



CONSTRUCTION EQUIPMENT®

September 2009
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HDD

Still at Work

Manufacturers line up new machines to meet
customer demands for new tasks **p. 40**



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CONSTRUCTION EQUIPMENT®

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GIANTS 2009

22 Relief Around the Corner, But Recovery Remains Distant

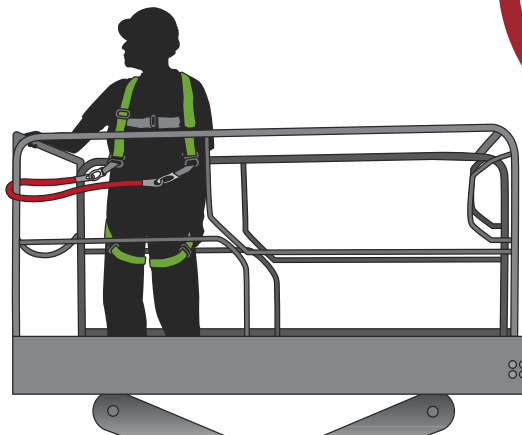
Construction Equipment
Giants, about 730 firms from many industries that own \$25 million worth of construction equipment or more, issued a dark forecast for 2009. Surveyed in May, just 17 percent of Giants expect increased work volume in 2009, and nearly half (48 percent) anticipate overall volume will fall. Executive editor Larry Stewart brings you their industry outlook and Giants listings.



SAFETY ILLUSTRATED

45 A Lanyard, a Harness and an Anchor: 3 Items That Could Save Your Life

Fall-protection gear is mandatory, with safety regulations developed by the Occupation Safety and Health Administration as well as the American National Standards Institute. Still, hundreds of workers are injured or killed in fall-related accidents each year. Associate editor Andrew Baltazar explains how to use that gear correctly.





HANDS-ON TRUCKING

38 Mack TerraPro Feels More Spacious

According to our truck editor, Tom Berg, TerraPro's cab interior offers noticeably increased room for the driver. It has 2 inches more space between the seat and the wheel and pedals, which are suspended rather than floor-mounted. This was done by redesigning the dashboard and moving the steering column forward. And the console area of the engine cover is lower by about a half a foot. The driver can readily see over the cover, and there's space on top to lay his lunch, among other things.

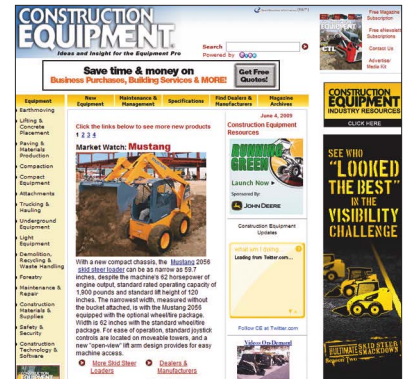
BUYING FILE

40 Conditions Notwithstanding, Need to Drill Remains

A challenging time for new-product sales is one thing; absolute industry dormancy is another, perhaps even mortally worse condition. Fortunately for manufacturers of horizontal directional drill (HDD) units, their sector is anything but the latter, says Richard Levings of Ditch Witch. Senior editor Mike Anderson reports on the current HDD market, which includes product-line upgrades in various size classes. At the top end, the industry's largest models remain rated at or just above the million-pound mark in maximum pullback.



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Highways, Not Health Care

We're sidetracked. If this country's economy were a train, we'd be banking the furnace waiting for an opportunity to start rolling again.

The health-care debate threatens to derail the job growth that an economic recovery promises. Instead of dismantling and repairing a system that works for the vast majority of citizens, our national leaders should be working on the next great stimulus program, the next jobs bill: The Surface Transportation Reauthorization Act.

We find it ironic, given the debates on health care, that the first "cost of decades of underinvestment" is fatalities and injuries due to bad roads and bridges. According to the blueprint put forth by the House's Committee on Transportation and Infrastructure, 42,500 people are killed each year and 2.5 million people are seriously injured in more than 6 million motor-vehicle crashes, which are now the leading cause of death of children and young adults ages 3 to 34.

Take a second to absorb that number, and the ages of the victims. These are our future generations, the workers for whom we're trying to create jobs. The workers who will pay the taxes to keep this country free and great.

Now consider the task ahead of us, again from the House Committee's report:

- Almost 61,000 miles (37 percent) of all lane miles on the National Highway System are in poor or fair condition;
- More than 152,000 bridges — one of every four bridges in the United States — are structurally deficient or functionally obsolete.

The current stimulus bill was supposed to help with infrastructure; the truth is it's not making a dent. "Shovel-ready" projects won't help our transportation needs because these bridge and road projects take a couple of years to execute once funded.

The Senate and House reconvene Sept. 8; the current bill expires two weeks later. Let's unite to help our representatives focus on something positive for the economy and for the nation's future: a highway bill. Ask them to tackle this and solve it now.

Read more on this issue and leave your comments at our blog at www.ConstructionEquipment.com/bigiron.



Rod Sutton, Editor in Chief

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Rod



"The Case excavator is responsive and has great digging power. It's also unbelievably quiet. The higher fuel efficiency means that, over a year, we will save a huge amount in fuel costs."

Billy Matkin, Matkin Brothers Excavation



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A summary of the month's primary machine introductions and model changes

By KATIE WEILER, Managing Editor



◀ Doosan

Doosan's 14-metric-ton DX140R excavator with reduced swing radius produces the same bucket and arm breakout forces as the conventional DX140LC, but tractive effort and tracking speed is increased about 6 percent and maximum pump flow has been pushed to 60 gpm. The counterweight extends just 7 inches beyond the track width. The six-cylinder

Doosan diesel in the DX140LC was swapped with a Cummins four cylinder to fit the DX140R's smaller compartment, but power remains the same with 96 horsepower at 1,850 rpm. Maximum dig depth is just over 18 feet.

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▼ Sakai

Powered by a 148-horsepower Tier 3 Cummins QSV4.5 engine, 12-ton-class Sakai SV610-III Series soil rollers come in three variations, all with dual amplitude. The smooth-drum roller weighs in at 27,555 pounds and is suited for rock and granular materials; the padfoot roller weighs 27,710 pounds and is designed for cohesive materials, silts and clays; and the padfoot/smooth combination weighs 32,560 pounds.

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◀ Terex Roadbuilding

The SF3500B Series concrete slipform pavers feature a 26-inch main-frame tubing for improved structural rigidity at extended pacing widths. That, combined with the ability to telescope up to 8 feet from one side of the paver, means the paver can deliver nearly zero-deflection paving, eliminating the need for diamond grinding to meet tough-ride specifications. The SF3502B is a two-track model with 14-inch-wide tracks, while the four-track SF3504B has 18-inch tracks. Maximum hydrostatic paving speed is 35 fpm.

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▶ Kawasaki

Equipped with a fuel-efficient Cummins QSM11 284-horsepower Tier 3 engine, Kawasaki's 92ZV-2 wheel loader has enough power for both digging and hill climbing. For improved reliability, the loader is built on a full box section frame with heavy center pins and support structures, and the dual Z-Linkage and new chassis design increase the loader's strength. The 58,025-pound loader has a maximum capacity of 6 cubic yards.

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Market Watch



Mustang

With a new compact chassis, the Mustang 2056 skid steer loader can be as narrow as 59.7 inches, despite the machine's 62 horsepower of engine output, standard rated operating capacity of 1,900 pounds, and standard lift height of 120 inches. The narrowest width, measured without the bucket attached, is with the Mustang 2056 equipped with the optional wheel/tire package. Width is 62 inches with the standard wheel/tire package.

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Komatsu

The 299-horsepower Komatsu WA480-6 wheel loader offers increased tractive effort for added productivity in V-cycle applications. Improved hill-climbing ability allows gears to be up-shifted faster due to improved acceleration, achieving higher gear ranges and maintaining higher ground speeds when working in load-and-carry applications. Weighing up to 56,340 pounds, the WA480-6 offers dumping clearance of 10 feet 6 inches when equipped with a 6-cubic-yard general-purpose bucket.

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Vermeer

Designed for wood-waste recycling, the HG6000E electric-powered horizontal grinder is powered by two electrical motors producing 600 horsepower. To maximize productivity, the SmartGrind feature stops and reverses material from feeding into the duplex drum when motor amperage exceeds an efficient operating range. A multifunction, wireless remote control allows the operator to control most operating functions from a maximum operating distance of 300 feet.

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The WCL version has a horsepower of up to 875 with a CAT or Cummins engine, with a 23-inch-diameter chipping capacity.

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Morbark

Now fitted with the Morbark Integrated Control System (MICS), the Model 23 Chiparvestor drum chipper automatically monitors hydraulic pressures and rpm for increased output while maximizing fuel efficiency. MICS also enables the remote monitoring via the Internet of the drum chipper's critical operating parameters and can send machine notifications and alerts.

McNeilus

In what it is describing as the first commercially available compressed natural gas (CNG) concrete mixer, McNeilus will offer a choice of Bridgmaster and standard versions on either a Kenworth W900 or T800 chassis. Meeting EPA 2010 heavy-duty engine emissions standards for nitrogen oxides and particulate matter, the CNG-powered concrete mixers will be fitted with a six-cylinder, 8.9-liter Cummins ISL G engine developed by Cummins Westport of Canada.

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Manitowoc

The 45-ton-capacity TM500E-2, replaces the TMS500E in Grove's truck crane line. The new crane is equipped with a 29- to 95-foot four-section boom, and a longer 32- to 102-foot four-section boom is optional. Maximum tip heights are 102 and 110 feet. With an optional 45-foot offsettable telescopic swing-away extension, maximum tip height increases to 154 feet. The crane's commercially sourced chassis is built to Grove specifications and is powered by a Cummins ISC 300-horsepower diesel.

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Market Watch



Komatsu

The 33,000-pound WA320PZ-6 wheel loader's Z-bar linkage features "PZ kinematics," which Komatsu credits with generating "large breakout forces for easy bucket fill, parallelism for fast pallet moving, and outstanding tilting forces for controlled work with large attachments." The hydrostatic drive system is easy to use and offers adjustable traction control. A wide-core radiator and auto reversing fan reduce cooling-system-related downtime. Automatic lubrication system simplifies maintenance.

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Imer Group

At InterMat 2009, the Imer Group displayed its new range of Ihimer rubber-tracked aerial work platforms. Three models — the LEM 1200, LEM 1500 and LEM 1800 — reach maximum heights from 40 to 60 feet, and lateral reach from 22 to 28 feet. The compact booms are available with a choice of Honda GX390 gasoline engine rated at 11 horsepower or Yanmar LN100 diesel engine rated at 9.9 horsepower.

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Morbark

Morbark has fitted its Beaver M20R drum chipper with a hydraulic folding in-feed deck with more than 2 tons of hydraulic pulling force for more efficient loading. With its new, powerful in-feed system, the unit easily handles crooked branches and bundles of smaller diameter wood. The hydraulic lift assist and constant hydraulic down pressure with 1,450 pounds of combined crushing capability provide excellent material control for improved safety, better machine feeding, and reduced saw labor.

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JLG

JLG's G10-43A telehandler for commercial and residential construction features standard outriggers, a maximum capacity of 10,000 pounds, and a capacity of 7,000 pounds at the 43-foot maximum height reach. The telehandler is ideal for picking and placing applications, says JLG. Like the existing G-Series models, the G10-43A sports a spacious, enhanced-visibility cab, as well as a high boom speed and tight turning radius.

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Bobcat

Bobcat will offer the 13,556-pound E60 rubber-tracked excavator that will compete in the 6-metric-ton class. The E60 has a dig depth of 13 feet 7 inches and, like the larger E80, features a spacious cab with a seat that adjusts nine ways and an HVAC system with true automotive-style controls. Greasing intervals for boom, arm and bucket bushings have been extended to 250 hours. The E60 has a pin coupler system as standard and comes clamp-ready.

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Volvo

Volvo's EC360CHR ultra-high-reach demolition unit with nearly 70 feet of reach joins the 106-foot EC700BHR. A 90-foot EC460CHR is to be introduced. A hydraulic, modular joint enables a 30-minute change from demolition to standard backhoe attachment. The high-reach machines come with both



demolition and digging boom and arm, with transportation cradles for each. Hydraulically tilting cabs with up to 30-degree tilt are standard.

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SUPPLIER WATCH

Pro Box Comes Stocked With Tools and Supplies

RSC Equipment Rental's Pro Box service allows customers to choose tools and consumable items and have them delivered to their jobsite in a secure storage box. The customer customized the Pro Box, selecting needed safety supplies, power and industrial tools from RSC's inventory. Intended to support industrial shutdowns, turnarounds, or scheduled maintenance projects,

Pro Box makes tools and supplies readily available under a single invoice.



Customers select the tools and safety supplies that RSC delivers in its Pro Box service.

INDUSTRY EVENTS

Rental Show Heads Back to The Big Easy

New Orleans is back in business... and attendees of The Rental Show want to join the party.

The February 2012 edition of The Rental Show, newly planned for the Ernest N. Morial Convention Center in New Orleans, will replace a previously scheduled date in Atlanta, says the American Rental Association (ARA). The annual Rental Show was last scheduled to be held in New Orleans in 2007, but Hurricane Katrina recovery efforts forced a move to Atlanta.

"The association listened to

both attendees and exhibitors, and the consensus of the ARA board of directors was that returning to New Orleans was a high priority," says Christine Wehrman, ARA chief executive officer. "ARA was able to meet this request and schedule a return to a location that has hosted The Rental Show six previous times. We're looking forward to returning to the city.

"Due to the rescheduling for 2007, The Rental Show has been to Atlanta frequently in recent years," Wehrman says.

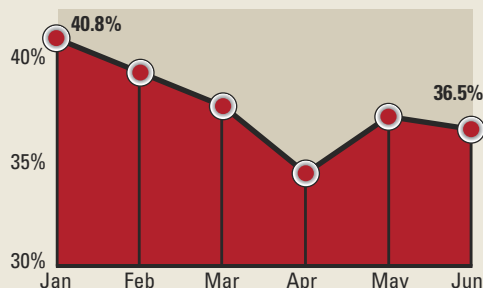


USED EQUIPMENT

Values Down

The Rouse Value Index

(Avg. orderly liquidation value as % of cost)



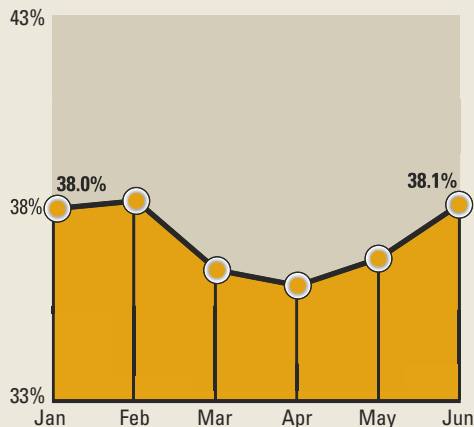
Note: Orderly liquidation value is expressed as a percentage of replacement cost (average cost paid for a new unit by large rental companies and dealers) for the average age of equipment within that category.

Includes 10 categories of equipment common to rental fleets.
Source: Rouse Asset Services

Orderly liquidation values dropped 1.8 percent in June, and values are down 11.1 percent over the past six months. Backhoe loader, skid-steer loader, and excavator values have bounced up a bit.

Excavators

(Avg. orderly liquidation value as % of cost)



Values of excavators pivoted in April, and June values are up 3.7 percent over May. The six-month trend is flat with values near the January level. Average selling age is 58 months for excavators.

MANUFACTURER NEWS

Navistar 2010 Engine Prices to Rise

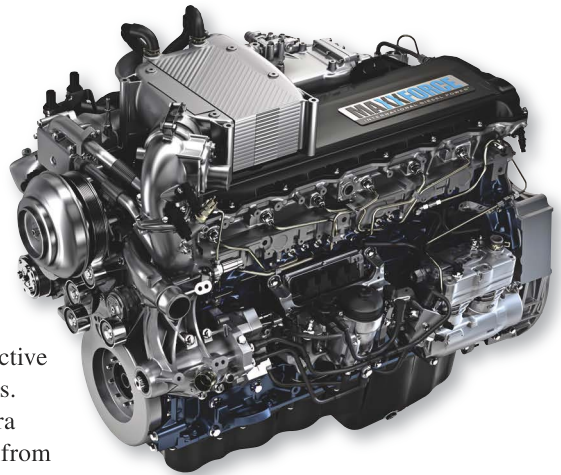
Upcharges for EPA-2010 diesels will be \$6,000 for a medium-duty truck and \$8,000 for a heavy-duty model, and final testing of the new engines is now underway, Navistar executives said during a press conference on July 28. The charges will be for engines built Jan. 1 or later, which in Navistar's case will include only Navistar-made diesels.

The extra cost will pay for development of Navistar's Advanced EGR system, which uses higher rates of exhaust-gas recirculation and in-cylinder enhancements, but not the urea injection to be used by all competitors,

says Jim Hebe, Navistar's senior vice president of sales operations. He repeated earlier claims of A-EGR's superiority, and again criticized competitors' selective catalytic reduction (SCR) systems.

Navistar engines will have extra coolers to handle the higher heat from greater amounts of exhaust gases introduced into cylinders to lower formation of nitrous oxides, says Jack Allen, president of Navistar's Truck Group. Those and an extra air cooler between two turbochargers on most engine models will syphon off heat before it gets inside engines themselves, so competitors' claims that Navistar diesels will run hot are not true, he insisted.

Larger radiators will be used on some trucks, including those with automatic transmissions and power take-offs and those rated for high gross weights. But careful attention to controlling weight means an International with an EPA-2010 diesel will weigh only about 50 pounds more than now, Allen says. Competitors have said that an SCR-equipped truck will typically weigh 350 to 400 additional pounds and require space for mounting the equipment.



Navistar trucks equipped with MaxxForce 7-, 11-, and 13-liter engines will see price hikes.

On-road testing of 2010 diesels in desert heat and at high altitudes is now underway, and millions of miles will be accumulated before the MaxxForce engines are released for production, says Ramin Younessi, vice president for product development and business strategy. Models in 2010 will include a medium-duty V-8 and inline 6s, plus "big-bore" I-6s. Navistar's MaxxForce 5 V-6 diesel will temporarily disappear from its 2010 lineup, he and Allen say.

Given current low sales volumes and stocks of pre-2010 diesels on hand, trucks with current less costly diesels will be produced several months into 2010, Navistar and others have said.

— TOM BERG

STATUS & FORECAST

CONSTRUCTION EQUIPMENT SHIPMENTS

Construction equipment shipments from U.S. factories dropped 4.5 percent in June. A further 5 percent decline is expected through next winter. Recent shipments have been far above orders. As a result, unfilled orders, including the impact of cancellations, are now about half of last fall's peak level. Shipments are expected to increase 40 percent through the end of 2011. Strong foreign economic recovery and the replacement of aging U.S. fleets will be the key drivers.

(% change from previous month)



Source: U.S. Department of Commerce

MANUFACTURER NEWS

Topcon to Acquire Some Qualcomm Contracts

Following through on a plan to exit direct sales of its construction-equipment services, Qualcomm will hand over some customer contracts for its fleet-management suite GlobalTRACS to Topcon's Tierra division, which also provides wireless fleet-management services.

According to Topcon, Qualcomm will provide managed network services through Topcon Tierra for those customers, but Topcon will handle sales, customer service and other direct support.

"Qualcomm's GlobalTRACS customers will continue to receive the service and support they expect, with Topcon Tierra committed to fulfilling the terms of the service contracts," says Ray O'Connor, Topcon Positioning Systems president and CEO. "New hardware, spares, ancillary parts and service will be provided by Topcon Tierra going forward. We have a very smooth transition planned."



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CONTRACTOR NEWS

Five Steps to In-House Biodiesel

Panama City, Fla., has been converting used cooking oil into B20 biodiesel since April. Fleet manager Rich Caprario expects to cut diesel usage by about 5 percent, recouping the \$15,000 investment within a year.

The biodiesel converter will process 150 gallons of cooking oil into 100 percent biodiesel in seven hours. Caprario mixes the bio with four parts diesel to produce 750 gallons of B20 that will run everything from heavy equipment to gen sets.

Want to set up something for your own fleet? Follow Caprario's five keys to success:

1. Do your research.

Caprario scoured the Internet and connected with the "great alliance" of people who are interested in such a brew of biodiesel. Information is "readily available," he says.

2. Have a supply of used oil.

Caprario modeled his program after a similar one in Daphne, Ala.,

and he expects to collect about 7,200 gallons of oil from his community.

3. Choose a good location.

Caprario initially wanted to process the oil inside his facility. Outside, though, is a better set up, he says. Although the unit produces fumes, they are not bad, "but you want it vented."

4. Decide where the finished product will go.

Panama City anticipates using a lot of biodiesel, so Caprario invested in a 500-gallon storage tank at the facility.

5. Filter, filter, filter.

Panama City's used cooking oil arrives at the fleet facility direct from the community. The first step: run it all through a screen strainer to "remove the big chunks."

Get more details at ConstructionEquipment.com/BigIron.

— ROD SUTTON

INDUSTRY EVENTS

Conexpo-Con/Agg 2011 Welcomes Concrete Expo

Yet another industry trade show is teaming up with Conexpo-Con/Agg. Following a successful launch this year, the International Concrete Exposition — or ICON Expo — will be held in conjunction with Conexpo-Con/Agg in March of 2011, at the Las Vegas Convention Center in Las Vegas.

Organized by the National Concrete Masonry Association as an annual gathering of exhibits, product demon-

strations, educational programs and networking, ICON Expo serves the concrete products industry, including producers, suppliers, designers, architects and specifiers.

"They represent an important industry segment," says Conexpo-Con/Agg show manager Megan Tanel, "and their participation broadens the scope of products for attendees and enriches the quality of industry interaction."



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Relief Around the Corner But Recovery Remains Distant

Stimulus that seems likely to shift construction spending positively this year could slow genuine recovery to an agonizing crawl

Recovery from today's recession appears to be shaping up much like the four recessions we've seen since 1980 in that employment is no longer expected to recover early. The difference this time around, because this is the deepest our economy has dipped since the Hoover administration, is that lagging re-employment and the inevitable cost of stimulus spending are likely to prolong the pain. It does appear that housing construction will be on the front of the recovery train, as it often is, leaving the station late this year. But heavy construction spending, despite ample stimulus opportunity,

may not be among the primary engines.

Construction Equipment Giants, about 730 firms from many industries that own \$25 million worth of construction equipment or more, issued a dark forecast for 2009. Surveyed in May, just 17 percent of Giants expect increased work volume in 2009 and nearly half (48 percent) anticipate overall volume will fall. That 17 percent is a full 21 percentage points less than the smallest portion of firms expecting work volume to increase in any of the past 10 years.

The 2009 predictions of Giant highway and heavy construction contractors — the dominant sub-group on the Giants list — reflect the Giants' pessimism overall. It seems exaggerated given last year's pleasant surprises. While only 22 percent of Giant highway-and-heavy contractors forecast work-volume increases in 2008, 42 percent measured actual work-volume increases after the year's books closed. Thirty-eight percent expected 2008 work volume to fall, but only 28 percent of Giant contractors actually recorded a slowdown.

Plunging value of heavy construction starts in the first half of 2009 explain the

Only 24 percent of Giant materials producers forecast 2008 work volume to fall, but 58 percent recorded actual volume drops. As a result, that same percentage (58) of materials Giants will buy less equipment this year.

TOP 25 Contractor Giants

Company	Fleet-Replacement Value (millions)	Giants Rank
1. Kiewit	\$3,000	4
2. Quanta Services	\$1,549	17
3. Granite Construction	\$875	31
4. Great Lakes Dredge & Dock	\$800	34
5. Hochtief Americas	\$694*	38
6. The Vecellio Group	\$508	45
7. Fluor	\$500	47
8. Elmo Greer & Sons	\$475	53
9. Las Vegas Paving	\$442	61
10. Weeks Marine	\$402	65
11. Bechtel	\$400	66
12. Skanska USA	\$400	69
13. The Walsh Group	\$400	70
14. T.J. Lambrecht Construction	\$375	75
15. Clyde Companies	\$373	77
16. Kokosing Construction	\$350	80
17. United Contractors Midwest	\$320	87
18. Clyde Hanson Industries	\$312	89
19. Layne Christensen	\$310*	90
20. Clark Construction Group	\$303*	93
21. KBR	\$302*	94
22. Price Gregory Services	\$300	96
23. Teichert	\$300	98
24. Traylor Brothers	\$300	101
25a. Wildish Construction	\$300	102
25b. Willbros Group	\$300	103

* Construction Equipment estimate

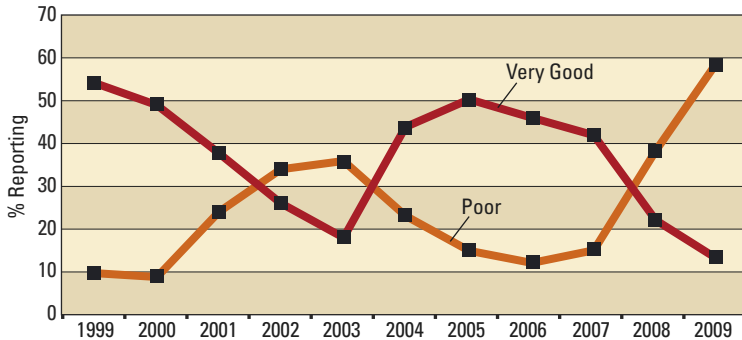
Source: Construction Equipment Giants list, 2009

See the complete Giants list at www.constructionequipment.com/community/862/Giants/23402.html

abrupt change in Giant's fortunes. According to Reed Construction Data (the construction research organization owned, along with *Construction Equipment*, by Reed Business Information), the aggregate value of all highway starts in the first six months of this year was 24 percent less than highway starts in the second half of 2008. Starts on water and sewage work through June this year were worth 43 percent less than those in the previous six months. The value of dam and marine projects begun in 2009 was down 58 percent, and various other civil works' value dropped 28 percent.

Soaring Sour Outlook

% of Giants forecasting the business year to be "very good" or "poor" overall



Source: Construction Equipment Giants Research

The percentage of Giants expecting a "very-good-to-excellent" business year is low, but remarkably close to the business outlook in 2003, at the height of the most recent recession. The severity of this recession is more obvious in the unrivaled percentage of Giants expecting "fair-to-poor" business.

Nevertheless, chief Reed Construction Data economist, Jim Haughey, expects federal stimulus spending to keep the heavy-construction recession brief and mild. The American Recovery & Reinvestment Act holds \$49 billion in transportation funding (\$28 billion for highways, \$18 billion for transit and rail and \$2 billion for airports) and \$12 billion for marine and water-related construction, \$11 billion for bolstering the electrical grid, and up to \$35 billion for federal buildings. That spending is expected to start having greater impact late this year and into next.

But the worst is not yet over. Haughey anticipates a steep decline in construction activity through this summer, with aggregate construction spending falling 11.7 percent. Like other economists, though, he predicts signs of recovery, including rising construc-

Pipelining was brisk last year, as robust developing economies drove astronomical energy costs. Those same off-shore markets are recovering quickly and their energy appetite should sustain pipe work.



tion spending, by the first of 2011.

So there's immediate urgency — keeping good people employed, equipment up to date and the lights on — with some relief only weeks away. But construction spending has lost a lot of ground since its zenith near the close of 2007. Haughey believes that steps the Obama administration is taking now that seem necessary for survival will slow recovery of that ground to an agonizing crawl perhaps beyond 2011.

“An end to the construction recession about year-end is suggested by recent market reports,” Haughey said in July. “As always, the timing of the turnabout will vary over a 12-month range by project type and region. We expect a variety of restraints stemming from the credit crisis and the response from Washington to keep the recovery subdued.”

One of the key restraints is likely to be access to credit. Credit has actually been flowing fairly readily, with interest rates depressed by low mortgage demand. Spot credit problems caused by closed or weakened regional banks notwithstanding, general access to credit appears to have only modestly impinged on spending.

Haughey warns, however, that the Obama foreclosure-prevention plans will very likely continue to be ineffective, as homeowners would rather be foreclosed than to have debt they could never really service restructured. Foreclosures tend to hold reasonably steady at about 2 or 3 percent of all home sales, and did so up through the third quarter of 2007, according to the Zillow.com Real Estate Market Reports. But foreclosures have risen steadily each quarter since then, reaching 24 percent of home sales in the first quarter of 2009. Many economists agree that the foreclosure rate will keep accelerating. Haughey expects the resulting strain on the banking system to be compounded dangerously by federal borrowing to pay for stimulus and other programs.

“How much extra the new team in Washington will borrow is still unclear,” Haughey admits. “They have pledged to boost the 2010

TOP 25 Materials Giants

Company	Fleet-Replacement Value (millions)	Giants Rank
1. Lafarge North America	\$3,584*	2
2. Martin Marietta Aggregates	\$2,861*	5
3. Lehigh Heidelberg Cement Group	\$2,850*	6
4. Vulcan Materials	\$2,397*	10
5. Oldcastle Materials	\$2,222*	11
6. Cemex North America	\$1,675*	16
7. MDU Resources	\$1,200	22
8. Holcim US	\$935*	28
9. Votorantim Group U.S.A.	\$558*	44
10. Buzzi Unicem USA	\$469*	55
11. Titan America	\$300	100
12. Haines & Kibblehouse	\$225	124
13. Rogers Group	\$190	147
14. Ready Mix USA	\$175*	158
15. Edward C. Levy	\$150	180
16. Fisher Industries	\$140*	191
17. A&A Ready Mixed Concrete	\$136	198
18. OHL USA	\$125	208
19. Syar Industries	\$122*	212
20. U.S. Concrete	\$120	222
21. Luck Stone	\$110	226
22. Fordyce	\$108	230
23. Consumers Concrete	\$100	246
24. Continental Materials	\$100	247
25. Lehman-Roberts	\$100	255

* Construction Equipment estimate

Source: Construction Equipment Giants list, 2009

See the complete Giants list at www.constructionequipment.com/community/862/Giants/23402.html

spending budget by nearly a trillion dollars. Both the pending healthcare and cap-and-trade (carbon tax) proposals may add a large share of an additional trillion dollars in the next few years. Also, most of the \$787 billion stimulus spending has yet to be borrowed. Federal housing finance agencies are on track to borrow over a trillion in the next few years to forgive mortgage payments. Financing the auto industry may cost several hundred billion, and the Federal Reserve Board will soon be desperate to withdraw the trillion dollars of added credit that it has provided on an emergency basis.

“Add it up,” Haughey challenges. “This

TOP 25 Rental Giants

Company	Fleet-Replacement Value (millions)	Giants Rank
1. The Cat Rental Store	\$6,019	1
2. Hertz Equipment Rental Corp. (HERC)	\$2,800	7
3. United Rentals	\$2,620*	8
4. Sunbelt Rentals	\$2,129*	12
5. RSC Equipment Rental	\$1,696	15
6. GE Commercial Finance	\$1,200	21
7. NES Rentals	\$1,000	27
8. Maxim Crane Works	\$840*	33
9. H & E Equipment Services	\$799	35
10. F & M Mafco	\$700	37
11. All Erection & Crane Rental	\$596*	41
12. Neff Rental	\$594	42
13. Finning International	\$576*	43
14. Ahern Rentals	\$474	54
15. Volvo Rents	\$461	58
16. Ring Power	\$456*	60
17. AmQuip Crane	\$440*	62
18. Sunstate Equipment	\$430	64
19. Milton CAT	\$400	67
20. Morrow Equipment	\$332	83
21. Aggreko North America	\$318*	88
22. Barnhart Crane & Rigging	\$220	126
23. Kirby-Smith Machinery	\$205	135
24. Battlefield Equipment Rentals	\$204	136
25. Laramie Crane & Equipment	\$141	189

* Construction Equipment estimate

Source: Construction Equipment Giants list, 2009

See the complete Giants list at www.constructionequipment.com/community/862/Giants/23402.html

is enough money to be a huge problem for the economy. As always, this scenario will play out with inflation (and rising credit cost) that permits the economic expansion to continue on the false premise that everything is fine. This could persist into 2011 yielding an abrupt end to expansion. Or we could take our medicine in small doses by boosting credit costs relative to inflation and slowing the pace of economic growth to below normal. Which path to take may well be hotly debated before the 2010 election.

“Credit constraints will worsen by year-end and stay serious for several years — expect higher credit costs ahead,” he concludes. “GDP [Gross Domestic Product] was boosted

2 to 3 percent in the spring and summer quarters, but that should ebb to negligible within a year.”

The Reed economist specifically predicts that the coincidental tightening of credit, escalating interest rates and inflation (with construction materials prices rising faster than overall inflation, courtesy of demand from faster-recovering, developing economies in Brazil, Russia, India and China) will limit GDP growth into 2011 to about 2 percent.

Perhaps the brightest aspect of the outlook is that heavy construction is expected to fall less than 2 percent before the year-end start of recovery. Building (residential and nonresidential) construction is expected to account for most of this year’s foreseen 11.7-percent drop in construction spending. It’s particularly good news for Giants because 44 percent of firms on the list are highway and heavy or other heavy civil contractors.

Construction Equipment’s Giants reacted quickly to plunging construction activity last fall and winter. Just 28 percent increased spending on new equipment in 2008, and 34 percent spent less. The worst year in the past dozen, 2003, saw 30 percent of Giant firms reduce fleet spending. On closer study, among Giant heavy contractors whose fleet-replacement values fell, the cut averaged 20 percent of the fleet value.

Half of Giants and 58 percent of the crucial materials-producer segment of the Giants list expect to buy less new equipment in 2009. Freefalling work volume for the first six months left a lot of under-used horsepower standing by for whatever work might come along before year’s end. Equipment spending will only very selectively help boost our economic recovery.

Rationalization of capacity with much-reduced demand is the essence of our economic malaise. With overall production currently so depressed, unemployment has skyrocketed.

National unemployment reached a 26-year high of 9.5 percent in mid-July, and the Fed predicts it will exceed 10 percent before year’s end. Since December 2007 (recessions officially start at the peak of the economic

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cycle, as measured by the National Bureau of Economic Research), unemployment has risen five percentage points, while the economy has contracted roughly 2.5 percent.

An historical rule of thumb once held that for each two-percentage-point drop in the

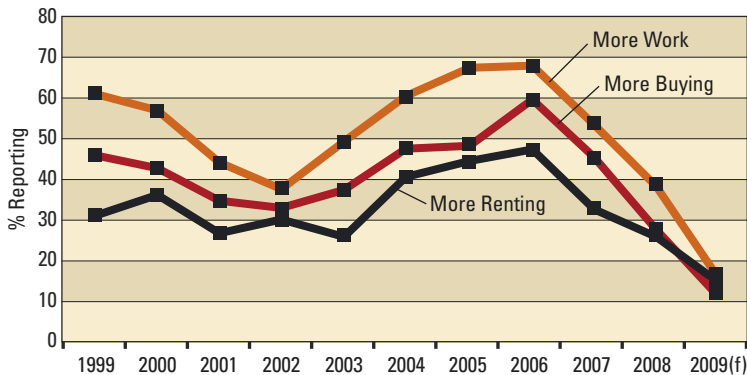
economic-growth rate, the unemployment rate rises one percentage point. In recessions since 1980, businesses have learned to quickly make much deeper payroll cuts, and they have rehired very slowly. The economy has shifted strongly toward recovery within 36 months in these past instances. But the depth of today's trough — not only in GDP but in employment — suggests that we might not expect a repeat of those dynamics.

"Final demand and production have shown tentative signs of stabilization," Ben Bernanke said in late July as part of the Federal Reserve chairman's semiannual report to Congress. "The labor market, however, has continued to weaken."

Until the employment trend reverses, it should diminish fantasies about quick returns to the mountain top inspired by encouraging monthly reports on construction spending, stock-market results or even housing starts. If consumers aren't secure in their jobs, they won't spend the kind of money necessary to help hoist the economy from the depths of its current pit. In that respect, much-diminished Giant fleets will be positioned well for the remainder of 2009, and probably well into next year.

Buying Plunges With Work

% of Giants that increased work volume, equipment buying and rental



Source: Construction Equipment Giants Research

With a free-falling percentage of Giants expecting work volume to increase, only 12 percent of Giants anticipate increased fleet buying this year — 21 percentage points below the previous nadir. Half of Giants expect fleet spending to fall. Those expecting to spend more on rental has plunged only a little less dramatically.

About CE Giants

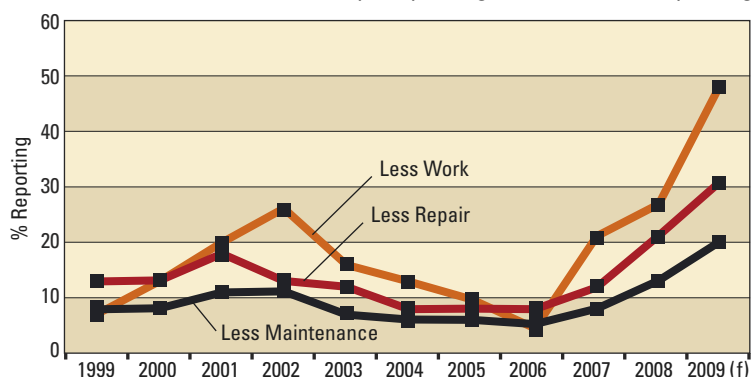
The *Construction Equipment Giants* list represents as closely as possible all firms that own fleets with replacement values of \$25 million or more. Equipment-replacement values are compiled by *Construction Equipment* magazine using information provided by the individual companies. When figures are not provided (identified with an asterisk), *Construction Equipment* estimates fleet value. If you feel your firm qualifies as a Giant, please write to Larry Stewart, Construction Equipment, at lstewart@reedbusiness.com or phone (314) 962-0639.

See the List

A list of Giants with fleet-replacement values of \$100 million or more can be found at www.constructionequipment.com/community/862/Giants/23402.html

Recession Retards Repair

% of Giants that cut work volume, repair spending and maintenance spending



Source: Construction Equipment Giants Research

The 20 percent of Giants expecting to cut equipment-maintenance spending this year is twice the size of any group reporting falling maintenance costs for the past 12 years. The portion of firms planning to spend less on repair has kept up with those experiencing falling work volume even more closely.

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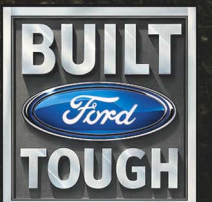
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Wait 'Til Next Year

By JIM HAUGHEY, Chief Economist, Reed Construction Data

Construction spending will continue to drift lower for the rest of the year as it has since the beginning of the year. This is the net of now rapidly declining nonresidential building construction, initial recovery in the residential market, and developing weakness in the heavy-construction market. The result is a forecast 11-percent decline in 2009 total construction spending largely due to huge residential- and nonresidential-building declines in November 2008 through January 2009. No significant impact from the stimulus plan is yet evident, but is still expected this summer along with a rise in single-family residential spending (annualized residential building permits increased from 518,000 in May to 563,000 in June).

The value of construction starts reported by Reed Construction Data fell by a third from an exaggerated peak last August to May 2009, then plunged to one-third of the August peak in June. Some pickup from the unusually low June level is expected this summer, but the pipeline of work in progress has shrunk enough to assure declining jobsite activity into the winter.

Heavy construction spending, measured in current dollars, was near last year's peak level at press time. However, the drop in materials cost for heavy construction since last year means that jobsite activity has, in fact, increased slightly. The June price index for heavy construction materials is 11.6 percent below a year ago.

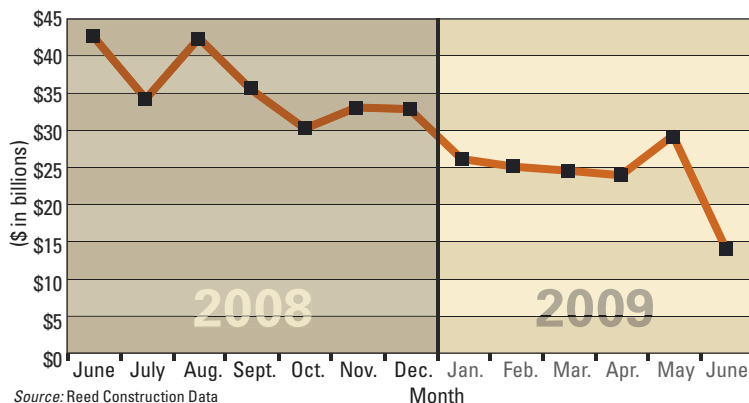
A 5- to 6-percent decline in heavy-construction spending is expected by year end, with an overall drop for the year of about 1.7 percent. It is expected to be brought about by a pullback in energy-related construction, the imminent bankruptcy of the federal Highway Trust Fund and some state funds, as well as spending cuts by many states in response to the sharpest drops in state tax collections in more than 50 years.

Highway construction spending has been slipping lower for 2 years apart from a brief surge in materials costs last summer and fall. Highway Trust Fund balances have been weakened by the recession and high fuel costs. Bonding and appropriations are now being reduced by plunging state budget balances. Stimulus funds will be spent too late to generate any increase in highway construction this year, but will boost highway activity 10 percent in 2010.

Power construction spending increased 2.1 percent in May, and has nearly tripled in the last 5 years. This surge was due to expanded electric generation, addition of alternative-energy

generating stations and a rapidly expanding domestic natural gas industry. Electric generating needs drop quickly during a recession, though; significant surplus capacity has appeared. Power-station starts deferred or cancelled have caused investment in natural-gas capacity to slow. Utility managers are re-

Value of Total Construction Starts



Monthly data is very volatile, but June's 30-percent construction-spending free fall suggests that the industry is far from any solid recovery. Residential and nonresidential building construction made up the vast majority of June's plunge, but heavy engineering did in fact fall 7.7 percent.

lucant to invest in new coal- or gas-generating plants while President Obama's carbon tax request is pending in Congress.

Water- and sewer-construction spending has remained about steady for almost 3 years apart from several wide swings in materials cost. Spending for treatment plants is higher than a year ago, but this is partially offset by a decline in water and sewer line construction as new site development has declined. Spending will resume growing modestly in late 2010 due to resumed growth in site development, both residential and commercial. But major projects will be deferred for another year until state and local government budgets recover.

Nonresidential-building construction spending has been stalled for three months at about 2 percent above the depressed winter level. But monthly spending will slip 8 to 10 percent lower over the next year. Reed Construction Data reports that the value of June starts plunged for all nonresidential categories, both public and private. Fewer projects in the pipeline will cause monthly jobsite spending to progressively decline. Healthcare and education will hold up best. Resumed growth is about a year ahead. 



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A Lanyard, a Harness and an Anchor: 3 Items That Could Save Your Life

Spending just two minutes putting on fall-protection gear could spell the difference between life and death

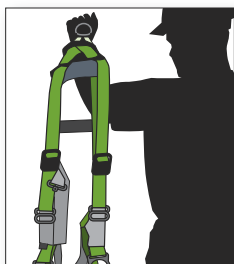
Remember those pictures of workers constructing the Empire State Building back in the early 1930s? On beams suspended a thousand feet up, they walked, they worked, and they even ate lunch, nary a look of worry on their faces. That's especially surprising considering nothing but good balance prevented them from falling to their death. Fall-protection equipment was almost unheard of in those days.

Today, however, fall-protection gear is mandatory, with safety regulations developed

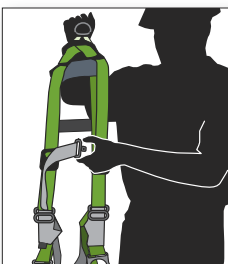
by the Occupation Safety and Health Administration as well as the American National Standards Institute. Still, hundreds of workers are injured or killed in fall-related accidents each year. According to OSHA, there were 809 fatal falls in 2006; most of them involved falls from roofs and ladders.

Although OSHA and ANSI have developed fall-protection rules for construction, workers still get hurt or die from falls for two reasons: Fall-protection gear is either used incorrectly or neglected completely.

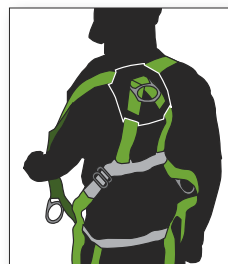
How to Properly Put on a Harness



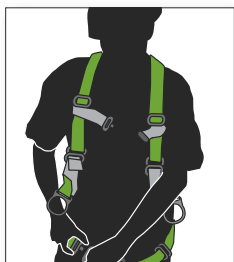
1. Hold harness by the rear D-ring.



2. Make sure chest, leg and waist straps are unbuckled.



3. Slip straps over shoulder. Position D-ring in between shoulder blades.



4. Pull leg strap between legs and connect to other end. Repeat with second leg.



5. Connect and position chest strap in mid-chest area. Tighten strap.



6. Tighten buckles so that harness is snug but allows for range of movement. Pass excess strap through loop keepers.

Instructions adapted from Miller Fall Protection

What Not to Do



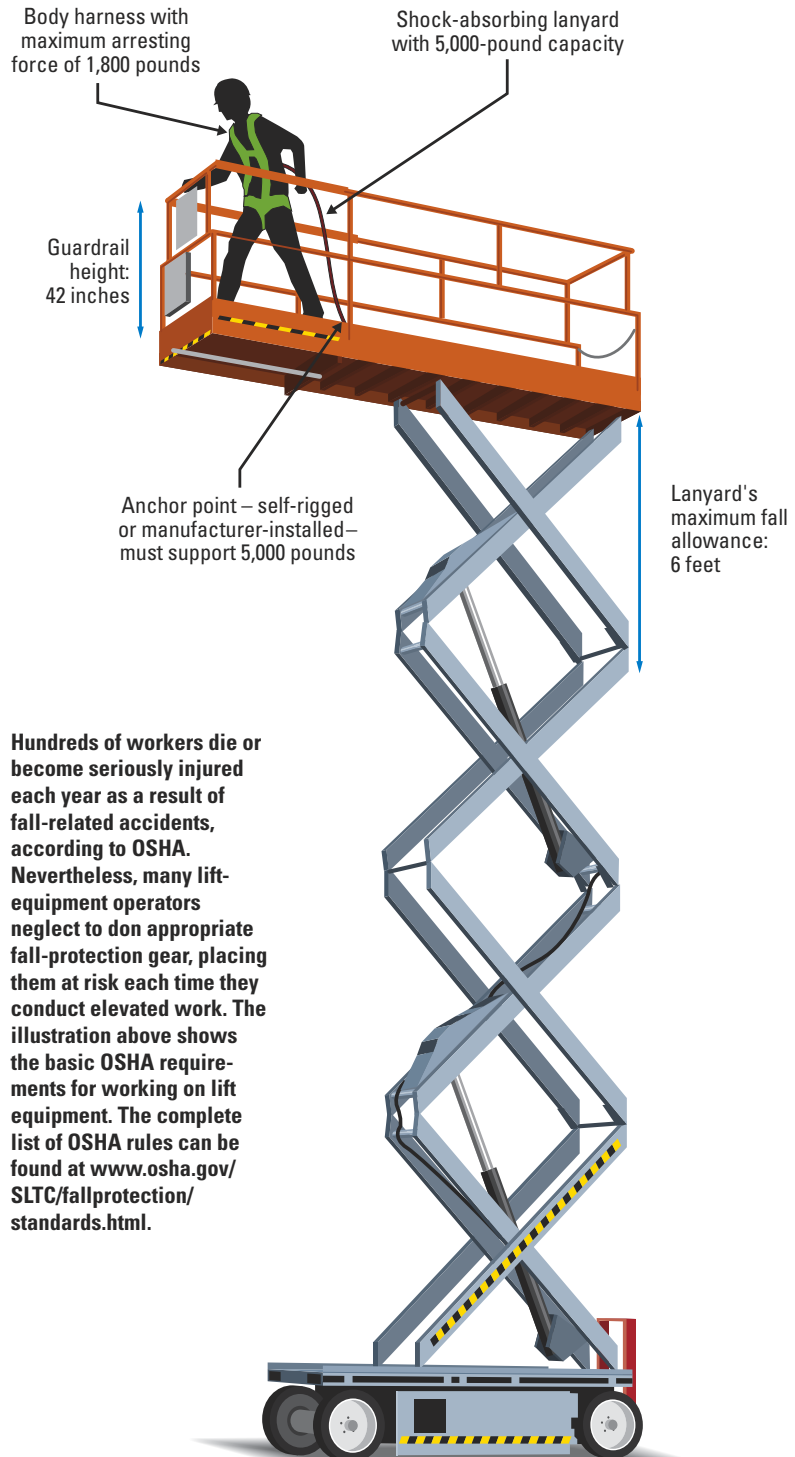
1. Do not use an aerial lift's guardrail as an anchor point for fall-arrest gear. It might be too weak. If your lift equipment lacks a dedicated anchor point, you can attach yourself to the railing with a fall-restraint lanyard.



2. In a fall-arrest system, do not use a standard lanyard or rope. Instead use a shock-absorbing lanyard to prevent serious injury or death in the event of a fall.

Illustration adapted from Canadian Industrial & Construction

OSHA Rules on Fall Arrest



Hundreds of workers die or become seriously injured each year as a result of fall-related accidents, according to OSHA. Nevertheless, many lift-equipment operators neglect to don appropriate fall-protection gear, placing them at risk each time they conduct elevated work. The illustration above shows the basic OSHA requirements for working on lift equipment. The complete list of OSHA rules can be found at www.osha.gov/SLTC/fallprotection/standards.html.

Understanding fall protection

“One of the difficulties is getting people to understand how the equipment should be used, what the correct application is, and what an incorrect application is,” says Geoff Locander, general manager of Sellstrom Manufacturing’s RTC Fall Protection, a manufac-

on putting on the equipment and using it with other equipment, such as aerial and scissor lifts. The owner’s manual also highlights inspection and troubleshooting procedures.

The fall-protection specialist

Every company that employs people who work on elevated platforms and equipment needs to have a competent person, Locander says. This employee should have taken an eight-hour or longer course on the basics of fall-protection equipment and act as the go-to person on anything related to fall-arrest gear purchased by the contractor. The fall-protection specialist also should be able to identify and remove worksite hazards and train other workers on how to correctly put on equipment.

Every contractor should make sure that a fall-protection specialist is on site if workers are doing elevated work, Locander says. “If the equipment is not being used correctly, it’s almost worse than useless. The number of people who are injured or killed in fall accidents is still very high, and in virtually every single case it’s by misuse of equipment.”

“If you’re going to fall, you’re going to sustain injuries,” says Kenneth Lemke, engineering manager with RTC Fall Protection. “We try to minimize those injuries and prevent serious injury or death.”

“If you’re on a bridge, for instance, you’re going to fall into the harness,” Lemke says. “It’s like getting into a car accident when strapped to a seatbelt.”

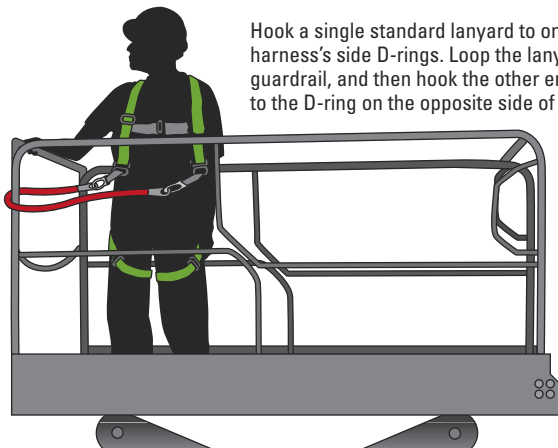
Securing yourself to lift equipment

Elevated construction work often involves lift equipment, such as aerial work platforms, boom lifts and scissor lifts. Lift equipment poses an added challenge and safety risks compared to working on building beams or ladders. For one, they can move in almost any imaginable direction.

“Unlike with other applications, with personnel-lifting equipment, you’re dealing with something that does not have a fixed anchorage,” Locander says, adding that lift equipment equipped with an overhead anchor point — the safest type — is rare. “With fixed

Fall ‘Restraint’ Keeps You in the Bucket

Hook a single standard lanyard to one of your harness’s side D-rings. Loop the lanyard around the guardrail, and then hook the other end of the lanyard to the D-ring on the opposite side of your harness.



If an anchor is unavailable, workers can use a fall-restraint system, which prevents you from going over the edge of the lift. The restraint device is very similar to a lanyard used to arrest a fall, but it does not have any shock-absorption qualities for deceleration. A fall-restraint lanyard loops around a guardrail and has two locking snap hooks on each end that attach to the D-rings on both sides of your harness, limiting you from getting to the actual edge where you can fall over.

turer of fall-protection equipment.

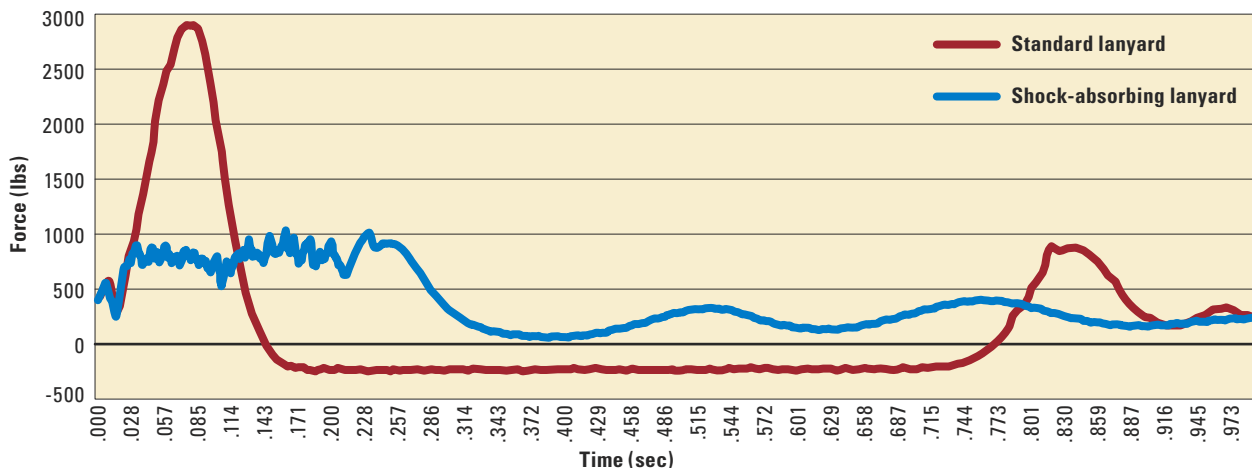
One of the first things that workers must understand is most fall-protection equipment does not prevent one from falling. Rather the equipment is designed to avoid fatalities and minimize injury in the event of a fall.

“We don’t really protect against falls,” Locander says. “The term ‘fall protection’ is kind of a misnomer. Our equipment and anyone else’s is designed to arrest falls within the guidelines of OSHA and ANSI standards.”

When workers believe that fall-protection gear stops them from falling or completely eliminates the chances of injury when they do fall, there is a good chance that those workers also use the gear incorrectly.

Locander advises workers to first read the manual that accompanies their fall-protection gear, as it provides detailed instructions

Always Use a Shock-Absorbing Lanyard for Fall Arrest



At its Illinois test facility, RTC Fall Protection dropped a dummy weighing 220 pounds in a 6-foot freefall. The dummy was strapped to a shock-absorbing lanyard for the first drop, and a standard lanyard for the second. The first drop generated a 1,000-pound impact force, which could cause minimal injury. But the second drop generated a 3,000-pound impact force, enough to inflict serious injuries or death.

Graph adapted from RTC Fall Protection fall-test data

anchorage, there are specific requirements as to how much weight the anchorage can bear.”

With mobile equipment, you not only have issues of working with no overhead means of anchoring, “but you’re also dealing with something that could fall over on its own or fall on top of you if you fall,” Lemke says.

RTC makes a product customized for aerial lifts called the Combo Kit, which combines a harness with a lanyard. In typical, non-mobile applications, the lanyard can be detached from the harness, but the Combo Kit’s lanyard is sewn on to the back of the harness so that the worker cannot take it off.

“One of the risks with aerial lifts is that the worker will take off the lanyard because of limited mobility,” Locander says. “That’s possible in other applications because you have another anchor: You can move anchor point to anchor point. But you can’t do that if you’re working in a lift.”

In a lift, the anchor point must have a rated capacity of 5,000 pounds or be designed to support twice the weight of the operator, according to OSHA. The length of the lanyard must be limited to 6 feet in order to reduce the impact force in the event of a fall.

If a manufacturer did not build an anchor point into its lift-equipment, fleets should

have an engineer fabricate a 5,000-pound-capacity, steel anchor point that attaches to the lift-equipment’s boom, Lemke says. OSHA forbids workers from tying to the guardrail.

If an anchor is unavailable, workers can use a fall-restraint system, which prevents you from going over the edge of the lift.

“If you can fall over, you wear equipment that will stop you from getting there in the first place,” Locander says.

The restraint device is very similar to a lanyard used to arrest a fall, but it does not have any shock-absorption qualities for deceleration. A fall-restraint lanyard loops around a guardrail and has two locking snap hooks on each end that attaches to the D-rings on both sides of your harness, limiting you from getting to the actual edge where you can fall over. It’s basically like a leash, Locander says.

The guardrail should be capable of withstanding at least twice the weight of a worker’s impact force.

Aerial-lift operators must be aware of the dangers of working high up. Many workers who for years have done their job untethered and without injury see no need in fall protection gear, Locander says. “It’s only when someone gets hurt that many contractors start doing something about it.” 

Mack TerraPro Feels More Spacious

Redesigned engine cover and dashboard adds room for the driver,
but this is still a Mack-tough truck



Lower engine cover makes the interior seem more spacious, and there's now sufficient leg and belly room for the driver.

Usually we open these articles with a front-corner photo of a truck because that's how we like to look at the vehicle. This time we went with a shot of the Mack TerraPro's cab interior because noticeably increased room for the driver is the main improvement over its successor, known simply as the MR low-cabover.

The TerraPro has 2 inches more space between the seat and the wheel and pedals, which are suspended rather than floor-mounted. This was done by redesigning the dashboard and moving the steering column forward. And the console area of engine cover is lower by about a half a foot. The driver can readily see over the cover, and there's space on top to lay his lunch and for a strapped-down fire extinguisher, among other things. The cover could be made smaller because the new-series MP7 diesel is more compact in height than previous engines.

The cab structure itself is no bigger, according to Steve Ginter, Mack's vocational-segment product manager. He showed me around the TerraPro during a visit to Allentown some months ago. Its letter designation is MRU, with U indicating the need to burn ultra-low-sulfur diesel fuel in the engine.

The TerraPro also got a chromed-trimmed grille and, more seriously, is multi-plex wired for modern electronic controls for its EPA-2007 diesel and all accessories. 2010 engines will also be efficiently wired in. It's a thoroughly modern truck even if it doesn't look all that different outside.

What seemed to remain traditional was the ride, but with reason. The bare chassis was set up for a concrete pumper body and without it was much too light for its stiff front and rear suspensions. The frame's main rails had no reinforcement channels, but their height was 13-3/8 inches, add-



Big windshield and side window provide excellent outward visibility. Frame is set up to mount a concrete pumper body. Grille opening has an M shape, like on most Mack models.

ing to the stiffness, which of course becomes necessary when the heavy body is installed and supported. As it was, the chassis was probably driven cross country to a dealer or body manufacturer, and its drive-away operator would've known with every bump in the pavement that this was not a fancy over-the-road tractor.

Of course, the driver's position looks and feels almost unique by truck standards. "Low-cab-forward" means what it says: The cab sits low and somewhat ahead of the engine, so the cover in the middle encloses the radiator, fan and shroud, and forward part of the engine block, which protrudes slightly from the cab's rear.

The new cover is still wide, but there's enough room for the shift lever. Higher, the cover slants inward and then flattens to accommodate a switch panel. The stuff atop the cover introduces a little hemmed-in feeling, but there's still a clear view to the right, through the passenger-door's window at what traffic's out there, and of course what's to the rear through the mirror.

Ahead and through the steering wheel is a pod with the speedometer and tachometer, which are in ready view through the wheel's rim and spokes. The headlight switch is in a small panel to the left, and a larger wing panel houses a pair of gauges and controls for the HVAC system. Instrumentation is sparse, but adequate for this kind of truck.

The shift lever mounts to a stationary pedestal on the floor; the lever stays in place when the cab is tilted, so the lever feels firm and never rubbery. The shift mechanism was new-truck-stiff, but I was able to easily find each gear position in the 9-speed transmission and had little trouble going through the few gears I needed.

With no weight aboard, the 405-horse MP7

diesel felt very peppy and propelled us briskly down the streets. The chassis' long wheelbase required some planning for square right-hand turns, but the smallish steering wheel was fun to spin. A heavy body would settle things down and give the truck an appropriately ponderous feel.

My drive was on streets in the vicinity of Mack's headquarters (soon to be moved to Greensboro, N.C.), where pavement was sometimes smooth and sometimes bowed. I couldn't help thinking that it was ironic that a concrete pumper truck would be subjected to a beating from less-than-par concrete pavement. Maybe the federal Stimulus money will find its way to Allentown and many other northern towns badly in need of street repairs.

So the TerraPro redesign improves the workplace for its driver and makes this tough Mack model more competitive. To be sure, one or two other truck builders offer bigger cabs and sometimes smoother-riding chassis, yet Mack's reputation for ruggedness and longevity makes the MR the most-seen model for this kind of service. TerraPro's improvements will help keep it on top. 

SPECIFICATIONS

Truck: Mack TerraPro MRU613-1120, heavy low-cab-forward, BBC 63 inches w/4.75 bumper extension, main-frame steel rails 3/8- x 13-3/8- x 3-1/4-in., GVWR 80,000 pounds

Engine: MP7-405 Maxidyne, 10.8 liters (659 cubic inches), 405 hp @ 1,500 to 1,900 rpm, 1,480 lbs.-ft. @ 1,100 to 1,300 rpm

Clutch: Eaton CL798 w/15.5-in. ceramic facing

Transmission: Mack T309LR 9-speed

Front axle: Mack FXL20, 20,000-lb. capacity on 20,000-lb. multileafs

Rear axles: Mack S440, 44,000-lb. tandem w/ 4.64 ratio, on Mack SS440 Camelback multileaf

Wheelbase: 235 inches

Tires & wheels: 425/65R22.5 Michelin XTE2 front, 11R22.5 XDE M/S rear, on Alcoa polished aluminum discs

Brakes: Meritor S-cam w/Haldex automatic slack adjusters and Bendix ABS

Fuel tank: 110-gal. polished aluminum, right-side mount



Exhaust stack includes a diesel particulate filter for the EPA-'07-spec engine. Air intake stack has a filter; near it are two fans for auxiliary radiator needed on higher-horse-power diesels.

Buying File: Horizontal Directional Drills

By MIKE ANDERSON, Senior Editor

Conditions Notwithstanding, Need to Drill Remains

And that's good news for manufacturers of HDD units that continue to enhance their product lines

A challenging time for new-product sales is one thing; absolute industry dormancy is another, perhaps even mortally worse condition. Fortunately for manufacturers of horizontal directional drilling (HDD) units, their sector is anything but the latter, says Richard Levings of Ditch Witch.

"The industry is actually pretty good," says Levings, a senior product manager for trenchless products, "in terms of the usage of HDD, the acceptance of HDD, and the move from other overhead-type installations. HDD, because it's minimally invasive, has opened up the opportunity for a lot of things that are normally put overhead to be put underground. For that reason, and because of just an overall acceptance and somewhat of a maturity stage of the industry, the utilization of HDD is very good.

"Unfortunately for manufacturers, the market for new HDD units is somewhat down, but the utilization is still there. It's not like, 'There's nothing going on; HDD is dead.' It's actu-

ally that the utilization is fantastic, but companies are now running their equipment longer and just getting more out of it rather than trading," says Levings.

"When the economy is really good and folks have a year's worth of backlog, they trade fairly often. Backlogs aren't typically out to a year right now; they're two to three months. And that makes a company evaluate their position and say, 'OK, let's fix this thing a little bit longer or let's ride it. Instead of a two-year trade-in time frame, we're going to go ahead and extend that to a three-year.' And we're kind of in that period. We had sold a lot of new machines the last several years, and so we're in that period of needing to wear those out, so we can cycle back into a period where they believe it is time to trade up."

In the meantime, customers have been telling manufacturers they want enhanced and new products, and accordingly product lines continue to evolve, as indicated in the gallery of manufacturers (p. 44) serving the market for

HDD units above 20,000 pounds in pull-

back. Updates to the specs chart available on our Web site were being made upon deadline at a pace uncommon to other equipment

The Navigator D1000x900 is the largest of three maxi-rig packages added to the Vermeer HDD line. Comprised of trailer-mounted drill racks, skid-mounted power units and skid-mounted operator control cabs, the maxi-rigs feature Hagglunds motors, Sauer-Danfoss pumps and Caterpillar engines.



types featured regularly in this space.

New mid-sized tracked HDDs from such brands as Ditch Witch and Astec Underground, as well as jumbo tracked and maxi-rig trailer units from the likes of Vermeer, American Augers and Barbcro push — and pull — the ability for customers to take on more and bigger jobs, says Vermeer's Jon Heinen. With the acquisition of the maxi-rig line from Horizontal Rig & Equipment (HRE) in early 2008, Vermeer offers the Navigator D500x500, D750x900 and D1000x900 units ranging from 500,000 to 1 million pounds in rated maximum pullback. The company's previous largest model was the 333,000-pound-rated jumbo tracked D330x500.

"Really what has drove us into the HRE acquisition was our customers," says Heinen, Vermeer's segment business manager for underground. "Vermeer prides itself on the 'Voice of the Customer,' listening to our customers, and the customers in that 330 market who we have good relationships with — they have come to expect the Vermeer support, and the Vermeer parts, and the local entity with the 330 — they asked us for larger machines.

"They asked us for larger machines, because the bids that they were seeing, the specs on the jobs that they were coming across, were growing, so for us the demand for a larger machine was growing. Basically, it was customer request saying, 'Hey, Vermeer, if you folks are looking to expand your product line, here's where you need to go and here's the reason why: The longer installations, the larger-diameter pipe, and the desire to do business with Vermeer on these larger installations.'

"If we're going to keep some of our existing customers, this is a natural progression for us," says Heinen. "This also opens the door to many customers we traditionally didn't do business with."

During a transition phase, the Vermeer-branded maxi-rigs were manufactured by Texas-based HRE. Now the units are entirely made by Vermeer in Pella, Iowa. The D500x500, D750x900 and D1000x900 pack-



With 100,000 pounds of pullback and 12,000 pounds-per-foot of torque, the 268-horsepower JT100 is the largest Ditch Witch horizontal directional drill, built for both long-range bores and large-diameter pipe installations. There's plenty of power, says Ditch Witch, for an optional onboard crane and anchor system.

ages are comprised of trailer-mounted drill racks, skid-mounted power units and skid-mounted operator control cabs.

A to Z

While recognizing the profound differences in the utility and maxi-rig markets for HDD, Heinen says the HRE product acquisition brings the worlds together under Vermeer.

"What it does for our product line is make us now really the only supplier in the industry to go from the smallest rigs used for telecom and fiber-to-the-home projects all the way up to the biggest rigs in the industry used on pipeline installations. We're really the only manufacturer that gives you an A-to-Z offering, from our D6x6, which is a 6,000-pound machine, up to our D1000, which is a million-pound machine," says Heinen. "One of our separating factors is that we are also the only company in the industry of the larger rigs, or maxi-rigs, that has a dealer network, that consists of nearly 200 locations."

The differentiation of the markets is reflected in dedicated Vermeer engineering, sales, management and now manufacturing staffs for the maxi-rig market, says Heinen. Natural-gas and oil-pipeline work is a core application for the products, he says, "but there's also just severe conditions that warrant this type of machine, let's say a long telecom

The Cost of Ownership

Maximum Pullback	List Price	*Hourly Rate
20,001 - 30,000 lb.	\$216,980	\$86.67
30,001 - 50,000 lb.	\$249,408	\$107.21
50,001 - 70,000 lb.	\$351,663	\$138.36
70,001 lb. and up	\$558,429	\$205.67

* Hourly rate represents the monthly ownership costs divided by 176, plus operating costs. Adjusted operating unit prices used in the calculation are diesel fuel at \$2.60 per gallon, mechanic's wage at \$46.29 per hour, and money costs at 5.75 percent.

Source: EquipmentWatch.com, phone 800/669-3282

For a complete listing of horizontal directional drill specifications, go to ConstructionEquipment.com; Magazine Archives tab, and select Buying File.

Buying File: HDDs



A brand of Astec, American Augers offers eight HDD models above 20,000 pounds in maximum thrust and pullback. The range is topped off by the DD-1100, which according to data compiled and verified by Spec-Check boasts the largest rated thrust and pullback in the industry, at 1.1 million pounds.

crossing going underneath the Mississippi River. A common theme that we're hearing is that jobs are getting larger in diameters — the pipe's getting bigger.

"It's been a thumbs-up in the market. We've had some good success, both domestically and internationally. We just bring a different perspective and a different approach to this market that it hasn't seen before. The factory-direct method, I'm not saying that's a bad method, but we have a different approach. The service commitment and the parts commitment that we have made, both at our headquarters in Pella and also in the field, is a new wrinkle. In this industry, downtime is not acceptable. You cannot have this amount of money tied up into a machine, this amount of money tied up into a product underneath the ground, and afford to be down. That's our separating factor; that's what we're exposing, that's what we're chasing. When you experience a problem, you have these nearly 200 locations around the world to go to for help."

At Ditch Witch, the HDD product offering remains focused on the utility and underground markets with compact, Mach 1 and All Terrain product families. This year, in response to mar-

ket demands, the company introduced its most powerful HDD model yet. The JT100 Mach 1, rated at 100,000 pounds of pullback, is based on the platform of the model it replaces — the 80,000-pound rated JT8020.

"Typically in that size class, they always want more," says Levings, "and some jobs were actually designed for and speci-

fied for a '100,000-pound unit.' The 8020 customers could actually do the job, but they didn't meet the spec. This gives them more flexibility. It gives them a machine in the size of an 8020, but with the power of a 100,000-pound unit.

"It is a more powerful machine; it is not a bigger machine," he emphasizes. "It does weigh a little bit more, but the physical dimensions are not bigger."

"What allowed us to go to the 100,000-pound on the same platform was the rack-and-pinion was heavy enough and the components were strong enough. We've always had the platform there to take the pullback. When we redesigned it and designed for the rack-and-pinion thrust and pullback drive, it allowed us to move on up into that 100,000-pound rating."

While extending Ditch Witch product use for existing customers, the 268-horsepower JT100 also serves contractors "doing pipelining type work and larger sewer and water projects who felt like they needed that 100,000 pounds of pullback," says Levings. "This let's us reach up into that market more effectively.

"The 100 is unique . . . for the unit size that it is. I guess the thing that makes it stick out the most is the

amount of available horsepower and power that it has, and that translates into productivity. We constantly hear from our end-users that they have used about all brands, but they have never run one quite like the JT100."

Following the industry shift from chain-and-sprocket thrust drive allowed Ditch Witch to offer a more powerful HDD on an existing platform. The JT100 has a heavy-duty, double rack-and-pinion thrust drive.

"Chains served the industry well, but we recognized that a rack-and-pinion system boosted longevity and it was quieter," says Levings.

In the Ditch Witch HDD product lines, only the smallest compact unit has a chain-and-sprocket thrust drive system. The All Terrain version of the 40,000-pound rated JT4020, which uses a two-pipe rock-drilling system, was upgraded to include a rack-and-pinion system in the past two years.

HDD markets, as reflected in product-line upgrades in various size classes, have been asking for more punch. But, at the top end, the industry's biggest models, although adding in number, remain rated at or just above the million-pound mark in maximum pullback. Recently joining the ranks is Barco with its BD-1MM TR rated at one million pounds. American Augers tops the group with the DD-1100 at 1.1 million pounds.

"I am starting to hear requests to go bigger, to push the limit," says Vermeer's Heinen. "Whatever somebody has the benchmark set at, always the question's going to be asked, 'Can I have the next one bigger?' Part of that is being driven by specs of the jobs; part of that is being driven by contractors wanting to offer the most power. Because of the customer request for longer installations and larger diameter that contribute to the requirement for bigger machine, I see it growing . . . I definitely see it growing." 



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Vermeer recently introduced its three largest HDDs. With maximum thrust and pullback of 500,000, 750,000 and 1 million pounds, respectively, Navigator D500x500, D750x900 and D1000x900 maxi-rig packages feature trailer-mounted drill



racks, skid-mounted power units and skid-mounted operator control cabs. The D330x500, with 330,000 pounds of thrust/pullback and 50,000 pounds-per-foot of rotational torque, is a self-contained tracked jumbo rig. The smaller D24x40, D36x50, D80x100 (photo) and D100x120, as well as the D20x22 rated right at 20,000 pounds of pullback, are Series II tracked HDDs.

Visit ConstructionEquipment.com/info and enter 150

DITCH WITCH

Most Powerful Unit Yet Hits Market



Ditch Witch released its most powerful HDD unit yet. The 268-hp JT100 Mach 1 is designed so that rotation, thrust and drilling fluid flow can operate simultaneously at full

power, resulting in faster job completion. With 100,000 pounds of pullback and 12,000 pounds-per-foot of torque, the JT100 is built for both long-range bores and large-diameter pipe installations. With another recent product upgrade, Ditch Witch offers the industry-standard rack-and-pinion thrust drive on the All Terrain version of the JT4020 (photo).

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BARBCO

Product Family Is Growing Up

Barbco offers six track-mounted HDDs ranging from 60,000 to 750,000 pounds in maximum pullback. The new 500,000-pound-rated BD500-TK (photo) has ground-bearing pressure of 8.5 psi.



The two tracked product families — three mid-rigs with maximum pullback from 60,000 to 120,000 pounds and the three new maxi-rigs topped off by the BD750-TK — have also been joined by the BD-1MM TR, boasting 1 million pounds of maximum thrust/pullback.

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AMERICAN AUGERS

On Track with Newest Large Model



The DD-440T offers a 440,000-pound-maximum-pullback-class solution in a track-mounted model. With rotary torque of 60,000 pounds-per-foot, it features the Wiggle Steer system

for rotating and thrusting drill pipe in a back-and-forth motion to open the bore path during steering. The DD-440T is built to international standards, boasting the smallest footprint in its class. The cabin is separate from the drill, allowing jobsite flexibility.

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ASTEC UNDERGROUND

New Model Coming Down the Pike

Astec Underground's HDD line moves above the 20,000-pound mark with the debut of the 40,000-pound-rated DD-4045, expected out in



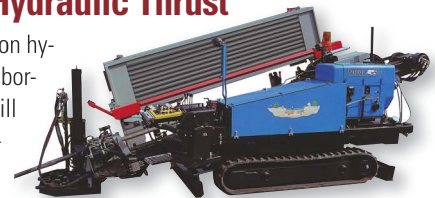
late summer or early fall. Sized between those models, the established DD-3238 (shown here), with 32,000 pounds of maximum thrust/pullback and 3,800 pounds-per-foot of maximum torque, has an enclosed onboard Triplex mud pump — with up to 47 gallons-per-minute of flow — to flush cuttings from the hole and maintain hole integrity.

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TT TECHNOLOGIES

An Alternative to Hydraulic Thrust

By incorporating a combination hydraulic/percussive steerable boring system with its Grundodrill 15X unit, TT Technologies offers an alternative to fluid-



assisted hydraulic thrust and rotational drills. Providing 33,000 pounds of pullback and thrust, the Grundodrill 15X is designed to penetrate compacted and rocky ground with an on-demand percussive hammer action variable up to 1,000 strokes per minute. Equipped with a drill-rod magazine holding 48 10-foot stems, the self-contained, track-mounted unit weighs 15,432 pounds including drill stems.

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Designed for sorting and loading demolished material, Atlas Copco's MultiGrapple features a 360-degree hydraulic rotary drive for quick and accurate positioning. The generous dimensions of the hydraulic cylinders mean short cycle times and high closing forces, the company says. Equipped with curved steel plates, the grapple improves sight lines for the carrier operator and facilitates material sorting by grade.

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MORBARK

The Morbark Predator high-torque, slow-speed shredder processes difficult materials such as construction and demolition debris, railroad ties and other mixed waste streams that are sometimes unsuitable for high speed grinding. The twin rotor unit offers high volume reduction, decreasing transportation and handling costs. According to Morbark, the Predator shredder can be used in a variety of applications with very low fuel and maintenance costs.

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VERMEER

Featuring a track undercarriage, Vermeer's HG8000TX horizontal grinder allows operators to efficiently move the machine around jobsites. Equipped with 28-inch double- or triple-grouser track pads, the tracks provide increased traction in unstable ground conditions, providing access to remote areas or transport across obstacles such as shallow creeks or ditches, soft sandy or wet soil conditions, and moderate inclines. The grinder is powered by a 1,050 horsepower Tier-2 CAT diesel engine and offers a large infeed opening with a millbox opening of 50x71.5 inches.

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WACKER NEUSON

Outputting 18 percent more power than previous models, Wacker Neuson's EH27 Low Vib electric breaker offers more power with less hand-arm vibration, thanks to the leaf-spring dampening system. The EH27 dampens vibrations in the entire upper housing — including the handles — which protect the user's body from vibrations, increasing productivity through reduced fatigue and longer working duration, the company says. Weighing in at 60 pounds, the breaker hits with 37 foot-pounds of impact energy at a rate of 1,000 blows per minute.

It also offers a third handle for maximum versatility at different angles and greater operator control.

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Trimble Connected Community Brings Web Collaboration to Construction

Web-based collaboration tools like Yahoo Groups for years have allowed Internet users to work together from different locations. Now those tools are making their way to equipment

Complementing Trimble's telematics software, Connected Community (TCC) is an online collaboration tool that allows construction contractors and clients to manage project data, keep visual tabs on project progress, and communicate with employees.

Because it is Web-based, no special software is needed to access the community. Think of TCC as a social network for workers in a construction project.

"The genesis of Trimble Connected Community was that we had to build a secure way to access project information ubiquitously, share it, and make it where mere mortals could use it," says Derrick Darby, division vice president of Trimble's Connected Site.

One of TCC's central features is its file-management system, which a fleet manager could use to organize and analyze equipment data, such as travel times, fuel costs and down time. More importantly, those data can be shared with anyone else who has access to the community.

"You can also use TCC to upload and download new design changes that go to the field," Darby says. "An operator in any location with Web access can grab the new or updated design from TCC, transfer it to a flash memory card, and then put it into a piece of equipment."

The fleet manager is just one of several members of the community. Each employee involved in a project can be a member, such as an engineer who posts a design change up to TCC. The updated design would later be reviewed on TCC by a field supervisor, for instance.

Once the review is complete, a site superintendent downloads the new design from TCC and puts it into a loader, excavator, or other equipment. All of this is done without anyone ever having to leave their office, Darby says.

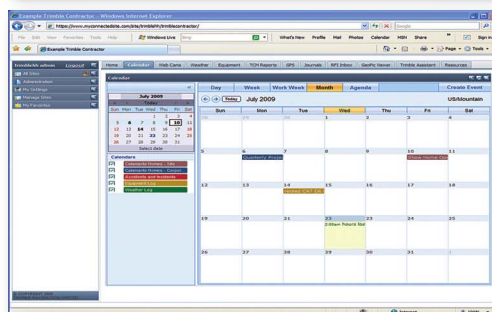
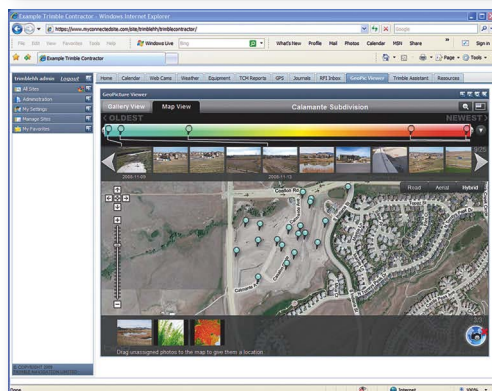
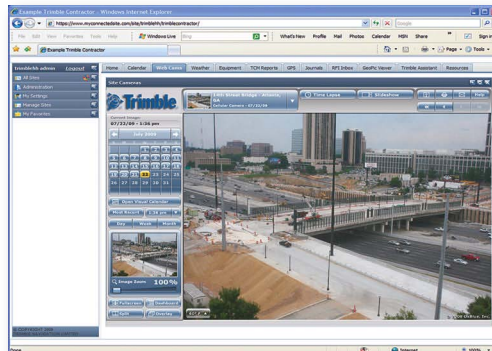
A collection of digital photos allows employees to view worksite progress. Each photo is accessed on TCC by date, showing you how your worksite looked on that particular day.

By using a GPS-enabled camera, TCC members can "geotag" each worksite picture, upload them to TCC's GeoPicture Viewer, and then virtually navigate a worksite.

TCC is full of tools commonly found in other online productivity suites. The calendar keeps track of meetings, project deadlines and equipment availability. A forum, blog and wiki facilitates exchanging of ideas, information and data.

"When you walk into a contractor's firm, you're likely to see a marker board showing where equipment is located, what projects they're working on, who the operator is, and more," Darby says. "What TCC does is use technology to recreate these marker boards electronically."

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Top: The Site Cameras feature displays photos and video of how a worksite looked on various dates.

Middle: With the GeoPicture Viewer, members navigate via map to different parts of a worksite. Selecting a location point shows pictures and other data from that location.

Bottom: TCC provides a calendar to keep members aware of project deadlines, equipment availability and more.

Market Watch Lite

By KATIE WEILER, Managing Editor

▶ **Paladin**

A new Bradco tree shear attachment for skid steers is capable of a 10-inch-diameter cut with its inch-thick cutter bar blades. The 1,122-pound Bradco tree shear measures 56.2 inches in width, 23.7 inches in height and 39.4 inches in depth. No flow divider is required for the hydraulic attachment, which features a single cylinder for reduced maintenance, a hardened steel bushing in the pivot joint, and an adjustable push bar/brush guard.

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▶ **Hotsy**

The redesigned version of the Hotsy industrial pressure washer product line's flagship, the 5700 Series features removable side panels for easy maintenance and a sleek, more compact appearance over previous models. A remote-ready Smart Relay System allows the user to have complete control over such operations as run time, auto start/stop and time-delay shutdown. Powered by a 20-horsepower Baldor electric motor, the 5700 Series delivers 7.8 gpm of flow at 3,000 psi of pressure.

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▶ **Paladin**

For use on skid steers, the Bradco PD4800 post driver does not require a separate hydraulic pump, hydraulic tank or setting of a flow control device, operating at full strength off the carrier's hydraulic system. With a maximum stroke of 48 inches, the 1,360-pound post driver attachment features manual side-shift of 12.65 inches to the left and right of center. The post driver features quick-change striker plate and collar assemblies, and can be used with the Bradco Tilt-Attach.

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▶ **Doran**

Able to keep tabs on 36 tires at once, the Doran 360HD Tire Pressure Monitoring System wirelessly alerts the operator in the cab at the first sign of a tire problem. A network of pressure sensors screwed on to the tire valve stems transmit the tire status to an easy-to-use monitor in the cab. The 360HD was designed for truck, tractor and trailer applications, and it is compatible with a traditional dual-wheel configuration or a wide-base single configuration.

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Topcon Positioning Systems

New GRS-1 from Topcon is a fully integrated, dual-constellation, network-enabled RTK rover system. Complete in a single handheld GNSS receiver and field controller, the unit includes a high-speed processor, increased memory, camera, compass, and bar-code reading device. Designed as a GPS network rover receiver, it has DGPS capability with an internal L1 antenna for GIS and navigation. External PGA-1 antenna connects to local GNSS network via internal modem.

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▶ **Rockland Mfg.**

Designed with a patented triangular design to create a tight fit with no rattles or jiggles, Rockland's Klac quick-coupler system allows its compact carriers to retain their original breakout forces. A coupler system for mini-excavators and backhoes, the "simple" Klac product has only five parts, contributing to low maintenance.

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▶ **Perkins Engines**

The latest Tier 4 Interim units, called the 1200 Series, will use the company's own NOx-reduction technology that does not require SCR and urea. A 7-liter, six-cylinder top of the range is capable of 302 horsepower, a 21-percent output increase over Perkins' current 5.5-liter engine. The 1206E-E70TTA has series turbochargers. The shorter stroke 1206E-66TA is a 6.6-liter under 175 horsepower; and the 1204E-E44 will be offered in a TA version, with single turbocharger, and a TTA twin turbo.

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◀ **Terex Roadbuilding**

With the aid of an on-board 18-horsepower gas engine, the Terex Hydra Platforms HPBW 12.5 bridge worker platform can be erected by a single person and ready for use in 5 minutes. With its 14-foot stroke, the tower unit is hydraulically adjustable, allowing the platform to be positioned for fascia work, stripping overhang brackets and bridge utility work. Measuring 12 feet 6 inches in length and 4 feet in width, the platform has a capacity of 1,500 pounds — enough to hold three workers and tools.

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▶ **Cimline**

Available with a 4-ton capacity, the towed Asphalt Optimizer pothole patcher from Cimline features an electronically ignited, self-priming, diesel-fired, 105,000-BTU burner that heats the hopper chamber without applying direct flame. This is designed to eliminate hot spots in the top-loaded material. Heat is also dispersed via a central 4-inch tube located near the top of the hopper. A 26-gallon fuel tank provides up to 72 hours of heating.

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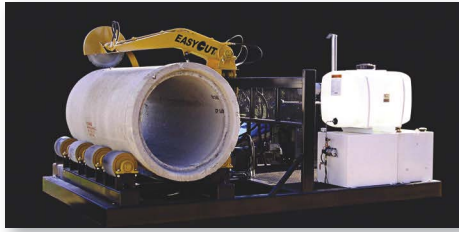


Market Watch Lite

▶ Easy Cut

Easy Cut's portable pipe-cutting system cuts up to 72-inch-diameter round pipe made of any material from reinforced concrete pipe, ductile iron pipe, CMP and more. The company says the machine can cut a 36-inch concrete pipe in a little more than 10 minutes. Benefits include one-person operation, precision cutting, single-point dust control, 1,000-watt light package option, and significantly reduced cutting time.

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▶ AGL

Described by AGL as the shortest pipe laser available, the 10.5-inch Grade-Light 2700 is sized for fitting tight inverts and small pits in such applications as pipe-jacking, tunneling and storm-



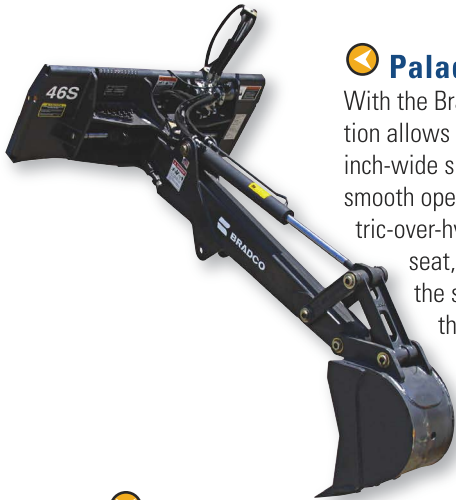
sewer construction. The GL2700 will self-level over a grade range of plus-40 to minus-10 percent. The unit's target panel is mounted at the front of the base, not the center, allowing an easier view for the operator.

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▶ Paladin

With the Bradco swing hoe attachment, 140 degrees of rotation allows the placement of spoil outside the tracks of a 72-inch-wide skid steer. The swing cylinder is cushioned for smooth operation with equal force in both directions. Electric-over-hydraulic controls, accessible from the skid steer's seat, operate both the swing and bucket functions of the swing hoe. Maximum dig depth is 76 inches, and the hoe attachment accommodates buckets ranging in width from 10 to 24 inches.

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▶ Hilti

Equipped with a 1,200-watt motor, Hilti's TE 60 Combihammer delivers high power for a variety of concrete, stone and masonry applications. Also avail-



able is the TE 60 ATC-AVR, which offers Active Torque Control and Active Vibration Reduction features. ATC shuts the motor off if the drill bit sticks and the tool body rotates too quickly; it also disengages the

drive system. AVR provides a built-in mass damper system that reduces vibration by up to two-thirds, the company says.

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▶ GOMACO

The roller-compacted concrete (RCC) telescoping screed by GOMACO boasts independent 14-inch dual augers for material spreading, and a high-compaction and dual-tamper bar system with variable speed control for more uniform compaction. Controlling grade or elevation is achieved through a variety of meth-

ods, including 3D-stringless, laser, sonic, or manual systems. For faster serviceability, the RCC screed has easily replaceable wearable components, and the screed's removable covers and front strike-off wall allow easy access to maintenance points.

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▶ Trimble

Powerful enough to run Trimble's SCS900 Site Controller Software, the Trimble Tablet for construction is a rugged portable computer that eliminates the need for multiple computing devices on the jobsite. The long battery life, solid state disk, and tough, rubberized design allow the Trimble Tablet to operate in the harshest conditions. Built-in cellular and WiFi capability enables contractors on the jobsite to share data with remote offices and keeps them updated on design changes, site problems, asset location, and more.



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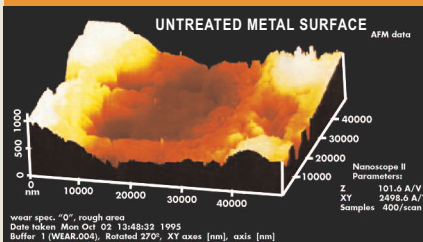


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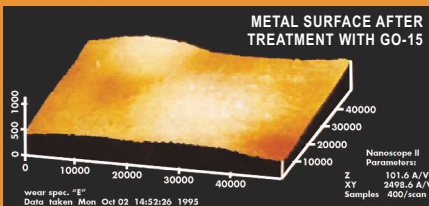
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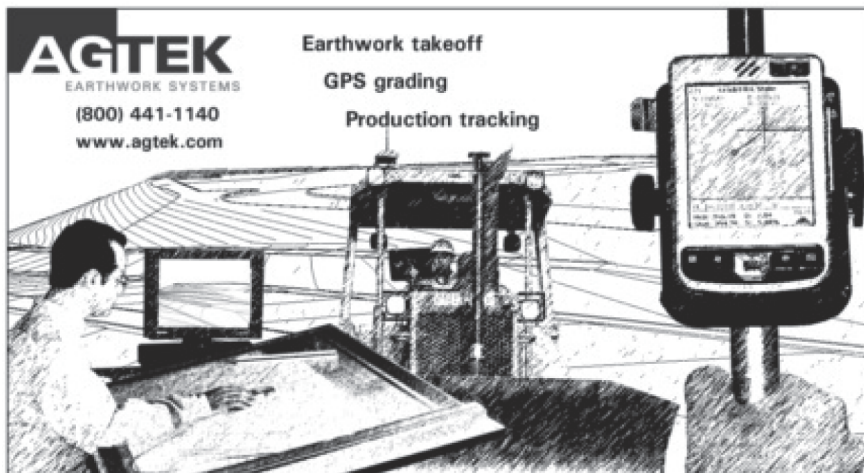


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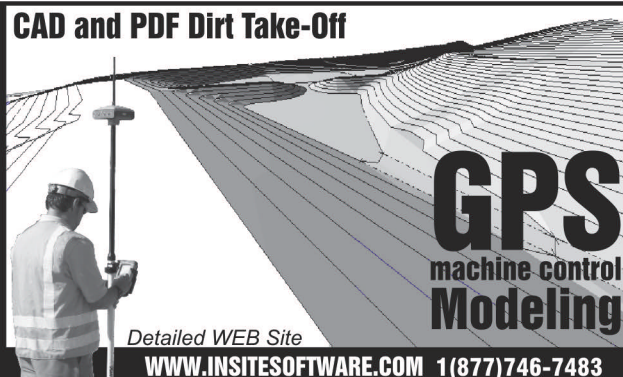


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Caterpillar	DPF	175 - 600 hp	1996-2005	240° C - 40% of the time	Off-roa rubber and tra
John Deere	Lonestar	150 - 350 hp	1996-2009	260° C - 70% of the time	Off-roa rubber
John Deere	Phoenix	≤ 12 liters	1996-2005	none	Off-roa rubber (condit verified

Which Retrofits Comply With Emissions Rules?

Construction Equipment is working to provide tools to help you get diesel emissions down to levels acceptable to the California Air Resources Board and other U.S. regulators who demand that industry clean up its aging diesel engines.

The latest is a table of CARB-verified diesel emissions control strategies (VDECS) that details the retrofits you need to satisfy the regulations.

You can sort the table by category, such as make or model, and you can easily find VDECS suitable for on-road diesels, for instance, or VDECS that regenerate passively. Visit ConstructionEquipment.com/Digest to view the VDECS table.

Latest Big Iron Blog Posts

- Larry Stewart explains why CARB-verified retrofit devices might be required outside of California.
- Rod Sutton says government should remain focused on repairing infrastructure. Tell us what you think.
- Mike Anderson finds out a little bit more about the rare, old Nelson loader.

Jump Start Operators With Virtual Training



Caterpillar, John Deere and Simlog have developed PC-based equipment simulators for operator-training purposes. Programs are designed for excavators, wheel loaders, haul trucks, motor graders, scrapers and more. Watch demonstrations from Caterpillar, John Deere and Simlog's virtual-training programs at ConstructionEquipment.com/Digest.



Trimble Creates a Community For Contractors



Trimble recently launched Connected Community (TCC), a set of Web-based collaborative tools for contractors. TCC allows contractors and their employees to share data, brainstorm ideas, upload worksite video and photos, and transfer design files from any Web-enabled computer. Trimble's Derrick Darby explains the features of TCC.

More Digital *Digest*

JCB Product Manager Discusses EasyControl Servo Control System



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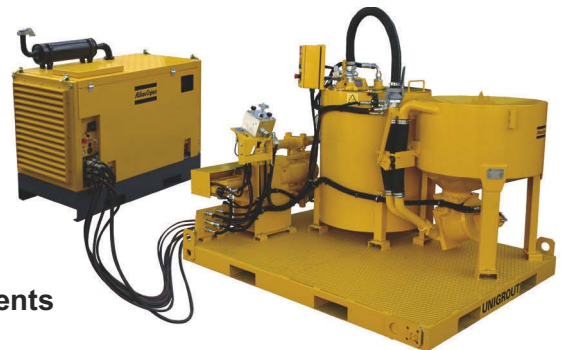
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