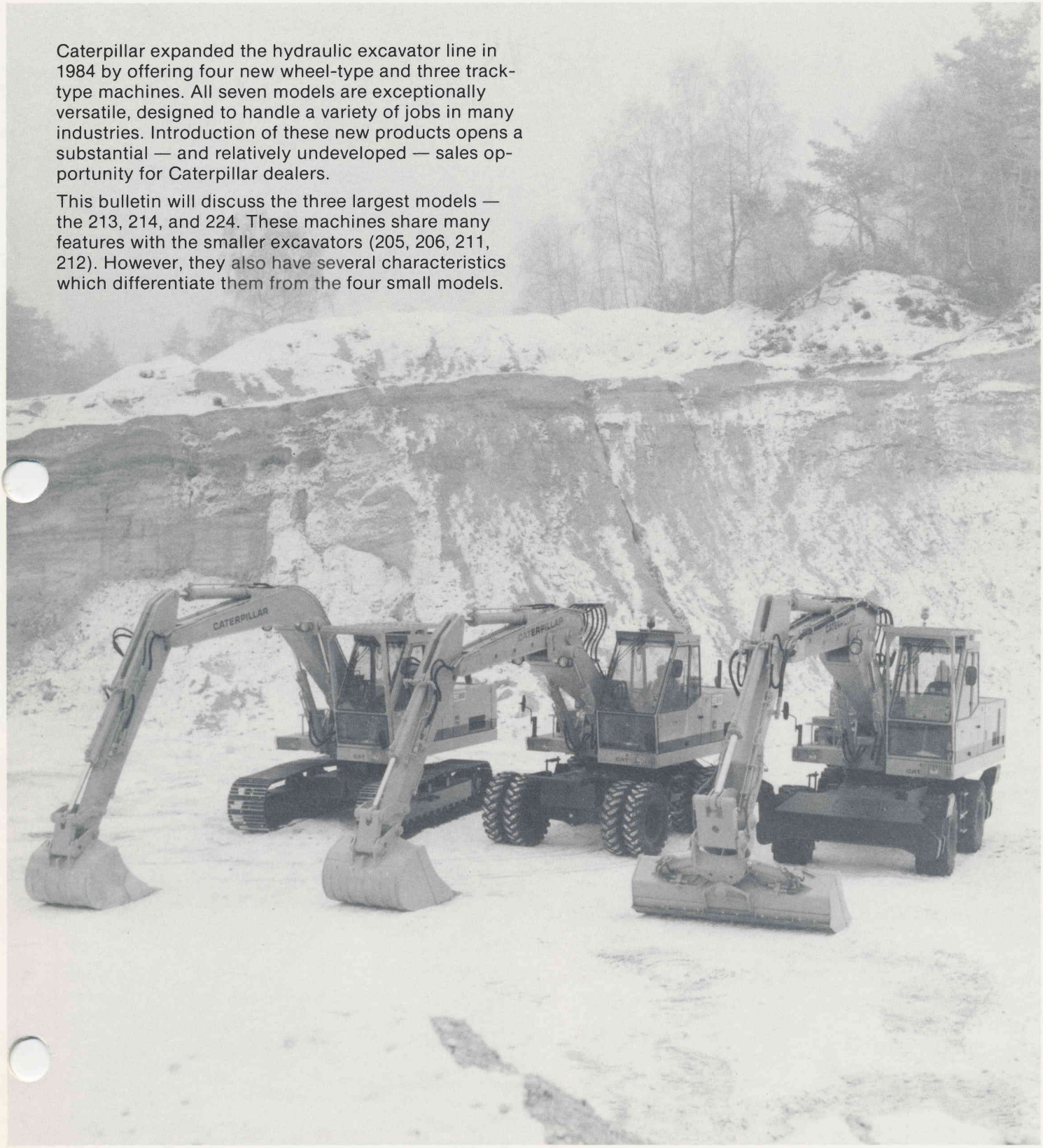
product training bulletin

213, 214 & 224
Hydraulic Excavators

Caterpillar expanded the hydraulic excavator line in 1984 by offering four new wheel-type and three track-type machines. All seven models are exceptionally versatile, designed to handle a variety of jobs in many industries. Introduction of these new products opens a substantial — and relatively undeveloped — sales opportunity for Caterpillar dealers.

This bulletin will discuss the three largest models — the 213, 214, and 224. These machines share many features with the smaller excavators (205, 206, 211, 212). However, they also have several characteristics which differentiate them from the four small models.



Sales Training Division, G.O.
Product Training Bulletin TECB8040

213, 214, 224 at a glance

	213/213LC	214	224
Operating Weight lb (kg)	35,825/38,140 (16 250/17 300)	36,600 (16 600)	44,300 (20 100)
Engine	Perkins 6.354.4P	Perkins 6.354.4P	Perkins T6.354.4
Hydraulics	Two variable displacement pumps with summated flow.		
Drive	Constant output hydraulic motor at each track.	Hydraulic variable speed drive motor. Two-speed transmission. Four-wheel drive.	
Brakes	Oil disc at track motors.	Drum-type service brakes at wheels. Air-over-hydraulic.	
Controls	Piloted	Piloted	Piloted
Steering	Fully hydraulic	Fully hydraulic	Fully hydraulic
Max. Travel Speed mph (km/h)	1.7 (2.8)	12.4 (20)	12.4 (20)

performance

engine

The new excavators are equipped with Perkins 6.354.4 engines. The "6" indicates that they are six cylinder engines, and the "354" refers to the engine displacement in cubic inches. The ".4" says this is the fourth generation design. The 213, 213LC, and 214 have 6.354.4 **P** engines. The "P" stands for premium. The 224 features a **T**6.354.4 engine. This is the turbo-charged version of the premium engine. (The "P" was dropped.)

Premium engines feature different piston assemblies and valve trains than standard engines. Premium pistons have three rings — two compression and one oil. The top ring groove is machined in a cast iron insert for better performance and durability. (Standard pistons have five rings set in grooves machined in the piston body.) The premium pistons feature less friction, superior oil control, and a closer fit inside the cylinder.

The premium engine also features a different valve train. Its rockers are bushed, rather than unbushed as in the standard engine.

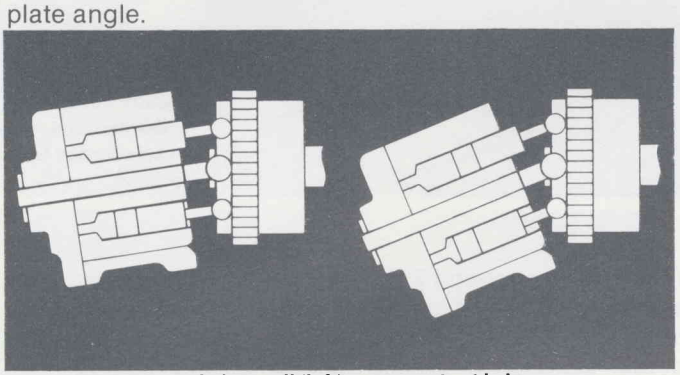
specifications

	213/213LC/214	224
Model	Perkins 6.354.4P	Perkins T6.354.4
Rating: hp (kW)	102 (76)	124 (92)
Displacement: in^3 (L)	354 (5.8)	354 (5.8)
Speed: rpm	2150	2150
Electrical system	24 volt	24 volt

The 214 is powered by the 102 hp Perkins 6.354.4 P engine.

hydraulics

The machines feature a pure-summing hydraulic system, similar to the 215 and 225. The system monitors hydraulic system pressure to regulate pump flow. Two variable flow bent axis piston pumps power the implement and travel circuits. These pumps differ from those used in the 215-245, because flow is regulated by adjusting the pump angle instead of the swash plate angle.



When the pump angle is small (left), pump output is lower. When the angle is large (right), output is higher.

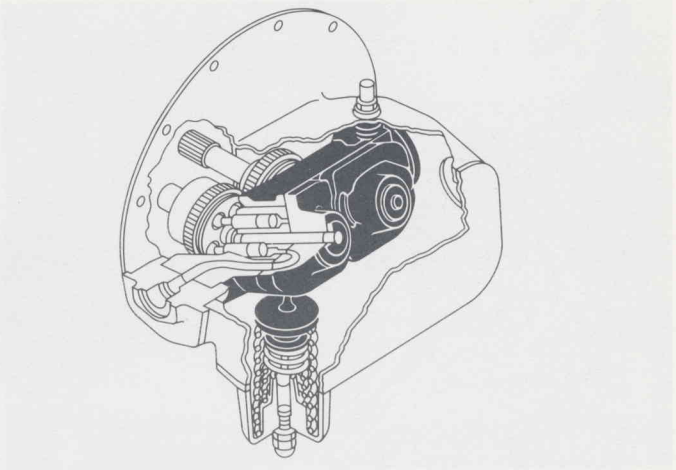
The two pumps are located in an inner casing which is contained in an outer housing. Oil is drawn from the outer case and discharged into the pressure line. Each pump has its own pressure connection, allowing two separate circuits with different pressures.

Piston stroke determines pump output. If the pump angle within the casing is large, the piston stroke is long and pump output is high. (Example: swinging back to the trench after dumping, where flow is high, pressure is low). If the pump pivot angle is small, the piston stroke is small and pump output is lower. (Example: digging tough materials where flow is low, pressure is high).

Both pumps provide identical flow rates to the system or a single circuit. Pumps turn the same rpm as the engine and are connected to it by a flexible coupling.

Other features of the hydraulic system include:

- Direct and simple routing of hydraulic lines. This minimizes energy loss through frictional oil heating. It also eliminates the need for air pressurizing the tank.
- All cylinders have rod and head end snubbers to cushion bottoming impact. This is a rare feature among machines of this size.
- The flow in boom and stick return lines can be restricted by adjusting a throttle valve. This helps an inexperienced operator improve load control.
- The machines can be equipped with a factory installed additional hydraulic circuit that can accommodate clamshell rotators, tilting buckets and other implements that require additional hydraulic functions. This circuit features quick disconnect hydraulic couplings.



- The excavators have a separate hydraulic oil cooler with a thermostatically controlled hydraulically driven fan. This design has two benefits: it draws additional air past the engine and cools the hydraulic oil for greater attachment work capacity.
- The Cat machines provide greater hydraulic horsepower than most competitors. Individual comparisons can be made using the formula:

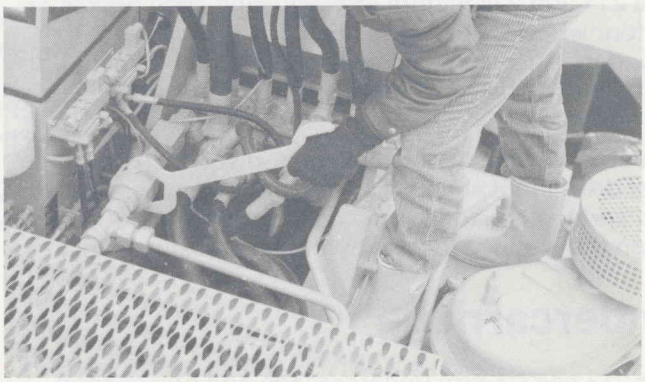
$$\frac{\text{Flow (L/min)} \times \text{relief pressure (bar)}}{598}$$

or

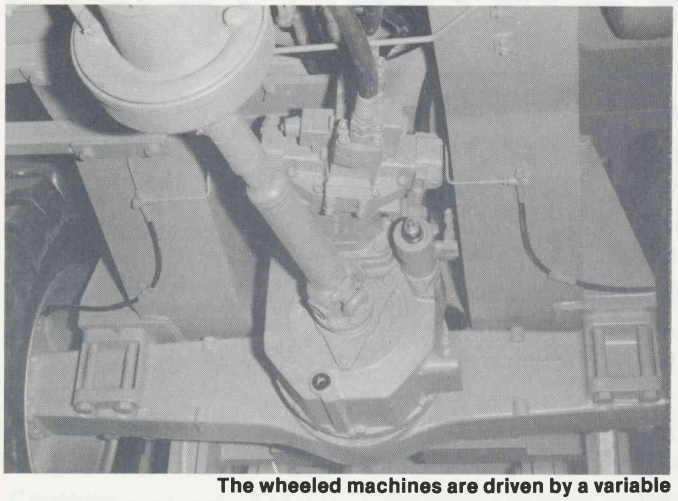
$$\frac{\text{Flow (gpm)} \times \text{relief pressure (psi)}}{1714}$$

specifications

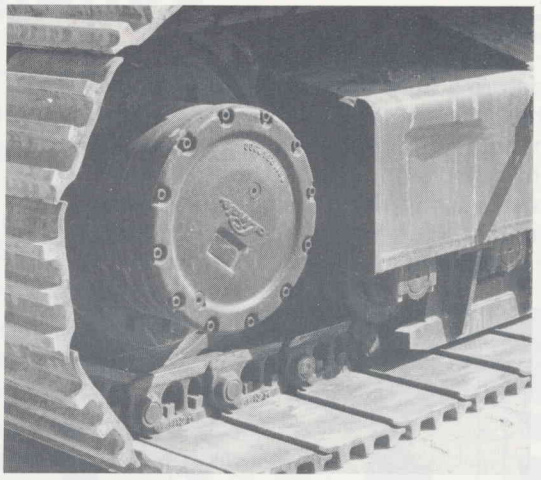
	213/213LC/214	224
Delivery: gpm	2 x 36	2 x 43
(L/min)	(2 x 135)	(2 x 162)
Primary relief valve: psi	4350	4350
(bar)	(300)	(300)
Hydraulic Power: hp	91	109
(kW)	(68)	(81)
Max. oil quantity: gal	84.5	92
(L)	(320)	(350)



The flow in boom and stick return lines can be restricted by adjusting a throttle valve.



The wheeled machines are driven by a variable displacement motor.



The track-type machines feature durable undercarriage — available in standard or long lengths.

drive

The wheeled machines are driven by one variable displacement motor which adjusts automatically to resistance to keep travel speed optimum. The motor is powered by only one pump, so power from the other pump is available for using implements to pull the machine through muddy spots.

A two-speed (work and travel speed ranges) manual transmission is mounted up on the rear axle to improve ground clearance. It is a sliding gear arrangement, activated by a piston. Shifting between work and travel speed ranges must be done when the machine is stopped. An overspeed valve in the transmission controls forward speed on long downgrades and reduces use of service brakes.

The 213 also features hydrostatic drive. Each track is driven by an axial piston motor connected to a spur/planetary final drive. An overspeed valve slows downhill speed and protects 213 drive motors against cavitation.

brakes

The 214 and 224 feature self-adjusting shoe brakes on all four wheels. The brakes can be locked during excavation. An auxiliary shoe-type parking brake mounted between drive shaft sections is spring applied and air released.

The track-type machine has multi-disc brakes on each final drive input shaft. They are hydraulically released and spring applied, so they automatically lock up when the engine stops or hydraulic pressure is lost.

undercarriage

The 213 has D4-size undercarriage and box-section roller frames. The long undercarriage is 30 inches (775 mm) longer and 7 inches (175 mm) wider than the standard. Standard length undercarriage has seven track rollers, plus one carrier roller per side. Long undercarriage has ten rollers plus two carrier rollers.

Bolted cover plates on each track roller frame provide access for adjusting the track. In addition, four track guiding guards are standard on the 213LC, two are optional on the 213.

The wheeled undercarriages on the 214 and 224 feature heavy duty axles. Dual steering cylinders mount behind the steering axles in a protected position. The tie rods are located above the axle. Most competitors mount the steering cylinders and tie rods in a more vulnerable position.

The front steering axle oscillates $\pm$ 8.5° and can be locked in any position by activating a switch in the cab. This feature adds greatly to stability when working on wheels only.

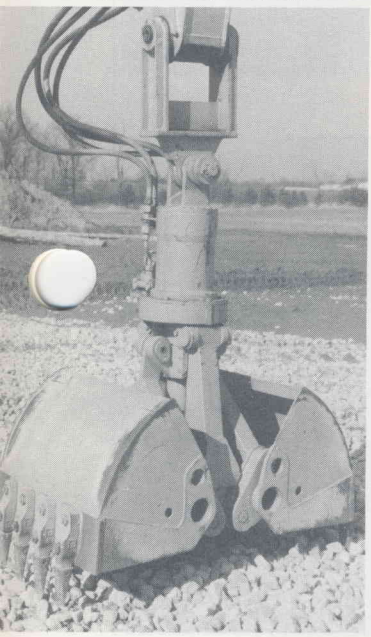
Rubber spacer rings are available for the wheeled machines' dual tires. This attachment, offered by few competitors, reduces the possibility of rocks from wedging in the dual tires.

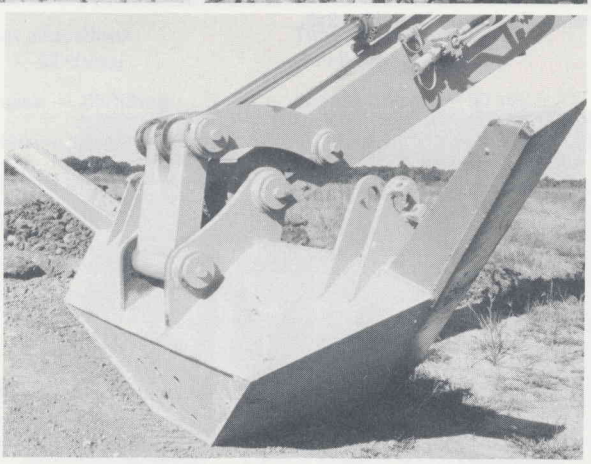
swing mechanism

The swing drive mechanism features a hydraulic vane-type motor and two-stage gear reduction to an externally toothed swing gear. The swing drive pinion is guarded, and if machines work in rough conditions, swing gear guards are available.

The machines have an open center hydraulic control for swing. In this system, rotation is slowed, but not completely stopped by bringing the control to the neutral position. Rotation is stopped by using a separate drum brake or reversing the swing.

For clamshell work, the separate drum type swing brake lets the operator brake gradually and limits the pendulum effect on the load.





versatility

One of the most significant selling points for these machines is their versatility. Many tools and attachments are available to make them useful in a variety of applications. The following attachments and options are available for the new excavators.

- One- or two-piece booms
- Three stick lengths, plus extra long stick
- Material handling stick
- Clamshells
- Clamshell extensions
- Buckets
  - general purpose
  - ejector
  - ditch cleaning (tilt option)
  - ditch grading (tilt option)
  - trapezoidal
  - rock
- Grapples
- Hydraulic hammers
  (Allied-Krupp and Tramac)
- Dozer blade (except 224)
- Front or rear mounted outriggers
  (rear standard on 224)
- Electric fuel tank pump
- Hydraulic quick disconnect couplings
  (standard with additional hydraulic circuit)
- Creeper speeds
- FOPS cab

operator features

The three machines feature well modulated, piloted hydraulic controls. All implement functions except the hydraulic hammer are included on the two joysticks. An electrical solenoid switch on top of the left joystick activates the optional additional hydraulic circuit.

On the 214 and 224, outrigger and travel controls are left of the operator's seat. The governor control is on the right. Switches at the operator's right block axle oscillation and lock service brakes on the wheeled machines during digging. A third control locks up boom cylinder hydraulics.

Steering wheel rotation is equal left or right, due to equal sized steering cylinders. This is often not true of competitive models. The vane-type steering pump is automatically controlled so steering speed remains constant in spite of engine rpm increases above 1000.

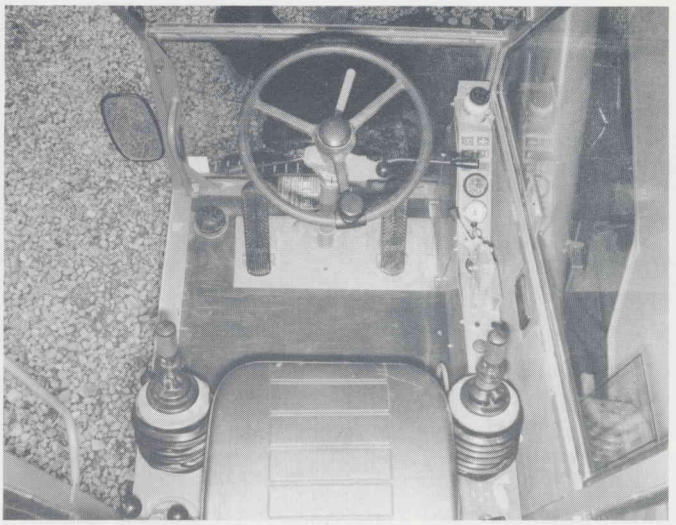
The swing brake and service brakes are controlled by pedals. The spring actuated/air released driveline parking brake can be gradually engaged or disengaged by a lever on the steering column.

The 213 has a single joystick in front of the operator that controls eight different travel commands. An electric solenoid atop the joystick sets and releases the parking brake.

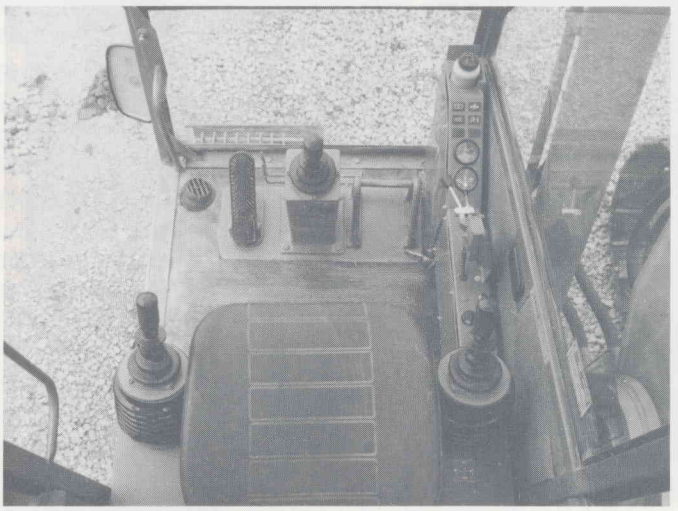
The three excavators are very quiet machines. Some of the design features that reduce noise levels include:

- six point resilient engine mounting
- location of the fuel tank behind the cab
- a specially designed air intake which muffles high frequency turbocharger/air inlet sounds
- a raised exhaust stack which permits low frequency engine sounds to dissipate at a higher level

Excellent visibility and operator comfort are two more features the excavators offer. Side visibility over the boom is good. The operator's seat adjusts up and down, forward and back. The seat back angle and springs can be adjusted to the operator's weight. Armrests are also adjustable. The sunroof hatch opens in any of four directions to improve air circulation.



Operator's compartment for 214 and 224.

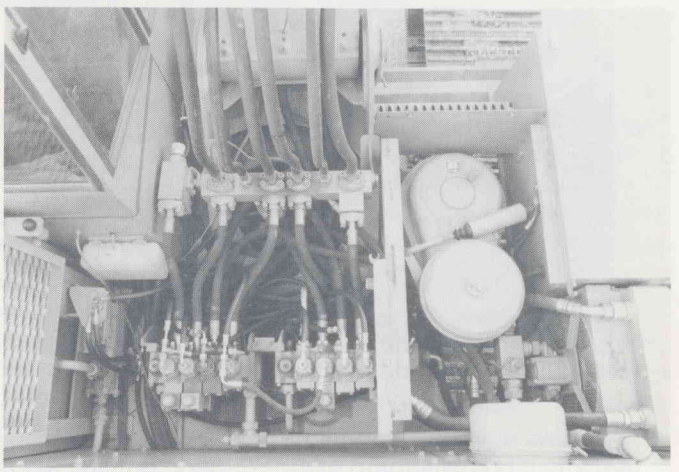


Operator's compartment for 213.

service

The machines are designed for easy service. All components are readily accessible for maintenance or removal. Bottom plates provide access to the engine for inframe overhaul. Main hydraulic and steering pumps can also be reached by removing the bottom plate. The hydraulic pumps come out as a unit.

The hydraulic/air swivel can be reached from the bottom of the machine by removing a driveline. This component is easier to service than most competitive models because the transmission is located near the rear of the machine.



All components are readily accessible for service.

Separate front and rear service brake systems are standard on the 214 and 224. The drum brakes adjust automatically so they are maintenance-free until lining replacement is necessary.

The machines feature lower maintenance costs than most of their competitors. Two thousand hour costs were calculated for the 214 and a major U.S. competitor — the Case 1085. The 214's maintenance costs were more than 10% lower than the Case model's.

2000 Hour Maintenance Costs

	214	1085
Grease fittings/machine	47	65
Grease fittings/2000 hrs	4280	4680
Oil/coolant changes	16	34
Oil gal	108.4	112.4
(L)	(410.3)	(425.5)
Coolant gal	2.5	6.8
(L)	(9.5)	(25.7)
Filters	31	46
Labor (hrs)	46.6	59.7
Costs		
Grease	$ 128.40	$ 140.40
Oil/coolant	388.15	420.60
Filters	489.34	385.25
Labor	932.00	1,194.00
Total	1,937.89	2,140.25
Percent difference	0	+10.4%
Cost/hr	.97	1.07

Cost allocations
Oil — $3.50/gal
Grease — .03/fitting
Filters — suggested retail
Ethylene glycol — $4.00/gal
Labor — $20.00

Time allocations
Oil change — 30 min.
Grease fittings — 30 sec.
Filter change — 5 min.

In addition to low maintenance costs, the machines feature a high degree of parts commonality between models. The following parts and components are interchangeable across the entire small excavator product line (205 through 224):

- All front end attachments (excluding 224)
- Swing bearings (excluding 224)
- Pilot valves
- Cab shell
- Parking brake (all wheel-type)
- Moving undercarriage (all track-type)

Many components are common to the 213, 214 and 224 only. They include:

- Main pumps
- Hose, tube sizes
- Hydraulic valves
- Swing motor/drive/brake
- Swivel (214 and 224)
- Differential (214 and 224)
- Wheel brakes (214 and 224)
- Transfer case (214 and 224)
- Tire rims (214 and 224)

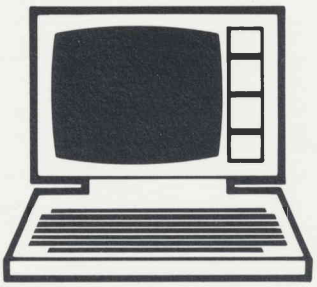
summary

The 213, 214 and 224 can be widely used in rural and urban construction, road maintenance, demolition, quarry work and other material handling applications. Some of the key features that make the excavators so versatile are:

- Compact design, short tail swing
- Maneuverability
- Gradability
- Rough terrain mobility
- Precise control of travel and implement functions
- Excellent stability and lift capacity

In addition to these features, the machines are productive, quiet and comfortable. They're easy to operate and maintain, and backed by Caterpillar's renowned parts and service support.

USCD dealers punch "ZTRN" to learn



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