Whenever a loader “attacks” a rock pile underground, a tremendous amount of power is required to thrust the bucket deep enough so that it can be filled to capacity. Wheels spin, buckets get stuck and the vehicle often has to make several attempts before successfully penetrating the muck. Sometimes, the driver has to be content to pull away with only a partial bucket load.

In the same way, LHDs that have to tackle steep, uphill gradients need extra power to maintain sufficient traction to ensure that the load will reach its destination within the projected cycle time.

The key source of power for thrust, bucket movement and traction does not lie in the size of the LHD’s diesel engine but in the hydraulic pumping system that distributes and controls the flow of hydraulic oil. This is where the power for all these critical functions is generated – but also where power losses can occur.

**Open Center Hydraulic System**

Today, there are two systems available – the traditional Open Center Hydraulic System, driven by a fixed displacement pump, and the Load Sensing Hydraulic System, which is driven by a variable displacement pump.

With the Open Center Hydraulic System, the pump constantly delivers a flow that is proportional to the speed of the engine. When no function is activated, the oil flows through the “open center” in the valve spools and is returned back to the hydraulic tank.

When a function is activated, the open center starts to close, which causes the pressure to rise. At the same time, the passage to the cylinder begins to open. The more the spool shifts, the more the open center closes and the more the pressure is increased.

When the pressure is higher than the cylinder pressure, the cylinder begins to move, but oil that is not directed to the cylinder is returned to the tank at a pressure drop, which, in turn, creates heat. When the spool has been fully shifted, the open center is closed and the entire flow goes to the cylinder.

If the load is higher than the maximum system pressure, the oil goes via the main relief valve back to the tank with a maximum pressure drop which creates a great deal of heat.

**Load Sensing Hydraulic System**

The Load Sensing Hydraulic System, on the other hand, is a modern, well-proven and reliable system. It was originally introduced for surface loaders but is now available on the latest underground loader from Atlas Copco, the Scooptram ST14, recently tested at the Kristineberg Mine in Sweden (see following pages).

Contrary to the Open Center Hydraulic System, the Load Sensing Hydraulic System on the ST14 has two variable pumps working together. This provides exactly the right amount of flow and pressure at any one time, distributing the power wherever and whenever it is needed.

As the system is activated only when moving the control stick, only a minimum of pumping power is lost, thereby reducing fuel consumption. Furthermore, the hydraulic system is faster, which means shorter working cycle times and higher productivity, and gives the operator better control of the load, resulting in a smoother, more comfortable ride for the operator.
The spools in the Load Sensing Hydraulic System are “closed center”, which means that when no function is activated, no oil flows through the system. The pump strokes back to zero flow and only maintains a low standby pressure. As soon as a function is activated, a pressure signal from the cylinder port is fed back to the pump and the pump regulates to a pressure level just above the highest load.

This means that the pump only delivers the flow that is needed at the required pressure level and that no oil is throttled back to the tank, creating heat. If the load is higher than maximum system pressure, the pump strokes back and holds the maximum pressure at zero flow – again, an energy saving solution.

The capabilities of the Load Sensing Hydraulic System enable the use of a stiffer converter with a higher degree of efficiency that transfers more of the power to the driving wheels and reduces the amount of heat loss. This results in a higher speed on grade for the ST14 and maximum utilization of the installed diesel power giving improved performance, minimum power losses and lower overall fuel consumption.

**High pressure + small movements = big losses**

Small movements under high pressure in conventional hydraulic systems always lead to substantial power losses and the use of the bucket is a good example. It is common practice to move the bucket slightly to make it easier to penetrate the muck pile.

With the Open Center Hydraulic System, a large amount of thrusting power is lost each time the hydraulic oil is activated and directed to the bucket-moving cylinders, which reduces the amount of power retained for traction. With the modern Load Sensing Hydraulic System, we can see that more than enough power is retained for both bucket movements and traction, and that the traction power drops only marginally with each small bucket movement.

The tests carried out with the ST14 prove the point. The extra wheelspin caused by the increased amount of available power was easily compensated for. By easing up on the throttle and attacking the muck pile at lower revs, the operators found they could get excellent traction and save fuel at the same time.

To summarize, it is clear that the search for increased efficiency in underground loading and hauling operations is best served by a vehicle that can deliver the exact amount of pressure and flow required for each function. In this context, the availability of Load Sensing Hydraulic Systems in underground equipment such as the ST14 is a milestone for Atlas Copco and a major step forward for the industry.