race engine TECHNOLOGY

50

SPECIAL 50TH ISSUE EDITION

THE COMMUNICATIONS HUB OF THE RACING POWERTRAIN WORLD

RACE ENGINE TECHNOLOGY 50/50

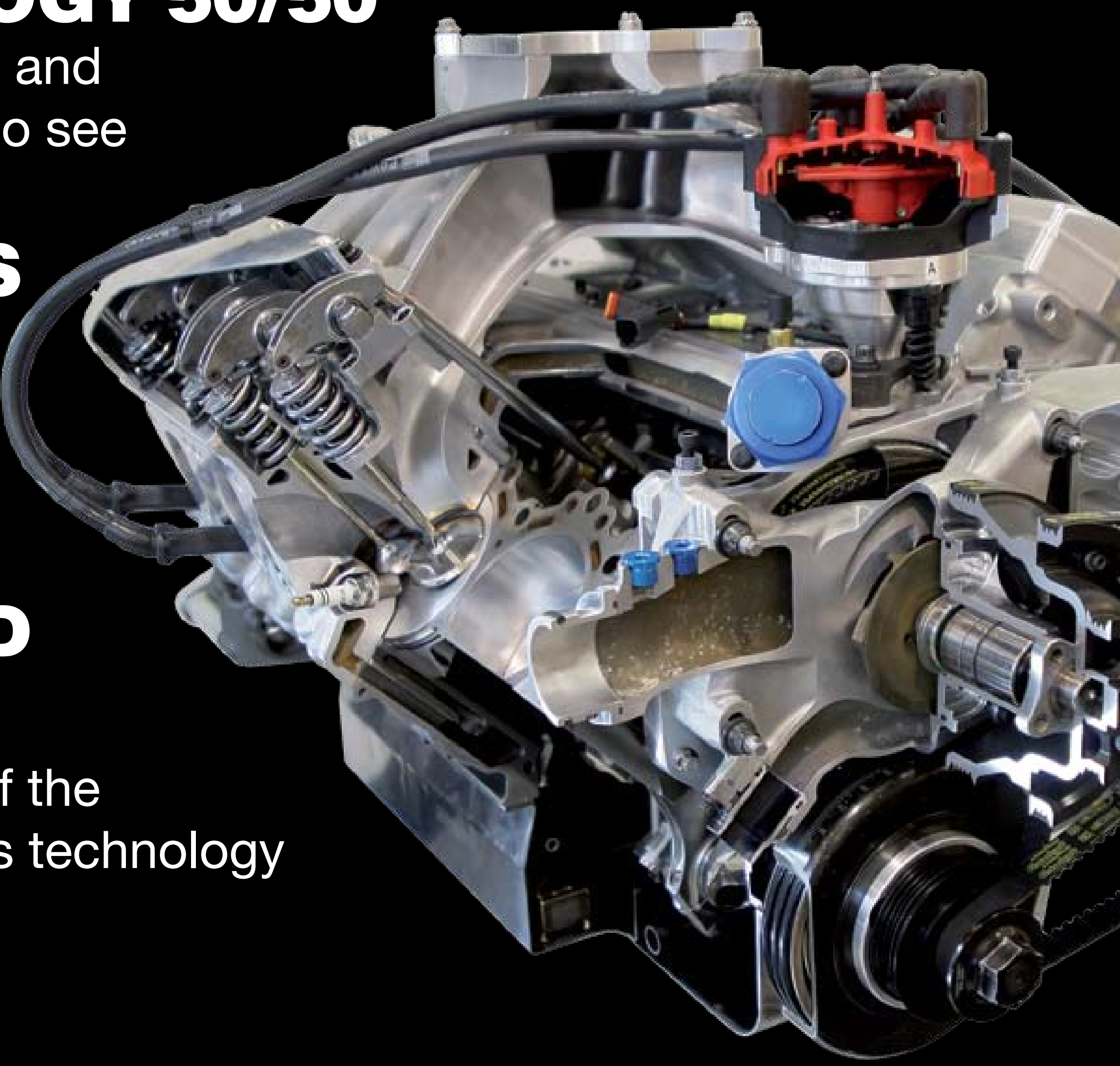
What we've seen and what we expect to see

JOE GIBBS TOYOTA

Hidden lubricant engineering

ADVANCED METALS

Keeping ahead of the game in materials technology



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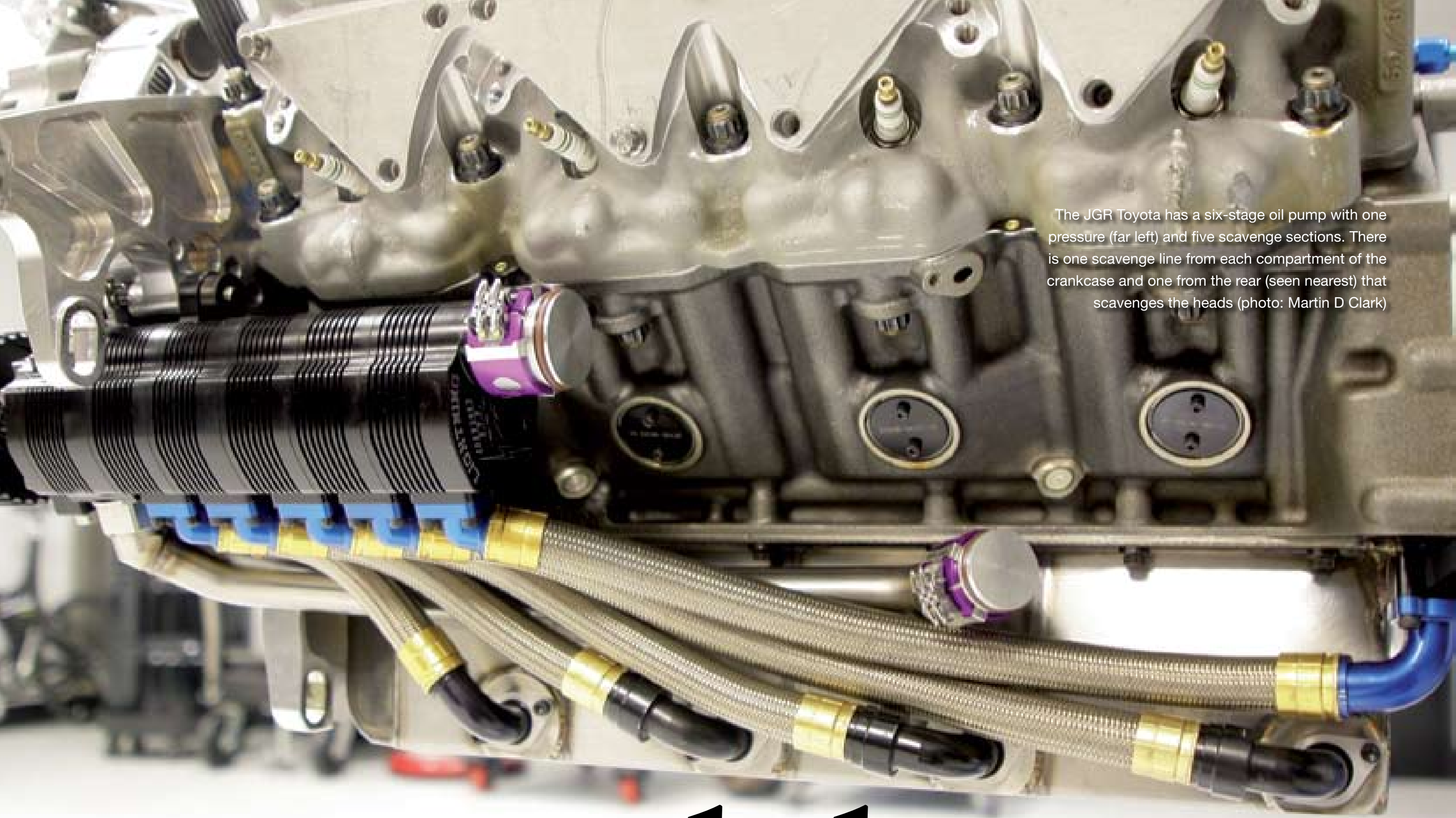


The JGR Toyota has a six-stage oil pump with one pressure (far left) and five scavenge sections. There is one scavenge line from each compartment of the crankcase and one from the rear (seen nearest) that scavenges the heads (photo: Martin D Clark)

Hidden engineering

Ian Bamsey finds out how JGR develops Toyota Cup engine components and the vital lubrication for them, all under one roof

When we look back over the past 50 issues of RET we see that, increasingly, high-end development has been pegged back by limits on engine speed – either actual rev limiters, as in Formula One, or effective rev limiters, such as the air restrictors governing Le Mans Prototypes or NASCAR's gear rule. Reviewing the contemporary focus on improving performance at a given engine speed, it becomes apparent that traditionally core aspects such as porting, valve timing and pressure wave tuning are nowadays well established; the winning edge is more likely to lie in improved component design, materials and coatings.

Above all, however, the message coming from Formula One, Le Mans Prototype and NASCAR racing is that the most crucial aspect is lubrication. The old saying goes that the key lies in the four 'Rs' – the right lubricant, in the right place at the right time and in the right quantity. That though is easier said than done. Development of the right lubricant is hugely specialised and challenging, while its ultimate application in a high-end race engine is equally taxing.

It's a crucial aspect of race engine performance these days, and is not simply a question of obtaining adequate lubrication but of providing not a drop more than each specific requirement within the engine so as to minimise the losses attributable to oil flow. Arguably oil development, its application and the implications of that in terms of component clearances, crankcase windage and so on are today's winning edge in the likes of Formula One, Le Mans Prototypes and NASCAR.

Joe Gibbs Driven

In NASCAR there is one operation that develops not only the Cup engine but also its lubricant – Joe Gibbs Racing (JGR). Its official statement is unequivocal: "We are not an oil company – we are a race team... Over the last 10 years, we have spent millions of dollars testing lubricants to find the best combination of increased horsepower and extended part life. We don't do it to sell more oil. We do it to win races and it has paid off with five NASCAR Series Championships."

The lubricant side, Joe Gibbs Driven (JGD) started with the loss of ZDDP (Zinc Dialkyl-dithio-phosphate), traditionally used in small concentrations in motor oil as an anti-wear additive. RET's fuel and lubricant expert John Coxon explains that ZDDP is a class of additive rather than a single chemical, and works not by chemical action as such but by a particular property of the compounds known as 'surface activity'. Over the years, however, the component parts of ZDDP – particularly phosphorus and, to a lesser extent, sulphur – have been linked increasingly with catalytic converter poisoning, gradually strangling it and thus reducing its useful service life.

The need to reduce the precious metal loadings of the catalytic converter, and calls for increased durability, led to requests to the oil companies to reduce the amount of ZDDP in engine lubricants or, if possible, eliminate it altogether. It was around the turn of the century that the effects of reduced amounts of ZDDP in the newer formulation motor oils started to be noticed, unbeknown to NASCAR racers who had been happily using their contracted brand of lubricants for many years. Cup engine builders were particularly hard hit due to the extreme requirement of the mandatory flat tappet.

Pushing the limits all the time, Cup teams had long noted there was enough tolerance within the regulations such that the tappet foot doesn't have to be literally flat but can be domed, albeit to a very subtle extent. At the same time, the corresponding cam lobe is given a slight taper: this strategy means contact between the cam and the edge of the tappet foot – an unavoidable consequence of pushing the limits – causes the tappet to rotate, which evens out wear. With the addition of a dedicated oil spray, contact between cam and tappet edge didn't routinely result in mechanical mayhem – at least not until ZDDP stopped coming to the rescue!

Coxon adds that the newer oil specifications were intended for use as 'factory fill' oils but very quickly 'service fill' oils had to find their way onto the market in order to prevent catalytic converter failures further down the line. While every effort was made to ensure backwards compatibility of these oils with older-design engines, as those engines gradually disappeared from regular use then demand for the older oil specification through the dealer network soon fell.

In time, and to protect against accidental catalyst failures through the incorrect choice of lubricant, the older oil specifications were withdrawn. Provision for older engines, however, was always expected to be made by specialist oil brands. In the case of the major oil suppliers, for most of their automotive customers the reduced amount of ZDDP – replaced in part by other, arguably less effective additives – was not an issue. Modern engine design, and the loads and speeds experienced under normal road traffic conditions do not generate high levels of engine wear.

Lake Speed Junior (son of the kart World Champion and NASCAR racer) heads Joe Gibbs Driven, JGR's in-house lubricant division. He recalls that Cup engine builders were initially puzzled at widespread camshaft failures but eventually word got around the garage area about the loss of ZDDP. This prompted JGR to start investigating production of its own bespoke oil.

JGR turned to the company that in 1941 had come up with the concept of ZDDP as an additive for motor oil. Formed itself in 1991, JGR had established a culture of doing as much as was feasible in-house rather than relying on vendors. It saw it as logical to work in partnership with a lubricant supplier to develop formulations specific to its requirements, as is normal in Formula One.

The key difference here is that the identity of the supplier was not disclosed, and JGR retained the rights to market the co-developed product. Of course, where Formula One engines are one of a kind, in terms of lubricant requirement Cup and Nationwide engines are not fundamentally different from those of other pushrod, stock-block V8 race engines, of which there are many thousands across the US.

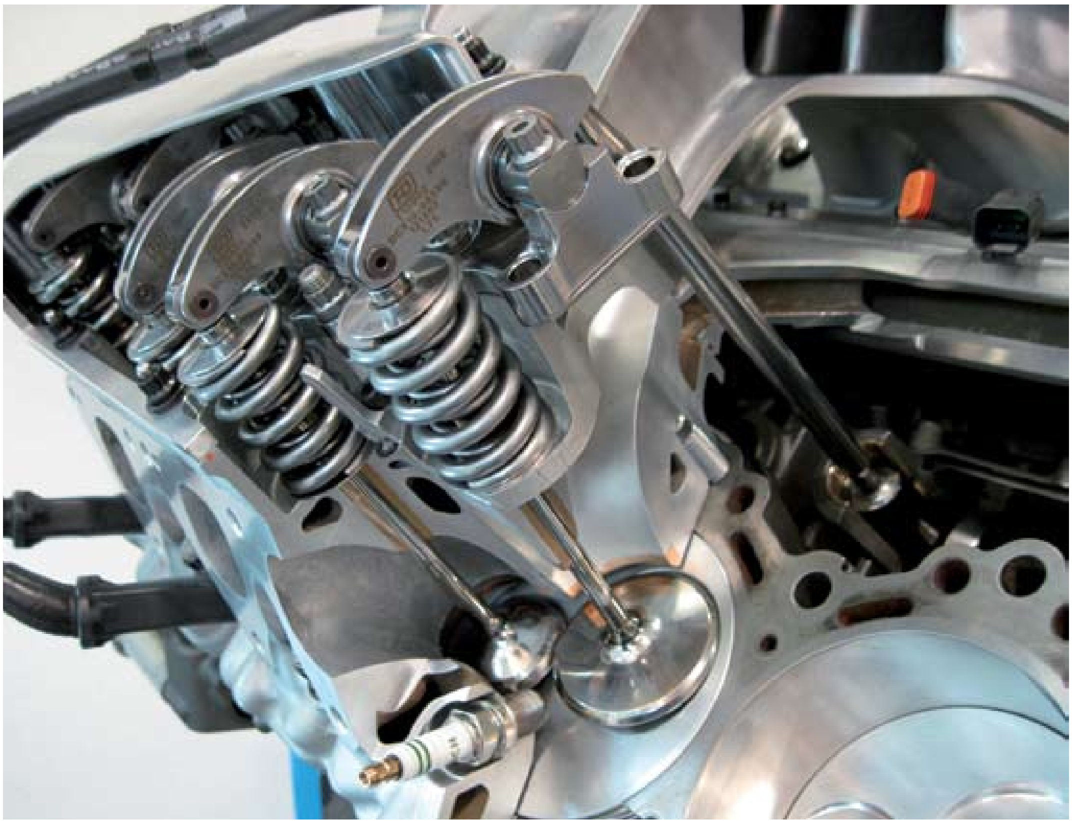
Cup engine oiling

Having started its new collaboration, JGR was able to study the individual lubricant requirements of different aspects of the Cup engine – particularly crucial are the cam/tappet interface, the ring/bore interface and the crankshaft fluid film bearings. These all have different operating conditions in terms of temperature, pressure and shearing characteristics, so it is necessary to find a good compromise between them. The right compromise will minimise friction, which in turn not only assists power output but also reduces wear and thus enhances engine life and minimises performance degradation through the course of a race.

The oil is also an important coolant within the Cup engine, however, so this function had to be taken into account as well. JGR was now ▶

Cutaway model of the 2009-spec JGR Toyota Cup engine (photo: Martin D Clark)

Cutaway of the 2009 Toyota Cup engine showing elements of the valvetrain including lifter, pushrod, rocker, valve and valve return springs (photo: Martin D Clark)



free though to develop the critical areas of the engine, in terms of materials and coatings, in conjunction with developing the lubricant. For example, ideally bore coating (if any) should be developed in conjunction with honing pattern, ring specification and lubricant specification. JGR was now in that ideal scenario.

Of course, tribology – the science and engineering of interacting surfaces in relative motion – is a daunting discipline, and JGR did not undertake the new challenge lightly. Speed Jnr says that from the outset there was a clear programme of progressive lubricant development.

JGR oil development

One characteristic of all the JGD lubricant used for Cup and Nationwide engines is that it is a synthetic rather than a mineral oil. "Synthetic technology allows us to produce oil that acts as both a lubricant and a coolant," Speed Jnr explains. "It is particularly important to cool the pistons and the valvesprings with oil spray jets. Mineral oil wouldn't survive the contact temperature as it hit the underside of the piston crown.

"The current JGD Cup and Nationwide lubricants are synthetic race oils with friction modifiers and so on, to help make more power as well as providing the necessary cooling," he says.

At first (in 2000), the concentration was on developing the baseline oil package, with the focus on overcoming the wear issues that had been associated with the loss of ZDDP from the previous oil. Since it was developing specific race oil, JGR was in a position to exploit ZDDP as appropriate, and it looked to a fast-acting ZDDP. It was also able to exploit a relatively high level of sulphur.

The next step, explains Speed Jnr, was to gain horsepower from lubricant development without compromising durability. This led to additive package development, a programme that began in 2004.

In fact, it was not until 2004 that JGR started marketing its oil to the wider racing community under the Joe Gibbs Driven banner. By this stage, Speed Jnr remarks, ZDDP levels had dropped further in regular motor oil, affecting huge numbers of flat-tappet V8 racers, even though their engines weren't as extreme as those of the Cup series. "There was then a pressing need for our product from flat-tappet racers across the US," he recalls.

Beyond development of the additive package, there was a further step to a 'third generation' of JGD lubricants, Speed Jnr remarks, which came in the spring of 2009. He adds that there isn't a generic specification of JGD oil – it is all application-specific.

In general terms, running higher rpm calls for lower viscosity oil. Cup Open engines run higher rpm than Plate or Nationwide engines but also produce far more power. Here there is a compromise since higher power and higher temperatures require higher viscosity oil.

Speed Jnr also notes that oil viscosity is not a fixed figure since in operation oil loses viscosity with rising temperature. On track, the oil temperature can vary from 200 Fahrenheit to 270 between solo running and hooking up in the draft.

In terms of dilution of the oil by fuel, Speed Jnr remarks that this is a small but significant factor in the case of a gasoline-fed Cup engine. For example, at the 2009 Bank of America 500, this was measured from one engine after the race as fuel comprising 0.5% of the content of the lubricant. "That does imply a loss of viscosity," Lake Jnr remarks.

NASCAR oil specification

These days a JGR Cup Open motor runs SAE 5W20 XP1 oil, and a Cup Plate motor SAE 0W20 XP2. The XP2 oil is also used in the Nationwide Open motor. In addition to those two NASCAR race oils there is the thinner XP0 SAE 0W qualifying oil. The Nationwide Plate motor runs a blend of XP2 and XP0.

In 2009, XP1 and XP2 were both upgraded using improved chemistry (retaining the same designation). Speed Jnr notes that XP1 and XP2 were established in 2004 and had the same formulation through to 2009. "We had tested other oils on the dyno but it wasn't until 2009 that we had a gain of both horsepower and durability."

The initial step for 2009 was an upgrade of XP2 worth, on the JGR dyno, 1 bhp just below peak power (for a fatter power curve) for no loss of durability. In fact, testing on the dyno revealed improved parts wear. After three full Daytona 500 simulations, all of them successful, ▶

SPECIFICATION: JOE GIBBS RACING TOYOTA CUP V8

Joe Gibbs Racing Toyota, open version
NASCAR Sprint Cup
90º V8
4.180 in x 3.250 in / 357 cu in
Naturally aspirated
94 Octane 260GTX Sunoco Racing Fuel
Iron block and aluminium heads
Linerless
Five main bearings, plain
Steel crankshaft, four pins
Steel con rods
Light alloy pistons; three rings
Pushrod, belt-driven single camshaft
Two valves per cylinder, one plug
Splayed and canted intake valves, upright exhaust
Valve sizes undisclosed
Analogue electronic ignition
Single carburettor
12:1 compression ratio
Maximum rpm 9600

JOE GIBBS RACING ENGINE DEPARTMENT SUPPLIERS

Heads: TRD
Block/Crankcase: TRD
Crankshaft: SP Crankshafts
Camshaft: In-house
Timing Drive: CV Products
Pushrods: Trend
Tappets: Precision Products Performance Center
Rocker Arms: In-house
Pistons: Bill Miller Enterprises
Rings: Total Seal
Piston Pins: Precision Products Performance Center
Con Rods: Carrillo
Big End Bearings: Clevite
Main Bearings: Clevite
Seals: Race Tec Motorsport
Fasteners: ARP
Valves: Del West
Valve Seats: Del West
Valve Guides: CV Products
Valve Springs: Performance Springs Inc
Ignition: MSD
Spark Plugs: Bosch Motorsport
Distributor: MSD
Carburettor: In-house
Water Pump: Adams
Oil Pump: Dailey Engineering
Alternator: McLaren Electronic Systems
Exhaust: Good Fabrication
Filters: Wix
Fluid Lines: Brown & Miller Racing Solutions
Wiring Loom: In house

it was fruitfully introduced for all the JGR cars at the 2009 Daytona 500. Thus validated, it was run at all subsequent Cup Plate races that year.

The corresponding upgrade of XP1 did not appear until late in the season, at Charlotte's Bank of America 500 where only the #02 car used it. Following a successful drain analysis it was used by the same car at Texas and again, along with the #18 car, at Homestead. With this validation it became standard issue for 2010.

The XP1 upgrade was actually in two steps – first the additive package was changed, then the base oil. The upshot, as seen on the JGR dyno, was an improvement of 2 bhp, again just below the peak power speed, together with superior wear characteristics.

XP2 followed the same two-step process. Step one was that used in the 2009 Cup Plate races, step two made its debut at Homestead at the end of the season in the two JGR Nationwide cars, one of which won the event.

Again worth 2 bhp just below the peak power speed as measured on the JGR dyno, step-two XP2 is the standard issue for Cup Plate and Nationwide engines in 2010. At the same time, XP0 has undergone the same two-step upgrade as its two sister NASCAR oils.

Using JGD oil in the Toyota Cup V8

The Toyota Cup car's engine oil system is such that the lubricant is pumped from the oil tank to the engine via an oil/air radiator and then an oil filter. JGR uses a Wix element in its own inline aluminium filter housing.

Speed Jnr notes that these filters offer low flow restriction with ease of servicing. Good access is particularly important since raceday data acquisition is banned, so the filter, along with the spark plugs, is a vital tell-tale sign of engine health.

"You soon learn what the filter is supposed to look like if the engine is running trouble-free," remarks Speed Jnr. "It is a good safety check.

"For example, at the 2009 (Indianapolis) Brickyard 400 the #20 car (Joey Logano/JGR Toyota) ran well in Happy Hour but afterwards we noticed tiny specks of aluminium in the filter. That prompted a borescope investigation of all the cylinders, which revealed top ring land damage on one of the pistons. An engine change dropped the car to the back of the field but at least it finished the race."

From the filter the oil enters the engine via a single connection to the front, which feeds it into the main gallery. The main gallery runs just beneath the single central camshaft (located in the valley) along the length of the engine. Each main bearing is fed in turn directly from the main gallery and then the adjacent big end is fed through a drilling in the crankshaft, in the conventional manner. The main gallery also feeds an oil spray jet for each cam/tappet interface.

At the rear of the main gallery, oil is fed into a distribution plate, which sends it through various additional passages. Oil is fed from the distribution plate to the piston oil spray jets, to the lifter bores and to each head, where in turn a passage feeds twin spray jets for each valve spring assembly. The oil passing into each lifter bore not only lubricates that but also passes into the hollow body of the lifter and then up through the pushrod, to lubricate the pushrod/rocker interface. The rocker itself pivots on needle roller bearings, which do not require forced oiling.

Thus oil arrives in the respective head at each pushrod/rocker interface and as a dual spray to each valvespring. In the past, some NASCAR engines used valve cover galleries to feed the spring spray jets but the Toyota engine incorporates the necessary gallery into the head casting. Oil drains back from each head into the central valley, where it helps lubricate the camshaft, along with the oil spilling from the cam lobe/tappet sprays (since the camshaft runs in roller bearings it does not require forced lubrication of its bearings).

Oil is scavenged from the rear of the valley and from the crankcase, which is divided into four compartments. NASCAR regulations mandate a maximum of six pump stages, so with five scavenge stages plus a pressure stage there is no room for an oil/air separator.

The five scavenge stages feed back through a single line to the oil tank. Air and blow-by gas in the returning oil flow has to be separated out at the tank. Mark Cronquist, director of the JGR Engine Department, says there is a swirl-pot arrangement within the tank, which is fed at the top and supplies from the bottom.

This arrangement though is nothing 'trick'. Cronquist remarks that, invariably, attempts to produce sophisticated separation systems don't transfer well from dyno development to the track, due to the g-forces acting on the car. "In years of development we've found nothing special that works really well on the track," he says.

In fact, Cronquist reports that the key to separating out the air/blow-by gas is the time the oil spends in the tank – "the longer the better". It follows that, ideally, the oil flow rate through the system is backed right off, but since that calls for more oil in the system, adding to car running weight, there has to be a compromise.

Cronquist reports that JGR's target is to circulate the oil at the rate of 10 gallons per minute, but for various reasons the current flow rate is 10.5-11 gallons per minute. Given that rate, and the fact that there are six gallons in the system at the start of a race, it follows that the oil in the tank is replenished almost twice per minute.

Cronquist says the engine can be run with only five gallons in the system but that the reduced time the oil consequently spends in the tank, and the ensuing increase of air/blow-by gas in the oil flow, can lead to cavitation at the big end bearings. Gas that is removed in the tank escapes through a dash-20 breather line to a catch tank at the rear of the car. Cronquist reports that this tends not to collect oil, except on very rare occasions when humidity has caused water to penetrate the engine and dilute the oil (even then, normally, engine warm-up will evaporate the water).

The running oil pressure is adjusted at the pump, by changing the spring in the pressure relief valve, which provides a range of 35-95 psi. Currently the pump is set to supply oil at a pressure of 65 psi. Cronquist says, "We have varied the pressure with development of the engine – it is a tool helping to get the oil to the right places in the engine."

Pressure is seldom adjusted at the track. If it diverges significantly from the set amount, that tends to be the sign of an engine problem.

Cutaway of the 2009 Toyota Cup engine showing valve spring cooling oil spray jets (photo: Martin D Clark)

In respect of temperature, the aim is to run that which gives best power, but inevitably on track there are temperature fluctuations according to running conditions. In this engine the XP1 oil gives best power at 240 degrees Fahrenheit and its temperature tends to run in the 240-260 degrees band. The thinner XP2 oil for the Plate engine gives maximum power over the 230-245 degrees band but in this application the temperature fluctuation is higher, mainly due to the effect of running in the draft.

Oil temperature is controlled by the size of the oil radiator, which sits immediately behind the water radiator in the nose of the car. The team knows which size of oil radiator is required to work in conjunction with any given water radiator. The radiator sizing tends to be consistent from track to track, varying only between Open and Plate configurations. For logistical reasons the team, including the driver, generally monitors only the water temperature since it and oil temperature are interlinked.

Engine/oil interaction

Cronquist says clearances in the Toyota Cup engine are specified according to the specific oil to be used. Clearly, thinner oil works with tighter clearances. In addition, the various spray jets have to be tailored according to the oil specification. In effect, for JGR the oil is an integral part of any engine-build specification.

The general approach to engine development is to minimise the amount of oil circulating within it, confirms Cronquist. He adds that one benefit of this is that the oil can spend more time in the tank. "In engine development we work a lot on directing oil to precisely where it needs to go; where the hot spots are," he says. "We have managed to progressively reduce the oil flow, especially through development of the piston and valvespring oilers."

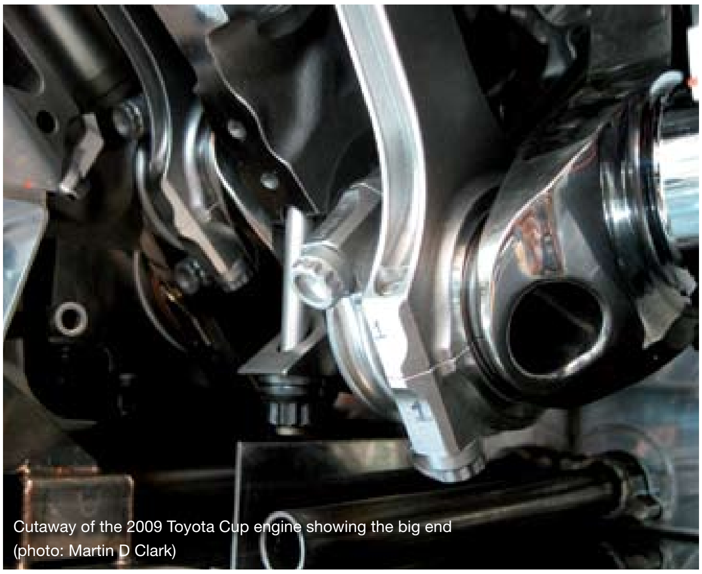
The current JGR Open and Plate engine specification is four oil spray jets per piston. How those four jets are used is the key. Logically, the exhaust valve side of the piston requires more cooling than the intake valve side, but the approach is far more subtle than that. JGR has years of data, especially from routine post-race hardness testing of each engine's eight pistons to help it understand where the cooling is required for each cylinder's piston.

There is naturally a different piston cooling requirement between Open and Plate engines. In addition, in each case there is a variation in cooling requirement from cylinder to cylinder.

Cronquist reports that even the re-paving of Talladega caused an issue in respect of piston cooling. The drivers ease off the throttle in the draft (due to the effect of the slipstream) and, thanks to the new pavement, there was more part-throttle running than before. In turn, that put more heat into the pistons and some cylinders were affected more than others. That is due to the way the single four-barrel carburettor's butterfly operates – as it rotates from fully open it affects the airflow to some cylinders more than others.

Likewise, in the case of a regular Open engine, there are variations in the loading between cylinders. Thus the four-jet package for each cylinder's piston always has to be tailored individually.

In the past, JGR has run oil up through a drilling in the con rod to lubricate the small end, but nowadays that technique is not required ▶


Cutaway of the 2009 Toyota Cup engine showing the big end (photo: Martin D Clark)

since, following the move to four jets, there is more oil being sprayed to the underside of the piston. Thus, as well as cooling the piston, the oil spray now has the role of assisting lubrication of the small end. It also helps lubricate the ring/cylinder wall interfaces.

At the top end, where there are two spray jets for each valvespring (or coaxial pair of springs), again the provision varies between Open and Plate engines, and in both cases it is not uniform across the two banks. As the car enters a turn on an oval circuit it is always going left, so the oil sloshes to the right, so special provision has to be made to oil the springs properly on the left-hand bank; for example, the jets are positioned closer to the spring. Cronquist observes that special attention has been given to separating the oiling system between the two banks on the most recent Ford engine – this impresses him.

It is oil spilling from the various valvespring sprays that primarily lubricates the respective valve stem. A stem seal controls how much oil passes down into the valve guide. Clearly the exhaust valve requires more lubrication than the intake, due to the higher temperature of operation. The oil passing through the guide runs out in the port.

On the exhaust side that isn't a problem since it is blown out of the exhaust. Cronquist says the amount of oil passing into the intake port and thus mingling with the intake charge isn't enough to be an issue. "You don't know it's there," he says.

In the JGR Toyota the interface between the valve and the rocker operating it doesn't get special attention, since a roller wheel is fitted to the nose of the rocker. JGR doesn't favour the approach of a rollerless (pad-nosed) rocker, which logically calls for extra lubrication.

In these engines one of the most crucial interfaces is that between the tappet and its cam lobe. JGR uses a DLC-coated tappet and a plain-finish camshaft, and it has found that Balzers' DLC works well with its oil, whereas a rival DLC is less successful. "The performance of the coating seems to be specific to the oil," remarks Cronquist.

For the piston pin, JGR has run the same supplier-specified DLC for five years, without issue. Normally, unless there has been some sort of unusual detonation issue, the pins look like new at the end of a race. DLC is not used on the piston skirt, however, nor on the rings. Those applications are not considered vital, either in terms of performance or performance degradation over the course of a race, and both represent a degree of risk.

Cronquist says JGR's oil development programme has helped to minimise performance degradation through the course of a race. This is particularly important in respect of the ring/bore interface, he notes. "If the rings get hot the oil gets abused. The better the lubrication here, the better the performance of the rings and the less degradation that will occur," he says.

Clearly, this comes back to the cooling provision for the piston, which in turn helps the rings run cooler. Some oil from the piston spray jets will also find its way onto the cylinder wall, again assisting ring performance. Cronquist notes that ring performance is also related to piston development – in particular the stability of the ring belt provided by a given design.

There is a compromise here, however, since the piston that is more stable tends to create more friction between its skirt and the cylinder wall. "We work to attain the right compromise," Cronquist says.

In practice, ring performance is such that Cronquist reports very little oil passing into the combustion chamber. "That is important – if oil gets burned there, that will carbon-clog the gas ports, which help seal the top ring," he explains. "So we monitor the situation to ensure we keep oil out of the chamber."

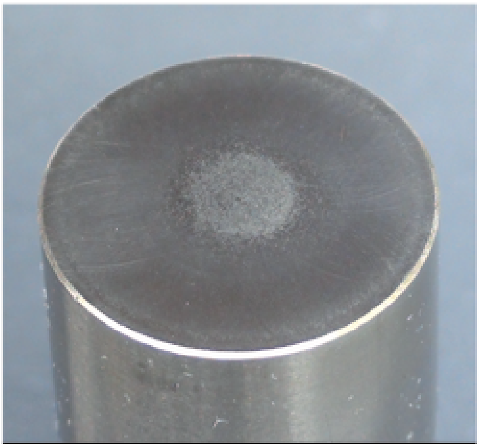
By the same token, the very effective ring package developed by JGR keeps blow-by to a minimum. "We don't see a lot of blow-by – unless there is a vacuum leak," remarks Cronquist. Given that the crankcase runs at well under atmospheric pressure it will draw in air if there is any problem at the crankcase/oil pan interface or with the crankshaft oil seals. Such problems are rare but, for example, it is not unknown for a seal to get a nick when it is installed, causing a vacuum leak.

Cronquist notes that JGR uses main bearings without a Teflon coating, since it has found that wear of such a coating affects running clearance through the course of a race. "If we set our clearance as 1.5 thou, using a Teflon coating it will be 2 thou by the end of the race. The Teflon-coated bearing is more forgiving on start-up, which is when most bearing/crankshaft wear occurs. We would rather accept a little wear in return for consistent clearance," he says.

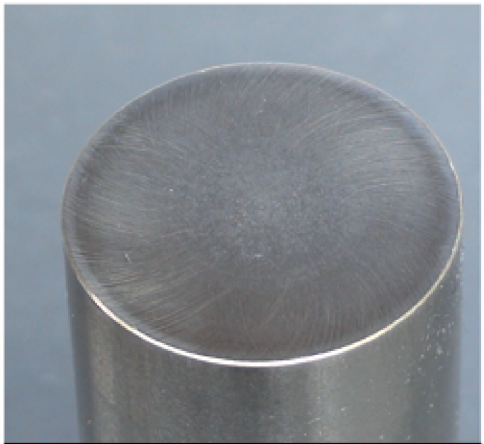
Crankcase windage is another factor into which JGR has put a lot of work. "The biggest thing is to get the oil out fast," Cronquist says. "The major gain came when we all started dividing the crankcase into separate compartments. Aside from that, it has been a matter of how you funnel the oil to the respective scavenge pick-up, and I think we all have a similar solution. However, the detail design is crucial, including the size and location of the scavenge pick-ups".

These days, for qualifying, although the race engine has to be used it is permitted to change engine oil before and after the run. Cronquist says the dedicated JGD qualifying oil (XP0) allows more engine performance to be extracted for two laps without harming the engine for the race.

"In the days of qualifying engines we had some very exotic oils and some radical oiling strategies, but those engines only had to last two laps," he says. "Now the motor must do the race, too, so we cannot afford to hurt it!" ■


API SN Oil


GM dexos 1 Oil


Joe Gibbs HR-4 Oil

WEAR TEST RESULTS

2011 brings new oil specifications for passenger car motor oils. Don't worry, we've already done the homework for you. We hired an independent engine builder to test these new oils in a flat-tappet, 383 c.i. engine to determine the wear results.

The pictures tell the story. After 6 hours on the dyno, the lifters using the Joe Gibbs HR-4 oil show no visible wear. The lifters using the new API SN and GM dexos 1 oils already show signs of wear.

Each lifter pictured above was broken-in for 30 minutes with Joe Gibbs BR Break-In oil, and then ran for 6 hours - cycling between 1,500 RPM and 4,000 RPM - on a 302 duration, .460 inch lift camshaft with 270 lbs. open valve spring pressure.

Even our used NASCAR flat tappet lifters show no visible wear after 728 miles of competition at 9,000 RPM and over 500 lbs. open valve spring pressure.

Lab results support the visual evidence. Scanning Electron Microscope surface analysis of Joe Gibbs Racing's used flat-tappet lifters revealed Joe Gibbs BR Break-In oil and XP1 Synthetic oil work together to create protective films on both the cam lobe and the DLC coated lifter.


Even after 728 miles of competition, XP1 prevented visible wear on these lifters.

Wear Metals	Joe Gibbs BR Break-In Oil	Other Brand Break-In Oil
ALUMINUM ppm	10	27
LEAD ppm	43	67
COPPER ppm	18	44
IRON ppm	37	84

Used oil analysis reveals that Joe Gibbs BR oil reduces wear during the break-in process.

The "system" of using BR followed by XP1 or HR-4 delivers proven protection.

Used oil analysis after break-in also proves Joe Gibbs BR Break-In oil reduces wear.

Two engines were broken-in on the dyno. One engine used Joe Gibbs BR Break-In oil. The other engine used another brand break-in oil. The engine builder reported a visual reduction in wear on the lifters using the Joe Gibbs BR, and the used oil analysis report shows the Joe Gibbs BR produced less wear metals than the other brand break-in oil. Less wear during break-in means longer engine life.

All of these results point to one thing - the "system" approach works. Using Joe Gibbs BR Break-In oil provides the foundation for protection. The XP series of synthetic racing oils build off that foundation to provide race proven protection. The HR series of high performance oils delivers cam wear protection for muscle cars.

Interested in changing your definition of "used" parts? Visit JoeGibbsDriven.com for more details or call 1-866-1820.

JOE GIBBS DRIVEN RACING OIL

SERIOUS OIL FOR SERIOUS ENGINES