Quick guide to emissions

Emission Regulation Regions

On Highway Units g./kW.hr. Test Cycles Europe	USA ESC	2000 FTP	2001	2002 FTP+ESC	2003	2004 ESC+ETC	2005	2006	2007 FTP+ESC	2008 ESC+ETC
USA		EPA1998		EPA2004					EPA2007	
Nox		5.36		3.35					0.27	
Particulates		0.134		0.134					0.013	
Europe		Euro3					Euro4			Euro5
Nox		5.00					3.50			2.00
Particulates		0.10					0.02			0.02
Off Highway **Units g./kW.hr.** **Test Cycles**	**USA/Europe ISO8178 8 mode**									
75 to 129 kW (100 to 173 hp)										
USA		Tier1			Tier2				Tier3	
Nox		9.20			6.20				4.00	
Particulates		0.54			0.20				0.20	
Europe		Tier1			Tier2				Tier3	
Nox		9.20			6.00				4.00	
Particulates		0.70			0.30				0.30	
130 to 224 kW (174 to 301hp)										
USA		Tier1			Tier2			Tier3		
Nox		9.20			6.60			4.00		
Particulates		0.54			0.20			0.20		
225 to 449 kW (302 to 602 hp)										
USA		Tier1	Tier2				Tier3			
Nox		9.20	6.40				4.00			
Particulates		0.54	0.20				0.20			
450 to 560 kW (603 to 751 hp)										
USA		Tier1		Tier2			Tier3			
Nox		9.20		6.40			4.00			
Particulates		0.54		0.20			0.20			
130 to 560 kW (175 to 751 hp)										
Europe		Tier1		Tier2				Tier3		
Nox		9.20		6.00				3.60		
Particulates		0.54		0.20				0.20		
> 560 kW (> 751 hp)										
USA		Tier1						Tier2		
Nox		9.20						6.40		
Particulates		0.54						0.20		
> 560 kW (> 751 hp)		No active consideration of legislation in Europe								

Region/Country	2002	Next round
Europe	Euro3	2005 Euro4
China	Euro1	2005 Euro2
India	Euro2	2005 Euro3
Australia/NZ	Euro2	2002 Euro3
South America	Euro2	2001 Euro3 (Brazil) 2002 Euro3 (Chile)
North America	EPA98	2002 EPA2004
Japan	Japan98	2004 Japan04

HOLSET
TURBOCHARGERS

EPA introduction 1 January, except Oct 2002 for consent decree companies.
Euro introduction 1 October.
FTP = Federal Test Procedure ESC = European Steady state Cycle ETC = European Transient Cycle

HTi

HOLSET
TURBOCHARGERS

The latest news for Holset Turbochargers' customers

Iveco Stralis

International 'Truck of the Year 2003'

Inside this issue

ISSUE 1

Looking to the next half century

Holset last year celebrated its 50th anniversary. Since the 1950s, from the very beginnings of exhaust gas driven turbocharging, the company has pushed forward the frontiers of turbine, compressor and related technologies. The result has been an astonishing increase in diesel engine efficiency. Today's Holset turbocharged engines, in both on- and off-highway applications, deliver more power per litre than ever before.

More importantly, for most applications they exert, in percentage terms, even more torque – and more usable torque, typically at lower engine rpms. That in turn plays its part in achieving levels of fuel consumption undreamed of when natural-aspiration was the norm, at the same time complying with ever more stringent emissions legislation.

Our turbocharger technology continues to advance, with exciting new developments on our designers' CAD screens. As Holset move into its second half century, with continued expansion of both the product range and manufacturing activity, I am pleased to welcome you to the first edition of **'HTi'**.

In its pages we bring you news of Holset's achievements in penetrating new markets and meeting technology challenges. Our 21st Century global business strategy is to continue our focus on the medium and heavy-duty commercial vehicles market and to pursue new opportunities in the light duty commercial vehicle sector. In these sectors, demands for ever greater turbocharger durability, as well as improved power density and fuel economy from progressively 'cleaner' engines, can only be met through continued R&D investment – which Holset is implementing.

Recent successful new product launches have also highlighted the strength of our policy of working in an ever closer partnership with you, our customers. We plan, in future editions of **'HTi'**, to keep you up to date with developments at the cutting edge of turbocharger technology as well as newsworthy applications of our proven products, manufactured by a global leader in one of the most specialised fields of the many-faceted engine business.

As well as celebrating our 50th anniversary, in Her Majesty the Queen's own Golden Jubilee year, our technical centre and manufacturing plant in the UK, were honoured in 2002 with two prestigious Queen's Awards for Enterprise, one for Export Achievement and the other for Innovation. On such occasions, it is good to reflect on Holset's history and the dedicated engineers and colleagues around the world who make that history one of continuing success, in not just meeting, but exceeding, customer expectations.

Mark Firth
Director – Sales & Marketing

HTi is the Holset magazine focussing on the world of heavy-duty turbocharging. It aims to bring you news on the product and market developments.
HTi is produced using an environmentally approved printing process and is printed on fully recyclable and biodegradable paper.

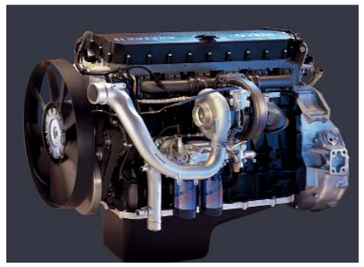
The VGT helps Iveco to prestigious award

Iveco became the first European truck and bus diesel manufacturer to adopt variable geometry turbocharging with the launch in the late 1990s of its all-new Cursor engine range, of 8, 10 and 13 litres capacity. The three Cursor engines have won praise from transport operators for their performance and their fuel efficiency. Now Iveco's achievement has been crowned with its Cursor-engined Stralis 44 tonne flagship truck winning the coveted International Truck of the Year Award for 2003.

Andy Salter, editor of the UK TRUCK magazine and vice chairman of the Truck of the Year jury, says 'this year's award decision was clinched to a large extent by the Stralis's advanced powertrain. The Cursor 10 and 13 engines set new standards of performance, in terms of power density and proven fuel economy. Thanks to their unique use of Holset VGT turbochargers, they are also able to 'punch above their weight', exerting high torque where it is most needed, at lower revs – and all from engines of more modest swept volume and noticeably lighter than those they replaced'.

'Not to be overlooked', says Andy, 'is the safety bonus on long downgrades during trans-alpine operations for example, which comes from the much enhanced engine braking - that is retarding - power conferred by the VGT. Wear, and the risk of fade, with the trucks main foundation brakes are also greatly reduced'.

Stralis made its debut at the 2002 Amsterdam Truck Show. With its introduction came a 12% increase in the maximum available power rating of the Cursor 13 engine, up from 480 to 540hp and with a prodigious 2350Nm maximum torque available across a wide 'plateau' from 1000 to 1610 rpm. For fleet users more concerned with payload and economy than outright performance, Stralis can be specified with the smaller Cursor 10 engine in ratings up to 430hp. Engineering changes which have made higher ratings possible include larger capacity charge-air coolers.



The newest eye-catching addition to Iveco's Cursor engined range of heavy trucks has become a best seller across Europe, attracting new buyers to the Iveco marque, with a host of operationally attractive features complementing the attributes of the Cursor engine. Its ergonomically well-designed 'Active Space Cab', impressive build quality and ground-breaking use of electronics, providing both driver and operator extensive vehicle and fleet management information were all included in the Truck of the Year citation.

Cursor engines now have several years of field service behind them in Iveco's established EuroTech and (now replaced) Euro Star chassis range, during which time their reliability in everyday service has been proven. The Stralis inherits that enviable pedigree in a truck that represents state of the art engineering and design.

Holset's VGT technology was developed through the 1990s in co-operation with the Iveco engine research centre at Arbon in Switzerland, to match precisely the characteristics of the Cursor engine concept under development at the same time. Reliability and durability were key drivers in the VGT programme – factors carried forward into Holset's dedicated VGT manufacturing and assembly facility at Huddersfield in the UK.

Increased output of VGTs to match Cursor demand is now planned. It will be augmented by the start-up of production at Holset's US plant in Charleston, South Carolina, where VGTs are manufactured for Cummins' EPA '04 compliant 15 litre Signature and ISX heavy-duty truck engines.

FACT FILE

- Stralis won the 2003 International Truck of the Year Award, with almost 50% of the total votes.
- Over 8000 Stralis chassis were ordered across Europe in its first 10 months.
- Iveco's market penetration in the Stralis weight sector has increased to 34 per cent on the same period last year, in contrast to a market which is down 16 per cent overall.
- Stralis is available with two different engines; the 10.3 litre Cursor 10 that comes in power ratings of 400 and 430hp and the 12.9 litre Cursor 13 that is offered at 480 and 540 hp.
- The Scuderia Ferrari Formula One Team was one of the first customers in the world to take delivery of the new Iveco Stralis.
- In excess of 100,000 VGT in service since the launch.

PAUL CROSET OBE

As Holset embarks on its second half century, HTi talks to the man to whom the company owes its existence, Paul Croset OBE. Paul stays in regular contact with Holset and HTi found him very much in touch with his life's work of helping to improve the efficiency of the diesel engine.

HTi: How did you start your career?

PC: In my early engineering days my father, who was Chief Designer for Crossley Premier Engines in England, encouraged me to study torsional vibration, which at that time was a major limitation for reciprocating internal combustion engines. I found the mathematics involved in solving vibration problems very interesting and challenging. I joined Paxman Diesels in Colchester, where I began to specialise in torsional vibration.

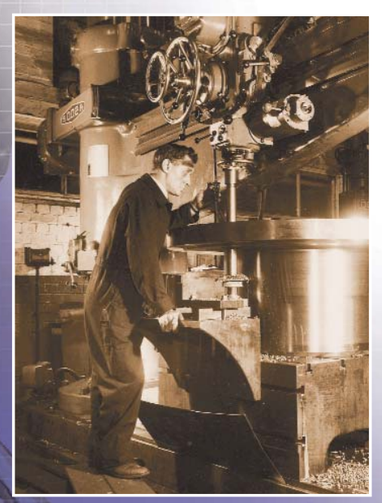
HTi: From Colchester to Huddersfield in one leap?

PC: My arrival in Huddersfield was a result of some contacts between my father and the Huddersfield company W C Holmes (WCH), which was granted a licence to manufacture a design of flexible coupling patented by my father. I was asked if I would be interested in joining the new venture. Frankly, I wasn't terribly enthusiastic about moving from Colchester to Huddersfield, but I could see there were opportunities perhaps to market some of my own designs for torsional vibration dampers. I met Mr Holmes and took a liking to him; we had similar interests. So on the 13 December 1948 I arrived in Huddersfield.

Huddersfield at that time was a typical Yorkshire industrial town, dominated by the chimneys of the textile mills. The stone footpaths had grooves worn into them where countless people for many years had walked to and from their work in the mills. In one of the mills there was even an old Cornish steam engine still working.

HTi: How long did it take for the new business to start?

PC: There was a steady trade in flexible couplings. But the real growth came from the torsional vibration dampers. At that time the leading product was the Lanchester damper, invented in 1910. It worked beautifully while it was 'in tune'. The trouble was it wouldn't stay that way for long. The first customer for my silicone damper was J & H McLaren in Leeds, a producer of marine engines, with an order for 50 dampers. This impressed the parent company WCH. However our credibility was really secured when I received an order from Rolls-Royce - Holmes had always had Bentley or Rolls-Royce cars.



HTi: What happened after Holmes realised they had a winner on their hands?

PC: Holmes were really gas engineers whereas I was an automotive engineer. They talked in sixteenths of an inch while I talked in thousands of an inch. I approached Mr Holmes and he agreed that the damper side of the business needed a separate identity. He suggested we call the new company Croset; I didn't like that – modesty I suppose - so after much thought we decided to put our two names together and go with 'Holset'.

I also wanted a distinctive logo for the company but I was bothered by what looked like an awkward gap between the 'L' and the 'S' with most typefaces. I was looking at various different forms and because of my close connections with Switzerland I noticed that the Swiss engine company Sulzer used a neat, rather squashed 'S' which looked much better. The blue colour came from my early business trips to Sweden where I used to see it used a lot on buildings and advertisements, so those were the influences on the Holset logo.

HTi: What was your vision for the new company?

PC: My central product vision was based around diesel engines. I wanted to concentrate on the strategic diesel components on which an external supplier could become a technology expert. Even at that early stage, I foresaw the exhaust gas driven turbocharger as something that could do for engine output and efficiency what damping had done for mechanical integrity. As an extension of my early involvement with flexible couplings, I also saw a market opportunity for components like fan drives for diesel engines.

HTi: And how did you see turbochargers evolving?

PC: I first talked to Eberspächer in 1949, but the product wasn't yet right for the automotive diesel engine. Then I talked to Bucchi, but questions arose such as 'do you attach the engine to the turbocharger, or the turbocharger to the engine?'. I was nevertheless determined to bring the turbocharger to Europe, and I had heard that the Schwitzer Corporation in the USA had developed a lighter version, and we purchased the manufacturing and design rights to its model 4 product. We had to do a good deal more development work to suit it to European applications. But that really was the start of Holset's involvement in turbocharging, setting the company on the road to becoming a world leader in a market where today every heavy-duty and mid-range truck and bus diesel engine in Europe as well as in North America is turbocharged.

HTi: How do you see the future for turbocharging and the diesel engine?

PC: There is obviously a great deal of pressure to improve emissions; we would all like to come back down to zero emissions if that is ever possible.

The turbocharger is a vital part in this because it is fundamental to the combustion process of the engine, so it is a must, enabling many engines to meet emissions requirements in many countries.

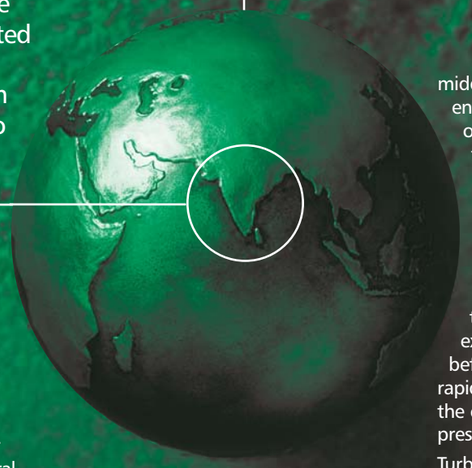
I don't see anything that will supplant the diesel engine, certainly in the next decade and maybe even as far as the next twenty years. We know a lot about the diesel engine and have a lot invested in it.

There are other hybrid types of prime mover coming along and perhaps the ultimate will be the hydrogen engine. This is not without technical and infrastructure problems but I am sure these will be solved in time.

There is nothing to replace the diesel at the moment and I think it still has a very good life ahead of it.

Turbocharging upgrades India's transport technology

India is a country of extremes. Home to over a billion people it is the second most populated country on earth. A true subcontinent, it extends from the Himalayas in the north to Indian Ocean in the south.



Both colourful and diverse, India is, surprisingly to some, the world's largest educator of IT personnel and a key exporter of booster rockets for the aerospace industry, just two of the high technology industries with which India is seeking to revolutionise its economy.

India is expected to be one of the fastest developing economies in the world. After making major improvements in agricultural output and basic industries during the 60's and 70's, the 1990's saw deregulation of many industries, unleashing its renowned but previously constrained entrepreneurial culture. Annual economic growth is now over 6%, and recent years have seen a focus on investment in basic infrastructures such as transport and power generation and distribution.

By the end of this decade India expects to have an intercity road network to rival those of Europe or the USA. In combination with its growing economic and commercial activity, that will inevitably lead to demand for more efficient buses and trucks, able to move people and freight over greater distances, more rapidly and reliably.

With European and North American experience as a pointer, the Indian government is keenly aware of the environmental implications of such growth. Investment has been ploughed into the country's oil industry to make available first lead-free petrol for cars and motor-cycles. Meanwhile India's refineries are well advanced in a country-wide programme to introduce low-sulphur diesel fuel.

Euro 1 emission standards now apply across the country for new diesel-engined trucks and buses going into service. In several metropolitan areas with more severe air quality problems, Euro 2 standards have been put in place. In addition some urban zones, such as the National Capital Region, now have solely CNG fuelled vehicles for public transport. This commitment to adopt emissions legislation continues into the future with a plan to commence the introduction of Euro 3 legislation by the middle of the decade.

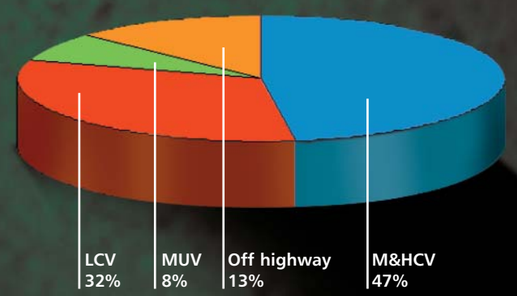
For India's commercial vehicle producers this represents a significant challenge. They must introduce new technologies to ensure compliance with the emission limits, while at the same time boosting transport efficiency by raising vehicle performance – while, if possible, improving fuel economy.

Meanwhile payload tonne-kilometre costs are being trimmed through the adoption of larger, higher load capacity vehicles, especially for the movement of bulk cargoes over longer distances. Where a middleweight truck with a 4 to 6 litre engine has traditionally been used, operators are now graduating to heavy tractor-trailer combinations grossing 40 tonnes or more requiring 8-9 litre – invariably turbocharged – engines. The Indian engineering conglomerate Tata recently announced plans to introduce trucks able to gross over 40 tonnes. These will use Holset turbocharged 8 litre engines. Rivals expected in this top end of the market before long include Ashok Leyland, the rapidly growing Eicher Motors and Volvo, the only European OEM with a significant presence in the Indian market.

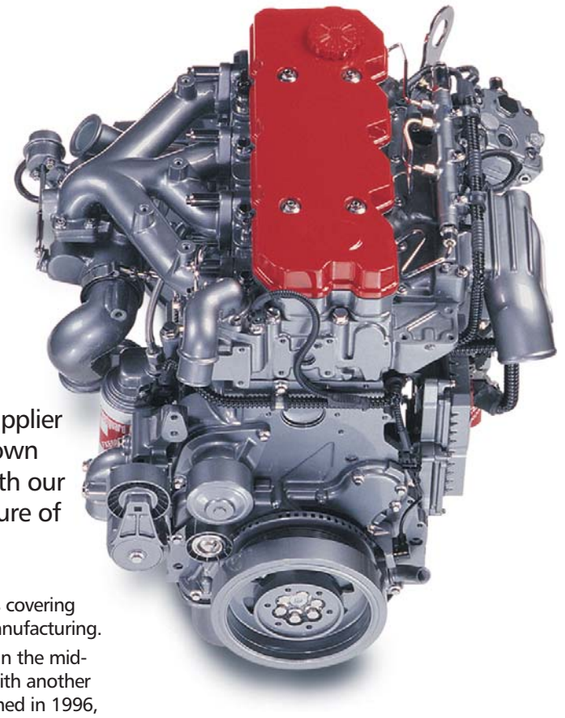
Turbocharging is a key technology in the modernisation of the Indian commercial vehicle fleet, bringing lower emissions, greater vehicle performance from given sized engines and lower fuel bills.

In line with Holset's commitment to support its OEM customers wherever in the world they are, the company is committed to grow on the Indian subcontinent and to deliver the turbocharger products which will bring those vital end-user benefits. The Holset controlled Tata-Holset operation based in Dewas, Indore recorded a 12% increase in sales in 2002, and its growth continues strongly. Holset is making significant further investments in India to develop its subsidiary into a key part of its global manufacturing, technical and customer support capability.

Indian Turbocharger market (Volume 124,562)



Growing success from partnership



No one would dispute that success as a key component supplier is directly linked with the success of its customers in their own markets. For Holset, our declared mission of 'Partnering with our customers to make sure they succeed', determines the nature of all our customer relationships.

Over Holset's 50-year history, we are proud to have built successful partnerships with many of the world's leading engine manufacturers. In the 1950s, our first turbocharger OEMs included Volvo and, as it was then, Scania-Vabis. The success of those partnerships, forged over 40 years ago, is evident in the fact that those two Swedish companies remain major Holset customers today.

In May 1995, we formed an alliance with MHI (Mitsubishi Heavy Industries) of Japan, aimed at tapping into the strengths of both companies in meeting customers' turbocharger requirements right across the full diesel engine size range. It is a different kind of partnership – one that gave Holset access to MHI's excellent range of smaller turbochargers designed primarily for engines of 2.5 to 4 litres capacity.

The alliance brought together two companies with complementary product lines and technological expertise, and with strong market shares in different parts of the world. An international marketing agreement between Holset and MHI ensures that cross-sourcing benefits are maximised. It is a partnership which also encompasses joint procurement of key materials, with all that implies in purchasing power. That is again complemented by agreements covering collaborative assembly and manufacturing.

Holset's alliance with MHI led in the mid-1990s to a new relationship with another diesel industry's alliances. Formed in 1996, the EEA (European Engine Alliance) was a three-way partnership between Cummins and the two Fiat group companies, Iveco and New Holland (now Case New Holland).

Its objective was to design and develop a range of 1 and 1.125 litre per cylinder engines in three, four and six cylinder configurations for the automotive, agricultural and industrial markets. These diesels were destined to replace all three partners' existing engines in the same size range.

By pooling their extensive diesel expertise and on- and off-highway engine application experience, the EEA partners aimed to produce a state-of-the-art family of diesel engines which, crucially, were capable of satisfying global emission laws through to 2010 or beyond, but which were second to none in fuel efficiency and performance. Simultaneously, the partners would reap the savings which would flow from sharing development, and to some extent manufacturing costs.

The result has been an excellent range of engines that have been exceptionally well received in the marketplace, for on-highway use certified to Euro 3 emission standards. Cummins' ISBe four- and six-cylinder (4 and 6 litre) units power the new generation 6 to 18 tonne DAF LF truck chassis range, which won the International Truck of the Year Award for 2001. Meanwhile Iveco's EEA-developed Tector diesels have given the Italian company's best-selling Cargo middleweight range a new more fuel efficient and vigorous lease of life.

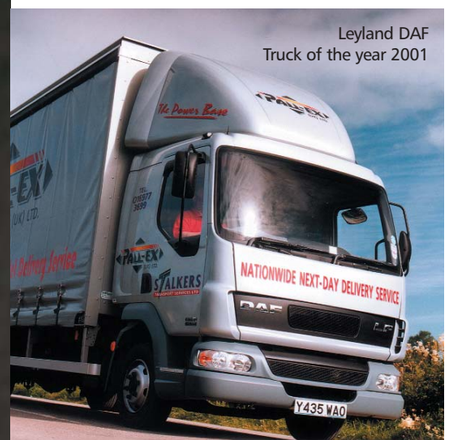
In partnership with MHI, Holset secured 75% of the total EEA business. Through this valuable supply contract, production volumes of our HX35 and HX20/25/27 turbocharger models will be substantial by the time output of the three EEA partners' engines reach maturity in 2006. The growth potential for Holset is considerable, promising a substantially increased share of both on- and off-highway markets.

The turbochargers developed for EEA are the Holset HX35 and the MHI- derived HX20–25-27 range. John Whiteley, the account manager for EEA says 'without our successful working partnership with MHI, Holset would not have been able to compete for all the EEA business'. He adds that 'working closely with the EEA engineers at their UK base, a number of technical challenges were met resulting, I am pleased to say, in an improved turbocharger product from Holset'.

The EEA developed engines are being assembled at each partner's facility, for the Fiat companies in Turin, Italy, and for Cummins at Darlington in the UK. Blocks and heads for all three EEA brands are machined in Turin.

Production of the new mid-range ISB and Tector engines for the European automotive market began in September 2000. Industrial engine production followed in early 2002 and, for the agricultural market, availability came by the end of 2002.

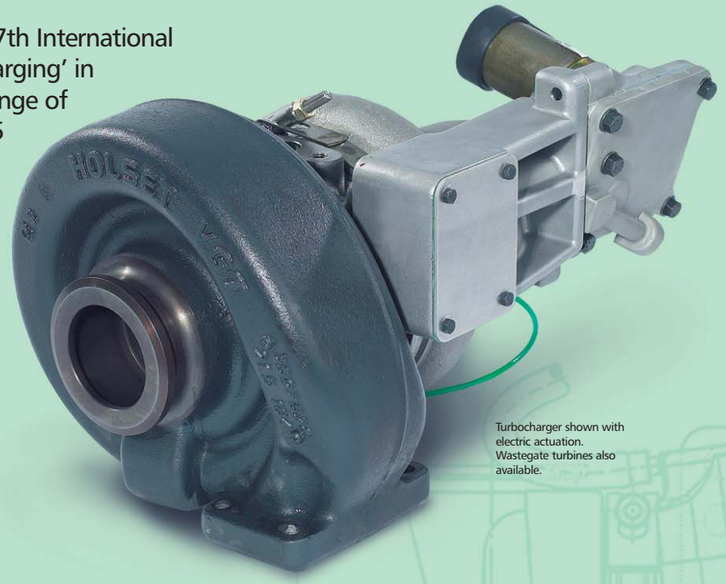
The EEA partners are now delivering a range of engines unmatched in their class for efficiency and end-user earning potential. Market response has been entirely favourable, helping to enhance the reputation of all three EEA partners and of key component-supplying partners, of which Holset is among the most significant.



Leyland DAF
Truck of the year 2001

At the Institution of Mechanical Engineers' 7th International Conference on 'Turbochargers and Turbocharging' in London, Holset launched its innovative E Range of advanced turbochargers for diesels from 5.5 to 16 litres capacity. They represent the very latest air and gas management technology.

Holset engineers, in establishing the design parameters for the E Range, recognised the complexity of the development challenge facing today's diesel engine manufacturers. Driven by the twin – potentially conflicting – constraints, of trucks and buses having to a) meet ever tougher exhaust emission standards and b) to return the best possible fuel economy, the performance of the turbocharger is becoming ever more crucial.



Turbocharger shown with electric actuation. Wastegate turbines also available.

The highly innovative new E range

Regarded at one time as almost a 'bolt on' accessory, the turbocharger has become an integral part of the sophisticated powertrain necessary for the modern engine. The advent of the wastegate, and subsequently VGT variable turbine nozzle geometry, has required turbocharger controls interfacing with the engine's management system. This enables induction boost and pressures to match electronically regulated fuel metering and injection timing, for precise control of the fuel-air mixture and subsequent combustion. This results in optimised fuel economy and engine performance – while ensuring compliance with emissions legislation.

Turbocharger shown with pneumatic actuation.

Holset's new E Range of turbocharger equipment, available in wastegate and more sophisticated VGT versions, will contribute vital technology as diesel engineers strive to meet the more severe oxides of nitrogen (NOx) and particulate matter (PM) emission limits. However, the ultimate market challenge, points out Steve Caddy, Engineering Director for Technology, is to meet those legal requirements in combination with market-leading fuel economy – a challenge addressed directly in the E Range development programme. The added potential of VGT technology to control exhaust pressure, and thereby increase the retardation power of an engine brake, brings a further operational bonus. The robust construction of the Holset VGT's unique fixed nozzle vane design prevents deterioration in engine brake performance over the life of the engine.

At the same time the E Range is engineered to set new standards of everyday reliability and component life. In the 21st Century, truck builders and transport operators have come to expect up-to-1 million kilometres of trouble-free service from heavy-duty engines. Two or three turbocharger replacements during the life of the engine - at one time thought unavoidable – is today, under conditions of intense engine utilisation, no longer tolerable, in downtime or cost terms.

Turbocharger shown with pneumatic actuation.

The Holset's VGT system, which is incorporated into the E Range have now been in production for over four years, accumulating millions of kilometres in a wide variety of truck and bus applications, notably in Iveco's Cursor range of 8, 10 and 13 litre diesels.

Higher pressure ratios are being demanded from turbochargers by the latest truck diesels now going into production in the United States, incorporating exhaust gas recirculation (EGR). In combination with the need for improved durability, the higher pressure ratios are being met by Holset E Range turbos with forged aluminium or, for the toughest applications, cast titanium impellers. Conventional cast aluminium impellers remain available for less severe duty cycles. All impellers feature the arbitrary surface blade geometry for optimal aerodynamic and mechanical performance.

Back in 1997 Holset was the first turbocharger maker to offer cast titanium impellers and in the automotive field remains the only supplier. The company's advanced manufacturing technology in the use of a traditionally 'difficult' material, is now well established. Particular attention is paid to the bearing systems of turbochargers with titanium impellers, to cater for the higher shaft drive torques associated with increased rotor inertia. All E Range VGT turbos in any case feature water cooled bearing housings which maximise durability.

Pneumatic-or-electric VGT actuation

Through the adoption of a modular ancillaries approach on all Holset E Range VGT installations, OEMs can now interface their electronic engine controls with either electric-motor or pneumatic actuators to regulate the turbo's nozzle geometry. With pneumatic actuation – normally harnessing air pressure from the vehicle braking system - production experience has led to the adoption of more precisely controllable, responsive and rugged piston actuators in place of the former diaphragm chambers. The alternative technique, of using a water-cooled – and automatically calibrated - electric motor actuator, makes for a simplified installation, while fully maintaining VGT responsiveness and overall turbo performance.

Provision is now made for input signals to the OEM's engine/powertrain management control system from sensors monitoring turbocharger speeds, temperatures and pressures. For either VGT or wastegated E Range turbines, a fully proportional pneumatic control valve controlled by the engine ECU can be specified. A similar valve is available, featuring built-in pressure and temperature stabilisation that allows nozzle geometry to be regulated by a simplified ECU signal. Specifically for wastegated models, a 'boost override' valve controlled by the engine ECU can be fitted, allowing the normal wastegate function to be overridden on demand.

Computer-aided design and development work on enhanced E Range impellers is well advanced that will take further advantage of the mechanical strength advantages of newer materials like titanium. As well as their enhanced durability, they offer possible reductions in rotor weight and inertia, leading to improved dynamic response – reducing even further the phenomenon of 'turbo lag'.

More information is available by requesting a copy of the E-Range brochure, detailing turbocharger specifications for the model HE300 (for 5.5 to 7 litre engines), HE400 (up to 9 litres) and HE500 (up to 16 litres) by e-mailing turbos@holset.co.uk or visiting our website www.holset.com

NEW MODEL TURBO HELPS DODGE RAM PICK-UP NEW AWARDS

Holset's latest HY35W wastegate turbocharger, fitted to the Cummins 5.9 litre ISB diesel in DaimlerChrysler's 2003 model Dodge Ram heavy-duty pick-up, has helped both the engine and the truck win new North American motor industry awards.

A study by J.D. Power, considered the industry benchmark for new vehicle quality, has ranked Cummins ISB as America's 'Number one diesel pick-up engine'. The study's ratings are based on responses from nearly 65,000 users of 2003 model-year trucks and cars surveyed after 90 days of vehicle operation.

The latest Ram model 3500 pick-up in 4x4 form has also been named 2003 'Truck of the Year' by the US magazine Motor Trend. Editor-in-chief Kevin Smith said "with its excellent powertrain, off-road prowess, smooth on-road driveability, and stump-pulling power, the heavy-duty Dodge Ram is our hands-down winner".

Widely dubbed 'King of the Trucks' by pick-up owners in the US and Canada, the Dodge Ram is the star performer in a hugely competitive market. For 2003 it has been given a new 'big-rig' look with a matching boost in performance and trailer towing capability. The Ram's power to pull 16,000lb – 7.25 tonnes in European terms - comes from the latest Holset-turbocharged Cummins 5.9 litre ISB in-line six diesel.

Universally praise has been lavished on the latest Ram's crisp throttle response – a tribute to the turbocharger characteristics, where a revised wastegate port flow design plays an essential role. It helps to make driving the Ram an experience that puts it ahead of its Ford and General Motors rivals.

The ISB engine uses a purpose-designed Holset HY35W turbocharger, and its groundbreaking performance standards have been achieved as the result of close development co-operation between Holset, Cummins and DaimlerChrysler engineering teams. The programme involved tough power output, durability and package size targets, making it essential to work closely with the engine and vehicle manufacturer as well as with other suppliers. One key result was the achievement of what is acknowledged to be unprecedented refinement, especially in terms of low noise levels.

For Holset engineers in the UK and the US, it meant going back to 'turbocharger basics' in the drive to push forward diesel air and gas management technology. Key features of the HY35W installation on the Ram's ISB engine include:

- A one-piece turbine housing with excellent thermal cycle capability and improved wastegate port flow performance.
- Jacobs exhaust brake close-coupled to the turbo - bolted directly to the turbine outlet.
- A new compressor cover incorporating elbow bends which reduce the turbo installation package size and eliminate unnecessary joints.
- NVH (noise, vibration & harshness) improvements, contributing to a significant noise reduction.

The new HY35W turbocharger will be produced at the company's North American plant in Charleston, South Carolina, in a facility that incorporates the latest quality-assured assembly processes. The plant is equipped to produce in large volumes the latest turbo for numerous ISB engine applications, including the Dodge Ram.

How to pick-up speed – with VGT

Holset has worked in partnership with US vehicle performance specialist Gale Banks Engineering (GBE), using VGT turbocharger technology to help set a new world speed record. The performance of a customised Dodge Dakota pick-up was boosted to achieve a maximum recorded speed of 357km/h (222mph), setting a two-way-average record of 349km/h (217mph). The previous record for a diesel pick-up was a 'mere' 256km/h (159mph).

It was at the famous Bonneville Salt Flats in Utah last October that the pick-up, converted by California-based Gale Banks Engineering and dubbed the 'Sidewinder', set a new record for all pick-ups, either diesel or petrol engined.

Gale Banks took the standard Dodge Ram configuration, powered by a Cummins 5.9 litre ISB in-line six 24-valve diesel and adapted it fit the Dodge Dakota. The vehicle underwent extensive modification in GBE's workshops to prepare for the speed record attempt. Most notably the Holset HX35W turbo standard on the on the ISB engine was replaced by a Holset HY55V unit, normally seen on 10 litre engines or larger which incorporates VGT variable turbine geometry.

As Gale Banks points out, controlling the turbo geometry enabled the engine's power and torque curves to be tailored to the needs of the speed record project. The Sidewinder's engine output is put at around 600hp, with up to about 1800Nm (1300lb-ft) of torque available.

The Sidewinder speed record venture is be used to promote the merits of diesel power in a country where for passenger cars, SUVs and pick-up trucks, diesels are still seen as sluggish and smoky. But, says GBE's founder Gale Banks, that is all history; diesels can hold their own, and not just in performance terms. He points to the refinement and low noise level of a state-of-the-art diesel like the ISB, added to which are its 'environment friendly' qualities – low emissions and improved fuel economy – with a corresponding greenhouse gas reduction bonus.

Even in speed record trim the Sidewinder powertrain is 'street legal' in the US.

The truck was driven by road to Bonneville, only its tyres and wheels having to be changed to suit the extreme high speed running across the salt flats.

For more details on the Gale Banks Sidewinder, visit their website on www.bankspower.com

Higher quality at higher volumes

Holset Turbochargers commissioned a new assembly line for its heavy-duty models at its Huddersfield plant in 2002. The new line is now fully operational and is running at about 70% of its potential capacity. HTi talked to plant manager Ray Dawson to find out more.

HTi: What were the objectives of the new assembly process?

RD: Our primary aim, in switching the production of heavy-duty turbochargers to flow-line form, was to take a significant step towards our goal of zero defects. The new production line introduces rigorous fail-safe measures. Standardised procedures ensure the right components are correctly fitted and that the assembly process conforms to agreed specification standards.

HTi: What is the new line's capacity/throughput time?

RD: Fully manned, the line is designed to produce 40 heavy-duty turbochargers per hour, a takt time of 90 seconds. From the decision on build plan to completed turbochargers arriving off the end of the line takes just 2 hours. The actual time from start to finish round the line is 30 minutes.

HTi: How was the line ramped up to full capacity?

RD: Assembly of the full mix of heavy-duty Holset turbocharger models began in June 2002. During the month we ran the line on a 50% output basis to enable previously unidentified minor assembly issues to be ironed out. By the end of the year, 75% of heavy-duty output was coming from the new line. The new line will be capable of building over 1000 heavy-duty build variations.

HTi: This is the third turbo production flow line installed at Huddersfield. What are the improvements made since the first assembly line was put in?

RD: After a new line is installed, it is continually upgraded to meet changing requirements in product mix, specification updates and new fail-safe procedures. The new heavy-duty line caters for a much greater variety of turbocharger models than either of the other lines in the plant. It covers the three frame sizes embodied in our HX50, 55 and 60 heavy-duty turbo models, including their numerous wastegate versions. Line feed conveyors deliver larger components in the correct sequence to pre-determined lineside stations. Their function includes component identification and verification.

Production programming and the fail-safe disciplines on the new heavy-duty line have benefitted from lessons learned – and upgrades implemented - during the set-up of the plant's two earlier lines. In turn that experience is benefitting other Holset manufacturing facilities around the world.

HTi: What are the key logistical features of the new line and how are components held prior to assembly?

RD: The line is essentially a rectangular loop, around which the work-piece pallets travel. An overhead bridge at one end gives access to the inside of the loop, so that both sides of the line can be reached easily. Most work stations are positioned on the inside of the loop, for ease of operator movement between stations.

Smaller components and assembly materials are stored in lineside 'pick bins'. Larger items are fed along the feed conveyors of what amounts to an ancillary line.

HTi: Does the line have any unique features?

RD: Though all the elements of the line are proven technology, I think I can say that some of its features are novel, maybe even 'adventurous'. There is an extensive use of vision systems for component verification. The system of using ancillary conveyors, to feed the larger parts to the lineside stations is new for Holset. The inbuilt production flexibility enables it to handle three turbocharger frame sizes, while also being able to satisfy repeat orders for older-generation product, a real challenge to the manufacturing hardware and line flow 'balance'.

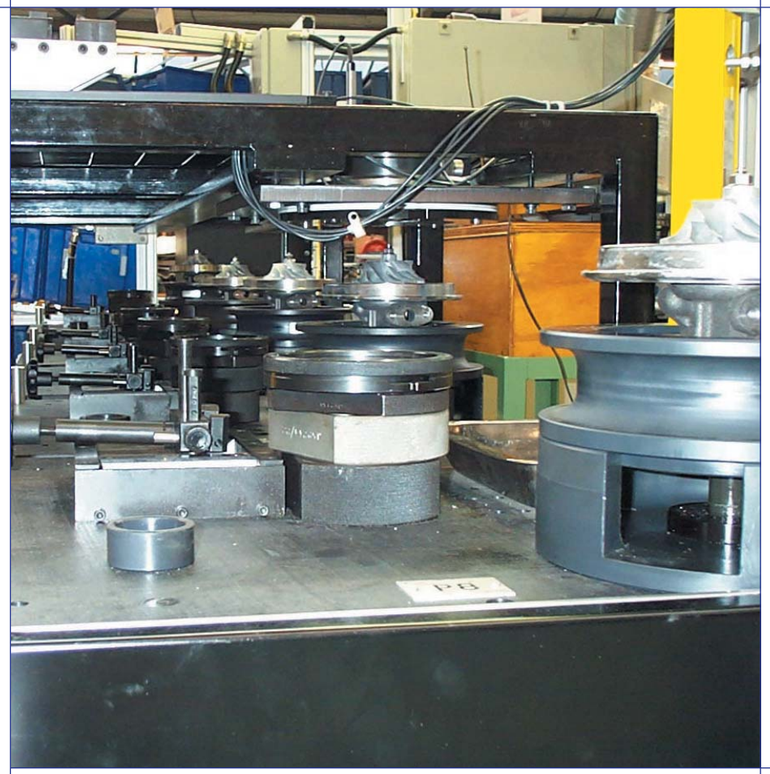
HTi: What about productivity improvements?

RD: The primary goals have been quality centred. But the aim is also to achieve a productivity increase, primarily through the application of better tools and lineside component placement. There is however always something of a productivity trade-off against the extent of the turbocharger model mix line coming down the line at a particular time.

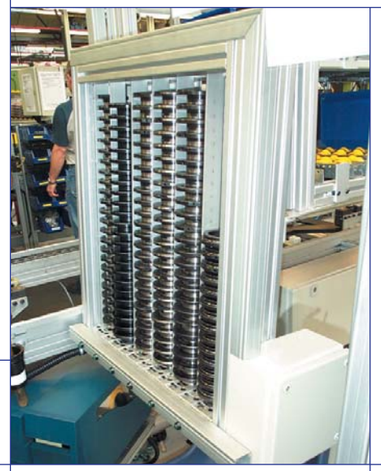
HTi: Finally, what has been the reaction of customers?

RD: Customer response has been very positive, for example when a party from Scania, a pioneer in the pursuit of manufacturing excellence, visited Huddersfield to look at the new heavy-duty line, Bo Carrick, the Swedish company's senior consultant on supply chain management, commented that "the standards and instructions, fail-safe procedures and 'poka-yoke' solutions are all to a commendably high level".

We were pleased to hear from Bo at a later date that some of the ideas he saw at Holset may be adopted by Scania.



Core assembly stations



Assembly locator carousel

Feed Conveyor for bearing housing

Holset to open a new world-class facility in China

Holset products have been manufactured in China for over 20 years. The Holset presence in this region will enter an exciting new phase by the end of 2003, with the opening of a new $8 million production facility and technical centre in Wuxi City.

As part of our global manufacturing strategy, Wuxi Holset are building a new 10,000m² world-class facility. Occupying a 30,000m² site, therefore allowing ample room for further expansion, it will comprise a turbocharger manufacturing plant, a technology centre and an aftermarket parts supply and servicing business. It will be located in Wuxi City's designated 'new development zone', some 12km from Holset's existing site.

Holset's production capabilities in what is probably the world's fastest growing market will be greatly enhanced, encompassing the manufacture of light duty, mid-range and heavy-duty turbochargers. The new technical centre will be the first in China dedicated to turbocharger technology. In its engine test cells, specific turbocharger applications testing for Chinese-based OEMs will be undertaken, as well as development testing of new and enhanced turbocharger hardware for other markets.

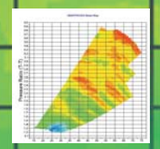
Three key business objectives have driven the development of the new Wuxi Holset facility. Firstly, there is a need to increase turbocharger manufacturing capacity. Euro 2 equivalent emission standards are being introduced in China in 2004, prompting Chinese and international OEMs to develop new lower-emission engines which must be turbocharged.

Secondly, Holset must affirm its 'world class capability' in China, enabling Wuxi Holset to build on the competitive advantage of its market-leading product line-up and sustain its position in China as the leading supplier of turbochargers to OE customers. The new facility will offer an enhanced service to new and existing customers. It is also expected to help in the recruitment and retention of talented engineers and support staff, and support local business initiatives, while meeting IS014001 environmental standards. An even greater emphasis will be placed on product quality, driven by a 'zero defects' mission goal.

Thirdly, there is the unremitting aim of sustaining profitable growth, through the application of more efficient manufacturing and commercial procedures to bring lower costs and greater added value.

Exciting times lie ahead for Wuxi Holset, with the new facility playing an essential role in our drive to establish a world class environment in every aspect of the expanded Chinese operation.

Artist's impression of the new Wuxi Holset facility



Vehicle generated noise has always received a great deal of attention. Engine Noise has traditionally been addressed by the introduction of improvements to components such as acoustic shielding and more recently, through design improvements to the engines.

Hush hush work

Like any other pollutant, noise is attracting constant attention from regulatory authorities with increasingly tough legal restrictions being introduced.

Noise generated by the turbocharger can be a particular problem. Holset is tackling this problem and has designed a unique test facility at our Worldwide Technical Centre to understand the fundamentals of turbocharger noise.

Making accurate and repeatable noise measurements of any product is difficult, but is particularly so with turbochargers. Turbochargers produce noise from a number of sources; the compressor and turbine blades generate what is termed 'aerodynamic' noise, and shaft and bearing system produce 'structural' noise. The noise we hear is pressure waves in the air, and the high frequency noise produced by turbochargers has wavelengths of a few millimetres. Often these are clearly audible single frequencies, which produce a whistle or siren-like sound. This can complicate the noise if measured in an environment such as a standard test cell where reflection of noise from hard surfaces, such as the walls, can result in interference patterns, with locally high and low levels of noise. These patterns change as the frequency, and therefore wavelength of the noise change, making detailed measurement difficult and prone to large errors.

The prominent high frequency 'whistle' noise of turbochargers is a consequence of the high rotational speeds encountered, with the frequency of major noise sources directly linked to speed. For instance, inadequate balancing of the rotor components can lead to high dynamic forces, which manifest themselves as a 'once-per-revolution' noise. As speed increases the frequency of this noise increases and -produces the distinct 'whistle' or 'whine' sound. Similarly, noise generated by compressor blades occurs at a harmonic of shaft rotational speed, related to the number of blades. This is much higher in frequency than 'once-per-revolution' sources, but again produces a distinct whistle-like sound. Holset engineers are now working to understand, reduce and control such noises, providing more refined products and robust designs. Data produced by the noise test cell is key to this process.

Commissioned in 2002, the facility was designed to meet existing international standards, however the complex nature of turbocharger noise measurement has meant that many new and innovative features have had to be developed specifically for this project. For example, the test cell comprises a number of separate chambers, which allows for simultaneous measurement of the different noise sources. Automated test and data processing procedures result in rapid evaluation of the test unit, with the results reported in a format familiar to both Holset engineers and customers already engaged in interpreting aerodynamic performance maps. The result has been a test facility that is considered to be unique within the turbocharger industry.

The test cell is now being used to characterise the noise emissions of current designs, help solve problems with existing products and provide data for the development of quieter future products. Such information will further enhance the comparative advantage of Holset's products, and ensure that Holset continues to meet and exceed customer expectations.