Tractor test: Updated test procedure explained

DLG PowerMix - dawn of a new tractor testing era

Time zips by when you're having tractor testing fun. It's now two years since we introduced the new DLG brake truck, along with its innovative technology for dynamically changing the load on a moving tractor as it delivers its pull, pto and hydraulic output. Today we start to bring that new technology into our reports by launching an additional element to our test. Tagged PowerMix, this better utilises the brake truck's full potential, and provides a more complete picture of the subject tractor's performance

The problem

Current tractor tests are, without doubt, a useful guide to a tractor's ability to carry out its daily tasks. Yet the tests have one major weakness. All measurements are taken from what amounts to a stationary machine, the tractor being hooked up to the brake truck to record pto output, lift force, hydraulic output and drawbar power. OK, so tractor drawbar power is recorded on the move but then only in isolation; that's in three different gears at about 7.5km/hr (an OECD standard). That's the big drawback: The individual tests are all carried out separately.

The reality, of course, is that a tractor rarely does one job at a time, spending its life turning wheels, spinning shafts and lifting/supplying oil to associated kit - simultaneously. Also, the drawbar power result, obtained at a single travel speed, again does not accurately reflect the capabilities of the modern tractor.

The idea

Dilemma explained, what could be done? Clearly the ideal is to come up with a test procedure that allows the simultaneous measurement of the drawbar power, pto and hydraulic output as well as overall tractor performance across a wider travel speed band. Better still, would be to build the above around test parameters that simulate real-life working applications. Which - surprise, surprise - is precisely what we've attempted to do. The newly developed test performance profiles are inputted into the DLG brake truck, and comprise varying 'percentages' of pull, pto and hydraulic demand to reflect the requirements of particular field/transport tasks. These profiles are then scaled up or down according to the size of tractor being tested, because a farmer obviously has very different requirements from an 80hp general-purpose machine as he does a 280hp arable lugger.

Also bear in mind that this PowerMix test better caters for the modern semi-p/shift and CVT tractors.

The technical solution

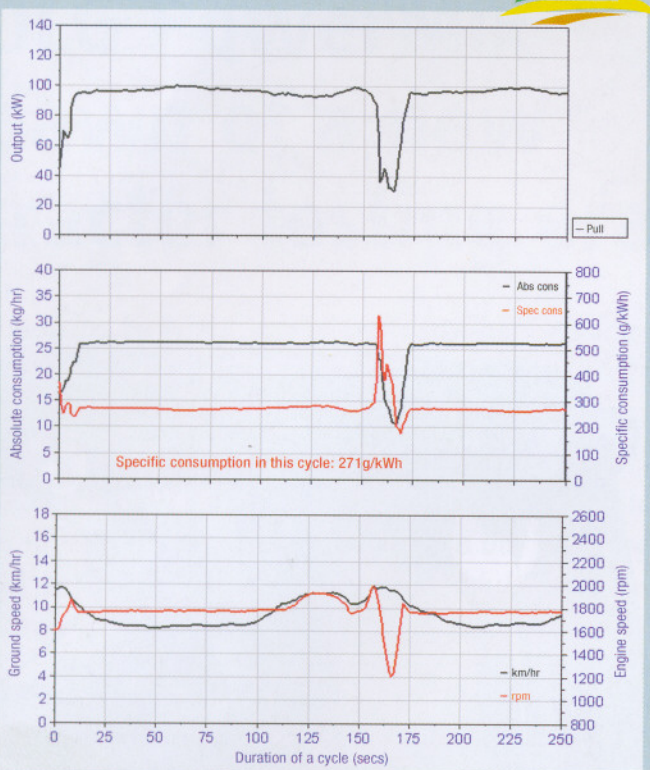
Bottom line is that we have had access to the necessary testing technology, in the form of the DLG brake truck, since 2003; it's just that there has been no protocol in place to utilise it. Hence the introduction of PowerMix and all its advantages.

As explained in profi international 03/04, the brake truck is able to place load on


FENDT
Terrano 3 FX

"Heavy pull" cycle

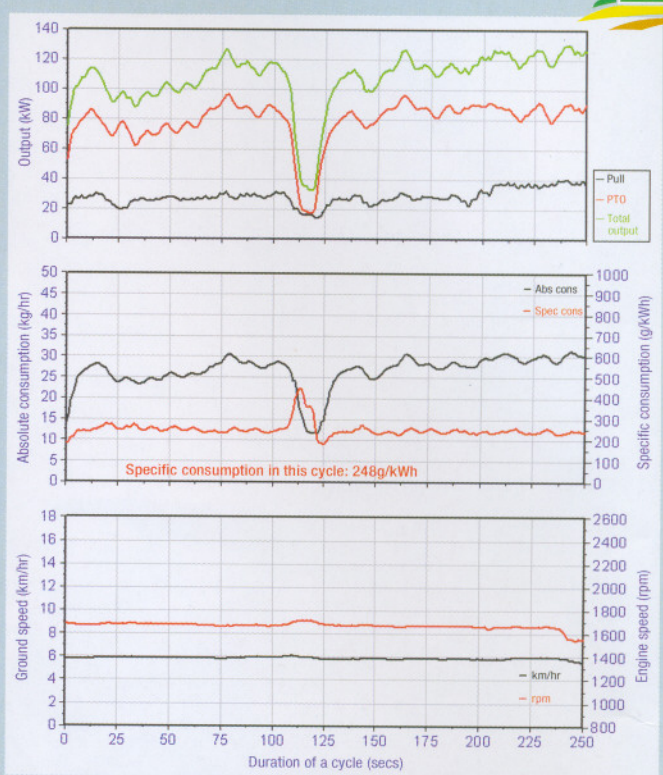
John Deere 6920 AutoPowr: Cultivator, 100% load



The black curve in the top graph shows drawbar power, with the dip indicating a headland turn. The graph in the middle displays fuel consumption. Down at the bottom, this graph records tractor ground speed (black) and engine speed (red).

"Heavy pto work" cycle

Fendt 818 Vario: Power harrow, 100% load



The top graph shows drawbar power (black), pto power (red) and overall output (green). The middle graph records absolute consumption (black) and g/kWh rate (red), whereas the lower graph reflects ground speed (black) and engine speed.

the tested tractor's hitch, pto shaft and hydraulic system – and vary this load on the move. It is then up to the tractor to decide how much forward and pto speed it can deliver. The brake truck also records fuel consumption as a key measure of the tractor's performance and ability to deal with the various tasks.

Keeping the above in mind, it is clear that setting the various load criteria was a fundamental part in the development of PowerMix – knowing exactly what stats to tap into the brake truck's software to replicate typical farm tasks. To achieve this, the DLG team put together a series of field tests. As part of these tests, the DLG engineers measure the amount of engine power that makes it through to the wheels, pto and hydraulic couplers as the tractor ploughs, spreads muck, mows and bales. All this data was then supplemented with results provided by manufacturers and colleges, and finally compiled and processed to produce those previously mentioned test performance profiles. It is these profiles that will now be used by the brake truck to control the load on future test tractors.

The Scheme

With all of the load data stored within the brake truck, the next development was to set out a scheme – to create a series of 'job descriptions' that could be applied to all test tractors likely to venture the DLG's way. After lengthy discussions between the DLG test station staff, manufacturer engineers and researchers, these various parties came up with the following break-down of tractor performance:

Draft work – heavy work (100% load) and medium work (60% load). These two categories are further sub-divided into two forward travel speeds – ploughing at 9km/hr and cultivating at 12km/hr.

Pto work – heavy work (100%), medium (70%) and light (40%). These, again, are split up into two forward travel speeds – power harrowing at 6km/hr and mowing at 16km/hr.

Mixed work – muck spreading, baling and transport. A real 'mixed' task bag.

Check out Table I (PowerMix results for John Deere 6920 AutoPowr), which shows all of the above eight profi test cycles. The exception, for now, is the transport cycle within 'Mixed work', but this will come. Current obstacle is that the DLG test track is not approved for travel speeds greater than 25km/hr, although there are plans in place to set up a longer test course in the local area, to better mirror a tractor's real-life situation.

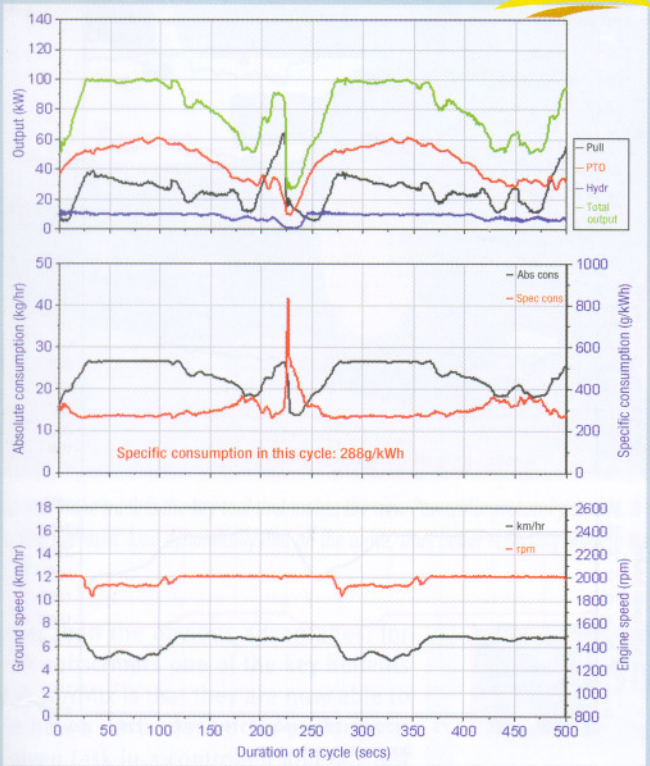
As already stated, the test cycles are all tailored to suit a particular hp class.

Measurement

The test procedure itself goes something like this. After inputting reference values for a specific tractor into the brake truck, the DLG team then runs through all of the individual job cycles, each of which lasts 250-500secs, the truck varying the load mix according to the particular cycle. It's even possible to include a specific head-land turn time, hence the dramatic dip in the load curve within the two graphs on

"Mixed work" cycle

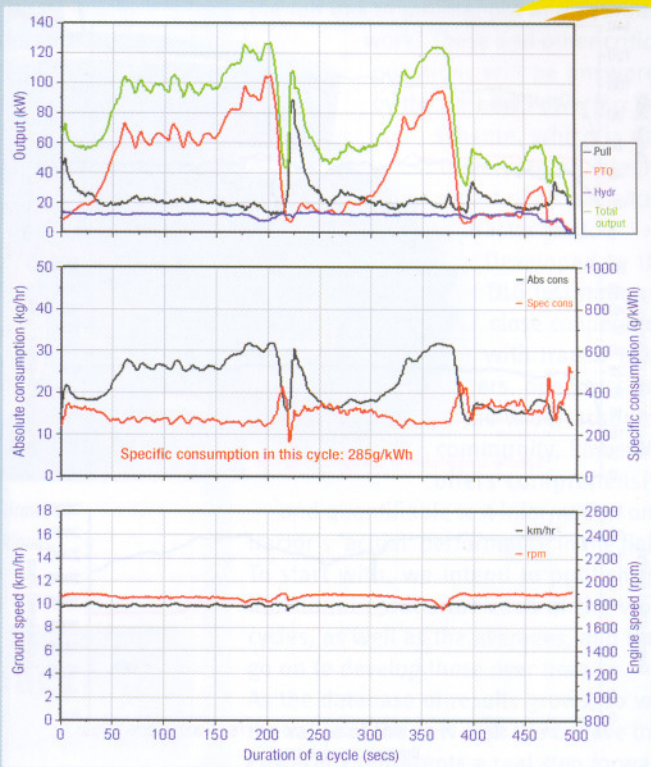
John Deere 6920 AutoPowr: Muck spreading



The top graph packs in drawbar power (black), pto output (red), hydraulic output (blue) and total output (green). The graph in the middle shows fuel consumption, while the bottom graph records tractor ground speed (black) and engine speed.

"Mixed work" cycle

Fendt 818 Vario: Baling



The top graph shows drawbar power (black), pto output (red), hydraulic output (blue) and total output (green). The graph in the middle illustrates consumption of diesel. The bottom graph sets out ground speed (black) and engine speed (red).

p12 (top left). The measurement itself is algorithm controlled.

Each of the eight cycles – seven until the new transport cycle becomes possible – is repeated three times and the resulting data, barring any anomalies, then averaged into a single figure. This represents the result for the cycle, and indicates the specific fuel consumption for the tractor in that particular application. Critically, it is now possible to compare this result with those of other tractors, because the returns will have been produced from absolutely identical profiles and test cycles – DLG brake truck loadings – for tractors in this power bracket. The lower the test fuel consumption recorded, the better the overall assessment.

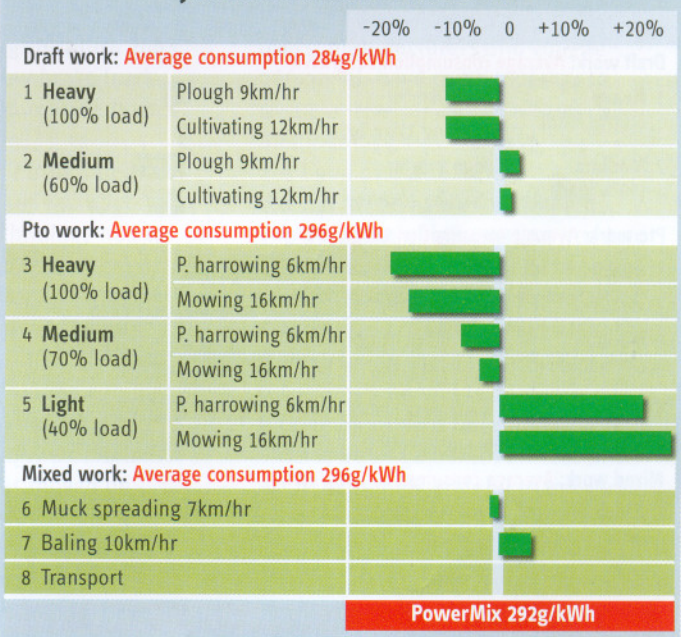
The results

Initial PowerMix tests were carried out on a John Deere 6920 AutoPowr and Fendt Vario 818, to show how the system will work in the future. These are illustrative results and, at this stage, should not be used to compare the two tractors.

What we can go on to discuss, though, are the principles. For example, take a moment to look at Table I, which shows a PowerMix profile for the John Deere 6920 AutoPowr.

Immediately it can be seen that the JD tractor is more fuel efficient in heavier draft applications than when used on pto or mixed work. The green bars over to the right indicate deviation from the average, and these again suggest that the JD 6920 is at its most efficient when labouring hard. See

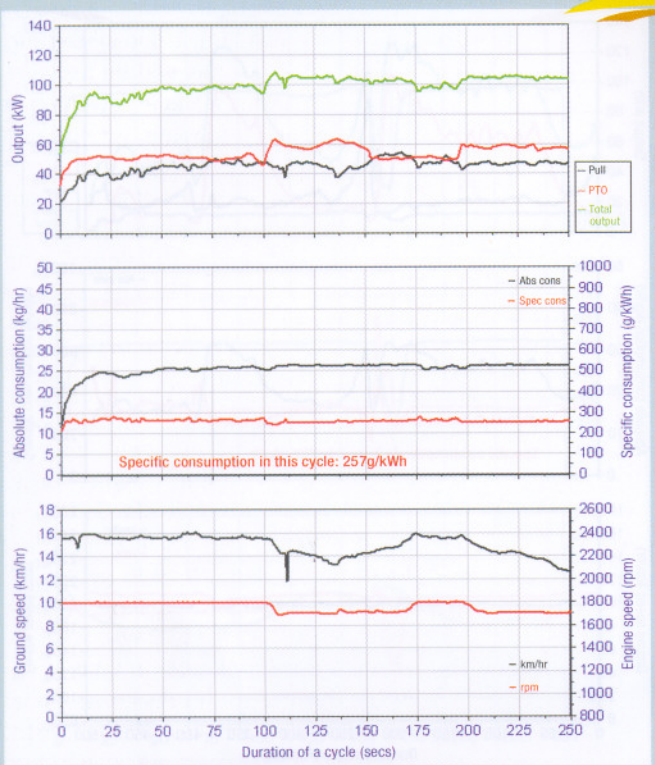
Graph I: PowerMix results for John Deere 6920 AutoPowr



The PowerMix result is shown at the bottom to the right, and is averaged from the seven individual cycles. Number of test runs is 36. The average data (in red) within the table indicate in which application/task the tractor's fuel consumption is more or less economical. Degree of deviation, plus and minus, from the tractor's average result is depicted by the length/direction of the green bars on the right of the chart.

"Heavy pto work" cycle

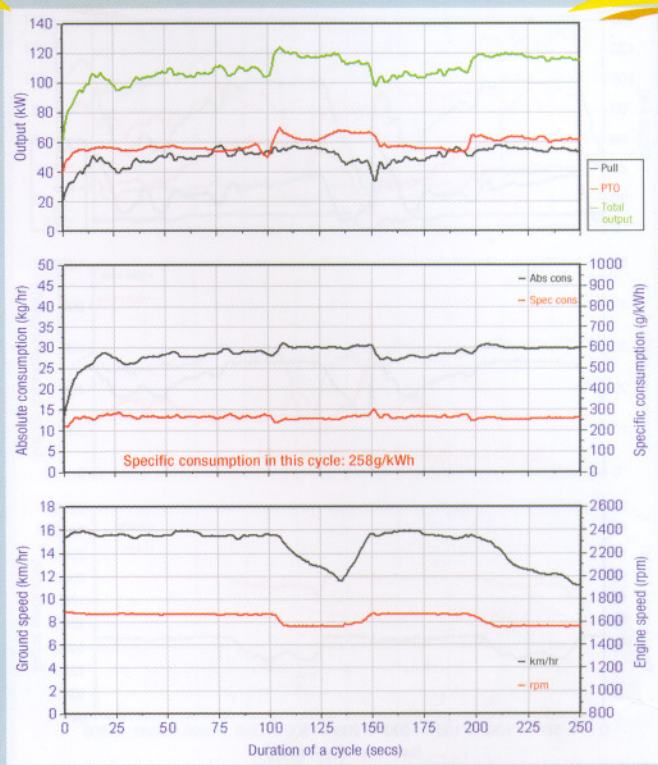
John Deere 6920 AutoPowr: Mowing, 100% load



The top graph shows drawbar power, pto power and overall output. The middle graph records absolute fuel consumption (black) and g/kWh rate (red), whereas the graph down at the bottom reflects ground speed (black) and engine speed.

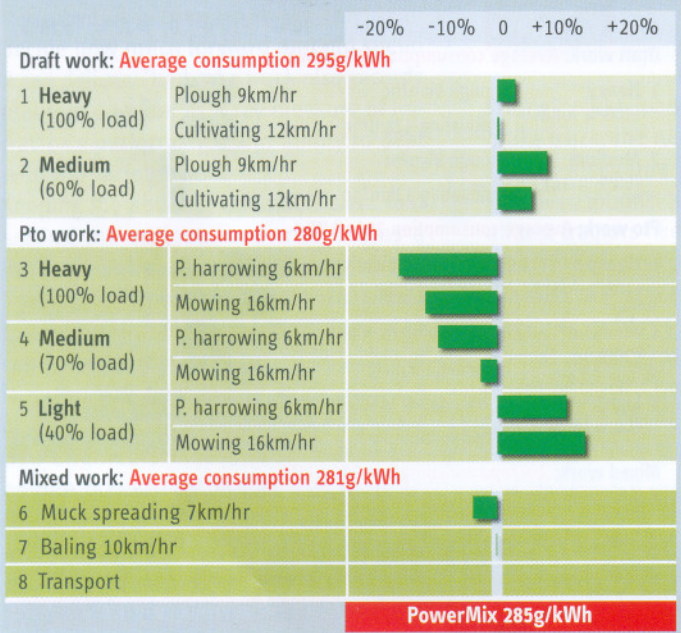
"Heavy pto work" cycle

Fendt 818 Vario: Mowing, 100% load



The top graph shows drawbar power, pto power and overall output. The middle graph records absolute fuel consumption (black) and g/kWh rate (red), whereas the graph down at the bottom reflects ground speed (black) and engine speed.

Graph II: PowerMix results for Fendt 818 Vario



The PowerMix result is shown at the bottom to the right, and is averaged from the seven individual cycles. Number of test runs is 36. The average data (in red) within the table indicate in which application/task the tractor's fuel consumption is more or less economical. Degree of deviation, plus and minus, from the tractor's average result is depicted by the length/direction of the green bars on the right of the chart.

how the JD tractor's diesel guzzle climbs on lighter pto work, the bar almost disappearing right off the end of the scale. For a very different set of results, turn to the Fendt Vario 818 (Table II). Again the PowerMix return, in terms of diesel consumption (g/kWh), appears as green bars to the right or left of the PowerMix mean for each of the seven cycles.

Depending on length and direction, each bar shows in which area the guzzle rates lower or higher than the average. Mean result is in red, and it is this that gives a clear indication of where the Fendt is more or less economical. Unlike the John Deere data, the suggestion here is that the 818 is happier when on pto and mixed work than when employed on a heavier application lug.

Irrespective of the tractor under scrutiny, the interesting element is that the curves reflect the machine's ability to react to a changing load. Although on a powershift tractor, for example, the most appropriate gear for the particular work/job cycle is selected at the start, the test is still able to illustrate how the complete driveline responds through the cycle – exactly how quickly it is able to return to the target setting as the load increases/decreases. Selecting a gear is clearly not an issue on a modern CVT stepless tractor.

The only other main factor that can have an effect is the type and condition of the tractor tyres. As for the test unit operator, the influence here is negligible. He literally just steers the tractor during the work cycle and doesn't alter any of the other controls. It is down to the tractor alone to react to the changing test truck-controlled conditions. There are no other factors.

The DLG brake truck is the key tool that makes the new PowerMix protocol possible. It changes drawbar, pto and hydraulic load dynamically and on the move, thus better reflecting modern tractor workloads.

Other than the obvious advantages, for profi subscribers one of the key benefits of PowerMix is that they are now able to see how a particular tractor performs at a given task in a controlled and fair test environment. This has not been possible in the past, because we have had to rely on procedures such as the stationary pto test. But now we have gone 'dynamic'. Everything is done on the move – and with a changing load. The prospective buyer is, in effect, able to look at the test results with the tractor's end use in mind. If, for example, he is after a prime arable mover, he can now focus on the 'heavy pull' cycle – and so on.

The future

There is no doubt that the DLG PowerMix represents the future for profi's tractor tests. Over the coming months we still have a number of old-style tests to run but, from now, any tractors going to the DLG will be subjected to the PowerMix protocol, and that's irrespective of whether the tractor is powered by a 60hp or 350hp motor. As soon as the test software is completed, the eighth transport cycle will be in there, too.

Is it all change, then? Absolutely not. We will continue to perform many of the existing profi tests, procedures that provide such vital data on maximum lift power and hydraulic output. The pto power is a fundamental part of PowerMix anyway.

Summary

How much fuel does a tractor get through when pulling heavy and medium-sized kit? Where does this guzzle go when on heavy and light pto work? And what happens when the tractor has to respond to the full mix of pulling, pto and hydraulic work? These and other critical questions will be answered by the all-new PowerMix test scheme, which is due to become an integral part of all our future tractor tests.

Developed by the DLG test station in close cooperation with tractor makers, operators and the wider academic community, PowerMix offers comprehensive and quantifiable test information on a tractor's 'actual' performance in the field. To start with, we intend to publish the individual results for each of the work cycles, as well as the averages, and then go on to develop these over time.

As the database of results grows, so will the value of the new test. We believe that PowerMix represents a real step forward in the business of tractor testing.

MN

DLG comment:

The long and winding road to PowerMix

Two years ago, at Agritechnica 2003, we introduced our new brake truck to the agricultural community. It was an important occasion.

As soon as we put the truck into operation, we could see the huge potential that this technology had to offer; it was something we needed. In the past we have always sought to meet the requirements of farmers, replicating conditions in the field as much as possible within the confines of a scientific environment, but this has become increasingly difficult. Tractor technology has moved on and undergone enormous changes, whereas testing methods, in many cases, have struggled to keep up. Modern electronics, however, have allowed us to play catch-up. It is these, and computer software, that have enabled us to bring testing methods up to date. We at the DLG, along with a representative group of users, manufacturers and college personnel, have come together to create a new concept in testing methodology. And the response has been overwhelming.

We still have work to do, though. The database of information needs to be built upon across a wide range of applications, because the more data that is included, the better tailored is the loading input from the brake truck. The potential is immense.

A huge amount of information has already been gathered, and for this we're extremely grateful to the various tractor manufacturers – John Deere and Fendt, in particular – along with all other parties that have contributed. These are exciting times. We hope that over the coming months profi readers are able to derive maximum benefit from this new generation of in-depth tractor testing data.

DLG test station