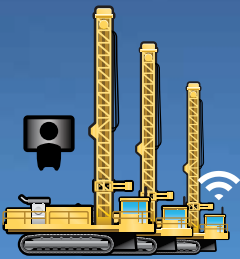




IN-CAB OPERATOR MACHINE ASSIST



NON-LINE-OF- SIGHT REMOTE CONTROL



AUTONOMOUS DRILLING SYSTEM

You can start your journey to autonomy with Operator Machine Assist—an operator assist technology—or begin with an off-site multi-row autonomous drilling system. Command also enables non-line-of-sight remote control of drills, with operators working either on- or off-site in a safe, comfortable Remote Operator Station (ROS). Command for drilling was designed for every step of your drill optimization journey.

IN-CAB OPERATOR MACHINE ASSIST

Machine assist provides operator-assist functionality to the operator. The system automates the entire drill cycle. The operator can select a row of holes and the drill navigates from hole to hole and auto-drills all holes in the selected row. The operator ensures safe drill movement before authorizing auto-tram to the next hole.

NON-LINE-OF-SIGHT REMOTE CONTROL

This solution allows the operator to remotely manage multiple drills. The operator is relocated to a ROS, a familiar and comfortable environment that replicates the cab of Cat® MD6250 or MD6310 rotary drills.

- + Operators can control a single drill remotely or manage multiple autonomous drills
- + Maintains use of base drill auto-functions
- + Provides situational awareness with onboard vision and collision avoidance sensors

AUTONOMOUS DRILLING SYSTEM

The Command for drilling Autonomous Drilling System enables multi-row autonomous drilling, empowering an operator to manage multiple autonomous drills across the mine. Drill controllers can safely manage autonomous drill assignments from a line-of-sight tablet or from a non-line-of-sight ROS located on site or off site. A line-of-sight tablet provides an opportunity to autonomously drill without the robust network requirements required for camera streaming to the ROS.

- + Single-row or multi-row solutions depending on drill model and application
- + Automates entire drilling cycle for a defined assignment
- + Autonomous tramming between holes and rows
- + Assignments launched from a tablet interface or ROS
- + One operator can manage multiple drill operations across the mine site
- + ROS located on site or at off-site command center



HOW DOES COMMAND MANAGE SAFETY?

MULTIPLE LAYERS OF PROTECTION—VALIDATED IN THE FIELD

Command contributes to a safer mining operation by removing operators from hazardous conditions. With multiple layers of safety, Command for drilling safely interacts with other autonomous machines, staffed vehicles and personnel working in the autonomous operating zone (AOZ).

COLLISION AWARENESS & AVOIDANCE

Command-equipped drills can take advantage of sophisticated technologies that help increase awareness of potential collisions, and in some cases prevent them by stopping machine operation when a hazard is detected.

Collision Awareness is compatible with Operator Machine Assist and Remote Control capabilities— notifying operators of the positions of nearby objects.

Collision Avoidance enables automatic machine intervention controls when dangerous interactions are detected with other machines or objects and is an essential feature required for safe autonomous operation.

LAYERS OF SAFETY

Caterpillar employs field-validated layers of protection to minimize interactions between machines and personnel and increase safety in an autonomous mining operation.

**Below is the same
copy as Command
for hauling and
needs to be
reviewed/updated**

**POTENTIAL
HAZARD**

1

**Perimeter
Security**

- + Mine area
- + AOZ

2

**Site
Procedures**

- + Clearly defined operational procedures
- + Detailed training

3

**Site
Awareness**

- + All vehicles in AOZ fitted and tracked
- + Autonomous machines have awareness of all vehicles and can avoid collisions

4

Office Stop

- + Can stop any or all autonomous machines
- + Always present on office screen

5

Perception

- + Detection of untracked objects
- + Designed to protect people and machines

6

Onboard Shutdown —

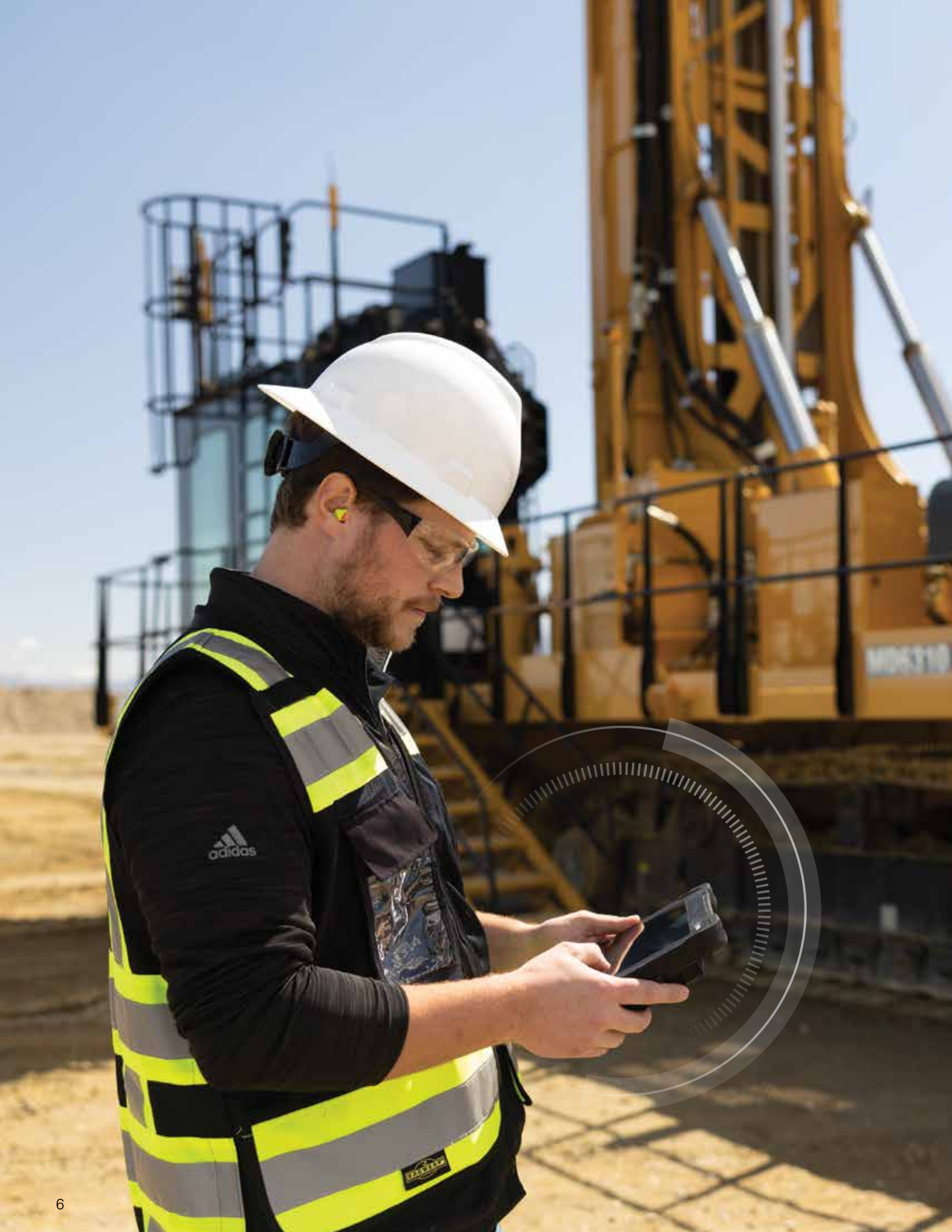
all autonomous machines halt for:

- + Loss of communication
- + Loss of control
- + Loss of positioning
- + Mechanical events

7

A-Stop

- + Handheld device
- + Stops all Command-equipped vehicles within about 300 meters (984 feet)





WHY SHOULD WE CONSIDER IT?

BOOST SAFETY, PRODUCTIVITY, UTILIZATION & ACCURACY THROUGH DRILL AUTONOMY

Cost-effective, high-precision autonomous drilling impacts your entire mining value chain. Cat® MineStar™ Command for drilling enhances safety and improves drilling accuracy, productivity and utilization, which will ultimately reduce your cost per ton.

The benefits of Command for drilling are extensive. Drilling automation:

- + Improves operator productivity and effectiveness, and increases safety by removing operators from dust, noise and vibration.
- + Boosts safety through:
 - Collision Awareness for Operator Machine Assist and Remote Control capabilities— notifying operators of the positions of nearby objects.
 - Collision Avoidance, which will safely bring the machine to a stop when objects are detected in the immediate path of travel of an autonomous drill— allowing essential tasks to be carried out safely on the same bench.
- + Delivers consistent and accurate drilling that pays off with better blasting outcomes, more productive loading and hauling, and more efficient final processing.
- + Delivers higher, more consistent drilling rates across varying geologies for all operators, resulting in an increase in overall fleet productivity.
- + Helps to ensure that every hole is accurately placed to plan and consistently drilled to the proper elevation and angle—improving final blasting results.
- + Reduces machine wear and tear by enabling optimized drill operation under OEM operational parameters.
- + Converts non-productive drilling hours into productive drilling hours.

WHY CATERPILLAR?

PROVEN SOLUTIONS BACKED BY EXPERTISE & SUPPORT



MINESTAR: A PROVEN SOLUTION

- + Robust testing and validation process
- + Designed for challenging environments
- + Validated across multiple applications



WORLD-CLASS SUPPORT FROM CATERPILLAR AND CAT DEALERS

Support options include online and remote support delivered by Caterpillar, on-the-ground support from Cat dealers, and consultation services provided by both Caterpillar and Cat dealer experts.

- + Realize the full potential of your investment
- + Achieve critical availability of your MineStar technologies
- + Sustain operational gains through continuous improvement





IMPLEMENTATION EXPERTISE

We're uniquely qualified to integrate our products into your environment and provide guidance for long-term success.

Installation and Deployment

We work with local Cat dealers to install, deploy and integrate MineStar software and hardware into your environment, and then ensure a smooth transition to your own team.

Training

Our comprehensive suite of training opportunities allows users to build skills through web-based, instructor-led, virtual reality and on-the-job courses.

Change Enablement

Caterpillar experts support initiatives to help your personnel prepare for the transition to technology.

Processes and Procedures

We work with site leaders to develop the operational processes and procedures that are essential to success.



MINESTAR: AN INTEGRATED AND SCALABLE ECOSYSTEM

MineStar allows you to tailor your technology journey, leveraging any of the building blocks that are the foundational elements making up your site operating system. Additional building blocks for safety and surface management use key common system components, allowing for the interchange of planning, blending, survey and production data within the one system.

- + Integrates data across the operation
- + Enables operational execution by managing and optimizing all assets



MINESTAR REPORTING

This centralized data warehouse consolidates data from multiple MineStar products. Flexible, customizable reporting allows you to extract the information you want, whether you leverage Caterpillar's own purpose-built mining analytics platform or export to a third-party platform.

TRACK, MONITOR, AUTOMATE AND MANAGE YOUR ASSETS WITH CAT MINESTAR SOLUTIONS

Cat MineStar Solutions is one of the mining industry's most comprehensive and thoroughly integrated suites of technology offerings for surface and underground operations.

MineStar can track, monitor, measure, manage and optimize all types of assets—from material and people to production machines and light vehicles on site. Whether you deploy a single technology or a multi-purpose solution, you can expect a safer, more productive and more efficient operation.

MineStar capabilities include:



TERRAIN, which increases efficiency and reduces variability of drilling, dragline, grading and loading operations through the use of high-precision guidance technology.



FLEET, which is an integrated fleet monitoring and management system that helps you measure, manage and optimize the use of assets at your site. It automatically records and tracks data up and down your value chain, providing insights that help you identify what's working and fix what's not.



DETECT, which helps increase operator awareness, enhancing safety at your operation. It includes a range of capabilities designed to assist the operator, including collision awareness and fatigue risk management for mobile equipment.



HEALTH, which delivers critical event-based machine condition and operating data for your entire fleet. It includes comprehensive equipment health and asset monitoring capabilities, with a wide range of diagnostic, analytic and reporting tools.



COMMAND, which makes it possible for mines to automate a single mining process, remotely control a single machine, automate multiple types of equipment across a mixed fleet, or implement a fully driverless fleet of trucks.

BOOST SAFETY, PRODUCTIVITY, UTILIZATION & ACCURACY — THROUGH — DRILL AUTONOMY

Command for drilling takes advantage of the most sophisticated technologies available to deliver a next-generation drilling solution — one that boosts safety, productivity, and utilization at mine sites, especially those in difficult or remote locations.

