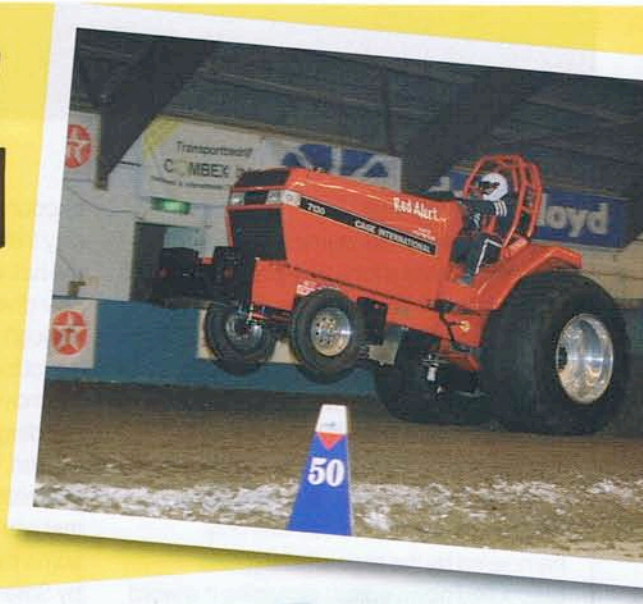
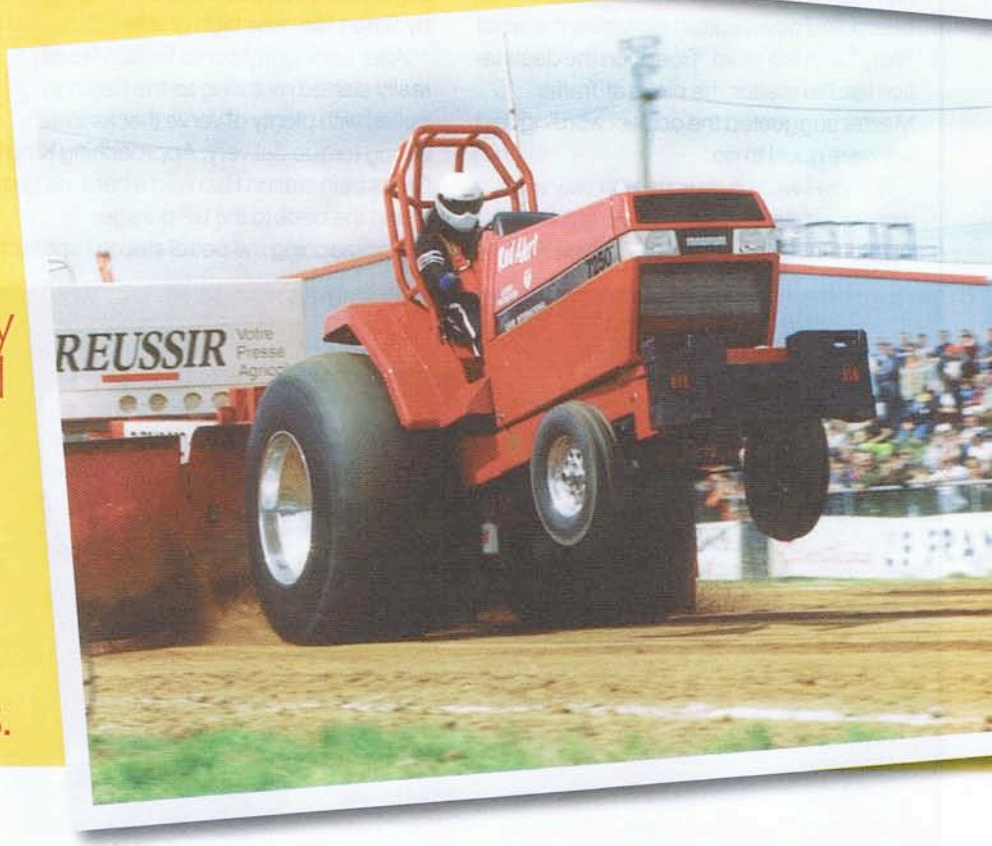
PULLING POWER



Few grudge matches are as fearsome as those in tractor pulling – where multi-engined tractors packing up to 10,000hp battle for supremacy. But for dairy farmer Peter Clarke and his team, a 3,500hp, 10-litre engine is more than enough to secure any number of podium finishes. Team-mate **Geoff Ashcroft** reports.



For Buckinghamshire dairy farmer Peter Clarke, the tractor-pulling bug took hold almost 30 years ago when the US-based sport surfaced in the UK.

Things were relatively straightforward back then; the farm's Fordson Major was turbocharged and its fuel pump tweaked to give a useful hike in power for competition, while keeping the vehicle reliable for farm work.

But as with any sport, tractor pulling has progressed and the standard has increased considerably. Moving that weight-transfer sled as far as possible along a 100m track requires an esoteric mix of speed, power and traction – it is crucial to get moving as quickly as possible, then keep the sled in motion to help counter the increase in load as the sled alters from being a rolling weight to a dead weight load in excess of 100 tonnes (see panel).

Force to be reckoned with

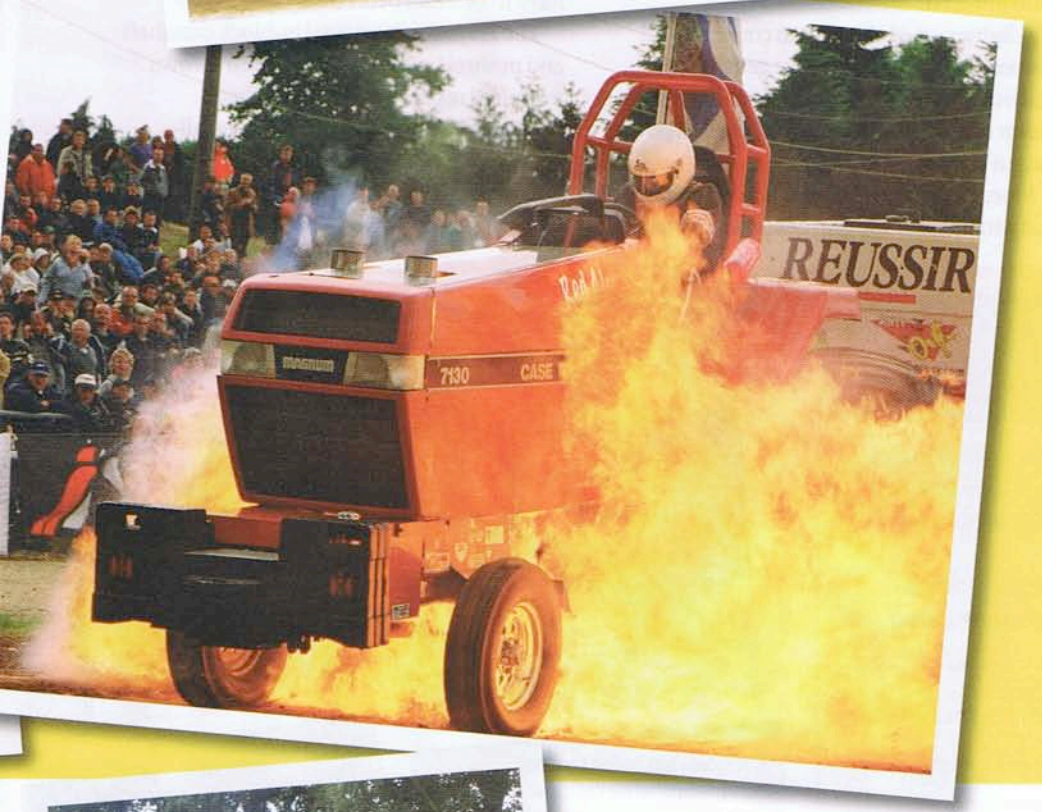
Despite such a load, it is common for a tractor to complete its run in a little under 10 seconds. But doing so requires power – and lots of it.

Aero engines, turbines, large-capacity industrial engines and trusty old V8s – you'll find them all at a tractor pull, bought or built to suit all depths of pocket.

Apart from these extensively modified machines, there are also two specific classes: pro stock and super stock.

Pro stock tractors are allowed just one turbo – super stock tractors can use up to four. And while a 300hp tractor once ruled the roost, now 3,500hp is necessary to make a difference – particularly in the super stock division, where Clarke's team (the 'Clarke Pulling Team') is one of the most successful in Europe.

But there is an added twist. Because of the



▲ It all looks impressive enough – but what these pictures can't portray is the earsplitting noise of these monstrous machines and the smell of over-excited diesel engines tuned to the screaming edge of insanity. No wonder this sport is catching on.

Pull the other one!

- A laser beam is used to measure the distance the sledge has moved with pin-point precision.
- A competitor has three minutes to make a measured pull when called to the track.
- After each tractor has pulled, the track is graded and rolled so all competitors get a comparable surface.
- Super stock tractors can use diesel or methanol fuel, and up to four turbos. Power outputs are typically 2,500-3,500hp. The maximum tractor weight is 3,500kg.
- Pro stock tractors are limited to one turbo and diesel fuel, but still squeeze over 1,200hp from an 8.3-litre engine. The maximum tractor weight is 3,500kg.
- Multi-engined modified tractors are also restricted by weights, but compete in 2,500kg, 3,500kg and 4,500kg divisions. Power outputs go up to 10,000hp.
- Rear tyres can be up to 30.5in wide for modified and super stock tractors, and 24.5in wide for pro stock.
- The sled delivers a progressively increasing load, by weight transfer: the further you pull it, the heavier it becomes.
- Agricultural rear tyres are bolted to wheel rims to help them withstand 160km/h wheel speeds and low inflation pressures typically around 5psi.
- Not even the power-crazed team's transporter escapes attention. The Volvo FH12-420 tractor is chipped to around 500hp to operate at 26 tonnes all-up.

sport's gasoline-based origins, spark plugs are allowed in super stock tractors. This has enabled many diesel-based engines to be converted to run on methanol – which has brought increased reliability and performance to the super stock division, but cries of despair from those hooked on diesel.

Trophies line the walls of Peter Clarke's workshop, testament to the spirit and enthusiasm that has brought his team numerous titles and a multitude of podium places as it competes throughout the UK and Europe with its two IH-based racing machines – Red Alert and Red Fever. It is fair to suggest that these two super stock machines will never be coupled to a plough again.

A traditionalist at heart, Clarke has always stuck to the super stock concept – and the rulebook says such tractors must be based on a factory-produced model, though modifications allow the use of up to four turbochargers in three pressure stages.

Homologation

In addition, the tractor must roll on 30.5in-wide rear tyres and until recently the rule book backed up such homologation with an insistence on standard driveline casings, including the original block and crankshaft.

There is little flexibility in such a design,

and more than enough inherent weight from those traditional tractor castings – given the maximum allowable tractor weight of 3,500kg.

Red Alert has been in the team's hands since 1996, when the once diesel-fuelled, four-turbo, super stock machine had a string of successes in the late 1990s. However, back then the seven-litre, in-line, six-diesel engine was running on the edge and delivering just 2,500hp, thanks to 300psi of boost pressure, extremely high temperatures and engine speeds of 5,500rpm.

There were few options available to get more power – and rivals in Europe were already converting diesel engines into spark-ignition, alcohol-injected motors.

Alcohol, specifically methanol, brings its own volume of oxygen to boost combustion. An engine burning methanol runs cool – far cooler than petrol – and produces a stable power output.

However, the fuel has its drawbacks. Its low calorific value means high volumes are needed, while low lubricity requires the use of a lubricant to preserve fuel pump life. Then there is a long warm-up period and the tendency to give oil a hard time – but the engine will run at full throttle for a matter of only seconds.

But just putting methanol in a diesel engine is something that leads to tears. A whole new motor is needed, as the fuel must be ignited with spark plugs and not through compression.

The benefits of methanol

Done properly, there's much to gain. Power comes partly from an increase in engine speed: as the internals of a spark ignition engine don't have to put up with such high compression, the parts can be much lighter and the compression ratio lowered.

A lighter set of aluminium con-rods and pistons and a change in valve gear – from pushrod to overhead cam design – mean the motor can be spun faster, which makes power output climb.

More power means faster wheel speeds – and with most of the grip generated by means of friction on the track's surface, that means a faster run down the track and consequently a longer pulling distance.

Red Alert has been transformed with a fresh IH-Navistar 466 engine, but sleeved out from the standard 7.2 up to 10 litres. The standard crank – albeit finely balanced – wears additional counter-weighting around the webbing for added flywheel effect, which puts back some of the weight removed from the new rods and pistons.

Six sleek aluminium con-rods and short-skirt aluminium pistons replace the heavier steel diesel rods and forged, deep pistons. The idea is to reduce drag and encourage engine speeds up to 7,000rpm, which is much more tolerable when large compression forces don't have to be absorbed.

The IH motor's original in-block camshaft and pushrod valve gear have been thrown away and replaced with an overhead cam system that resides on top of an all-new cylinder head. This hemi-style head with inclined valves is machined from an aluminium alloy billet.

Clarke Pulling Team

Base:	Windbush Farm, Tingewick, Buckinghamshire
Tractors:	Red Alert (Magnum 7250), Red Fever (MX285)
Engine specs:	Six-cylinder, 10-litre, two valves per cylinder, overhead camshaft
Induction system:	Triple turbochargers in two stages for 80psi boost, wastegate controlled, charge-cooling with fuel
Power output:	3,500hp at 6,500rpm (estimated)
Fuel system:	Triple injector, methanol system – burns 25 litres in 10 seconds
Ignition:	Spark-type, breakerless ignition using Crane and MSD drag-race systems
Clutch:	Red Alert – 11in, five-plate; Red Fever – 13in, four-plate
Transmissions:	Four-speed mechanical, choice of close-spaced ratios to give up to 160km/h wheel speeds
Rear axle:	Red Alert – modified IH original with steel diff; Red Fever – Rockwell with outboard planetaries
Tyres:	30.5 R32 shallow-vee Firestone Puller
Team members:	Peter Clarke, Geoff Ashcroft, Ian Thomas
Transport:	Volvo FH12-420 CD with triaxle box trailer provides living accommodation and mobile workshop space for two tractors during weekend competitions
Web:	www.clarkepullingteam.com

▲ A triaxle box trailer provides accommodation for the team

▼ Rival competitors David Jones, left, Peter Clarke and Geoff Ashcroft

Each combustion chamber gets a single spark plug, while airflow is assisted by titanium valves large enough to serve your dinner on.

The block runs dry, as methanol absorbs heat when it is burned, leaving the oil to fulfil a cooling and lubricating function. Given that the fuel is hosed into the engine along with air from three colossal turbos that produce around 80psi of boost pressure, the valve gear and pistons are almost washed cool.

Fuel is delivered through three injectors per cylinder – two of which are boost-controlled and simply return fuel to the tank until turbo pressure starts to climb. With more air comes more fuel, metered progressively, to allow the 10-litre engine to slurp its way through 25 litres of methanol in 10 seconds – or 33 gallons per minute in old money, equivalent to 88 gallons per mile.

Lighting the fuel-and-air mix is a potent drag-race ignition system, triggered by flying magnets on the crankshaft. There is no advance or retard, but an electronic rev limiter holds the 10-litre straight six back at 7,200rpm should a driveline fail. No EGR or AdBlue here – it's just straightforward mechanical metering.

All of which sees the 3.5-tonne tractor pack a power-to-weight ratio of 1,000hp per tonne.

Keeping tabs on the turbo boost, fuel pressures, individual exhaust temperatures and revs is a sophisticated data logger. A print-out from each run enables engine performance to be analysed and further tweaks to be made.

A five-plate slipper clutch lets power run through a twin countershaft four-speed gearbox, and out through a steel differential with roller bearings. No diff-lock here, as power will feed out evenly if internal friction is kept low.

Red Fever

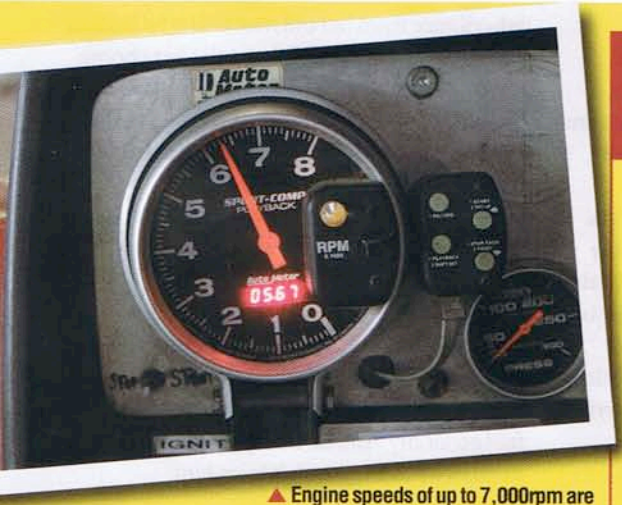
The team's second tractor runs a near-identical engine, fuel and turbo system to Red Alert, but is wrapped in a space-frame tubular chassis, eliminating cast-iron transmissions and rear ends normally associated with conventional tractor production. But the standard IH engine block and crankshaft remain.

In August 2003, Red Fever rolled out of the Clarke workshop after a period of eight months under construction, in preparation for the 2004 season.

Assembled from specialist component steel and aluminium parts, Red Fever is lighter than Red Alert – enabling more moveable weight to be distributed around the tractor to get up to the 3,500kg maximum allowable weight. More importantly, the chassis allows the tractor to twist and absorb its torque, which keeps the rear wheels of the 3,500hp machine more firmly planted on the track.

Both machines have brought the team considerable success. Winning the Eurocup circuit and European Championship events in 1999 with Red Alert has been backed up by regular podium finishes.

The 2006 season saw one or both tractors on the podium at every UK and European event that the team attended. Proof, if it were needed, of the team's determination to stay at the top of its game. ■



▲ Engine speeds of up to 7,000rpm are common in tractor pulling

▼ More blow than your average turbo set-up

Tractor pulling – an overview

It's all about pulling a weight transfer device – called a sled – along a 100m track. The tractor that moves the sled the furthest distance wins. So it's all about max power, right? Not quite.

Getting a good start and plenty of speed is essential to maintaining momentum as the sled gradually gets heavier – and to do that you need bags of power. But the sled is technically ingenious, behaving as a rolling weight when it leaves the start line and then progressively transforming into a dead-weight load as it travels along the 100m dirt track.

It achieves this by moving a ballast box from above the sled's own wheels (where it acts as a rolling weight) and up onto a skid pan that supports the front of the sled (where it becomes a dead weight).

This progressive method of weight transfer is achieved by driving the ballast box directly from the sled's wheels – hence the further it moves, the heavier it becomes. And adding or taking away weight from the ballast box enables the sled to be fine-tuned to suit the class of tractors in competition.

After each tractor has pulled the sled along the track, the distance moved is measured by laser, accurate to within 10mm, before the sled is returned to the starting line ready for the next competitor. Grading and rolling take place on the track, so each competitor faces the same track conditions and pulls the same load.

Track quality varies throughout the pulling circuit; clay is preferred, but some tracks are sand-based – which makes tyre pressures and the position of tractor ballast weights quite critical, as friction levels differ enormously.

And spinning those giant, shallow-vee tyres more quickly – provided they can get hold of the track surface – generates more forward speed. So having all that power won't guarantee a win. It needs to be applied wisely.