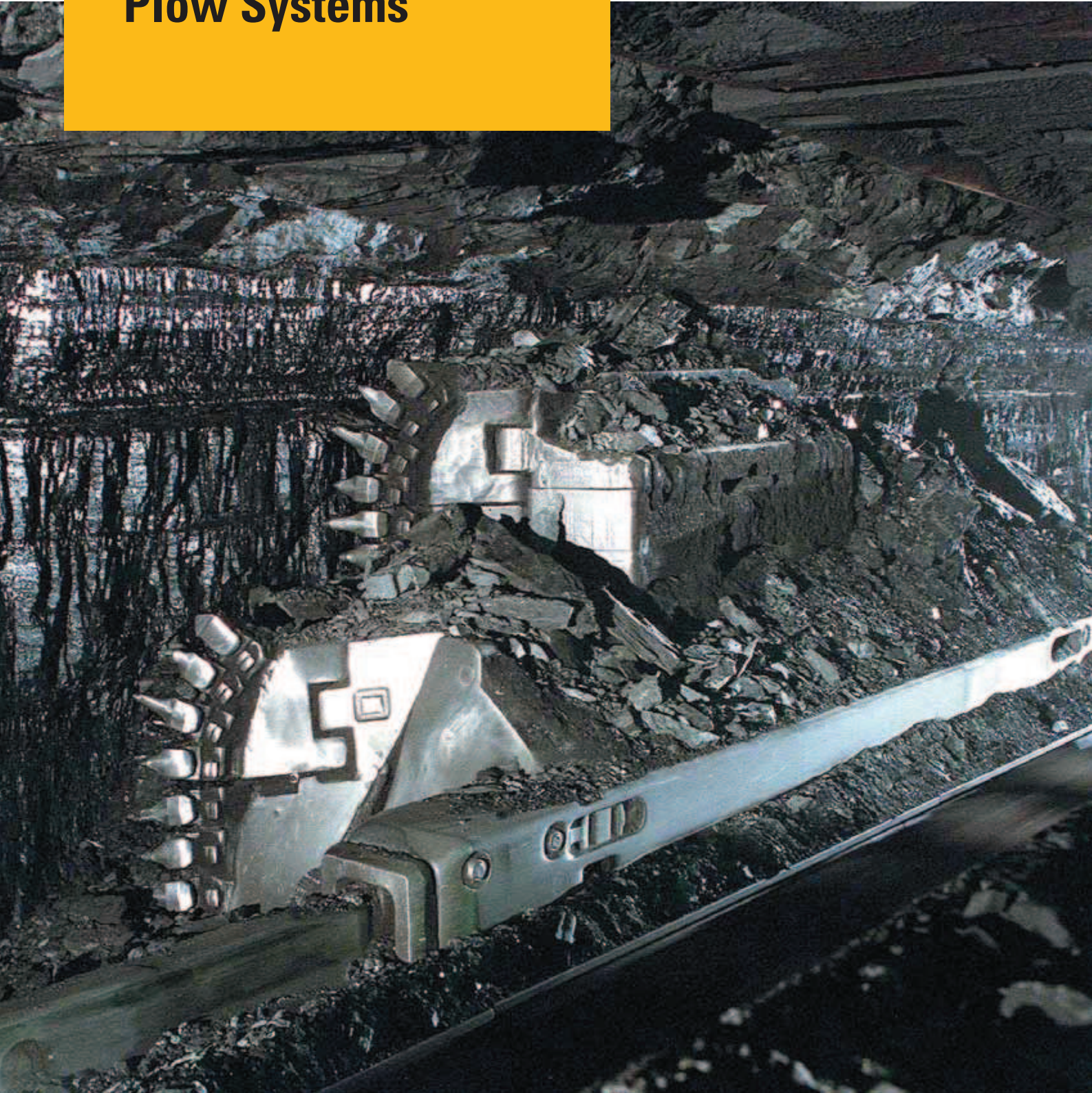


# Automated Plow Systems





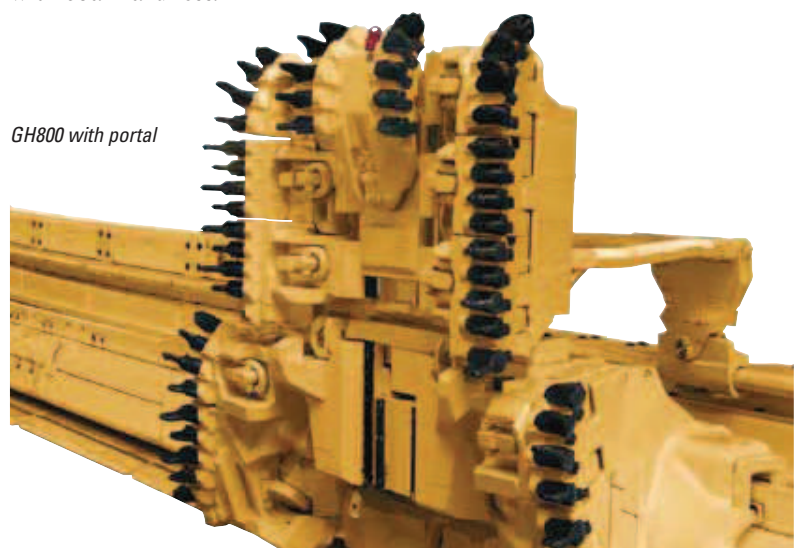
## High-level Automation

We have been designing and building longwall plows since 1941 – and things have come a long way. Technical developments since 1990 have once again established plowing as the preferred longwall mining method for seams below 1.8 m (71 in) Cat® plows offer world-leading features that other manufacturers cannot and a cost of ownership that far outstrips the shearer when mining thin and medium seams. Their reliability, high-productivity and ability to mine in-seam make them the ideal choice for longwall mining medium and thin seams.

### Cut any Coal

There was a time when the application of plows for longwall mining was limited by the type of coal to be cut. With Cat plows, this is no longer the case. Advancements in drive, control and transmission systems – with more powerful motors, stronger plow chain, increased plow speeds, higher advancing force provided by the roof supports, precise control of the cutting depth, and plow bit design improvements – all combine to allow Cat plows to be used for any coal hardness and with higher efficiency than other longwall extraction methods in low and medium heights. This is supported by greater installed power than any other manufacturer – up to 1 600 kW (2,160 hp) with the GH1600.

Incremental plowing means that Cat plows cut a precisely defined depth, regardless of coal hardness, seam structure and faults. On older-style systems, the cutting depth is typically controlled by adjusting the shield advancing ram pressure, with the result being that cutting depths vary with coal hardness.



*GH800 with portal*

Horizon control is provided by the hydraulic steering cylinders and allows exact control of the plowing angle, ensuring that the plow does not dive or climb unless required by the seam geology. This control capability also allows mining of seams with an inclination of up to 60°.

We offer plows systems as complete and fully-automated or semi-automated versions. Cat plows undergo constant development to meet special requirements for our customers.

### How it Works

The plowing principle is simple: A sculpted steel plow body equipped with strategically-placed cutting bits is pulled along the face conveyor from one end of the face to the other by a continuous loop chain powered by drives located at the face ends. Cutting depth is electronically controlled by pushing the AFC toward the coal face in preselected increments after the plow has passed. The height of the plow body is easily and completely adjustable within a certain range, ensuring that only coal is cut. The plow body height can also be adjusted in larger increments by installing or removing additional bit blocks. Both adjustments can be performed quickly and easily from the gobside.

The plow body consists of mechanical components with all wear parts being replaced underground. Shields can be positioned to best suit the longwall's geology and normally advance automatically in concert with the cutting action of the plow. No operator is required within the longwall face itself. Operation can be controlled from a central control station either underground – for example, at the headgate entry – or on the surface. As a result, the operators are not subjected to difficult working conditions, they can be located a safe distance away in a dirt- and dust-free area. The outrigger steering system provides vertical horizon control. Steering is normally operated manually, but can be automated.

### Systems of Choice

The production rate achieved by plows compared to shearers has continued to increase over the years, making the plow a reliable, high-productivity longwall mining system for thin and medium seams.

For seams with an average height under 1.8 m (71 in), plows are now the system of choice for longwall mining. The GH1600 plow, due to its higher installed power, can cut up to 2.3 m (91 in) when fitted with a portal stabilizing arm.



*Plow horizon control*



*GH1600 gliding plow in hard coal*

In seams from 1.8 to 2.3 m (71 to 91 in), the choice between a plow or shearer depends largely on the geological conditions. But for any given height within this range, the plow outperforms the shearer in terms of productivity.

Average seam height	< 1.8 m (< 71 in)	1.8 – 2.3 m (71 – 91 in)	> 2.3 m (> 91 in)
Preferred mining method	Plow	Plow or shearer depending on geological conditions	Shearer

# Features of Cat® Plows

## Horizon Control

Effective plow horizon control is necessary to cope with undulations in the coal seam. Providing the plow with the ability to follow the seam minimizes cutting of adjacent rock strata and the associated preparation costs, reduces cutting tool (bit) consumption and reduces power consumption while maximizing seam recovery. Caterpillar has developed an outrigger steering system for vertical horizon control that employs the use of hydraulic cylinders located between the gobside of the AFC and the relay bar of the shield. Extension of the cylinder promotes a downward (digging) cutting direction of the plow. Retracting the cylinder promotes an upward (climbing) direction of the plow. The steering cylinders can be controlled either manually or automatically via the Cat PMC™-R electro-hydraulic control system. A block anchorage system consisting of cylinders installed between face conveyor and shields (at the face ends) controls conveyor creep and helps maintain the proper tension in the plow chain.

### Benefits

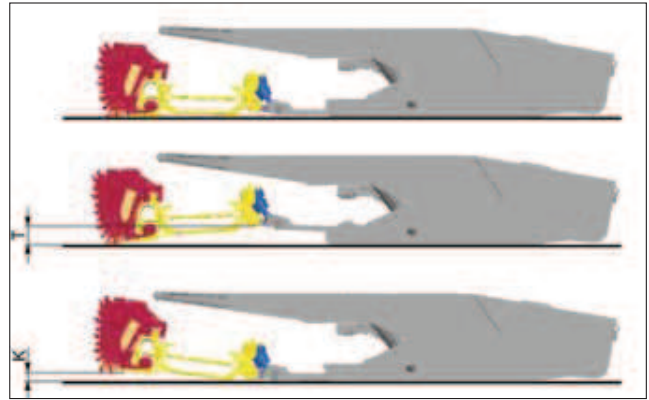
- The plow is advanced in relatively small increments (cuts) compared to a shearer. This allows the horizon control system to vertically steer the plow, keeping it in the seam even when severe seam undulations are encountered. A shearer, due to its larger cutting depths and fixed position relative to the AFC, can only make gradual changes in vertical alignment. Therefore, in severely undulating conditions, the product mined with a shearer contains a higher amount of "out-of seam" dilution.
- Easy height adjustment allows plows to work smoothly through faults or undulations, minimizing the cutting of adjacent, unwanted strata.
- Coal production is maximized while preparation costs are minimized.

## Load-sharing

Variable Frequency Drive (VFD) motors allow speed to be varied between 0 and 120% of nominal while maintaining constant torque throughout a wide range of speeds. Power consumption on the motors is constantly monitored to allow load-sharing between the individual drives.

### Benefits

- Full utilization of available power
- Prevention of motor overheating and resultant downtime
- Reduced motor current with optimum torque during startup
- Excellent power factor (~1)

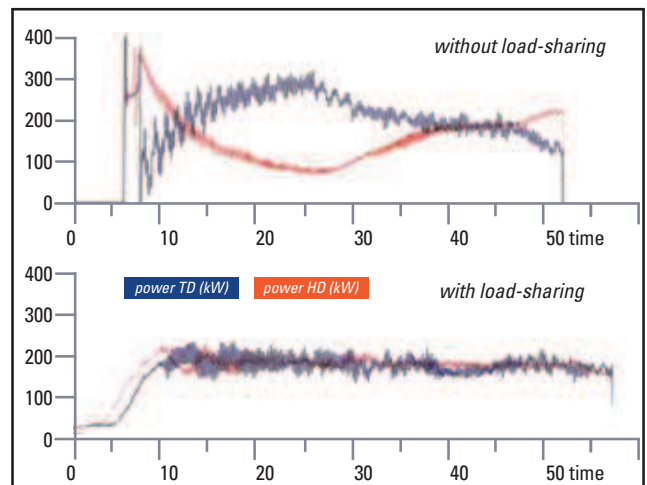


Plow horizon control with outrigger steering system



Horizon control for easy height adjustments

### Load-sharing capabilities of the drive system



TD = tail drive HD = head drive



## Overload Protection

Effective overload protection is essential for fast, high-power plowing. The Cat planetary UEL overload protection system has an integrated multi-disc clutch with the pressure set to allow the clutch to slip well below the torque required to reach the breaking strength of the chain. If “clutch slip” is sensed, the gearbox torque is immediately decreased, combined with a simultaneous shutdown of the plow motors to prevent damage to the chain.

### Benefits

- Eliminates shock loads from all drive components
- Minimizes chain failures and maximizes component life
- Allows for a quick system restart

## Shock Absorber

Caterpillar has developed an innovative shock absorber to provide added protection for the plow and chain. The elastic coupling inserted into the plow pulling sledge contains elastomers with properties that reduce the peak forces applied to the chain. This results in smoother plow operation, minimizing loads on the plow chain, the plow connectors and the drives, thereby extending their effective service life. The shock absorber is only available for the gliding (GH plow).

### Benefits

- Reduces wear and tear on plow, drives and chain
- Smooth plow operation extends overall service life

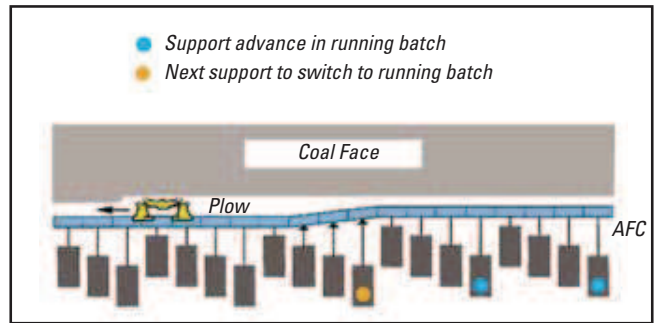
## Incremental Plowing

The key requirements for high-performance plowing are remote control, adjustable cutting depth and the ability to maintain a straight face line. These requirements are all achieved by the Cat incremental cutting system and the fully-automated plow longwall system. With conventional plows, variations in coal hardness lead to variations in cutting depth that often result in overloading of the conveyor and downstream equipment or jamming of the plow. Incremental plowing prevents these problems by keeping the depth of cut constant regardless of coal hardness or presence of rock bands. The plow makes a double cut – or a cut with double web – at each drive end, keeping the face straight at all times.

Under favorable roof conditions – where the shield tip-to-face distance is not an issue – the shields are positioned in a saw tooth form: Only every 4th or 5th shield performs the “lower – advance – set” sequence during each plow pass. This minimizes the hydraulic pump capacity required



Shock Absorber for reduced wear



Principle of the incremental plowing method

for the shields and assures that plowing does not need to be halted for the purpose of advancing shields. If the roof is friable, shields can be programmed to advance more frequently, minimizing the average shield tip-to-face distance and maximizing the effective support. Also, in order to guarantee effective support of the roof, the PMC™-R electrohydraulic control system monitors pressure in the shield legs and prevents two adjacent shields from being lowered simultaneously.

### Benefits

- Remote operation allows highest safety and maximum productivity in low coal.
- The AFC/plow system and shield supports can be positioned exactly where they are needed (snakes, roof condition, faults etc.).
- System is self-correcting for over- or underpush, thereby maintaining a straight face regardless of conditions.
- Optimum use of installed power for maximum cutting depth for every area of the face.
- Automated Cat plow systems allow access to extended reserves in low coal seams to achieve a higher percentage of reserve recovery.
- Significantly more coal can be mined with more efficient layouts that reduce overall costs.