OU-72/OW72

Yamaha's Answer To The Harley XR750

(There was a time when the XS650 shed its wimpy reputation and put on Superman's cape!)

This 90 horsepower hybrid was the final evolutionary step in the XS650's development as a race engine. In 1975-1976 a really talented team of Southern California tuners, fabricators and specialty suppliers engaged in a crash program to create a version of the engine that could take on the factory Harley XR750s. The nomenclature is seen as both OW72 and OU-72 in publications from the time, however a Yamaha International Corporation publication in 1976 refers to it as OU-72, so that's what I'll use.

At the time, Kenny Roberts was Yamaha's only fully sponsored AMA dirt track competitor, and Yamaha was eager to do whatever it took to help him retain the number one plate. Everyone understood that the number one goal was to make the XS650-based dirt tracker a more effective weapon. Essentially, this meant it needed more power. In late 1974 Yamaha USA had hired Tim Witham, founder of S&W Engineering, and a very highly respected ex-dirt track tuner, to manage an engine improvement program. He was somewhat successful and managed to squeeze another approximately 10 horses – probably reaching the mid-70s if tested on a modern dyno - while still using highly modified stock castings. Reliability was becoming a problem however, and the final versions had strengthened crankcases, stronger gearboxes, clutches, beefy connecting rods and upgraded valve trains. Unfortunately, the alloy Harley XR750 was evolving also and continued to retain a small but very real advantage.

Facing 1976 with few tuning options left, the stock head castings became the obstacle that couldn't be overcome. Every trick was tried by the very best air flow specialists available, but they couldn't make the stock head flow any more air and still retain any kind of a manageable, linear power band.

Consulting with C.R. Axtell and a number of other specialists, Witham had a set of engineering drawings put together that depicted a new head casting that would have higher flow potential while retaining the necessary interfaces with the stock barrels and cases. The new design featured revised intake and exhaust valve angles and straighter, larger ports with optimized shapes. Also included was a new barrel with some detail changes including "750 cc" replacing the stock engine's "650 cc" raised lettering on the casting.

In July 1975 Pete Schick, Yamaha's Racing Manager in the US, met with Yamaha engineers in Japan and asked them to cast at least 24 prototype heads per the drawings he'd brought with him (24 or more heads were needed because per the racing rules in force at the time the AMA had to see 24 actual, running units in Yamaha's Southern California distribution warehouse before permission could be given for use in the 1976 racing season). The timing was good because Yamaha was just getting into four strokes and Yamaha's Engineering management thought this would be a good exercise for the production team and

also, of course, because it would assist Roberts to retake the number one plate and sell more Yamahas in the US. They agreed to supply the castings.

It was already October 1975 and there was no time to waste. The team only had eight months before the engine's scheduled debut in May 1976 at the San Jose Mile.

A few months later the first castings showed up. They had no real ports – more like small tunnels along the port's centerline, no valve seats or guides, and of course no camshafts, valves or valve springs. Everything had to be spec'd, sourced, fabricated, or cut. Vendors were developing and producing improved pistons, gears, rods and even the crankshafts had to be specially weighted, balanced, and fitted with larger crankpins. Dozens of pairs of cases were magnafluxed to find those with the fewest casting flaws.

On April 14th, just a little more than a month before San Jose, the first engine fired on the dyno at Yamaha's race shop. Bud Aksland had assembled the engine himself and after four hours on the dyno he saw larger torque and horsepower numbers than any prior Yamaha XS650/750 race engine had ever produced. The 24 complete running bikes with OU-72 engines were frantically assembled by borrowing mechanics from Yamaha's snowmobile division. This was completed just in time for Earl Flanders, an AMA tech inspector, to check out the bikes at Yamaha International Corporation's facility at Buena Park. To make sure he wasn't being given a snow job, Earl had them tear apart some of the engines and also started a few others. Everything passed and the OU-72 would be recommended for approval at the AMA Professional Rules Committee meeting on May 4th.

Actually, none of the engines Flanders inspected were the race versions. Six race engines, including three earmarked for San Jose, were receiving special cams, pistons and other components as rapidly as they could be fabricated and delivered. C.R. Axtell and Mike Libby were flowing and finalizing the new head's ports and zeroing in on desired camshaft lobe contours. Kel Carruthers in San Diego had three race bike chassis ready awaiting arrival of the completed engines. Sig Erson, Forged True, Webster Racing, Pete Smiley and a host of others worked incredible amounts of overtime to make it all happen.

On May 6th the engines were run on an engine dyno (not a chassis dyno) and recorded numbers that translate to approximately 90 horsepower. The still hot engines were immediately trucked to San Diego so Carruthers could install them in the three race bikes. On May 9th the fully assembled bikes were taken to the deserted Santa Clara County Fairgrounds (which had been rented for a day of private testing) so Kenny Roberts could have an initial outing on the bikes. To everyone's relief and joy, the test was a complete success.

The race weekend began on May 16th. In practice, Roberts and the OU turned laps around 38 seconds; only one of the Harleys was as fast. Engine power

wasn't the problem … there was plenty of that. However, once Robert's fresh tires began wearing traction became an issue. By the mid point in his heat race Robert's bike was slewing dramatically, getting too sideways to maintain momentum and losing traction on each drive out of a corner. He had to make a last lap pass to transfer directly to the main event.

Unfortunately, the story doesn't have a fairy tale ending. As a final exclamation point on a frustrating day, the bike refused to start for the main. A later inspection revealed a coil wire coupler had failed and caused a short. The tiny part may have cost ten cents. After a few more race weekends the frame geometry and suspension were tweaked and tuned to provide a better balance, traction wasn't a continuing problem and the OU-72 went on to win its share of AMA national and regional events.

During 1975 - 1976, additional batches of heads – totaling perhaps 50 or 60 - were sent from Japan to the Yamaha Race Department. Most were sold to privateers and non-factory tuners. Cutting ports into a head from scratch is a daunting task and few are up to such a challenge. It is unquestioned that the best OU-72 heads were those ported by C.R. Axtell and Mike Libby. Axtell's shop continued to develop and evolve the OU-72's porting and component specifications throughout 1976. Their engines routinely produced 80 – 83 rear wheel horsepower as we would measure it today, and featured very progressive, powerful torque and horsepower curves. But, there weren't very many of those as a percentage of all the OU-72s being run at flat tracks across the nation. The average, so-called privateer OU was generally not as effective as a high level, expertly modified AMA Grand National caliber XS750 with a stock-based head, and many OU-72s were simply expensive underperformers.

As Yamaha *exotica* goes, an OU-72 engine in reasonable shape is the cherry on top of a XS650 sundae. An unmolested unit from Axtell's shop is the Holy Grail for serious collectors and vintage competitors.

► *The following is a retyped copy of the Yamaha International Corporation Racing Department OU-72 Specifications sheet published in September 1976.*

MODEL	XS750-DT (OU-72)
MAXIMUM HORSEPOWER	(not listed)
MAXIMUM TORQUE	(not listed)
BORE X STROKE X CYLINDERS	80.5mm X 74mm X 2
DISPLACEMENT	744.5cc (45.43 c.i.)
COMPRESSION RATIO	11.5

IGNITION	Total Loss
CARBURETOR	Lectron 36 – 38mm
AIR FILTERS	K & N Oiled element
FUEL	98+ Octane
CYLINDER HEAD	OU-72 with 29º (IN) valve angle, 27º EX Flow ported by C.R. Axtell (see enclosed flow charts)
VALVE GUIDES	Aluminum bronze
COMBUSTION CHAMBER VOLUME	36cc with pistons
HEAD GASKET THICKNESS	Copper .055”
CAM SHAFT	Sig Erson 224 - 104
VALVE SPRINGS	S & W Engineering
SPRING RATE	305 lb. per inch
Installed length (closed)	1.600”
Installed pressure (closed)	120 lbs.
Compressed length (open)	1.100”
Wire diameter	.160” outer springs, .120” inner spring
Number of windings	6 turns outer, 7 turns inner
VALVE TO PISTON CLEARANCE	Figure varies according to pistons and cam timing
	Intake .050” minimum
	Exhaust .070” minimum
VALVE – INTAKE	Modified high performance GM valve by C.R. Axtell
Clearance (cold)	.006”
Head diameter	44mm
Length	109.7mm
Seat width	.065”
Seat angle(s)	45º and 37º
Margin thickness	.6mm
Stem diameter	8.0mm (O.D.)

Stem to guide clearance	.0013”
VALVE SEAT – INTAKE	
Angles	45º and 53º
VALVE – EXHAUST	Modified high performance GM valve by C.R. Axtell
Clearance (cold)	.008”
Head diameter	38mm
Length	116.4”
Seat width	.065”
Seat angle	45º
Margin thickness	.6mm
Stem diameter	8.0mm
Stem to guide clearance	.002”
VALVE SEAT – EXHAUST	
Angles	45º and 60º and 67.5º
CYLINDER	OU-72
Bore diameter	80.5mm
PISTON	Forgedtrue (1474-A modified to fit)
Clearance	.006”
Pin to crown	25mm
Pin to skirt	32.5mm
Rings	Standard TX750 (2nd O.S.)
Ring clearance	Standard TX750
WRIST PIN	Harley XR-750
Diameter	20mm
Length	60.75mm
CONNECTING ROD	Warren Machine (Carrillo)
Length	5.670” (8mm longer than standard)
Small end I.D.	20mm

Big end I.D.	39mm
Small end width	22.0mm
Big end width	22.0mm
Clearance(s)	Standard XS650
CRANKSHAFT	0.25” band added to O.D. and three additional weights added in holes opposite pins.
Metal added	“Malory” metal
Crank pin diameter	29.0mm O.D.
Balance factor	67%
Total weight added	9 lbs. (added to flywheels only)
Dimensions	Standard XS650 tolerances
CLUTCH	Modified hub – hub is deeper and has more plate and load capacity
Friction plates	Standard metal friction 9
Clutch plates	Standard clutch plate 8
TRANSMISSION	Special close ratio by Webster Racing

Ratios	Drive Axle	Driven Axle	
1st	13	23	1.769
2nd	15	22	1.466
3rd	16	20	1.250
4th	18	20	1.110
5th	19	20	1.050

CARBURETOR	Lectron – tract length 7” from head to carb center
Size	36 or 38mm
Needle	2 – 3 needle; 2 turns down
LUBRICATON SYSTEM	Standard
Capacity	2.0 quarts
Recommended Oil	Mobil or Valvoline Racing
IGNITION	Total loss
Ignition timing	34º

Point gap	.012” - .015”
CONDENSER	Standard XS650
SPARK PLUGS	Champion R84G (12mm)
Gap	.022”
Battery	12V
COIL	Chrysler Marine
EXHAUST	
TT racing	1 ¾” X 42” exhaust pipe
½ mile and mile racing	1 ¾” X 28 ½” exhaust pipe
Megaphone (for mile racing only)	1 ¾” opening with a tapered body that extends for a length of 17 ¼”; at which point the megaphone has a width of 3 ½” ; this is followed by a 1” reverse cone angled so that the exhaust exit opening has a diameter of 2 ½”.

The following information is current as of 9-11-76. For updates or any questions, contact Y.I.C. Racing Department (714-522-9397).

LATEST HEAD (#4) AS OF 9-9-76 (C.R. AXTELL)

Inches of valve lift	Intake	Exhaust
.100”	35	15
.150”	75	40
.200”	128	75
.250”	180	125
.300”	240	175
.350”	295	200
.400”	332	230
.450”	330	265
.500”	335	275

(Figures are relative to flow bench C.R. Axtell)

Best flow (highest numbers) to date. Head not run yet.

► *What followed here was a list of suppliers. The data isn't helpful because all of them have either moved or are no longer in business. The names included well know vendors such as Axtell, S&W Engineering (now R/D Valve Spring), Forgedtrue pistons, Carrillo, LA Sleeve, Shell Racing Specialties, etc.*

► *This note appeared at the bottom of the September 1976 OU-72 Yamaha publication:*

NOTE: Before ordering any of the above items determine the exact model and year. Secondly the purpose. The above items may require extensive reworking (machining) before they are usable. Others can be used as supplied.

This engine was developed for professional racing purposes only with cost not being a factor. If you are not an experienced engine builder or have limited funds we urge you to refrain from attempting an OU-72 type engine.

Should you have any questions please contact Y.I.C. Racing Department before ordering parts or service. 714-522-9397.

During the racing year of 1976 we have found this engine to be quite reliable. However, engine life is greatly influenced by maintenance and rider usage. As a result we cannot be responsible for any failures resulting from following these specifications, services listed, or race track performance.