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INTRODUCTION

GENERAL INFORMATION

This handbook describes parts and procedures used to prepare **ECO**TEC race engines used by GM Racing in professional Sport Compact Drag Racing and Drifting, as well as engine, transmission, and chassis modifications designed for sportsman-level drag racers.

This handbook is intended to be used by experienced and knowledgeable race engine and chassis builders. It does not cover all basic engine blueprinting and assembly procedures, since it is assumed that the reader is already familiar with machining, measuring, and inspecting the components. Some of the procedures described require specialized tools and skills. If you do not have the appropriate training and equipment to perform these modifications safely, this work should be performed by other professionals.

There are, of course, many other possible combinations of components and modifications that may produce equal or superior results. However, by using the combination of parts and procedures described in this handbook, an experienced engine builder can build a competitive and reliable **ECO**TEC Race Engine.

It is not the intent of this book to replace the comprehensive and detailed service practices explained in the GM service manuals. GM service manuals are available from:

Helm Incorporated www.helminc.com
PO Box 07130
Detroit, MI 48207

Observe all safety precautions and warnings in the service manuals. Wear eye protection and appropriate protective clothing. When working under or around the vehicle support it securely with jack stands. Use only the proper tools. Exercise extreme caution when working with flammable, corrosive, and hazardous liquids and materials.

PROGRAM HISTORY

The General Motors Sport Compact Drag Racing Program was kicked off at the 2001 International Auto Salon (IAS) in Long Beach, CA. During IAS, GM identified Sport Compact Drag Racing as the highest opportunity to gain awareness in the sport compact market. The first Chevrolet Cavalier and Pontiac Sunfire front-wheel-drive drag race cars were unveiled at the 2001 SEMA show, and, in February of 2002, GM Racing made their competitive debut in Palmdale, CA. In 2003 and 2004 the GM Racing team won back-to-back championships in both the NHRA Hot Rod and ProFWD categories. In 2005, GM transitioned from a factory race team to factory support of independant teams.

Fig. 1

Gary Gardella earned the 2005 NDRA Pro 4 cylinder championship in his first year running an **ECO**TEC race engine. 2006 and 2007 brought more championships, records, and wins for Chevy and **ECO**TEC.

WHY WE RACE

At GM, we race because it's where we came from and because it fuels our love for competition.

Racing has been part of the GM culture since auto pioneers like Louis Chevrolet relied on speed records and racing victories to launch his fledgling car company. GM has remained in racing for two basic reasons - to win on the track and win in the marketplace.

Racing is a compelling demonstration of the depth of GM's technical resources, the capabilities of its people and the performance, reliability, quality and safety of its products. The race track is the toughest of proving grounds to forge engineering, marketing and business skills into tangible results. Few, if any, environments can match racing's ability to build awareness and consideration of a manufacturer's products to new customers, while simultaneously solidifying the loyalty of current customers.

FIVE PILLARS GUIDE GM RACING'S INTEGRATED STRATEGY

It provides a **dynamic training ground** for GM engineers. In racing, decisions must be made at a rapid rate. You must be ready at all times, on time, and solve problems quickly and effectively. Racing's demands are the perfect venue in which to exercise the mind and expand abilities, improve teamwork and communication - and do it all without making excuses.

This leads to **technology transfer**. Racing is well known to have introduced improvements in the auto production industry in areas such as suspensions, brakes, engines, aerodynamics and safety - but there's also a transfer in technology through people who work in racing, then take those improved skills and knowledge to the production process. Likewise, the advanced technology and people involved in the mass production of vehicles has enhanced the development of race cars.

Human nature dictates that **people want to compete** - and win. There is a strong competitive spirit within GM, and success in racing produces a vibrant esprit de corps. GM is not a sponsor of racing - we are an active, engaged participant who produces the cars and the components, and provides the technology essential to the sport.

If racing did not already exist, auto manufacturers would invent it as the **perfect marketing platform**. Racing is a sport that's all about the product and the people, followed with cult-like passionate fans who buy cars and trucks at a higher and more loyal rate than the average consumer.

Grass roots racers and enthusiasts demand the best, and have made **GM Performance Parts** the leader in over the counter components and engine assemblies. GM's approach, as a participant in racing, is to take responsibility to support the sport. Someone else might even build a motor that beats the factory team. But it's this democratization of racing that sets GM apart, and is the cornerstone of GM's total business approach.

LEGAL INFORMATION

This publication is intended to provide technical information on the GM **ECO**TEC engines, Hydra-Matic transmission, and Chevy Cobalt used in sport compact drag racing at the professional and sportsman level.

This handbook pertains exclusively to engines and vehicles which are used off the public highways. Federal law restricts the removal or modification of any part of a federally required emission control system on motor vehicles. Further, many states have enacted laws which prohibit tampering with or modifying any required emission or noise control system. Vehicles which are not operated on public highways are generally exempt from most regulations, but the reader is strongly urged to check all applicable local and state laws.

Many of the parts described or listed in this handbook are merchandised for off-highway application only, and are tagged with the following "Special Parts Notice":

SPECIAL PARTS NOTICE
This part has been specifically designed for Off-Highway application *only*. Since the installation of this part may either impair your vehicle's emission control performance or be uncertified under current Motor Vehicle Safety Standards, it should not be installed in a vehicle used on any street or highway. Additionally, any such application could adversely affect the warranty coverage of such an on-street or highway vehicle.

The information contained in this handbook is subject to change. General Motors also reserves the right to make changes at any time, without notice, in equipment, manufacturers, specifications, and materials, or to discontinue items.

The information in this publication is presented without any warranty. *All the risk for its use is entirely assumed by the user*. Specific component design, mechanical procedures, and the qualifications of individual readers are beyond the control of the publisher, and therefore the publisher disclaims all liability incurred in connection with the use of information contained in this publication.

ORDERING PARTS IN THIS BOOK

Parts described in this book are from several sources. Many parts are available from aftermarket suppliers. The contact information for these suppliers is listed in a separate section of this book. Note that some parts may be available from additional sources.

There are three types of General Motors parts listed in this book. First are parts used in regular production vehicles. These are regular service and replacement parts, denoted as 'GM' parts in this book. These parts are available through any GM dealer. See www.gmgoodwrench.com for more information and to locate a dealer near you.

The second type of GM parts shown are GM Performance Parts. These parts are available only through authorized GM Performance Parts dealers. Not all GM dealers are authorized to sell GM Performance Parts. For more information or to locate an authorized dealer, visit www.gmperformanceparts.com. Please note that not all parts are listed on the GM Performance Parts website. Your authorized dealer has a more complete list. If your dealer is an authorized GM Performance Parts dealer and still cannot locate a GM Performance Part listed in this book, please e-mail GM Racing through our website www.gmtunersource.com.

The third type of parts listed in this book are available exclusively from GM Racing. These are typically low-volume parts for professional racing applications. All GM Racing Parts are for off-highway use only and are tagged with the ″Special Parts Notice″ shown previously in this book. GM Racing Parts are available only by e-mailing us through our website www.gmtunersource.com. Racing personnel will respond to you with additional ordering information and part availability. Please allow up to twelve weeks for delivery.

All part numbers are subject to change. Please contact the appropriate source for the most recent information.

BASE ENGINE OVERVIEW

The engine is the heart of a competition car. It must be capable of delivering full power reliably run-after-run on race day, at engine and vehicle speeds far in excess of those encountered in normal driving. Every part of a competition engine must be as nearly perfect as possible – the slightest failure can put you out of the race.

Since 1955, the Small Block Chevy has proven its versatility, durability, and performance potential with automotive performance enthusiasts. The **ECO**TEC engine has all the basic mechanical components to repeat this success. A sound base engine structure, excellent airflow capability, easy serviceability, compact size and low weight. These qualities, along with the very successful race program, demonstrate the **ECO**TEC engine is a driving force in the sport compact segment. (Fig. 2)

Fig. 2

GM's **ECO**TEC engine has proven to be a reliable and competitive engine for use in Sport Compact Drag Racing. It has also proven it's superior durability in grueling five mile runs at the Bonneville Salt Flats with speeds over 300 MPH and in showroom stock endurance road racing competition. The number of stock components utilized in the race engine demonstrates the robust design of the **ECO**TEC engine.

The **ECO**TEC's outstanding feature to performance enthusiasts is it's impressive strength. GM Racing dynamometer tests confirm that major horsepower gains are possible with minimal modifications. For instance, when building an **ECO**TEC engine to the 400 hp power level, no modifications to the cylinder head, block, main girdle or crankshaft are required.

The production **ECO**TEC engine block is manufactured out of aluminum using a lost-foam casting process. This process allows for both a stronger and lighter part. Flanged, thin-wall iron cylinder sleeves are press-fit into a semi-floating aluminum support structure. The **ECO**TEC block is supported by a massive die-cast aluminum girdle/main cap assembly and structural oil pan for noise and vibration suppression. The main-cap structures are each supported with six fasteners. Extra-thick main bearings resist the differential thermal expansion of the nodular iron crank and aluminum block.

All **ECO**TEC blocks are cast with passages for piston-cooling jets and an oil cooler for high-output turbocharged applications. The fully-boxed block requires no windage tray, even on applications up to 600 horsepower. An auxiliary chain drives the water pump and balance shafts from the crank.

To reduce the risk of hot spots, pressure-cast, non-squish dished pistons are manufactured without valve reliefs. The symmetrical, barrel-faced moly-coated top ring fits in an

anodized ring-groove below a super-thin 3 mm top ring land, creating a low crevice volume for reduced emissions. The pistons deliver power through full-floating piston pins and powder-metal or forged steel connecting rods.

The **ECO**TEC twin-cam cylinder head uses low-friction hydraulic roller finger-followers, which have been proven reliable and effective up to 11,000 rpm. Head fastener placement permits cylinder head removal and installation without removing the camshafts. The camshafts are driven directly off the crank by a chain. The design includes provisions for variable cam phasing now found on select **ECO**TEC variants. The finger-follower design permits a light-weight narrow profile and reduced valve angles(the intake valve is 18 degrees from vertical and the exhaust valve 16 degrees).

The design of the intake manifold eliminates the need for variable-length intake runners and some **ECO**TEC engines now include direct injection.

The **ECO**TEC engine management system uses a port-EFI design with cassette waste-spark ignition.

The next several sections of this publication focus on performance modifications for the 2.2L **ECO**TEC engine installed in a 2005 Chevy Cobalt. The modifications shown could be performed on a number of GM vehicles.

See your local GM dealer for more information on ordering a vehicle equipped with the **ECO**TEC engine.

ECOTEC ENGINE CODES

Engine Code	Usage	Displacement	Bore x Stroke	CR:1	Fuel	Induction	Hp @ rpm	Tq @ rpm
L61	Saturn ION & VUE Chevy Malibu, Cobalt & HHR Pontiac G5	2.2L	86 x 94.6 mm	10	SFI	Naturally aspirated	148 @ 5600	152 @ 4200
LE5	Saturn ION & Sky Chevy Cobalt Sport & HHR Pontiac G5 GT, G6, & Solstice	2.4L	86 x 98 mm	10.4	SFI	Naturally aspirated with VVT	173 @ 6200	163 @ 4800
LSJ	Saturn ION Redline Chevy Cobalt SS S/C	2.0L	86 x 86 mm	9.5	SFI	Supercharged	205 @ 5600	200 @ 4400
LNF	Pontiac Solstice GXP Saturn Sky Redline Chevy HHR SS & Cobalt SS	2.0L	86 x 86 mm	9.2	DI	Turbocharged with VVT	260 @ 5300	260 @ 2500
LK9	Saab 9-3	2.0L	86 x 86 mm	9.5	MPFI	Turbocharged	210 @ 5300	221 @ 2500
LAT	Saturn Aura Green Line	2.4L	86 x 98 mm	10.4	SFI	Naturally aspirated hybrid	164 @ 6400	159 @ 5000

SPORTSMAN ECOTEC RACE ENGINE

Fig. 3

The **ECO**TEC engine is the perfect starting point for performance enthusiasts. Power levels of up to 400 horsepower can be achieved with the installation of connecting rods and pistons, a new head gasket and head bolts, adjustable cam gears and a nitrous oxide system or a turbo kit. No modifications to the cylinder head, block, main girdle or crankshaft are required. You can purchase upgraded components such as:

- Air Intake Systems
- Exhaust Systems
- Exhaust Headers
- Adjustable Cam Gears
- Nitrous Oxide Systems
- Supercharger Kits
- Turbocharger Kits
- ECM Reflashes

Note that power levels in excess of production may require additional upgrades to the production drivetrain and chassis such as clutch, transmission, engine mounts, axles, etc. not covered in this book. For information specific to modifying the supercharged **ECO**TEC 2.0L LSJ, see the **ECO**TEC 2.0L LSJ POWER Book, part number 88958686.

ADJUSTABLE CAM GEARS

Fig. 4

An excellent way to optimize cam timing with aftermarket cams or other engine modifications is to install GM Performance Parts Adjustable Cam Gears part number 88958613. (Fig. 4)

COMP Cams offers street cams for the **ECO**TEC engine.

SUPERCHARGER

Fig. 5

GM Performance Parts has developed a bolt-on supercharger kit (part number 1780003) for the 2.2L **ECO**TEC engine. Fits 2003-2005 model year Cavalier and Sunfire. Also fits certain 2002 Cavalier and Sunfire equipped with Delphi fuel inejectors. This kit contains all the components necessary for installation. (Fig. 5)

NITROUS OXIDE SYSTEMS

Fig. 6

With a stock 2.2L L61, the maximum Nitrous Jet Kit you can use is 75 hp. With upgraded rods and pistons, the maximum nitrous jet you can use is 150 hp.

Nitrous Express offers a stand-alone kit which has been tested and proven to work well. The Nitrous Express Kit contains a single nozzle with a nitrous jet and a fuel jet. Use a pressure tap on the production fuel rail for the fuel jet's supply. (Fig. 6)

TURBOCHARGERS

Fig. 7

Hahn RaceCraft currently offers a bolt-on turbo kit for the **ECO**TEC engine. It contains all the components necessary for installation. It has a Fuel Management Unit (FMU) which provides proper fuel delivery without the need to change engine calibrations. (Fig. 7) **ECO**TEC turbo kits are also available from other aftermarket companies.

CONNECTING RODS

We recommend that the connecting rods be upgraded because stock 2.2L L61 rods are not designed for power levels over 250 hp.

Fig. 8

The 2.0L LSJ and LNF **ECO**TEC engines have forged steel rods similar to Small Block Chevy "Pink Rod." The forged steel rods are made of high quality material and have a cap screw, 23 mm small end, and a full floating bronze bushing. These rods are available through GM service parts. These rods require an aftermarket piston set to work with the stock 2.2L crankshaft. Alternatively, Eagle and Manley both offer a CNC machined H-Beam rod which is an exact replacement for the stock 2.2L rod. (Fig. 8)

PISTONS

Fig. 9

The stock 2.2L L61 **ECO**TEC pistons have been tested to power levels approaching 300 hp. However these pistons should be replaced with a stock forged-type piston for applications over the 250 hp level. JE, Wiseco and Diamond offer pistons in various compression ratios that work for most applications. We recommend a compression ratio of 9:1 or less for blown gas applications, and 10-11:1 for normally aspirated with premium fuel.

INTAKE MANIFOLD

The production intake manifold has been tested to the 350 hp level.

HEAD GASKET AND HEAD BOLTS

Fig. 10

The stock head gasket is part number 24444091 and the head bolts are part number 90537691. The production head bolts are "Torque-to-Yield." It is important that these bolts are replaced each time they are removed to provide proper head gasket clamp loading. (Fig. 10)

VALVE SPRINGS AND RETAINERS

Fig. 11

Bates Engineering offers an up-level stock-replacement valve spring (part number ESGV0001) that fits in the stock cylinder head with no modifications. This spring uses production locks and retainers. The springs will increase the production valve train limiting speed to over 7500 RPM. The stock camshafts are good up to 400 hp with these valve springs and a power adder. (Fig. 11)

CYLINDER HEAD

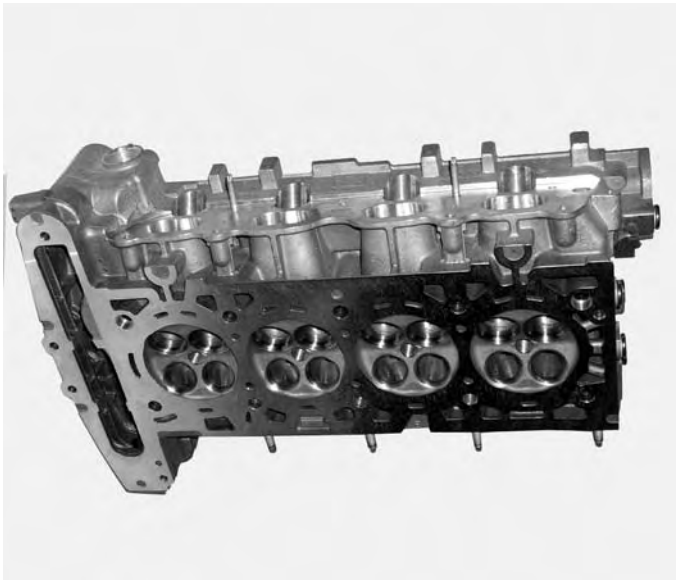


Fig. 12

The GM Performance Parts sportsman cylinder head part number 88958619 is a modified production L61 head. This head is cast from aluminum using a lost foam process; it features CNC Street porting for port to port consistency. (Fig. 12)

The spark plug holes have been modified to accept 3/4″ reach spark plugs.

A complete competition valve job has been performed on the cylinder head using a Serti Head Machine with a Serti cutter # HP2022.

This head with production valves has been run to over 500 hp on gasoline with 25 lbs boost.

For improved durability it is recommended to upgrade to the production 2.0L LSJ valves or Ferrea (part number F1963P intake and F1961P exhaust) valves.

Note that, for the 2007 model year and beyond, there was a change to the production 2.2L L61 head and valve cover. The change was to accomodate a cam sensor. The GM Performance Parts sportsman cylinder head part number 88958619 is for **ECO**TEC L61 engines prior to the 2007 model year.

SPORTSMAN CYLINDER HEAD GENERAL DATA		
	Intake	**Exhaust**
Valve Head Diameter (in.)	1.400″	1.200″
Valve Stem Diameter (in.)	6 mm	6 mm
Valve Seat Angle (degrees)	45.0°	45.0°
Valve Spring Installed Height (in.)	1.210″	1.210″
Valve Spring Seat Pressure (lbs)	92	92
Spring Pressure Over Nose (lbs)	250 lbs @ .500 lift	250 lbs @ .500 lift

GM Racing also offers an exhaust ported version of the 2.0L LSJ head. Part Number XGH734. This part will be offered in limited quantities only.

HIGH PERFORMANCE PISTON AND ROD R&R PROCEDURE (COBALT)

Fig. 13

The following procedure describes the installation of up level connecting rods and pistons in your **ECO**TEC 2.2L L61 engine. A base ’05 Cobalt is used for the procedure. (Fig. 13)

CAUTION: All machined edges on this engine are razor sharp and extreme caution must be used when working on this engine.

Fig. 14

After removing the negative battery cable, remove the splash shield to expose the lower crank balancer pulley. (Fig. 14)

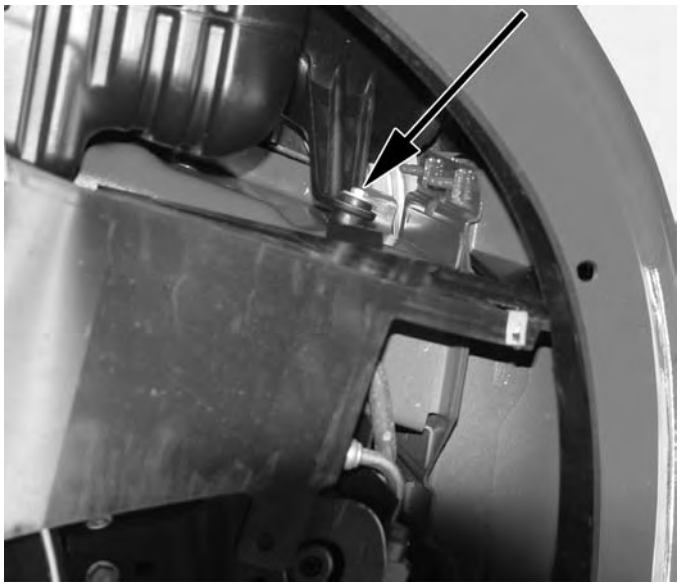


Fig. 15

On a Cobalt, a shroud fastener is hidden up on the frame extension. It can be accessed by partially removing the fender well fasteners and pulling back the fender well to reveal the fastener. Requires a 10 mm socket. (Fig. 15)

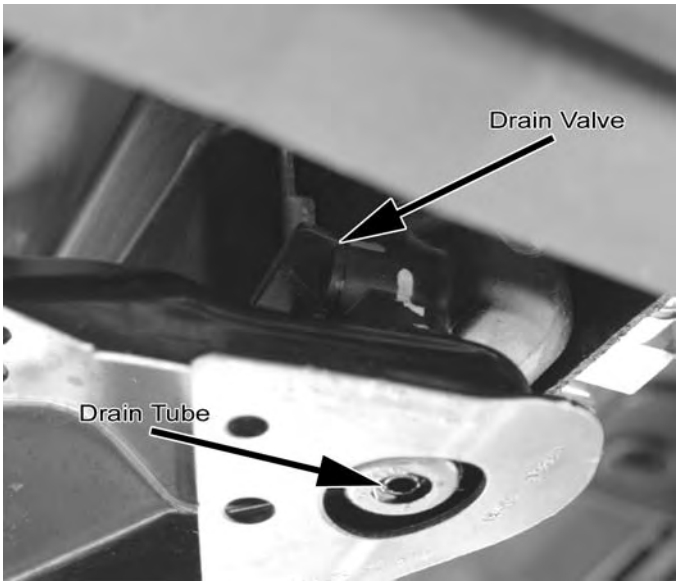


Fig. 16

Drain engine coolant and engine oil. This figure shows the location of the radiator petcock. (It loosens counter clockwise) (Fig. 16)

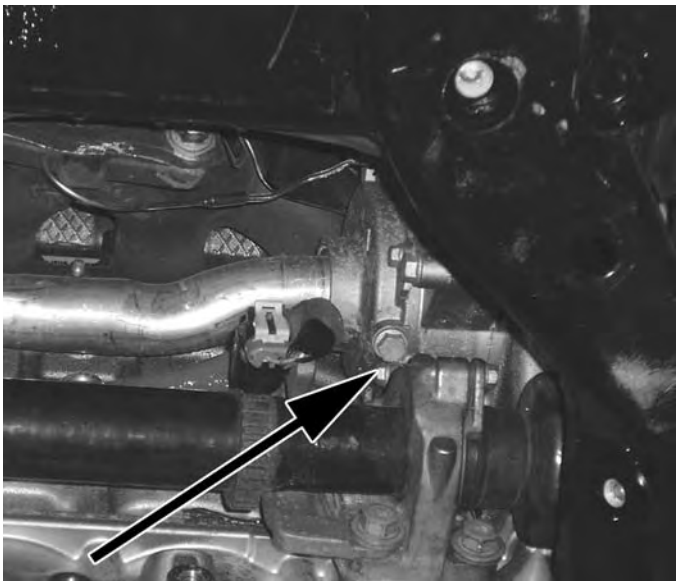


Fig. 17

The water pump coolant drain will remove the coolant from below the deck for head gasket service. (Fig. 17)

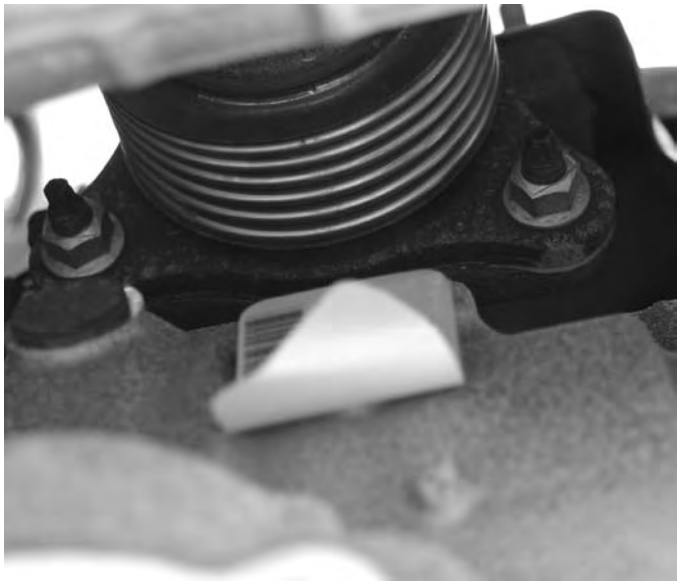


Fig. 18

To remove the exhaust, remove the three exhaust nuts with a 15 mm deep universal socket. (Fig. 18)

Fig. 19

One fastener can be removed from above. (Fig. 19)

Fig. 20

It is important to remember to remove the HO2S (oxygen sensor) connector, so when you remove the head and exhaust manifold as an assembly, this won't hold you up. (Fig. 20)

Fig. 21

Remove the two stud bolts that secure the fuel rail. Remove the fuel rail. It's not necessary to disconnect the fuel line. Disconnect the single injector wiring harness and MAP connector. Set the rail and injectors by the coolant reservoir. (Fig. 21)

Fig. 22

Cover the injector ports to prevent any debris from falling into the cylinder head. (Fig. 22)

Fig. 23

Remove the upper radiator hose at the cylinder head. (Fig. 23)

Fig. 24

Remove the bolt shown to disconnect the coolant pipe from the head bracket. (Fig. 24)

Fig. 25

Remove the dipstick tube bracket support bolt as shown. (Fig. 25)

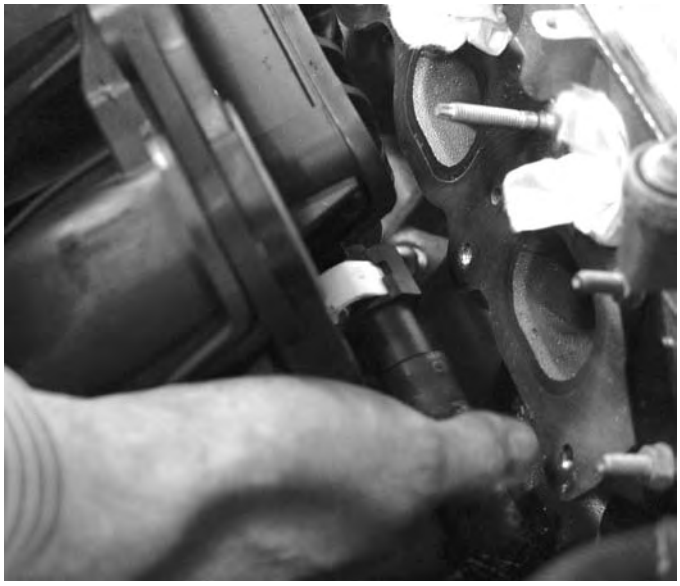


Fig. 26

Remove the intake manifold fasteners and vacuum hoses. Pull the intake partially away from the engine, and unclip the white clip from the power brake vacuum hose. Slide this hose off the pipe and remove the intake. Cover the intake ports. (Fig. 26)

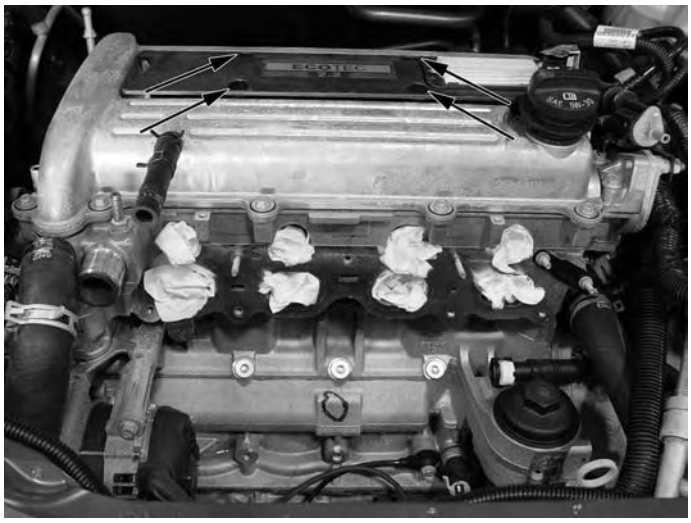


Fig. 27

Remove the fasteners that hold the coil cassette module to the valve cover. (Fig. 27)

Fig. 28

Fig. 29

Remove the bracket, ground strap, and the electrical connector. Lift the cassette module from the engine valve cover. (Fig. 28 and Fig. 29)

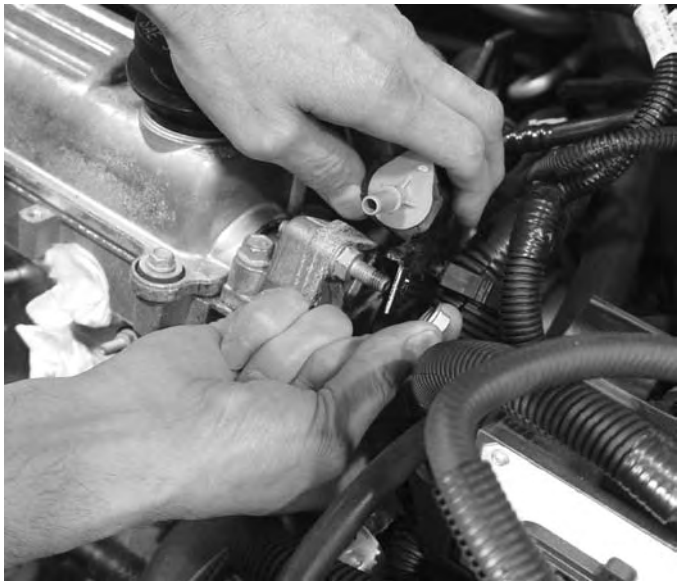


Fig. 30

Remove the 13 mm nut and bracket that holds the evap solenoid support bracket to the head. (Fig. 30)

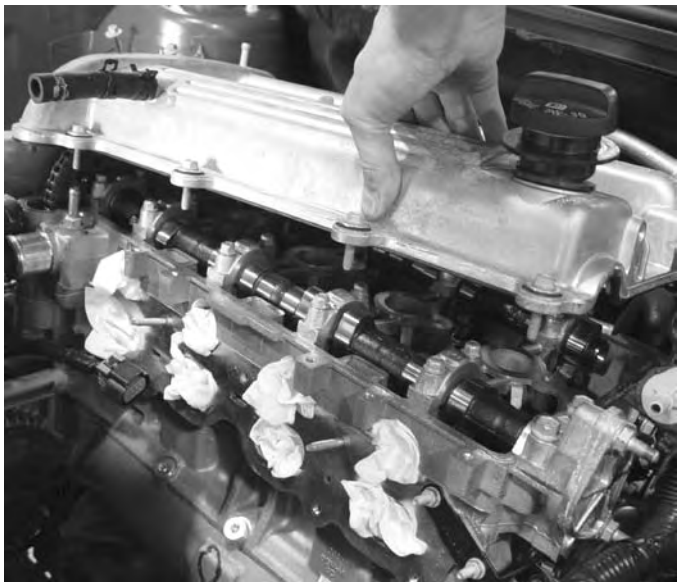


Fig. 31

Remove the valve cover by removing all fourteen fasteners around its perimeter and the fasteners under the coil module. (Fig. 31)

Fig. 32

Pry the dipstick tube out of the oil pan with a flat head screwdriver. (Fig. 32)

Fig. 34

Remove the bolts that connect the oil pan to the transmission. (Fig. 34)

Fig. 33

Remove the bolt on the A/C compressor to drop the oil pan. (Fig. 33)

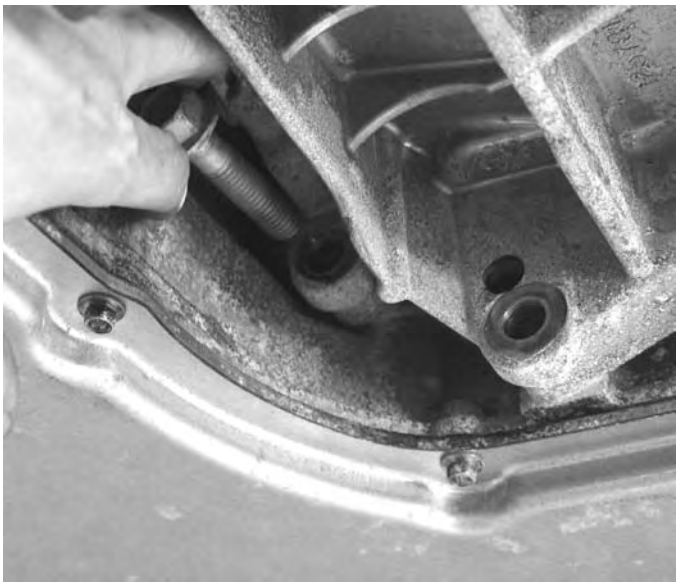


Fig. 35

The bolt shown above is easy to miss, so don't forget to remove this bolt as well. (Fig. 35)

Fig. 36

Remove the remainder of the fasteners from the oil pan. (Fig. 36)

Fig. 37

Use a pry bar in the pry point to remove the oil pan. (Fig. 37)

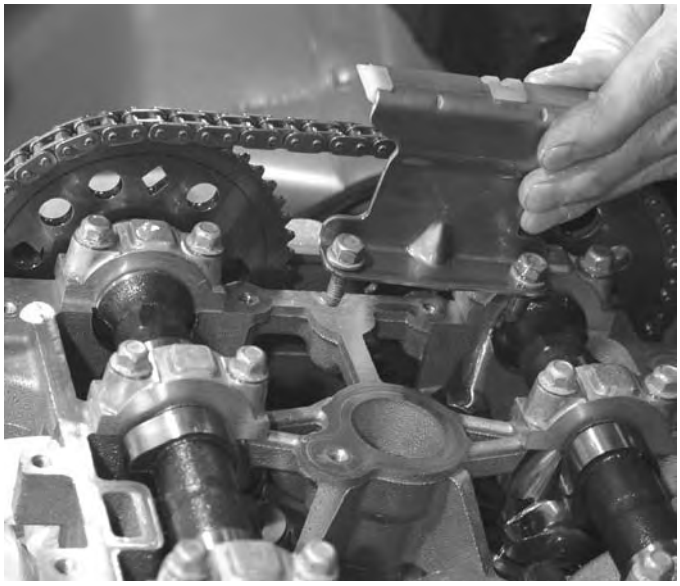


Fig. 38

Remove the upper timing chain guide. (Fig. 38)

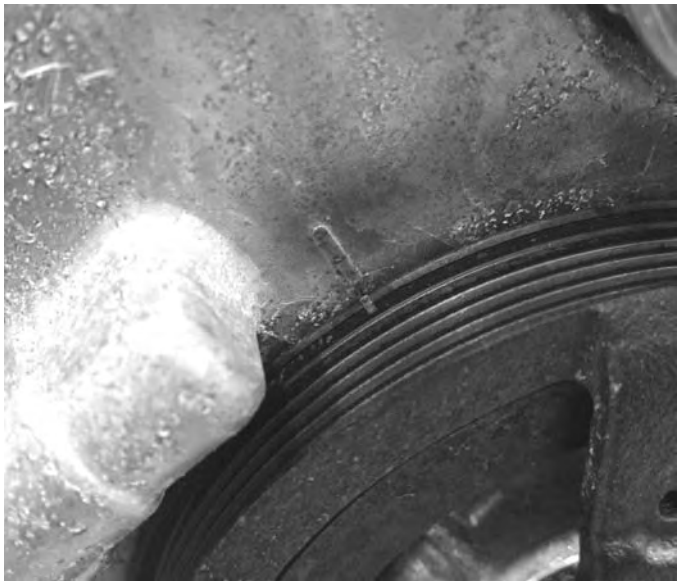


Fig. 39

Rotate the engine by hand to TDC. (Fig. 39)

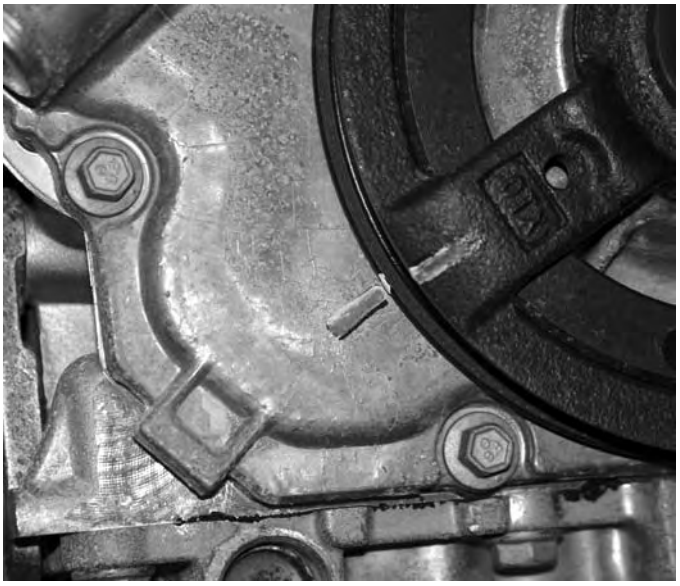


Fig. 40

Using the crank bolt, mark the balancer and timing cover, this will make it easier to return to engine to TDC for reassembly. (Fig. 40)

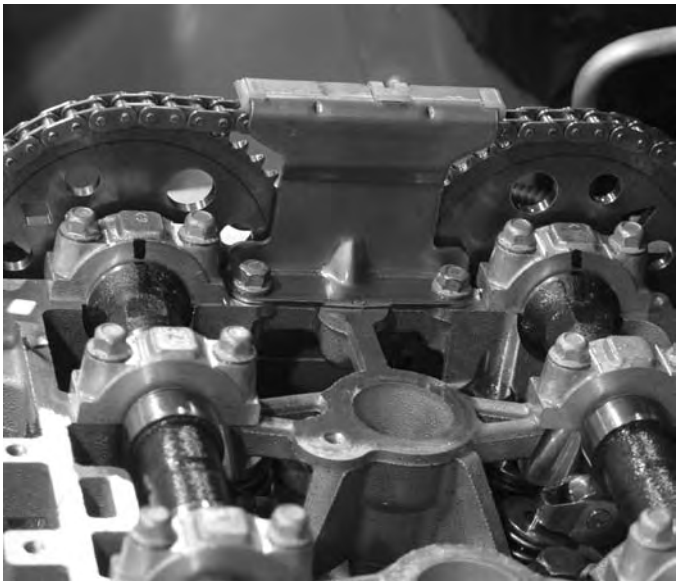


Fig. 41

Mark the cams to indicate TDC position. (Fig. 41)

Fig. 42

Use a 1 1/4″ wrench to loosen and remove the hydraulic chain tensioner. (Fig. 42)

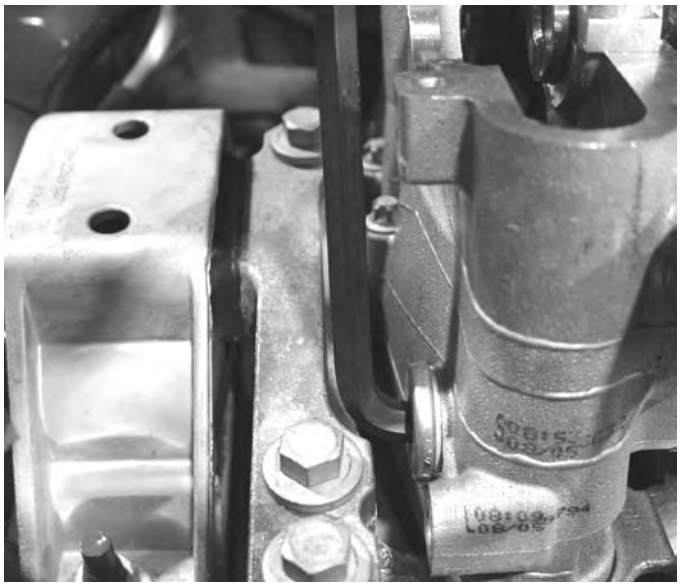


Fig. 43

Remove the chain guide bolt access plug. Use a shortened allen wrench to access the chain guide bolt. (Fig. 43)

Fig. 44

Use a 1/4″ drive 10 mm universal socket to loosen the fastener and remove the chain guide bolt. (Fig. 44)

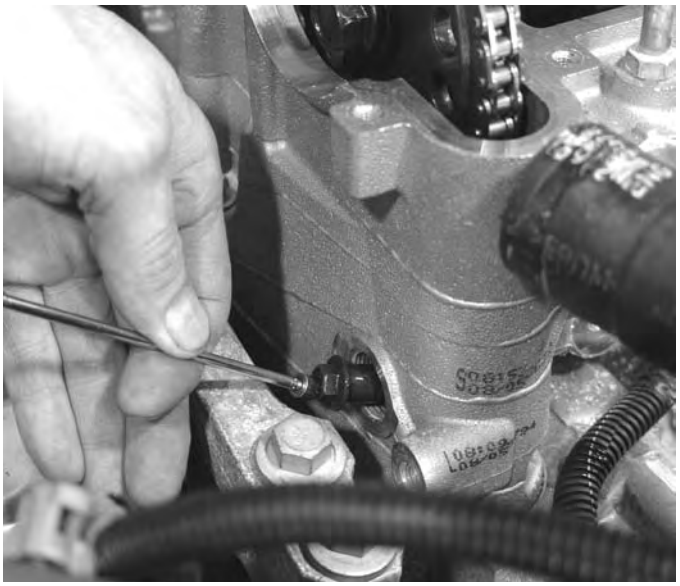


Fig. 45

To prevent the fastener from dropping in to the engine, use a magnet to remove it. (Fig. 45)

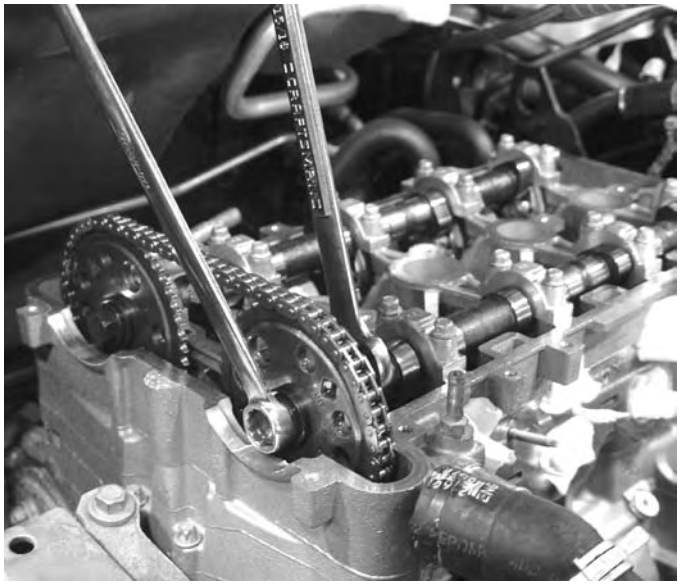


Fig. 46

Use a 15/16″ back up wrench and an 18 mm to remove the timing gear bolts. Do not use an impact to do this operation. Remove the timing gears. (Fig. 46)

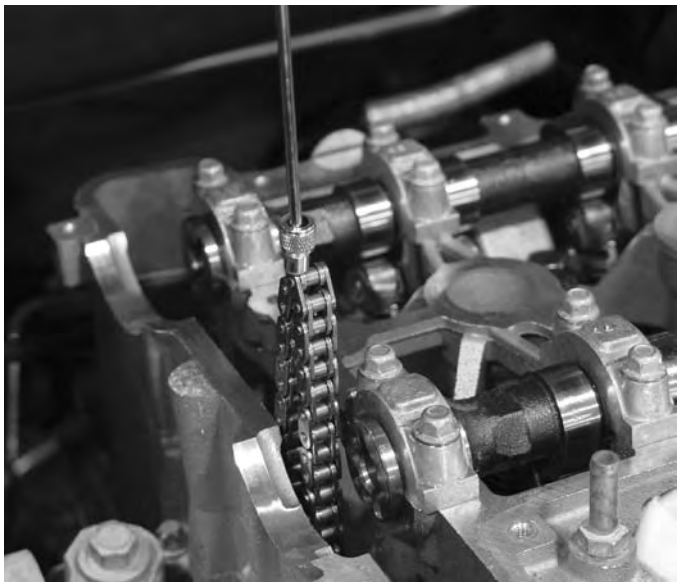


Fig. 47

Use a magnetic rod to lower the chain onto the oil nub in the block. (Fig. 47)

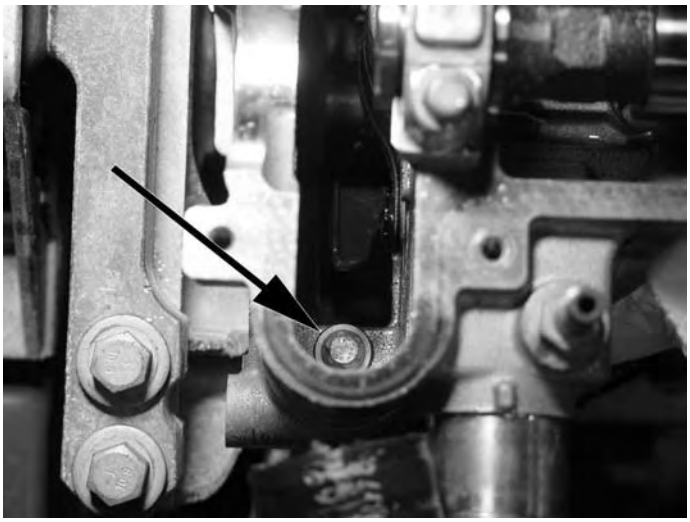


Fig. 48

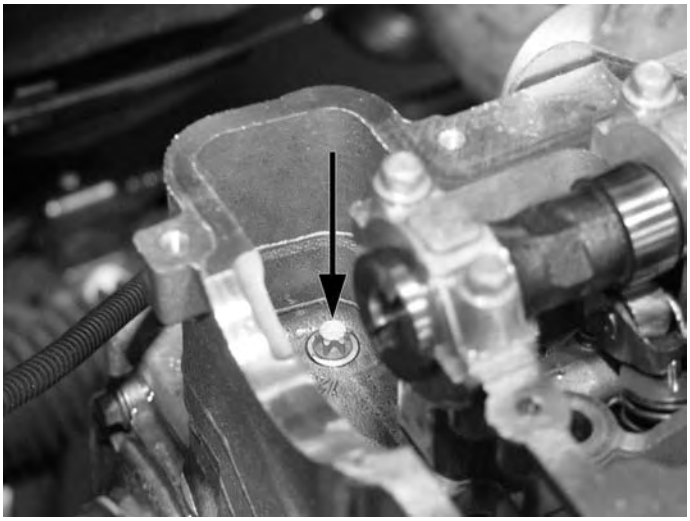


Fig. 49

Remove the two torx head bolts shown in Fig. 48 and Fig. 49.

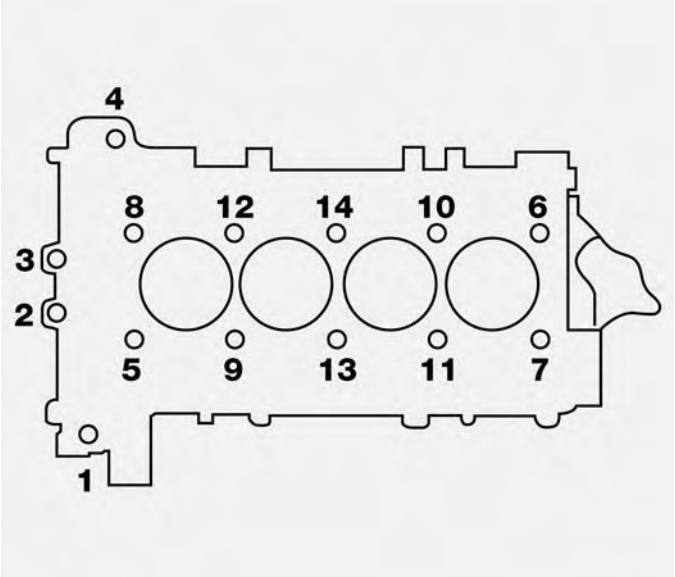


Fig. 50

Continue to remove the rest of the fasteners on the head. Remove the outside torx first and then the head bolts in a circular pattern from the outside to the center, as not to warp the head. (Fig. 50)

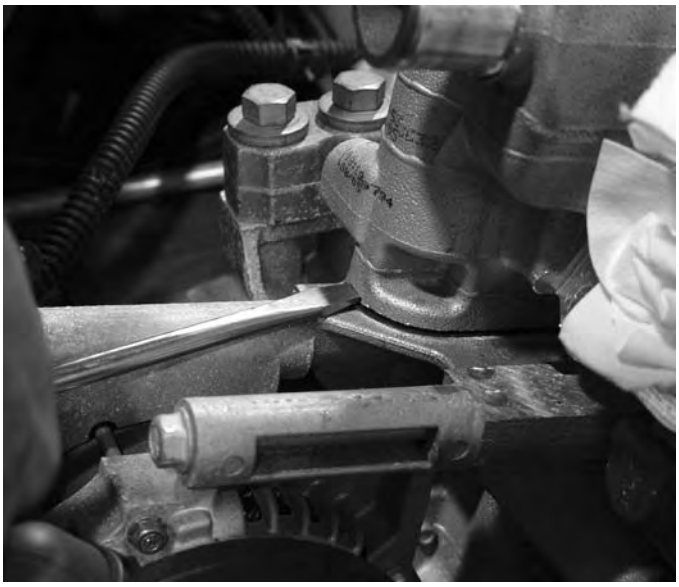


Fig. 51

When all of the head bolts have been removed, place a flat head screwdriver in the slot as shown above. Pry up on the head to loosen it from the block. Remove the head and exhaust manifold assembly, have someone help you with this task. Do not lay the cylinder head face down as valve damage may occur. (Fig. 51)

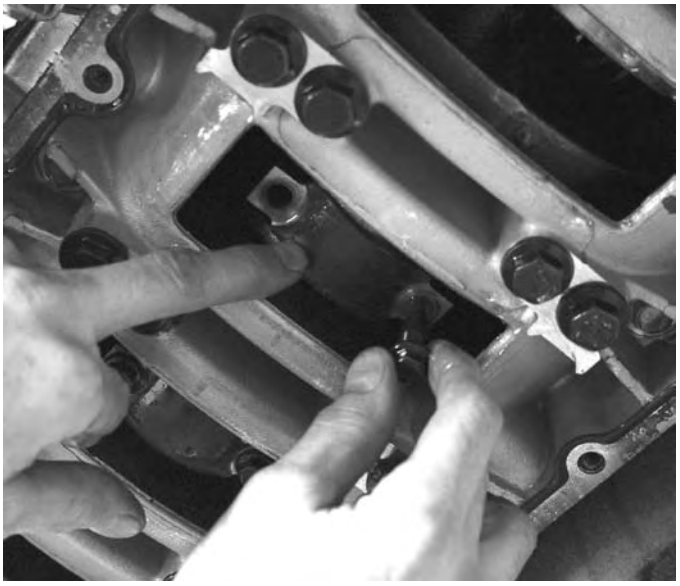


Fig. 52

Remove the rod caps on the connecting rods. (Fig. 52)

Fig. 53

Shown above is a rod cap fully removed from one of the connecting rods. (Fig. 53)

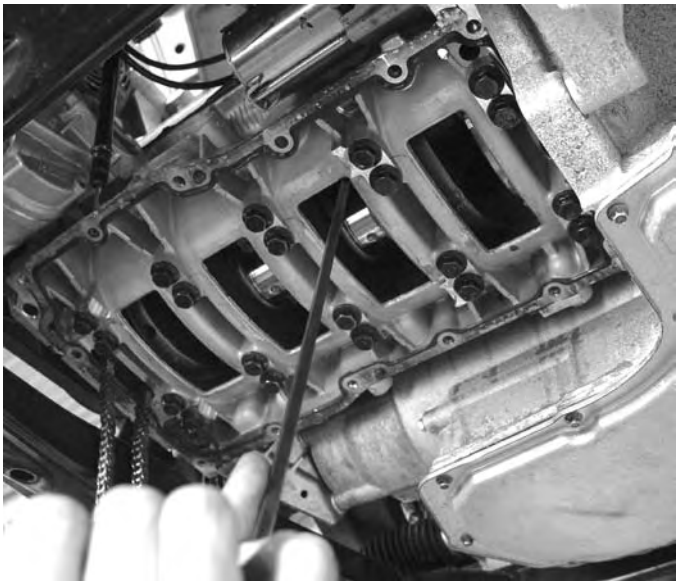


Fig. 54

When all of the rod caps have been removed use a long object (one that will fit in the cylinder and clear the crank, we used a long screwdriver) and push up on the piston until it is no longer flush with the block's surface. Remove the pistons from the block. (Fig. 54)

Fig. 55

The illustration above shows the new Diamond piston and LSJ (2.0L) connecting rod on the left and the stock piston on the right. (Fig. 55)

Fig. 56

Install the rings from the old pistons on to the new pistons in similar fashion. Remove the piston rings from the stock piston by unwinding as shown above. Rings are fragile so care must be taken. A ring expander tool can be used. (Fig. 56)

NOTE: Do not change the order or flip the rings over. Do one piston at a time. The rings must stay in the same cylinder as removed.

Fig. 57

NOTE: The oil ring support dimple must be installed as shown. Make sure the rings are free and not binding. (Fig. 57)

Fig. 58

If the old bearings are in good condition install them on the new rods. (Fig. 58)

Fig. 59

A sleeve is recommended for the piston installation, because the rings are thin and small. (Fig. 59)

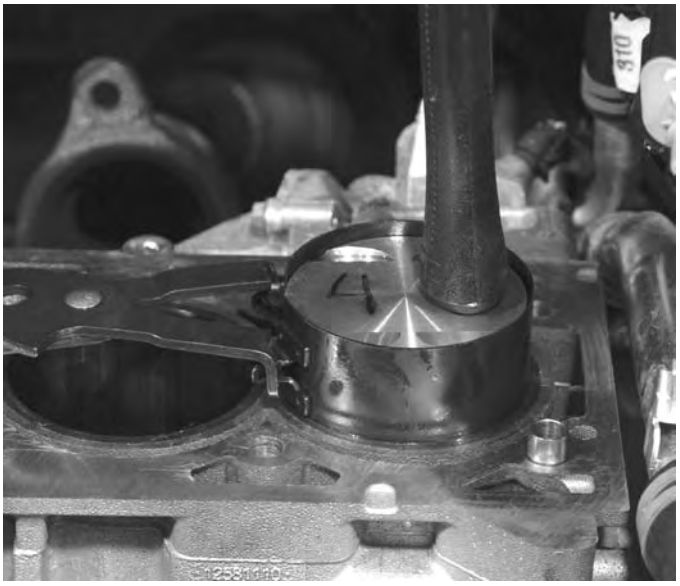


Fig. 60

With journals one and four at bottom dead center, install cylinder one and four assemblies. Rotate the crank to put journals two and three at bottom dead center. Install assemblies two and three. When the piston is being pushed down in the bore, make sure to guide it carefully onto the rod journal. Do not nick the crank journal or rod end. (Fig. 60)

NOTE: Large valve reliefs are for the intake valves. Small valve reliefs are for the exhaust valves. Install pistons with large reliefs to front of vehicle.

Fig. 61

Install the rod caps, bearing tang to bearing tang. Torque to 18 ft. lbs. plus 100° with a torque angle meter. (Fig. 61)

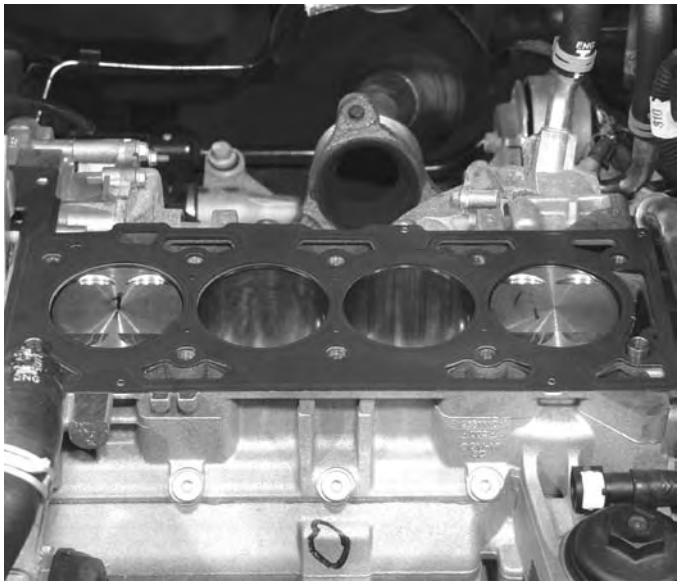


Fig. 62

Rotate the crankshaft to drop the number one piston 1″ below the deck, before setting the head on the block. This will keep the valves away from the pistons until the head is torqued. Piston is shown at TDC in Fig. 62.

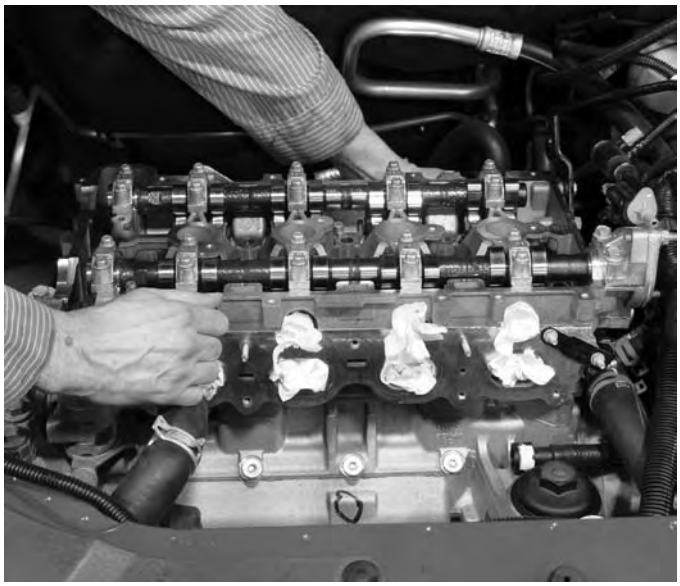


Fig. 63

Install the head and exhaust manifold assembly. Insert the exhaust manifold studs into the pipe flange and place the head on dowels. Have someone help you with this task. (Fig. 63)

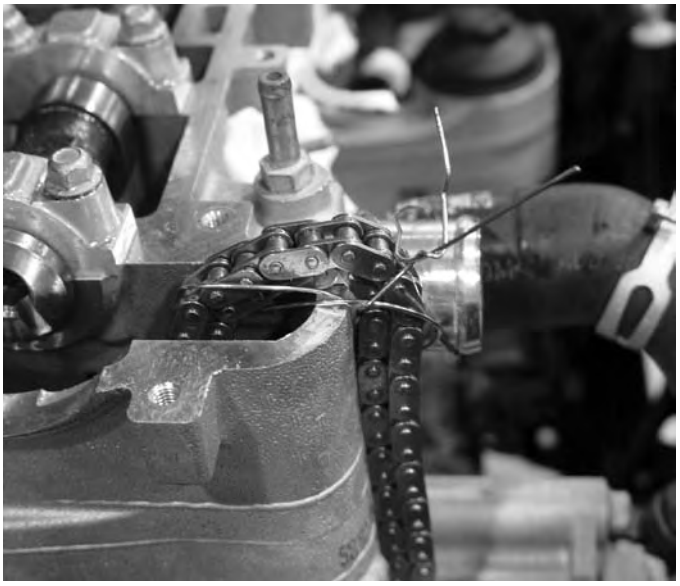


Fig. 64

Free up and support the timing chain before torquing down the head. (Fig. 64)

Install the guide bolt and torque it to specification.

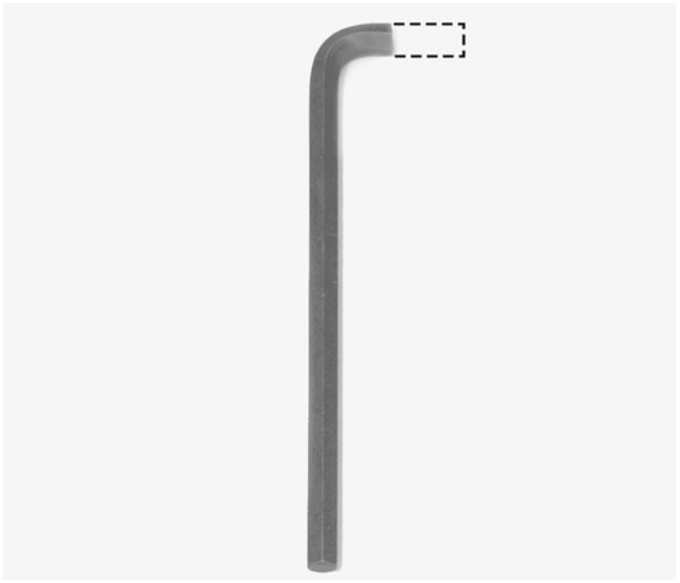


Fig. 65

Install the plug using a shortened 10 mm allen wrench. Rotate engine to TDC before installing the timing chain. (Fig. 65)

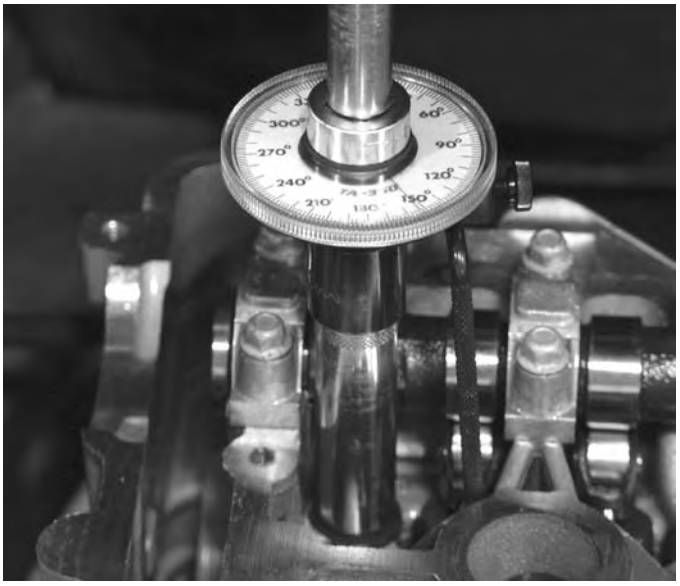


Fig. 66

Install the head bolts using a torque angle meter and torque them to 22 ft. lbs. plus 155°. (Fig. 66)

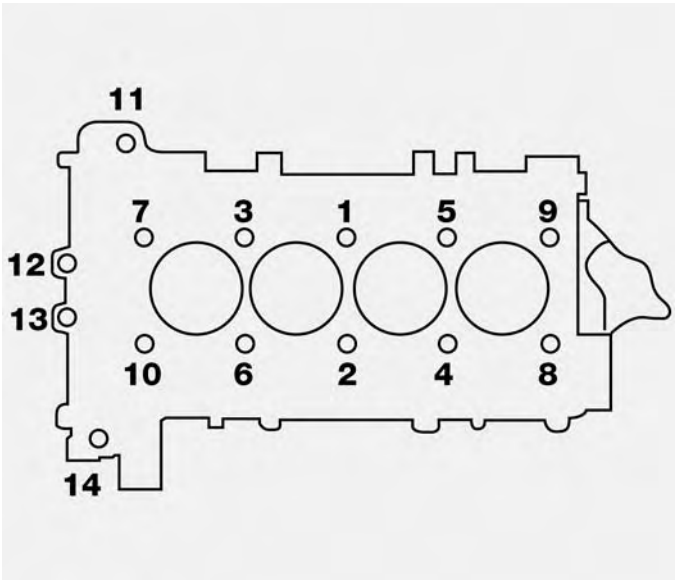


Fig. 67

After torquing the ten large fasteners in order shown to specification, install the four front torx head bolts (2 inside, 2 outside) and torque them to 18 ft. lbs. (Fig. 67)

Using red locktite on the bolts, install the timing gears. Torque the bolts to 70 ft. lbs. Hold the cams as you install the bolts.

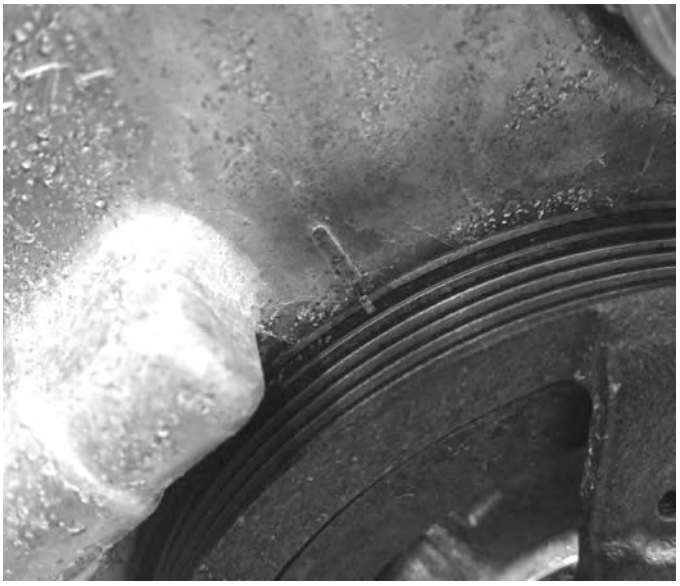


Fig. 68

After torquing the head bolts turn the engine back over to TDC. Check your marks and the production marks to confirm location. (Fig. 68)

Fig. 69

Compress tensioner to approximately 2 3/4″ (slightly longer) then install. Install the tensioner making sure the groves in the chain yoke are vertical. (Fig. 69)

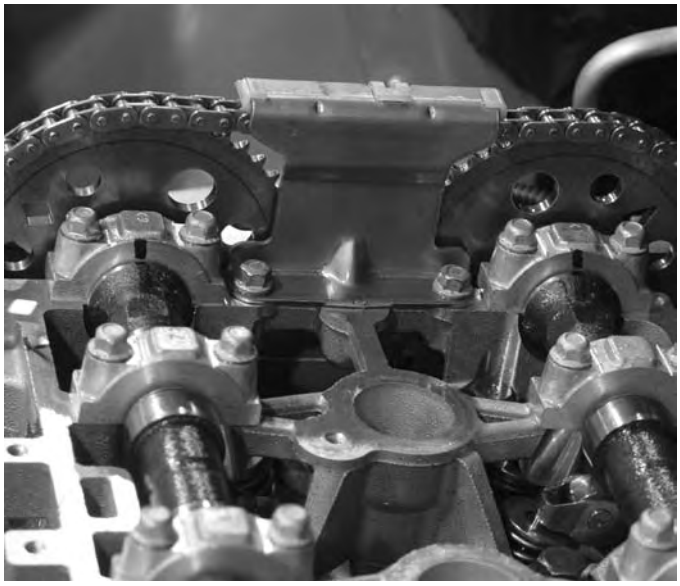


Fig. 70

Rotate the crank shaft two rotations and align all timing marks. (Fig. 70)

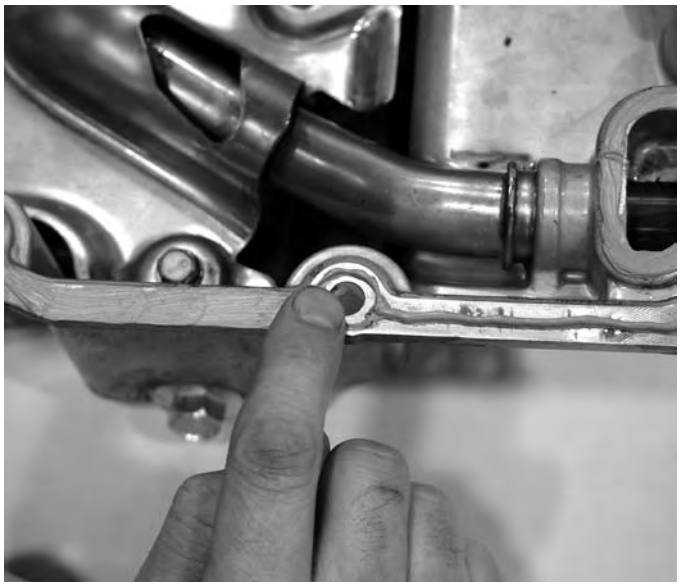


Fig. 71

Apply grey silicone (Loctite #5699) sealer on the oil pan rails. Smear the sealer with your finger to make a uniform coating. (Fig. 71)

Fig. 72

When installing the pan, do not to disturb the sealer by touching other parts of the engine. Align the pan dowels and install the bolts finger tight. Guide the dip stick tube into the pan as you install the lube o-ring. Install all the pan fasteners and torque to 18 ft. lbs. (Fig. 72)

Fig. 73

Install A/C compressor bolt and torque to specifications (Fig. 73)

Install the exhaust manifold to the exhaust pipe nuts.

Fig. 74

Reconnect the HO2S oxygen sensor as shown above. (Fig. 74)

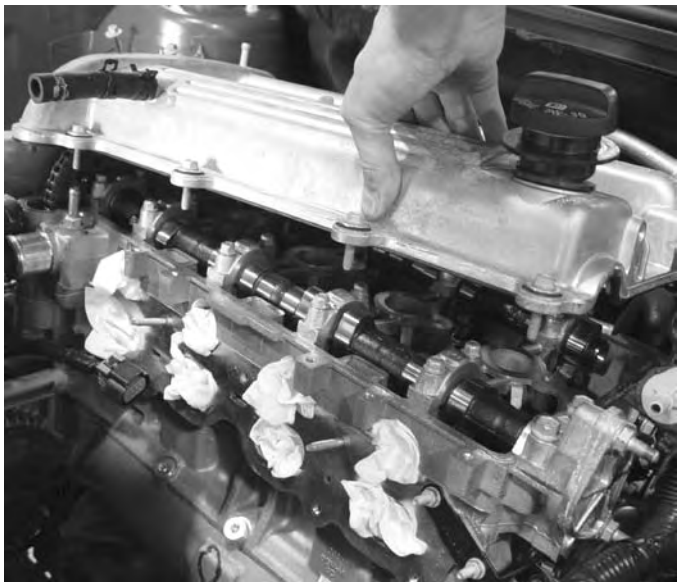


Fig. 75

Install the valve cover, ground strap and bracket and the coil cassette assembly with electrical connector. (Fig. 75)

Fig. 76

Remember to remove all the injector plugs and intake port plugs and rags to allow proper assembly.

Lube o-rings and install the fuel rail. (Fig. 76)

Tighten the two stud bolts to 89 in. lbs. and connect the rail wiring connector.

Install the brake vacuum hose onto the intake manifold and install the intake manifold to the cylinder head. Torque all fasteners to 89 in. lbs.

Fig. 77

Install throttle body electrical connector. (Fig. 77)

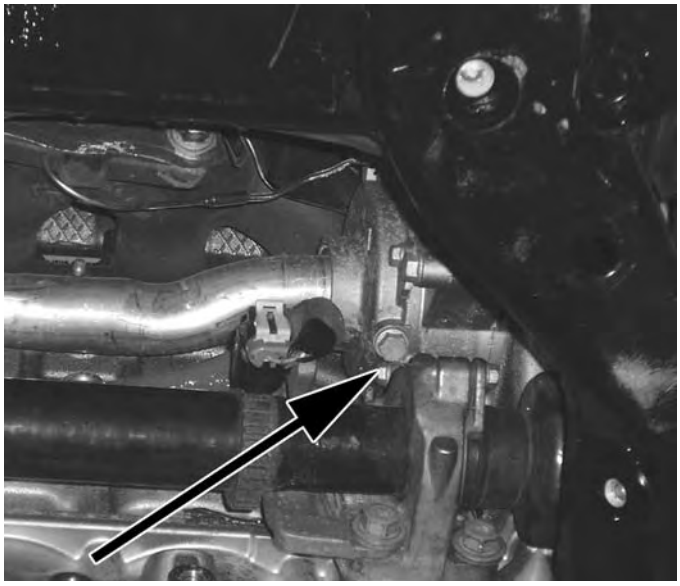


Fig. 78

Install the coolant pipe plug located on the bottom of the water pump. (Fig. 78)

Install the dipstick bracket bolt and check the oil drain plug for tightness.

Fig. 79

Connect the upper radiator hose. (Fig. 79)

Add coolant and oil to the motor.

Install the air duct/air cleaner (motor will not run properly without this duct in place).

NOTE: Wire loom zip ties will break, the dealer may be able to supply new ones.

Fill cooling system. Air vents through the top of head coolant hose.

Start the engine and check the oil pressure. Turn off the engine and check the oil level. Add oil as necessary.

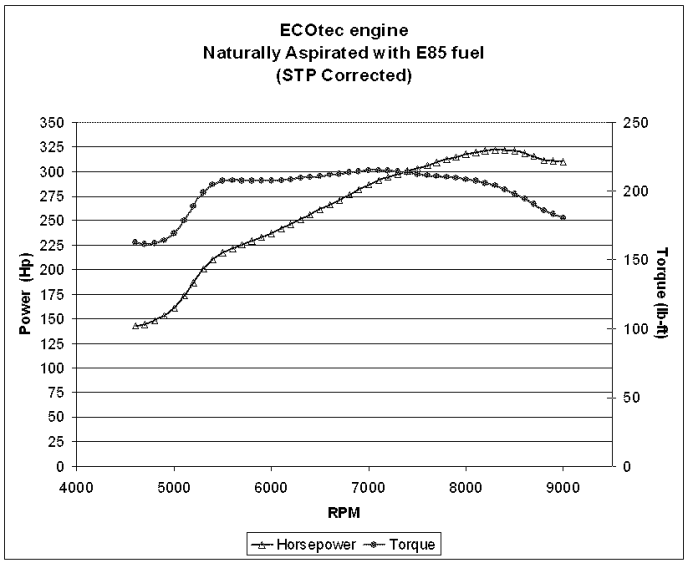
Install plastic engine shroud, wheel well fasteners and the wheel and tire.

Check for any leaks and then test the vehicle.

SPORTSMAN ECOTEC PARTS LIST

PARTS LIST		
DESCRIPTION	**PART NUMBER**	**SOURCE**
2.2L L61 Sportsman Cylinder Head, Ported	88958619	GM Performance Parts
2.0L LSJ Exhaust-Ported Cylinder Head	XGH734	GM Racing
2.0L LSJ Intake Valves	12786696	GM
2.0L LSJ Exhaust valves	12791961	GM
2.2L L61 Head Gasket	24444091	GM
Stock Head Bolts (Qty 10)	90537691	GM
2.2L L61 Piston Rings	21018813 (4 req)	GM
LSJ Connecting Rods (less than 300 hp only)	12755162	GM
Performance Connecting Rod	various	Eagle/Manley
Performance Forged Pistons	various	Wiseco/JE/Diamond
Performance Wrist Pin	various	Manley/JE/Wiseco
Adjustable Cam Gears	88958613	GM Performance Parts
Performance Cam Shafts	various	COMP Cams
Nitrous Express Nitrous Kit	various	Nitrous Express
2.2L Supercharger Kit	17800003	GM Performance Parts
Hahn Racecraft Turbocharger Kit	—	Hahn Racecraft
Bates Engineering Valve Springs	ESGV0001	Bates Engineering
2.0L LSJ Piston w/Pin and Pin Retaining Clip	12791210	GM
2.0L LSJ Piston Rings	93180138	GM
ECOTEC 2.0L LSJ Power Book	88958686	GM

NATURALLY ASPIRATED ECOTEC RACE ENGINE



Roush Industries, in conjunction with GM Racing, has done development and testing of a naturally aspirated **ECO**TEC race engine. The engine generates approximately 325 hp on E85 or 340 hp methanol.

At this time, neither GM nor any aftermarket companies offer the modified production blocks and heads used in this application. Roush Industries in Livonia, Michigan offers this complete engine package for sale.

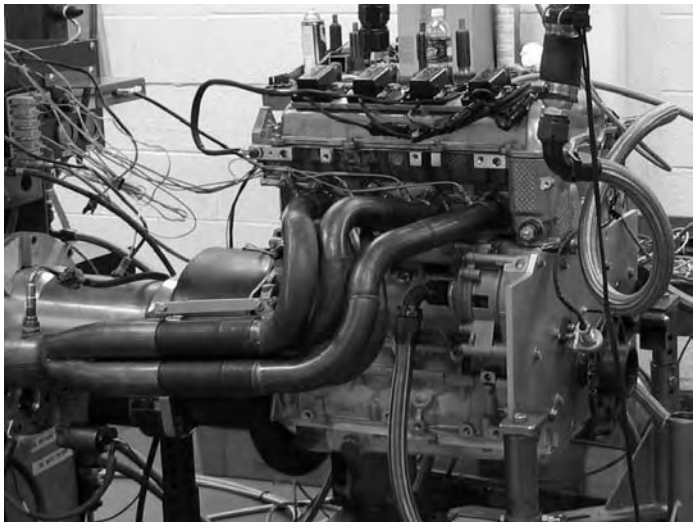
The base for the naturally aspirated race engine is a complete production L61 (2.2L), LE5 (2.4L) or LSJ (2.0L supercharged) **ECO**TEC engine. The block is bored to 88.9 mm (3.500 in) and sleeved. We use a production-replacement Eagle crank for improved longevity, although it is possible to retain the production L61 or LE5 crank. The resulting displacement for the engine is 143.4 cubic inches.

The production head from a L61 (2.2L), LE5 (2.4L) or LSJ (2.0L supercharged) **ECO**TEC engine is ported specifically for this naturally aspirated application and machined to match a 88.9 mm bore size and accept high-lift camshafts.

Additional long block parts include:

- ARP headstuds and fasteners
- Eagle forged steel crank and connecting rods
  (Crank part number 2237245765,
  Rods part number CRS5765C3D)
- JE forged aluminum pistons
- Cometic head gasket
- Roush fabricated oil pan and front engine plate
- Comp Cams billet race camshafts
  (Intake 8780 Exhaust 8781)
- GM Performance Parts adjustable cam gears
  (part number 88958613)
- Ferrea stainless steel valves and keepers
  (F806695. F806694, K10036)
- PSI valve springs (CT-1530ML)
- Trick Titanium retainers (KRERT001)

For induction, we have used a TWM K20 intake, modified to fit this application, or a Kinsler individual runner intake for **ECO**TEC. The exhaust manifold is custom fabricated by Roush Industries.



This engine has been run in the Inboard Power Boat racing circuit. In addition to the parts listed above, it employs a Daily Engineering dry sump pump, a Weldon 2015A electric fuel pump and fuel regulator, RC Racing fuel injectors, XRP lines and fittings, a Roush-modified production fuel rail, FAST XFI engine control unit and electronic distributor, MSD DIS 4 ignition box and crank and cam triggers, and a Roush custom wiring harness.

NOTES

PRO ECOTEC RACE ENGINE

Fig. 80

PRO ENGINE ASSEMBLY

GM Racing uses the same basic engine long-block for all professional-level **ECO**TEC racing engines. The engines described in this chapter are used in Formula Drift drifting competition (500 hp) and in several classes of NDRA and NHRA Sport Compact Drag Racing (750-1450 hp). Some engine specifications, particularly pistons and fuel system components, will vary for the particular engine application.

ENGINE BLOCK

The engine block used in all applications is a production **ECO**TEC block used in the L61, LE5, LNF, and LSJ engine variants. This block is cast from aluminum using a lost foam process. For applications ranging from 400 to 800 hp, a production block that has been screened for cracks, high porosity, or other imperfections and re-sleeved with a high-quality aftermarket iron sleeve is acceptable. This block can be flat-decked for use with the production head gasket up to 600 hp or an after-market mutli-layer head gasket up to 800 hp.

For applications above 800 hp, the GM Racing modified block XGH679 is used. (Fig. 81) While some of the features of this block are not necessary at horsepower levels between 800 hp and 1200 hp, the features increase block longevity at any power level. The modifications and checks made to the original production cylinder block include:

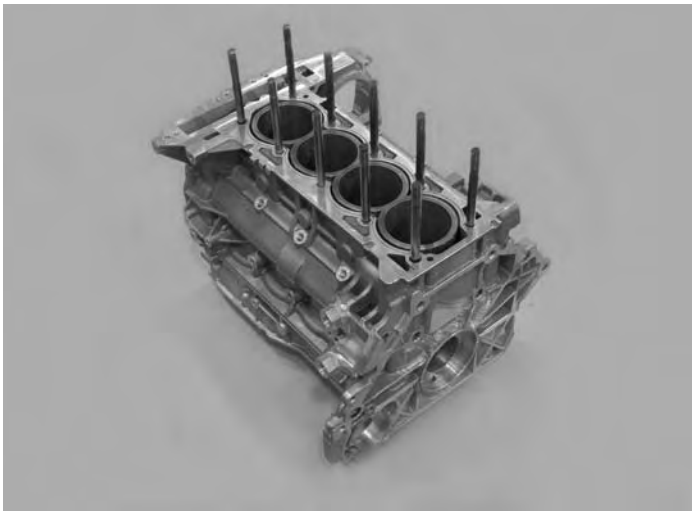


Fig. 81

The Zyglo system is used to check for cracks and imperfections in the engine block.

All oil gallery plugs are removed to clean and inspect all passages.

The stock cylinder sleeves are machined out and new nodular iron cylinder sleeves are installed and bored to 3.500″. The sleeves are installed .008″ proud of the deck and machined to accept .041″ thick stainless steel o-rings.

Fig. 82

All cylinder head, main, and girdle bolt holes are machined to accept ten ½″ studs. These ″uni-bolts″ extend the entire height of the engine, from the girdle through the head. (Fig. 82)

The main journals are line-honed to 2.5225-2.5235″.

The block is machined to accept piston oil squirters for cooling. In applications where piston squirters are not used, these holes must be plugged or oil pressure loss will occur.

The factory crankshaft position location hole is tapped to -08AN thread and plugged. The oil filter boss is removed from the block. This can be done on a mill or with a sawzall. A female -10 ORB fitting is welded on the block. For wet sump applications, both oil in and oil out are used. For dry sump applications, plug the oil out hole.

The block deck is machined to fit larger cylinder head alignment dowels. The new dowels measure .675″ tall, .630″ O.D., .515″ I.D.

The front two oil galleries are plugged with ½″ steel plugs or tapped for 9/16-18″ threaded rod.

The girdle is installed using extreme pressure lube. Bolts are torqued to 15 ft. lbs.

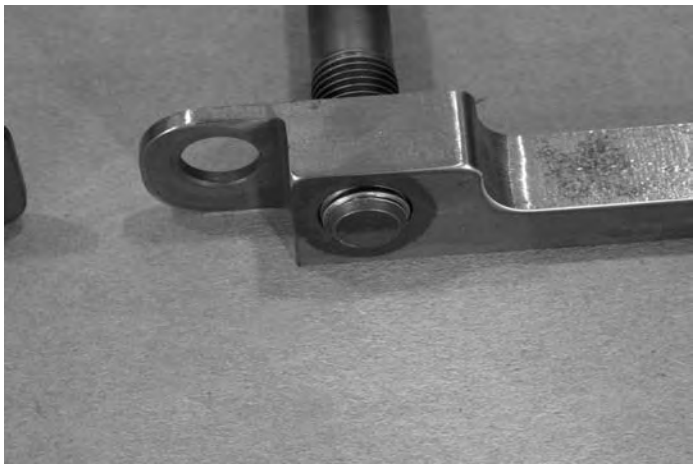


Fig. 83

Five sets of uni-bolts are assembled. Two bolts are threaded by hand into a connecting strap using green Loctite. Thread protrusion on the under-side of the strap is 1½-2 threads. (Fig. 83) Loctite is allowed to set over night.

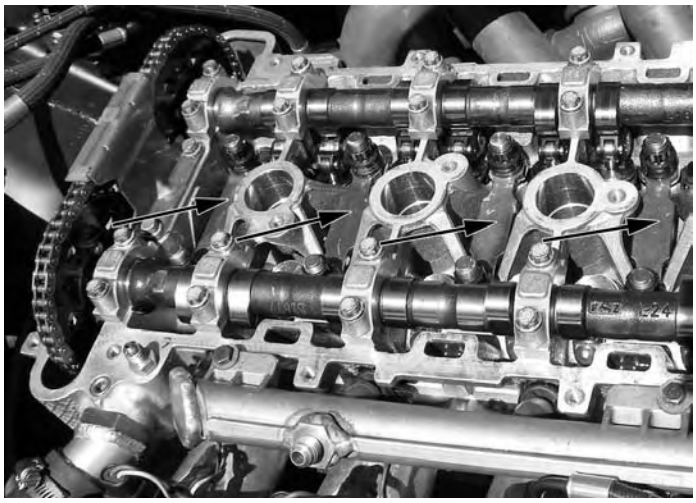


Fig. 84

Uni-bolt assemblies are installed from the bottom through the girdle and block. The uni-bolts will protrude above the top of the block to attach the engine head assembly. Head straps shown in (Fig. 84)

OIL PAN

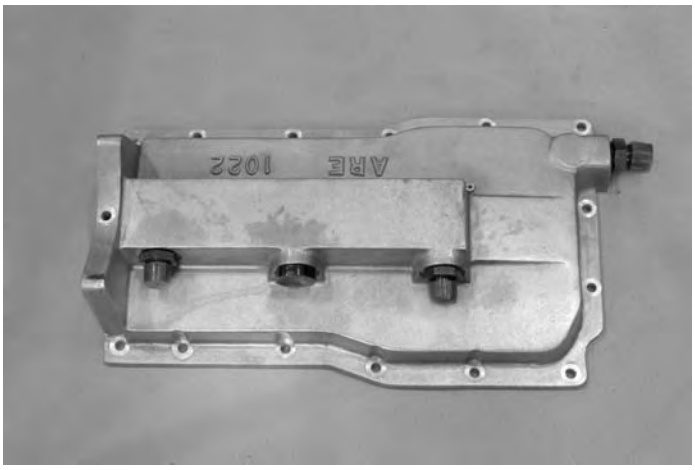


Fig. 85

Drift engine (500 hp) applications use an ARE aftermarket scavenge style pan. (Fig. 85) This is basically a dry sump pan with a stock style oil pressure pump. A tank is used to store scavenged oil and the stock pump is supplied from the bottom of the tank.

Turbo Street engine (less than 900 hp) applications are production-based race cars with a production engine compartment. The production oil pan is used.

Hot Rod engine (900-1200 hp) applications use a wet sump oil pan. These are front-halved race cars that maintain a transverse engine orientation. Custom wet sump oil pans are available from sources including Bates engineering, Roush Industries, or Steph's.

Fig. 86

Pro FWD engine (over 1200 hp) applications use a dry sump oil pan. These are full tube chassis race cars with longitudinal engine orientation. There are three oil scavenging lines incorporated into the aluminum fabricated oil pan on the dry sump race engines. (Fig. 86) Custom pans are available from several sources including Roush Industries, Bates Engineering or Steph's.

CRANKSHAFT

Fig. 87

The production 2.2L L61 crankshaft has been run in drag race applications to over 500 hp with no durability issues. Alternatively, Eagle offers a production- replacement 4340 forged crankshaft (with and without timing reluctor ring) for **ECO**TEC engines. Eagle claims that this crankshaft is adequate to power levels over 600 hp. The Eagle and 2.2L L61 cranks have 6 bolt-holes. Note that production **ECO**TEC cranks from production LNF turbo or LSJ supercharged applications are 8-bolt cranks.

For drag racing applications over 500 hp, a 4340 billet steel crankshaft is used. It is a 3.505″ stroke crankshaft with 1.8887″ rod journal, production main journal (2.2038″), and 12 bolt holes. (Fig. 87) It is available from GM Performance Parts, part number 88958620. With the 3.500″ bore race engine, this crank provides a total displacement of 135 cubic inches (2.2L).

For drifting and other applications which require more displacement (for power over a broad rpm range), a longer stroke 4340 billet steel crankshaft is used. It is a 3.750″ stroke crankshaft with 1.8887″ rod journal, production main journal (2.2038″), and 12 bolt holes. It is special-ordered from Sonny Bryant. With the 3.500″ bore race engine, this crank provides a total displacement of 144 cubic inches (2.36L). Note that, for power levels below 500 hp, the production 2.2L L61 or 2.4L LE5 crankshafts offer similar stroke. See the production specifications chart that can be found in the appendix of this book.

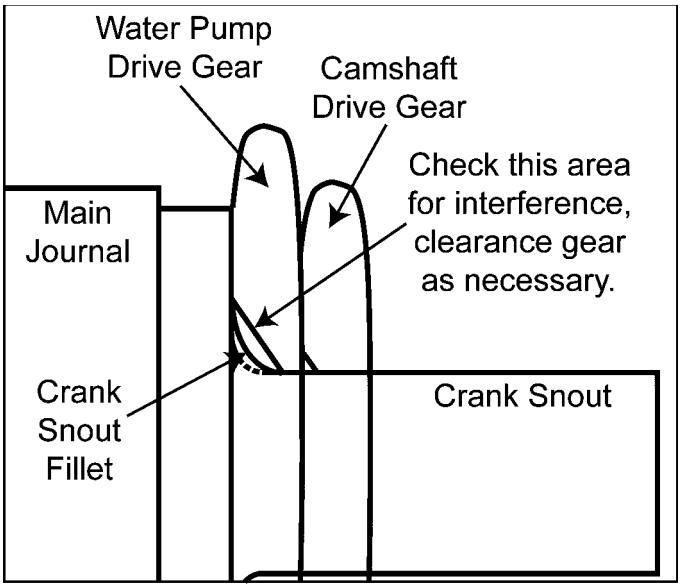


Fig. 88

ASSEMBLY TIP
Check the water pump chain drive gear for interference on the front crankshaft fillet.

CRANKSHAFT MAIN BEARINGS

Fig. 89

The recommended crankshaft main bearing is a production main bearing. The part number for this main bearing kit is #12591092. When using the production main bearings with an aftermarket crankshaft, check the clearance between the fillet radius of the crank and the bearing. Contact can cause premature engine failure. (Fig. 89)

CONNECTING RODS

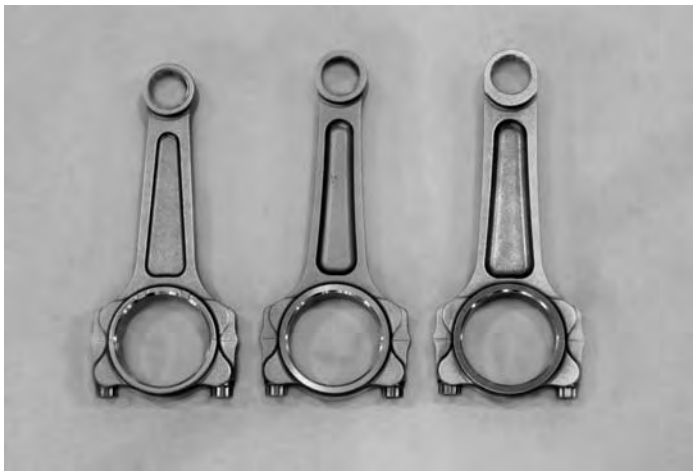


Fig. 90

The 2.2L L61 production-replacement rod from Eagle has been tested to 550 hp at 8000rpm. From 500 hp to 1000 hp, a billet steel or 300M connecting rod with a 22mm small end is used. Both Carrillo and Manley offer a high quality rod for this application. Recommended wrist pin clearance is .0012″ to .0015″

Above 1000 hp, only 300M rods from Manley are used. (Fig. 90) A large cross-section is required for applications approaching 1400 hp, as rods of lesser material or thinner cross-section will buckle at this power level (with 55-65 psi of boost).

RODS CURRENTLY USED IN GM RACING ECOTEC RACE ENGINES

	1000 hp+ Drag	750-1000 hp Drag	500 hp Drift
Manufacturer	Manley	Manley	Manley
Part #	15499GR	14499GR	15417GM
Material	300M	300M	300M
Length	5.888″	5.888″	5.636″″
Big End Size	2.0152″	2.0152″	2.0152″
Small End Size	0.868″	0.868″	0.868″
Bushing Material	Bronze	Bronze	Bronze
Bolt Size/torque	3/8-50 Ft lbs	3/8-50 ft lbs	3/8-50 ft lbs
Beam Type	I Beam	I Beam	I Beam
Total Weight	675 Grams	635 Grams	610 Grams

CONNECTING ROD BEARINGS

Fig. 91

The recommended connecting rod bearing is a CLEVITE, part number #1663 H or HX. Crankshaft fillet clearance must be checked. (Fig. 91)

PISTONS, PISTON RINGS AND PISTON PIN LOCKS

Fig. 92

Pistons for use in **ECO**TEC race engines are available from various sources such as JE, Mahle, and Arias. All pistons used by GM Racing come with rings and piston pin locks (or buttons). If needed, pistons are machined in-house to provide the target compression ratio. GM Racing has primarily used JE Pistons in **ECO**TEC race engines (these are shown in the chart below). However, we have also had success with Arias. Piston scuffing is a concern in the highest horsepower (1400 hp+) race engines on methanol. In these high horsepower applications, or in applications requiring longer run time, production piston oil squirters (from 2.4L LE5 or 2.0L LNF **ECO**TEC engines) are used.

PISTONS CURRENTLY USED IN ECOTEC RACE ENGINES

	1000 hp+ Methanol	750-1000 hp Race Gas	500 hp Drift E85
Manufacturer	JE	JE	JE
Part #	JEP-257853	JEP-259256	JEP-259195
Material	Forging 87M	Forging 87M	Forging 87M
Compression Ratio	10.0/ 51CC Head	8.5/ 51CC Head	13.75/ 51CC Head
Bore	3.500 in	3.500 in	3.500 in
Compression Height	1.055 in	1.030 in	1.180 in
Pin Diameter	.866 in	.866 in	.866 in
Pin Length	2.250 in	2.250 in	2.250 in
Top Ring	1.2mm	1.2mm	1.2mm
Second Ring	1.2mm	1.2mm	1.2mm
Oil Ring	3 mm	3 mm	3 mm
Lock	.063 wire	.063 wire	.063 wire
Piston to Wall Clearance	.008 to .009 in	.008 to .009 in	.008 to .009 in
Top Ring Gap	.030 in	.030 in	.030 in
Second Ring Gap	.026 in	.026 in	.026 in
Oil Ring Gap	.030 in	.030 in	.030 in
Piston, Pin Clearance	.0016 in	.0016 in	.0016 in

PISTON PINS

Fig. 93

22mm diameter piston pins from PPP are used in all professional-level **ECO**TEC race engines. These pins are made of C350 and are casidium-coated. The wall thickness is .180″ to .200″. (Fig. 93)

CYLINDER HEAD

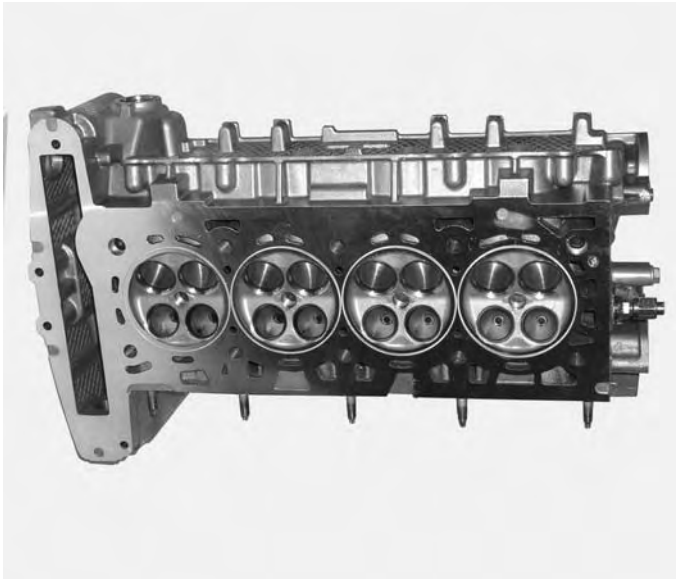


Fig. 94

For all professional-level **ECO**TEC race applications, the production sand-cast 2.0L LSJ or SAAB **ECO**TEC head is modified by GM Racing. (Fig. 94) Note that it is possible to use a race-ported production 2.2L L61 head at power levels up to 900 hp, as long as the combustion chamber is staked.

Modifications and checks made by GM Racing to the production 2.0L LSJ head include:

- The ZYGLO system is used to check for cracks and imperfections in the cylinder head.
- The head is machined to match the 3.500″ bore race block.
- The cylinder head alignment dowel holes are opened to 0.629″.
- CNC Race porting for port-to-port consistency.
- The spark plug holes are modified to accept ¾″ reach spark plugs.
- The diameter of the valve spring seats are machined to 1.150″.

A receiver groove is machined for GM Racing sealing rings (this application uses a copper head gasket with sealing rings). This race head and rings are available from GM Racing (email through www.gmtunersource.com). The head is part number XGH614. Sealing rings are part number XGH674.

For applications using a production head gasket (below 500 hp) or Cometic multi-layer head gasket (below 900 hp), the same race-ported head can be used, but must be machined flat for these applications that do not use sealing rings. This version of the **ECO**TEC race head has been used in NDRA Turbo Street and Formula Drift competition.

RACE CYLINDER HEAD GENERAL DATA		
	Intake	**Exhaust**
Valve Head Diameter (in.)	1.400″	1.200″
Valve Stem Diameter (in.)	6.0 mm	6.0 mm
Valve Seat Angle (degrees)	45.0°	45.0°
Valve Spring Installed Height (in.)	1.210″	1.210″
Valve Spring Seat Pressure (lbs)	92 lbs	92 lbs
Spring Pressure Over Nose (lbs.)	250 lbs @ .500 lift	250 lbs @ .500 lift

RACE CYLINDER HEAD FLOW											
RACE CYLINDER HEAD FLOW NUMBERS – PERFORMED ON A SUPERFLOW SF-1020 FLOW BENCH											
Intake Valve Test Data at 28.0 Inches of Water											
Valve Lift	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.550
Corrected Flow	43.1	86.3	125.4	165.5	204.2	233.5	254.1	269.6	281.2	224.4	288.7

RACE CYLINDER HEAD FLOW											
RACE CYLINDER HEAD FLOW NUMBERS – PERFORMED ON A SUPERFLOW SF-1020 FLOW BENCH											
Exhaust Valve Test Data at 28.0 Inches of Water											
Valve Lift	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.550
Corrected Flow	37.1	84.7	125.7	162.6	189.8	201.4	208.3	213.7	217.6	220.7	222.7

CYLINDER HEAD COVER

Fig. 95

The LSJ 2.0L race head requires the production LSJ valve cover. A breather provision is added to the valve cover. A minimum of a -12 hose is recommended. If a dry sump oiling system is used, a hose is attached to the provision on the cover and this is connected to the dry sump oil tank above the oil level. (Fig. 95)

CYLINDER HEAD GASKET

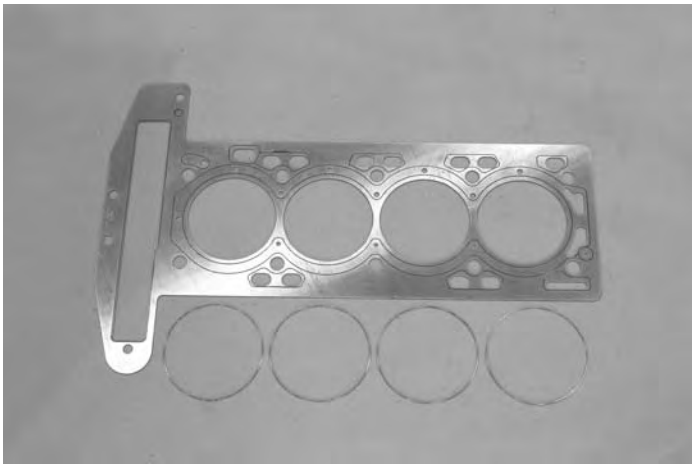


Fig. 96

A .043″ copper head gasket is used with sealing rings for most **ECO**TEC professional-level race engines. This head gasket is available from GM Racing (email through www.gmtunersource.com), part number XGH616. (Fig. 96)

Alternatively, an aftermarket multi-layer head gasket from Cometic has been used with a flat-deck block and machined flat head at power levels below 900 hp.

VALVE SPRINGS AND RETAINERS

Fig. 97

PSI part number CT1530 dual valve springs are used in **ECO**TEC Racing cylinder heads. Trick Titanium has developed a titanium retainer to work with this spring and the 6 mm Ferrea valve and keeper. (Fig. 97)

VALVES AND KEEPERS

Fig. 98

High quality 6 mm diameter stem valves are used in the race **ECO**TEC engine. These valves are made by Ferrea. The intake valves are 1.40″ diameter and made of stainless steel. The exhaust valves are 1.20″ diameter and are made of Inconell. Ferrea 6 mm keepers are recommended.

ROCKERS AND LIFTERS

Fig. 99

For applications above 42 psi of boost, a dual roller rocker from Jesel is used. The recommended valve lash is 0.005″ at the valve.

At lower boost levels, the production intake rocker arm can be retained. Bates Engineering offers a cast rocker arm for use with the Bates Engineering solid lifter. The recommended valve lash is 0.005″ at the valve. To adjust lash or roller to cam clearance, the bottom of the solid lash adjuster is machined down in a lathe until proper lash is achieved. For each 0.0025″ machined-off the solid lash adjuster, there should be a 0.001″ increase in lash or roller to cam clearance.

CAMSHAFTS

Fig. 100

GM Performance Parts offers a matched pair of high performance cams, part number 88958648 for the set (Fig 98). These high performance cams are used in all boosted professional drag race ECOtec engines. The cams are ground from a cast 2.2L L61 cam blank and fit the production 2.2L L61 head, prior to the 2007 model year. Bates Engineering valve springs and retainers are required to avoid coil bind. COMP Cams offers a selection of other performance cams for the ECOtec engine, and 2.2L L61 (prior to 2007 model year) cast cam blanks are available from GM Performance Parts, part number 88958611 and 88958612.

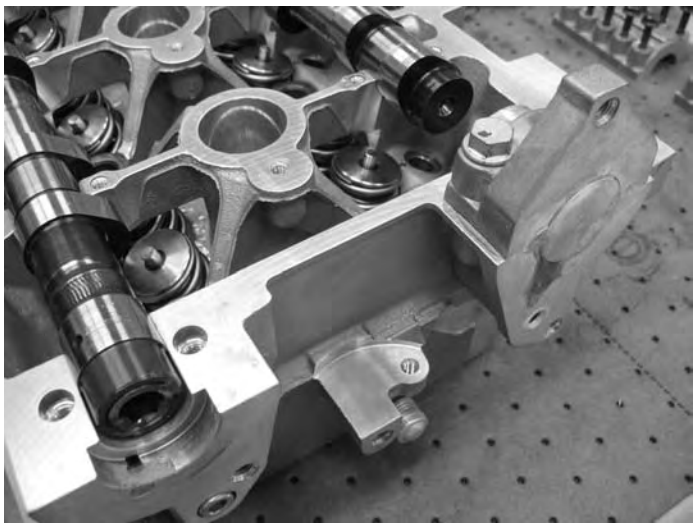


Fig. 101

GM Racing modifies the GM Performance Parts high performance cam set by pressing and welding a hex into the intake cam. This hex is used to drive the MSD distributor on professional-level ECOtec race engines.

CAMSHAFTS CURRENTLY USED IN ECOTEC RACING ENGINES

	Drag, Cast	Drag, Billet	Drift
Manufacturer	**GM Performance Parts**	**Comp Cams**	**Comp Cams**
Intake Part #	88958636	8766	113251
Intake Lift	0.499″	0.499″	0.478″
Intake Duration @ .050″	247	247	210
Installed @ (BTDC)	117 Deg	117 Deg	116 Deg
Exhaust Part #	88958637	8767	113402
Exhaust Lift	0.499″	0.499″	0.453″
Exhaust Duration @ .050″	249	249	224
Installed @ (BTDC)	117 Deg	117 Deg	114 Deg
Lifter Type	Mechanical	Mechanical	Hydraulic
Lash	.005-.007″	.005-.007″	N/A

Alternatively, COMP Cams offers a set of billet cams with the same configuration and grind that already have a hex in the intake cam, as shown in (Fig. 101).

For professional-level ECOtec race engines, GM Racing uses a race-modified 2.0L LSJ cylinder head. When using an LSJ-based cylinder head, an aluminum plug must be used to seal the production cam sensor drive opening on the exhaust side (the exhaust cam will fall short), as shown in Fig 99. Note that, because the production 2.0L LSJ engine uses a hex on the exhaust cam for cam signal, the race cams and cam blanks described in this section cannot be used in a production 2.0L LSJ engine, or in any ECOtec engine other than the pre-2007 2.2L L61. Other cam or cam blanks may be available from GM Racing, COMP Cams, or other aftermarket cam suppliers in the future.

MECHANICAL TIMING CHAIN TENSIONER

Fig. 102

For applications where extended time will be spent on the rev limiter, it is recommended that the hydraulic chain tensioner be converted to a mechanical tensioner. Take a 7/16-14 bolt and cut the head off for an overall length of 3.100″ and radius. Then cut the end of the bolt.

Slot the threaded end for ease of adjustment. Drill and tap the end of the adjuster for 7/16-14 thread.

To adjust the timing chain tensioner turn the engine to TDC (cylinder number 4) and tighten the adjuster to finger tight. Bar the engine over until the timing chain slacks between the cam gears. The number 1 cylinder intake lobes should be pointing straight up. Take a straight edge and lay it across the top of the cam gears. Adjust the tensioner to give .200″ chain deflection. Use silicone or an o-ring to seal the thread. Install the jam nut using silicone to hold it.

For applications over 1400 hp, a billet version of this chain tensioner is used (shown in Fig. 102).

TIMING CHAIN GUIDE

Fig. 103

The production timing chain guide is used until 1400 hp. Beyond 1400 hp, a billet timing chain guide is used. (Fig. 103) This billet timing chain guide is available from GM Racing (email through www.gmtunersource.com), part number XGB693.

FLYWHEEL AND FLYWHEEL BOLTS

Fig. 104

Twelve 12 mm x 1.25 pitch, special flywheel bolts are required to clamp the flywheel to the crankshaft at these high power levels. The crank to flywheel interface in a high powered 4 cylinder engine is very critical. The use of high quality flywheel bolts is highly recommended. GM racing has worked with A-1 Fastener Co. to design a high quality bolt for this application. The GM racing part number for these bolts is XGH677. (Fig. 104)

The flywheel shown in Fig. 104 is for the automatic transmission (Hot Rod) application. It is from Bates Engineering. For clutch cars, we use a modified (a steel washer plate is added) flywheel from ACE, along with twelve GM Racing flywheel bolts XGH677 and an ACE 6-disc clutch.

FRONT HUB

Fig. 105

Front Hubs are available from Bates Engineering and ATI. GM Racing or Bates Engineering hubs are used on our Pro FWD and Hot Rod engines (1000 hp +). ATI dampners with an integral hub are used on Drift (500 hp) and Turbo Street (800 hp) applications.

COOLING SYSTEM

Fig. 106

The production ECOtec water pump is used in Drifting (500hp), Turbo Street (800hp) and when required by class rules. In applications that retain the production or any chain-driven water pump, either the GM Performance Parts neutral balance shaft kit or the GM Racing balance shaft elimination kit is used (GM Racing recommends using the neutral balance shaft kit, as a special tool is required for the elimination kit). The mechanical

water-pump is driven by the same chain as the balance shafts.

In Hot Rod and Pro FWD applications (over 1000hp), an electric water pump is used. Using an electric water pump permits the removal of the water pump drive chain, and, therefore, also permits the removal of the balance shafts (oil holes must be plugged). Do not remove the water pump drive gear from the crank snout, as it spaces the cam drive gear out the proper distance. The Meziere water pump 366, rated at 55 GPM, is recommended (Fig 106).

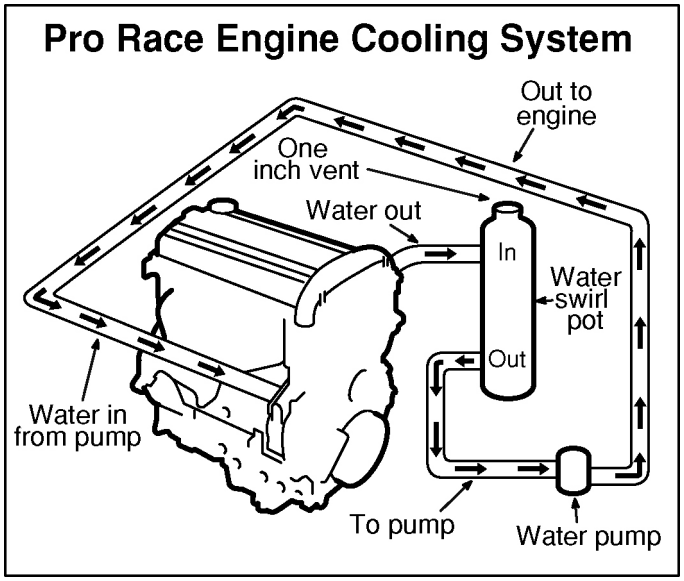


Fig. 107

For all professional-level (over 500hp) drag race applications, GM Racing recommends using a non-pressurized cooling system, vented with a swirl pot.

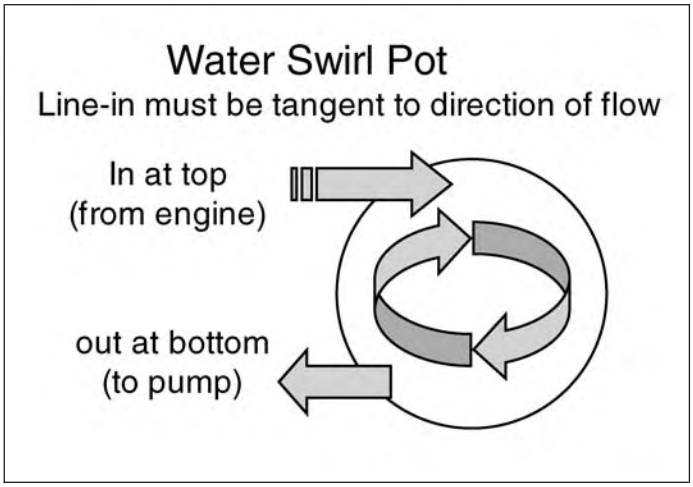


Fig. 108

Water with Water Wetter is used as the coolant. When running methanol fuel in high-boost applications, a radiator is not used. (Fig. 107)

OIL PUMP (WET SUMP)

Fig. 109

The production wet sump lubrication system, with the gerotor-style oil pump, is used on **ECO**TEC race applications below 1200 hp. Oil pump gears are upgraded to billet gears from Bates Engineering.

OIL PUMP (DRY SUMP)

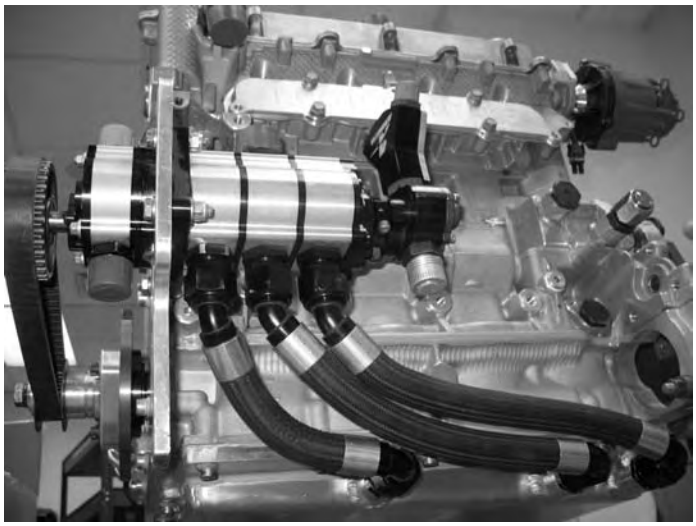


Fig. 110

On 1400 hp **ECO**TEC applications, a dry sump lubrication system is used (Fig. 110). The dry sump system includes a Daily Engineering 3 stage scavenge pump and accessory drive components from Jones Racing Products. The pump runs at 50% of engine speed.

For drifting, we use the production oil pressure pump, upgraded with Bates Engineering billet gears, and a two-stage dry-sump system from ARE.

INTAKE MANIFOLD

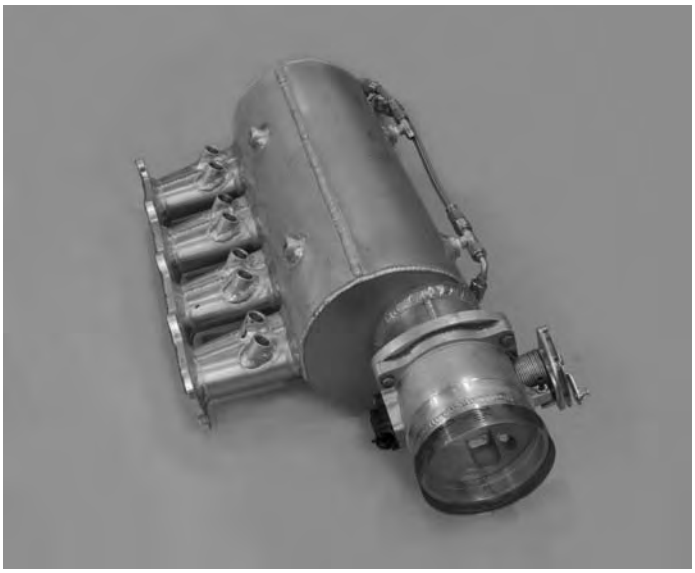


Fig. 111

The intake manifold used on the **ECO**TEC pro race engines is a sheet metal fabricated intake manifold. (Fig. 111) Manifolds are available from Bates Engineering and Roush Industries. Manifolds are made from 6061 Aluminum and are completely TIG welded. They have larger, shorter runners to improve high rpm performance and fit a 90 mm throttle body from UMI. Manifold flanges for the **ECO**TEC engine are available from GM Performance Parts, for those wanting to fabricate their own intake.

If the engine is producing more than 1000 hp on methanol, provisions for four additional fuel injectors are added to the intake, resulting in a total of three 160 lbs/hr injectors per cylinder.

EXHAUST HEADER

Fig. 112

The exhaust header used on the **ECO**TEC pro race engines is a sheet metal fabricated exhaust manifold (Fig. 112). Headers are available from Full Race and Roush Industries. Headers accommodate dual waste gates on applications producing 60 lbs. of boost (or more). Header flanges for the **ECO**TEC engine are available from GM Performance Parts, for those wanting to fabricate their own exhaust.

PROFESSIONAL LEVEL ECOTEC ENGINE PARTS LIST

Description	Part Number	Source	Qty
3.500″ ECOtec Race Block Assy with uni-bolts	XGH679	GM Racing	1
Race-ported ECOtec Sand-Cast Cylinder Head, bare	XGH614	GM Racing	1
Valve Cover for Sand-Cast Race head	XGH672	GM Racing	1
Billet Crankshaft, 3.505stroke	88958620	GM Performance Parts	1
3.500″ Head Gasket	24444091	SCE	1
3.500″ O-Ring	XGH674	GM Racing	4
Rods, 300M (set)	See Page 33	Manley	1
Rod Bearings	1663H or 1663HX	Clevite	1
Pistons	See Page 34	JE	1
Piston Pins	MC-86622462005-TC	PPP	1
Main Bearing Kit	12591092	GM	1
Rear Crank Seal	90298408	GM	1
Main Stud 7/16″	H-11 24DKSIMIN-4375	A 1	10
Tie Bars for Head Studs, set	XGH678	GM Racing	1
Head Dowels	ESGH1100	Bates Engineering	2
Head Nut 5/8″ 12 pt. 1/2″ X 20	231-4701	ARP	10
Head Nut Washer 1/2″	300-8336	ARP	10
Main Nut 7/16″ X 20	300-8333	ARP	10
Main Nut Washer 7/16″	2008406	ARP	10
Water Block-off Plate	XGH675	GM Racing	1
Water Pump Gear, Crankshaft	90537301	GM	1
Billet Front Hub	88958631	GM Performance Parts	1
Flywheel Bolts	XGH677	GM Racing	12
Billet Chain Guide***	XGB693	GM Racing	1
Timing Chain, Gears, and Guides Kit	12578218	GM	1
Timing Attachment kit	12578209	GM	1
Timing Chain Guide Bolt	11517591	GM	1
Timing Chain Guide Bolt	11588522	GM	1
Exhaust header flange	88958632	GM Performance Parts	1
Intake Manifold flange	88958633	GM Performance Parts	1
Starter (stock)	89017756	GM	1
Fuel Rail	12574291	GM	2

Description	Part Number	Source	Qty
ValveTrain			
Cam Gears (adjustable)	88958613	GM Performance Parts	1
Cam Gear Bolts	90537451	GM	2
Race Camshaft Set	88958648	GM Performance Parts	1
Exhaust Jesel Lifters	KLA-81500 or 81550	Jesel	8
Exhaust Jesel Followers	OCF-8100	Jesel	8
Exhaust Jesel Shim Assortment	KLA-81555	Jesel	8
Intake Lifters	ESGV0200	Bates Engineering	8
Intake Followers	12565203	GM	8
Intake Valve	F 806695	Ferrea	8
Exhaust Valve	F806694	Ferrea	8
Keepers	K10036	Ferrea	32
Retainers	KRERT001	Trick Titanium	16
Locators	N/A	Roush / Custom	16
T-Washers	ESGH0200	Bates Engineering	10
Springs	CT-1530 ML	PSI	16
Ignition			
Distributor	8498	MSD	1
Spark Plugs	R5724-10	NGK	4
Spark Plugs Wires	32769	MSD	1
Crank Trigger	8600	MSD	1
2 Injectors per Cyliner, Wet Sump Engines			
Neutral balance shaft set*	88958615	GM Performance Parts	1
Balance Shaft Elimation kit* (requires special tool)	XGH676	GM Racing	1
Balance Shaft Gear kit	12604864	GM	1
Balance Shaft Gear Bolts	11516328	GM	4
Alternator Belt	5PK850	GoodYear	1
Alternator	22683070	GM	1
Oil Pump / Front Cover	12584621	GM	1
Front Cover Gasket	24435052	GM	1
Billet Oil Pump Gears	ESGV0105	Bates Engineering	1
Oil Pan (Wet Sump)	Custom	Bates Eng / Roush	1
Oil Pre-Heater	23980	Moroso	1
Fuel Pumps	2345A	Weldon	2
Fuel Regulator	2040-281-A-120	Weldon	1
Fuel Injectors 160 lb/hr	0280150846/842	FiveO Motorsports	8
Water Pump	12591894	GM	1
Water Pump Chain Guide	90537336	GM	1
Water Pump Chain Guide Bolt	11588522	GM	2

Description	Part Number	Source	Qty
Water Pump Chain Guide	90537369	GM	1
Water Pump Chain	90537370	GM	1
Water Pump Chain Guide	90537299	GM	1
Water Pump Chain Gear	90537298	GM	1
3 Injectors per Cyliner, Dry Sump Engines			
Front Engine Plate	Custom	Roush or GMR	1
Timing Pointer	SUM-163625	Summit	1
Fuel Injectors 160 lb/hr	0280150846/842	FiveO Motorsports	12
Belt Drive Manderal	DA 8101-WC-SB	Jones Racing Prods	1
End Cap	BEC-2109-H	Jones Racing Prods	1
Oil Pump Belt	632-8M-20	Jones Racing Prods	1
Oil Pump Pulley	OP 6103-34	Jones Racing Prods	1
Crank Pulley	CS 6102-AS-17	Jones Racing Prods	1
Crank Pulley	CS 6102-AS-30	Jones Racing Prods	1
Belt Guide	BG 6108-C	Jones Racing Prods	1
Belt Guide	BG 6108-A	Jones Racing Prods	1
Spacer 3/4 Thick x 1.125″ ID	SP-6103-D-A	Jones Racing Prods	1
Dry Sump Pump	02-99-1209-2	Daily Engineering	1
Fuel Pump	1003	DSR Fuel Systems	1
Fuel Distribution Y-Block	15620	Aeromotive	1
Fuel Regulator	2040-281-A-120	Weldon	1
Oil Pan (Dry Sump)	custom	Bates Eng / Roush	1
Screened fittings for oil pan	23961	Moroso / Motorstate	3

*Balance Shaft Elimination kit can be used in-place of Neutral Balance shaft for professional builders only. The Elimination kit requires a special bushing-removal tool and machining.

**For GMR parts, email us through our website www.gmtunersource.com. For all other parts, see your GM Performance Parts dealer or the source listed.

***Billet chain guide is only used in exceptionally high vibration and high hp applications, such as 1450hp dragster. Less harsh applications can retain the production chain guide.

ECOTEC RACE ENGINE CONTROL SYSTEMS

ENGINE METRICS

The Air Fuel ratio is dependant on the type of fuel, the type of sensor, and what system is reading it. Below are the generally suggested air-fuel ratios and, more importantly, the suggested EGT range used by GM Racing on the GM ECOtec turbocharged race engines. Note that the amount of spark lead has a major influence on the exhaust temperature.

In gas race engines, GM highly recommends Torco 118 over C16 race gas. E85 is another good fuel choice at the sportsman-level, as it helps to keep engine temperatures down.

Fuel	AFR	EGTS
C-16 Fuel	10.2 to 10.8	1500 to 1600 max
Torco 118	10.8 to 11.4	1300 to 1550 max
E-85	7.1 to 7.3	1200 to 1400 max
Methanol	3.75 to 4.3	1180 to 1300 max

On the naturally aspirated ECOtec race engine, which runs on E85, we have AFR of 8.9 to 9.2 with EGT readings in the 1200 to 1380 degrees F range.

In boosted **ECO**TEC race engines, a maximum of 14 degrees of spark timing is recommended to start performance testing.

FUEL INJECTORS

Fig. 113

Injector applications are as follows: (Fig. 113)

Horsepower	Fuel	Number of Injectors	Injector Flow Rate
400 to 600	Gas	4	70 lbs. per hour RC high impedance
400 to 600	Methanol	4	160 lbs. per hour
400 to 600	E85	4	160 lbs. per hour
600 to 900	Gas	8	83 lbs. per hour
600 to 1250	Methanol	8	160 lbs. per hour
1250 and up	Methanol	12	160 lbs. per hour

Here is the basic process we use for determining injector sizing.

1. Calculate the base injector size.

(Desired Engine Power @ Flywheel x BSFC) / # of cylinders = required injector size in lbs/hr

For BSFC (Brake Specific Fuel Consumption) use:
Naturally aspirated engines-0.4-0.5
Supercharged or Turbocharged engines-0.5-0.6

Note: This assumes 1 injector per cylinder and a fuel pressure of 43.5 psi with gasoline as a fuel.

For example, here is the calculation for a turbo-charged 400 hp I4 engine:
(400 x 0.6)/4 = 60 lbs/hr

Note: When using a fuel other than gasoline, adjust your fuel requirement by the percentage difference between the gasoline stoiciometric fuel ratio and that of the fuel you wish to use. For example, the difference between gasoline (14.7:1) and E85 (9.76:1) is 50%. Therefore, instead of 60 lbs/hr, you would calculate 90 lbs/hr for E85.

2. Adjust for percent duty cycle.

The base calculation above assumes 100% duty cycle of the injector, which is not realistic. We recommend a maximum of 80% duty cycle. Divide by 0.8

60 lbs/hr / 0.8 = 75 lbs/hr

3. Know your engine management system.

Find out if your engine management system requires ″Peak and Hold″ or ″Saturated″ style injectors. The Peak and Hold injectors are low resistance (2.5-3 ohms) and the Saturated injectors are high resistance (12-16 ohms). Most aftermarket engine controllers prefer the Peak and Hold, but some will run either.

4. Choose your injectors.

For our example, the two closest size injectors available are 72 lb/hr and 83 lb/hr.

FUEL PUMP

Here is the basic calculation we use for determining required fuel pump flow.

1. Calculate the base fuel pump flow.

Flow in gal/hr = HP * BSFC *(1 / fuel weight)

For BSFC (Brake Specific Fuel Consumption) rated in lbs. per horsepower-hour, use:
0.45 to 0.5 for naturally aspirated engines
0.55 to 0.60 for supercharged engines
0.60 to 0.65 for turbocharged engines

For fuel weight, use
6.216 lb/gal for regular unleaded
6.350 lb/gal for premium unleaded

For example, here is the calculation for a turbo-charged 400 hp I4 engine on premium unleaded gasoline.
400 * 0.60 * (1/6.350) = 38 GPH

2. Include a factor of safety.

We recommend a 30% increase for safety, which is the generally accepted amount for fuel pump sizing. Multiply by 1.3.

38 GPH * 1.3 = 49 GPH

3. Choose your fuel pump.

Choose a fuel pump that has the calculated flow at minimum output. Methanol fuel requires about twice the flow of gasoline.

Fig. 114

An Aeromotive or Weldon boost compensated fuel pressure regulator is used by GM Racing. (Fig. 114)

As boost rises, the fuel injector needs more pressure to overcome the increasing pressure in the intake manifold and spray the proper amount of fuel. The special regulator has a boost pressure sensing line which allows the regulator to increase fuel pressure by one pound for every

pound of boost. This keeps differential pressure constant across the injector. (Fig. 114)

Fig. 115

Cobalt Phase5 (500 hp): Aeromotive A1000 high pressure fuel pump part number 11101 (Fig. 115)

The stock fuel line bundle can be used for fuel supply and return. Adapting AN fittings to the factory lines is the preferred method. (Fig. 115)

Fig. 116

Turbo Street (800 hp) and Drift (500 hp): One Weldon 2345A high flow, high pressure fuel pump with Weldon 1021 fuel pressure regulator. Recommended base fuel pressure is 45 psi static.

Hot Rod (1200 hp): Two Weldon 2345A high flow, high pressure fuel pumps with Weldon 1021 fuel pressure regulator. Recommended base fuel pressure is 70-75 psi static. (Fig. 116)

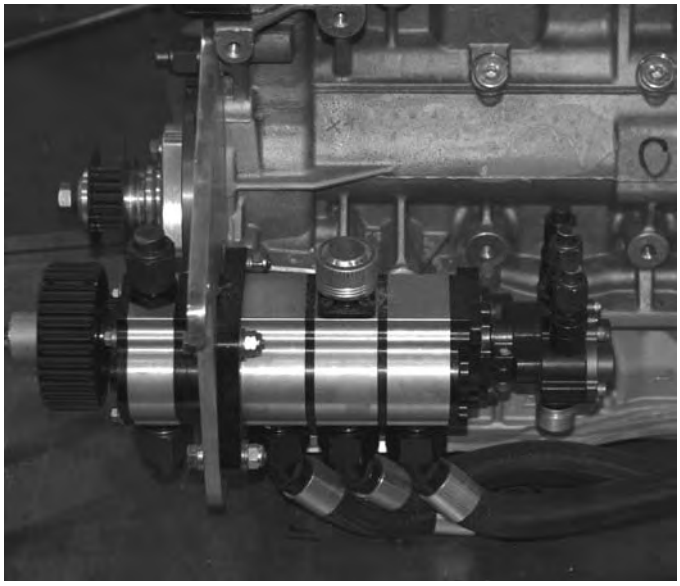


Fig. 117

Pro (1400 hp): DSR –1 mechanical fuel pump driven off of dry sump oil pump with Weldon 1021 fuel pressure regulator. Recommended base fuel pressure is 70-75 psi static. (Fig. 117)

Caution:
Utmost care must be taken with the fuel system components when using Methanol fuel. The fuel system must be flushed with a gasoline type fuel after use.

ENGINE MANAGEMENT

Fig. 118

GM Racing uses and recommends F.A.S.T. XFI engine controllers in all professional-level **ECO**TEC-powered race cars (Fig. 118). GM Racing has several F.A.S.T. XFI base

calibrations for ECOtec race engines, which are available on a case-by-case basis. Custom wiring harnesses for use with this system are available from Roush Industries.

At the sportsman level, F.A.S.T. XFI and MEFI controllers have been used in applications where the production controller and wiring harness are removed. Note that these application also involve an after-market dash and mechanical throttle.

For production-based applications (typically below 325hp), 'piggy-back' controllers or a production controller re-flash may be included with aftermarket power-adder kits. The GM Performance Parts Stage Three kit for the 2.0L LSJ engine in the Cobalt SS Supercharged includes a re-flashed controller. Additionally, HPtuners offers aftermarket software that is capable of tuning select **ECO**TEC production controllers.

IGNITION SYSTEMS

Fig. 119

A distributor system is currently used on all professional-level drag race **ECO**TEC engines. It includes:

- MSD 75314 Programmable Digital 7
- MSD 8261 Pro Power HVC II Coil
- MSD 8498 **ECO**TEC Distributor
- MSD 32769 8.5mm spark plug wire kit

For applications under 40psi of boost, an MSD 8251 Pro Power HVC Coil is used instead of MSD 8261.

GM Racing modifies the MSD distributors used on professional-level **ECO**TEC drag race engines (Fig. 119). The rotor-holder included with the distributor is either re-welded or replaced with a billet rotor-holder made by GM Racing. Green wicking Loctite is used between the rotor-holder and shaft. Red Loctite is used on the two rotor-holder allen bolts. Lock-nuts are added and/or blue Loctite is used on the two rotor screws. These screws are double-checked before every run.

A mini-blaster coil system is currently used on Drift and naturally aspirated **ECO**TEC race engines. This system includes:

- MSD 62153 DIS 4 Plus
- MSD 8207 Blaster SS coils (Qty 4)

TURBOCHARGER

Fig. 120

The following list shows recommended baseline turbos for a given power level. Check with your preferred turbo dealer for specific turbo recommendations. Borg Warner AirWerks turbo is shown in Fig. 120.

400-600hp

Borg Warner AirWerks S200 (part number 317222)
Garrett GT 35R
Turbonetics T3/T4 Hybrid

600-1000hp

Borg Warner AirWerks S400SX, 71mm
(part number 177248)
Borg Warner AirWerks S400SX, 74mm
(part number 177101)
Garrett GT 40R

1000-1200hp

Borg Warner AirWerks S510 (part number 174289)
Garrett GT 42R

1200-1500hp

Borg Warner AirWerks S510 (part number 174289)
Garrett GT 45R

BOOST CONTROLLER

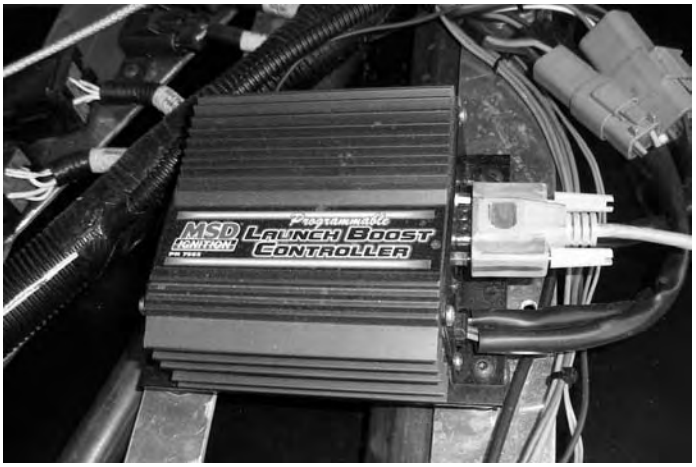


Fig. 121

Innovative and MSD offer boost controllers specifically designed for drag racing. The Innovative controller changes boost and boost ramp rate based on which gear the transmission is in. The MSD system is based on time from vehicle launch has a tuneable PID controller and a user-defined boost curve. Because of its greater tuneability, GM Racing uses the MSD boost controller in professional-level drag race cars. (Fig. 121)

Both systems output a P.W.M. signal that controls a solenoid to vary pressure on the top of the waste gate. This pressure change opens and closes the waste gate to vary engine boost as required.

Be sure you have sufficient pressure on top of the waste gate to ensure that the waste gate will stay closed when high exhaust pressure is present.

In drifting, GM Racing uses a mechanical HKS waste gate with a 20-22 lb. spring. We found this set-up to be best with varying throttle input.

WASTE GATES

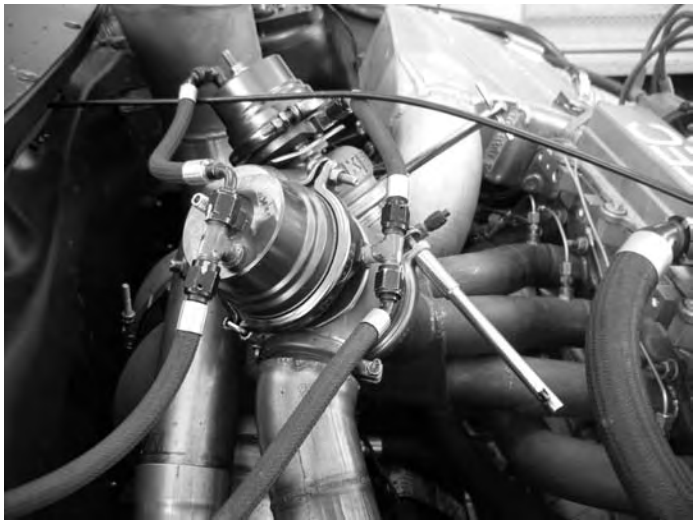


Fig. 122

ECOTEC racing engines use the following waste gates:

- Tial 42 mm (below 900 hp)
- HKS 60 mm GTII

In front wheel drive drag racing boost control is critical. The waste gate(s) should be sized to enable the boost controller to reduce boost to a level low enough to control wheel spin in the lower gears.

In applications using an aggressive two-step rev limiter (such as professional-level drag racing), GM Racing uses the HKS 60 mm GTII gates with modifications to the valve guide and seal. These modifications are made by Roush Industries and are required for reliability.

In applications reaching 60 psi of boost, it may be necessary to utilize two waste gates. These gates should be plumbed in parallel.

For drifting, GM Racing uses a single 40-42 mm waste gate.

INTERCOOLER

Fig. 123

Air-to-air and air-to-water intercoolers reduce the inlet charge temperature to improve performance and reduce spark knock sensitivity. (Fig. 123) An intercooler core from Precision Turbo is used in a air-to-water system on GM Racing professional level **ECO**TEC drag cars.

Fig. 124

Intercooler circulating pump (Fig. 124)

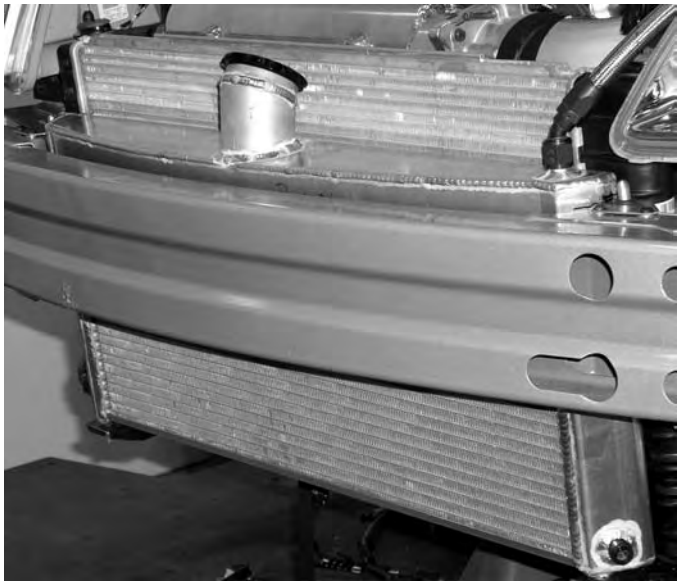


Fig. 125

Fig. 125 shows a sportsman application using an air-to-water intercooler.

4T65E RACE MODIFIED TRANSMISSION

This section illustrates parts and modifications that are used to transform a 4T65-E automatic transmission for Off-Highway drag racing. Starting with the heavy duty or V8 application of the production transmission, the gearbox is modified into a three speed transmission with an aftermarket performance torque converter. The changes have proven to be reliable behind a 600 hp engine and track proven behind a 1000 hp **ECO**TEC engine.

The information contained in this section of the handbook has been provided by GM Powertrain in conjunction with GM Racing. The photographs shown are from a transmission that is configured for Sport Compact Drag Racing. This handbook attempts to illustrate the changes; however, it is not totally inclusive of all changes needed for a 1000 hp application.

Extensive modifications have been developed by GM Racing/Hydra-Matic to keep this transaxle consistantly performing at high horsepower levels.

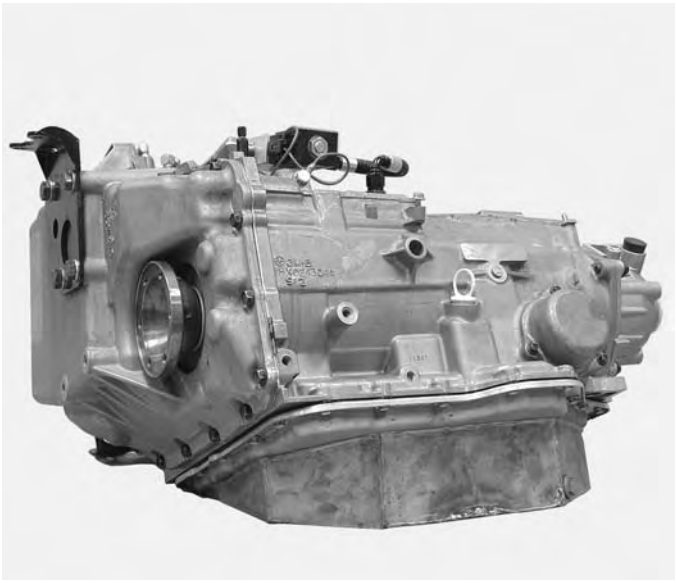


Fig. 126

The rear view above shows the oil pan modifications, transbrake location, plumbing, the output speed sensor location and wiring. (Fig. 126)

TRANSBRAKE

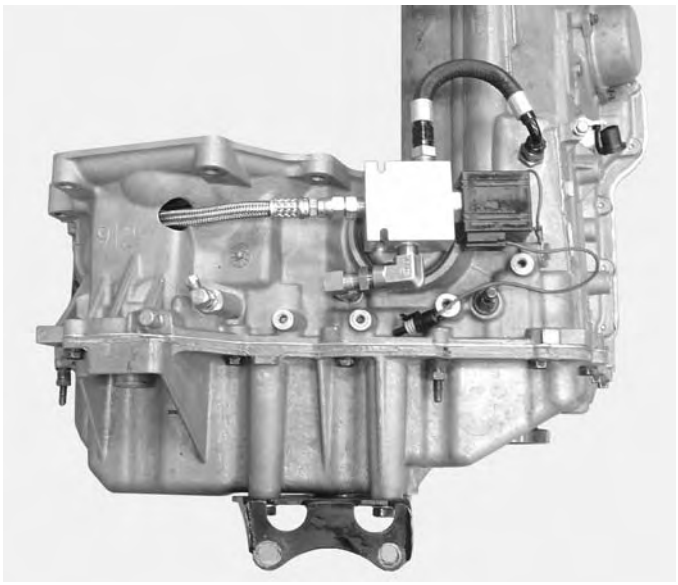


Fig. 127

The transmission brake is mounted externally on top of the transmission case and is operated with an on-off switch by the driver. A transmission brake may not be required on applications below 800 hp, although it is recommended where class rules allow it. (Fig. 127)

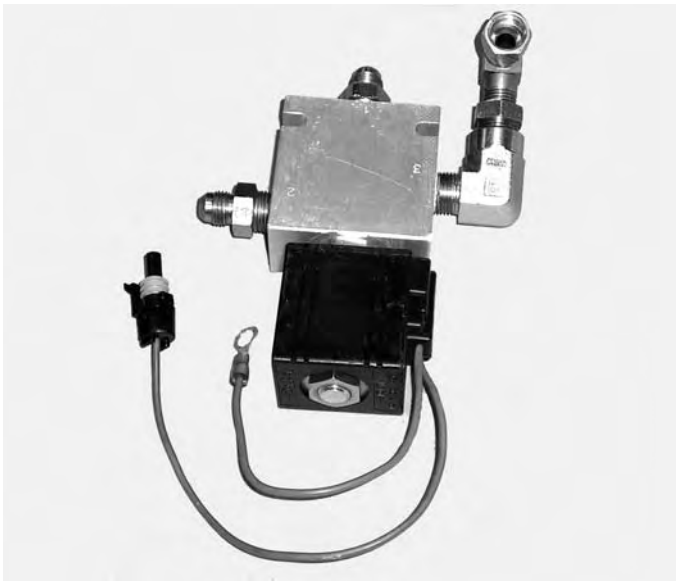


Fig. 128

The transbrake assembly is mounted externally above the reverse band servo cover and requires a 12 volt current to activate it. (Fig. 128)

Fig. 129

The major sub-assemblies of the transbrake are shown above. The check ball assembly is not shown. (Fig. 129)

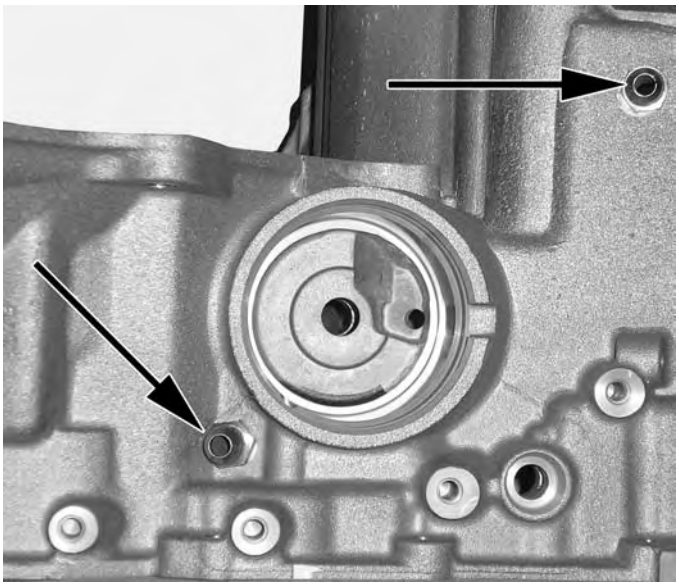


Fig. 130

The two fittings shown in the case are used for the transbrake system. The fitting in the lower left of the view is where low-1st gear oil is routed from the transbrake to apply the reverse band. When the transbrake is released, the oil is exhausted through the fitting shown in the upper right corner of the picture. (Fig. 130)

Fig. 131

A clearance hole through the case bell housing is provided for plumbing of the supply oil to the transbrake. (Fig. 131)

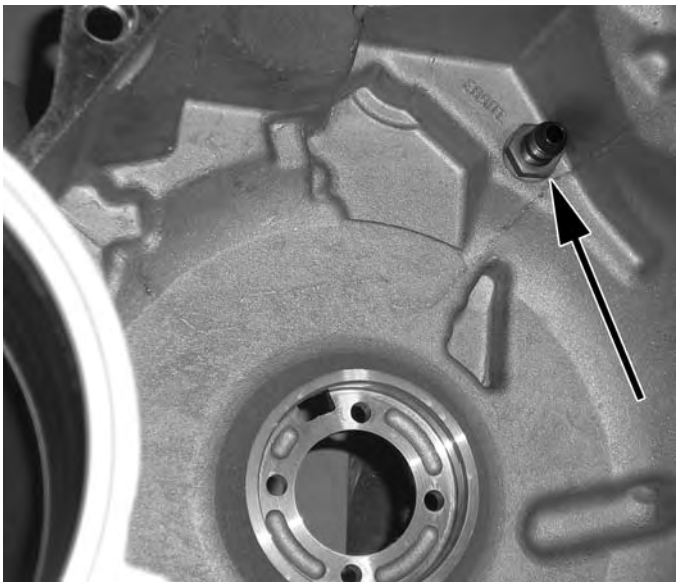


Fig. 132

This is the location of the transbrake pass-thru fitting on the torque converter side of the case. Oil is routed from this fitting through the hole in the top of the transmission bell. (Fig. 132)

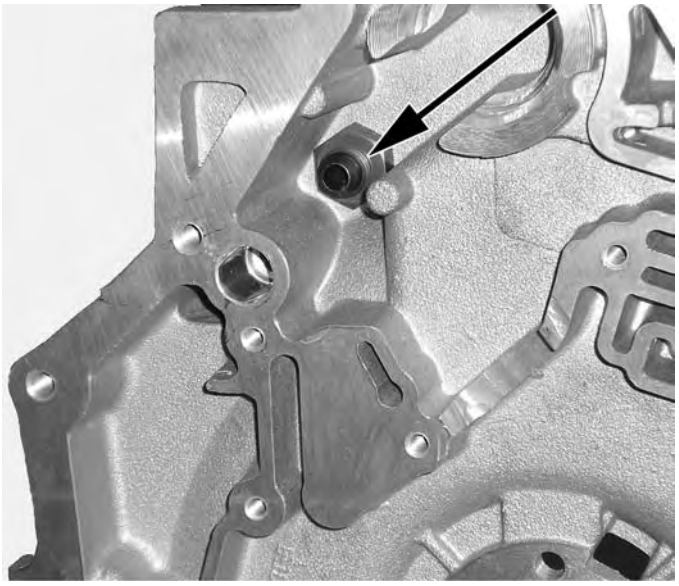


Fig. 133

This is the location of the transbrake pass-thru fitting on the case cover side of the case. Case ribbing is cut back to allow for clearance of the transbrake supply plumbing in this side of the case. Because of the modification to the case, the middle section of the upper case cover gasket is removed, making it a two-piece gasket. (Fig. 133)

TRANSMISSION CASE

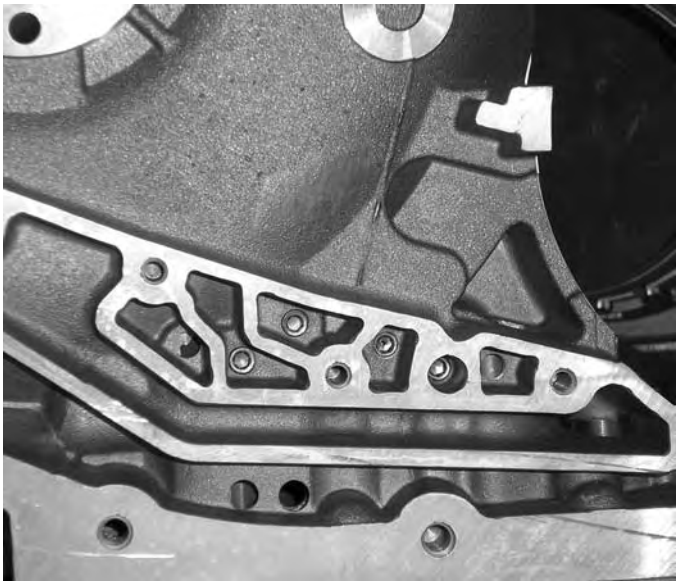


Fig. 134

Three passages are plugged in the lower part of the case because the 2-3 accumulator and the manual 2-1 servo are eliminated in the race unit. This allows two of these plugged passages to be drilled through for use as additional drain hole for the side cover cavity. The 1-2 accumulator is used in the race unit but the 2nd clutch feed oil to it, is reduced. (Fig. 134)

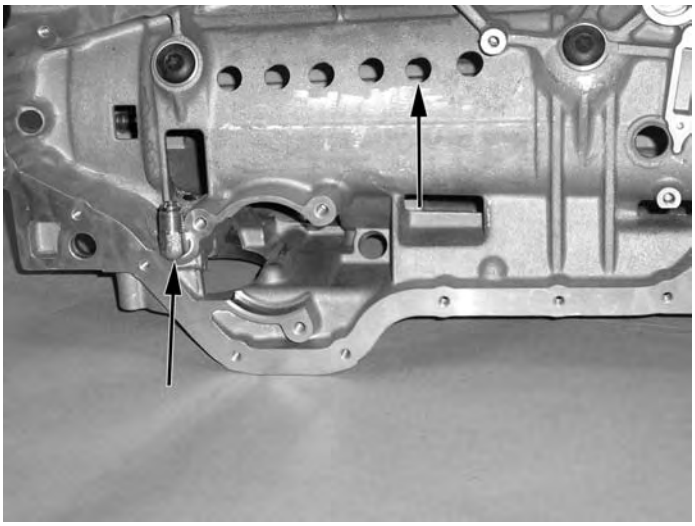


Fig. 135

Six additional oil drain holes have been added to the bottom barrel of the case. The thermal element is eliminated. A fitting is added for direct plumbing of forward servo oil from the lower accumulator housing. (Fig. 135)

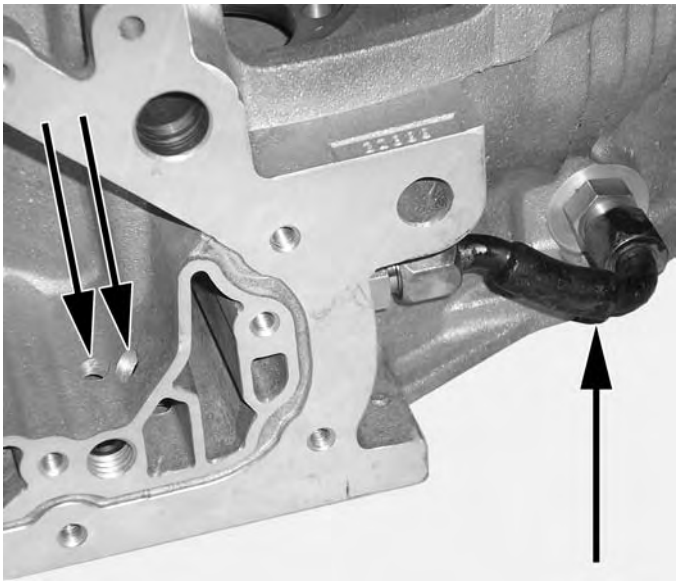


Fig. 136

The outlets of the additional side cover drain back holes in the case are shown above. The 3rd clutch oil passage is plugged to keep oil from accumulating in the 2-3 accumulator cavity. Also shown is the transmission oil cooler loop. A transmission oil cooler is not required in drag racing. (Fig. 136)

STATOR SUPPORT

Fig. 137

The O.D. of the drive sprocket support (stator support) is cut to clear the 1″ wide x 7/16″ pitch drive sprockets. (Fig. 137) The modified part is shown on the bottom of Fig. 137.

TORQUE CONVERTER

Fig. 138

The torque converter is manufactured by Coan Transmissions & Converters as specified for each application. (Fig. 138)

INPUT SHAFT

Fig. 139

The race input (or turbine) shaft is shown above on the right. The race shaft has increased wall thickness and the torque converter seal groove has been removed. In addition, the diameter of the shaft where the two torque converter seals are seated has been reduced. (Fig. 139)

OIL PUMP SHAFT

Fig. 140

The race pump shaft is on the top. This shaft is modified to fit inside the thicker walled turbine shaft. (Fig. 140)

DRIVE CHAINS

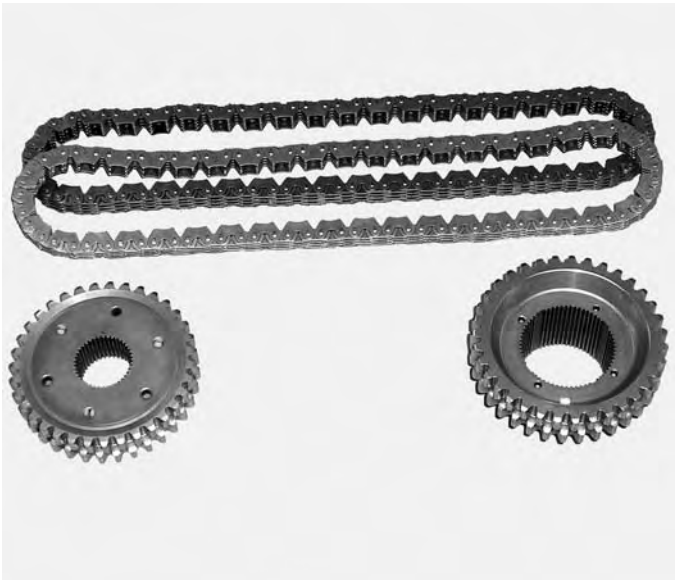


Fig. 141

Shown is the production dual Gemini chain and sprockets. (Fig. 141)

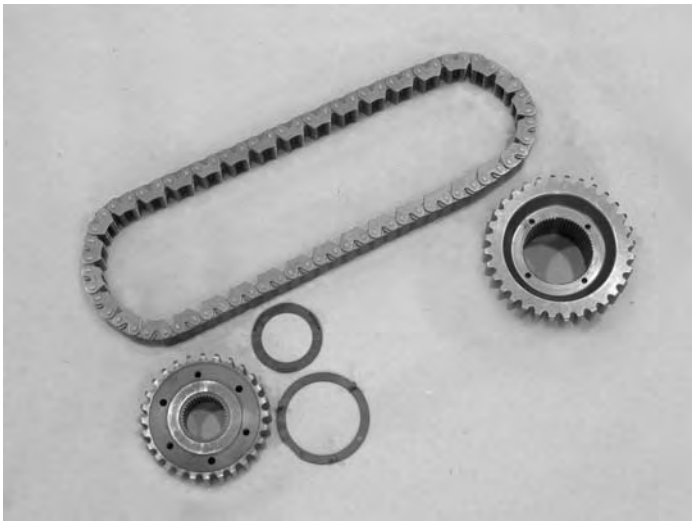


Fig. 142

The drive chain in the race unit is a 1″ wide x 7/16″ pitch chain with specially designed sprockets.

Note that the race-unit sprockets are not designed for use with the production speed sensor reluctor ring. Modification is required.

Thrust washers with PEEK material are also used in the race transmission. These washers are available as a GM service part, part numbers 24204840 and 24216480. (Fig. 142)

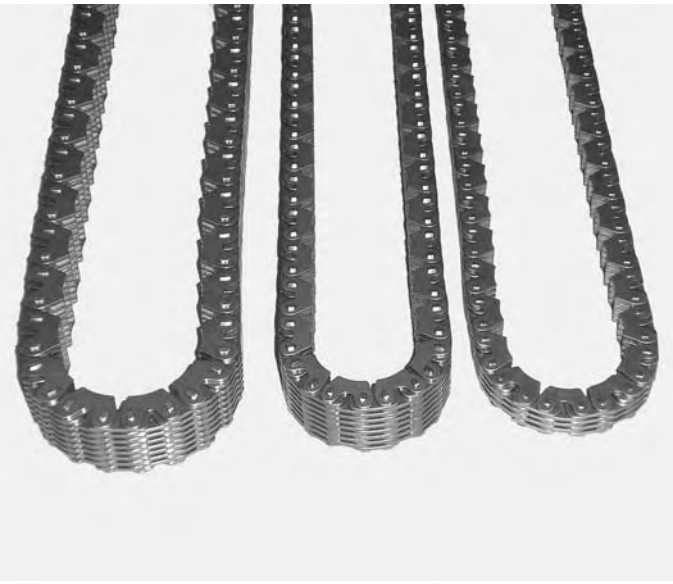


Fig. 143

The chain on the right (two required per transmission) is a production chain. The chain in the center, 1″ wide x 3/8″ pitch, was initially developed for the race unit, but was replaced by the 1″ wide x 7/16″ pitch chain on the left to handle the high horse power and torque. The 1″ wide x 3/8″ chain is excellent for applications up to 800 hp. (Fig. 143)

The drive link lube scoop must be modified to clear the chain. The amount of modification needed depends on the chain sprocket ratio. The production scoop comes in three different sizes.

SECOND GEAR CLUTCH

Fig. 144

A modified production 2nd clutch pack is used in the race unit. Another production plate is added to change the unit from a six to a seven plate clutch pack. (Fig. 144)

THIRD GEAR CLUTCH

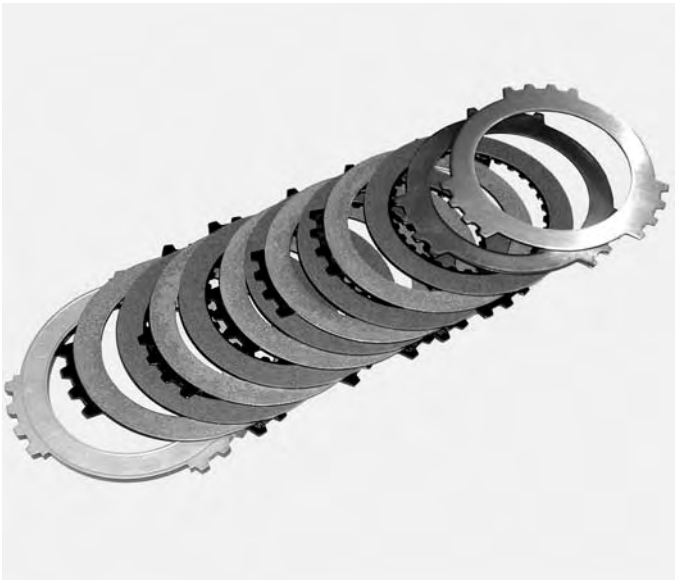


Fig. 145

The racing 3rd clutch pack is a specially designed Z-Pack 3rd clutch pack from Raybestos Powertrain. (Fig. 145)

Fig. 146

The race unit uses a specially designed backing plate from Raybestos Powertrain for the Z-Pack 3rd clutch. (Fig. 146)

FOURTH GEAR CLUTCH

The fourth clutch pack and piston assembly are removed from the race unit.

SINGLE WRAP BAND

Fig. 147

The production reverse band is modified to be a single wrap band for quicker release of the transbrake. The modified band is shown on the upper right of Fig. 147.

OIL DAM

Fig. 148

The production oil lube dam has been modified so that it can be assembled with the 4.0 final drive components. (Fig. 148) The modified part is shown on the left.

PLANETARY SET

Fig. 149

The input planetary carrier and reaction planetary carrier are stock V-8 LS4 application components. The gear sets are used without modifications. Specific to the V8 LS4 application are shot peened pinion gear teeth and roots, and lube scallops to direct oil to the pinions in the input carrier. (Fig. 149)

SPRAGS

Fig. 150

The current production pawl-type one-way clutches are used for 3rd and input without modifications. The one-way clutch on the left has the retainer removed to show internal components. (Fig. 150)

SUN GEAR AND SHAFT

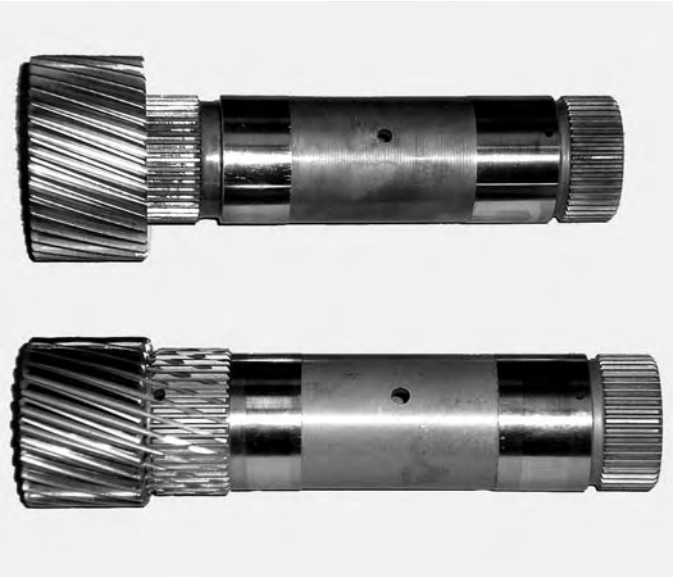


Fig. 151

The production sun gear and sun gear shaft (top) is replaced by a one-piece design (bottom) in order to package a final drive gear ratio change to 4.0. (Fig. 151) The one piece sun gear / sun gear shaft requires a revised park gear.

PARK PAWL GEAR

Fig. 152

The I.D. spline on the production park gear (left) is enlarged to fit onto the one piece sun gear / sun gear shaft. The modified part is shown on the right. (Fig. 152)

TORSEN® DIFFERENTIAL

Fig. 153

The production differential is replaced by a torque-biasing differential. The pinion carrier in the assembly is also replaced. The pinions in the carrier shown above are for a 4.0 final drive ratio. (Fig. 153)

Fig. 154

Production differential and pinion carrier. (Fig. 154)

RACE OUTPUT FLANGES

Fig. 155

The race output flanges were designed to work with Porsche 930 CV joints. (Fig. 155)

ACCUMULATOR AND FORWARD SERVO

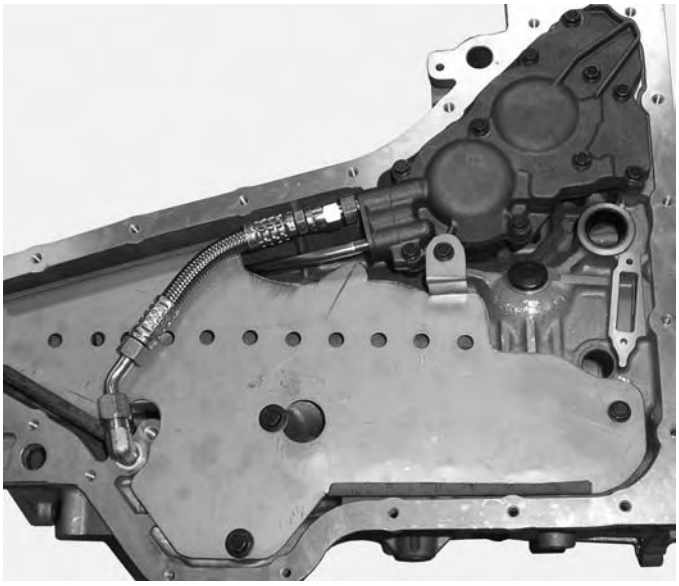


Fig. 156

Shown is the race unit with the lower accumulator assembly, oil baffle plate, and forward servo plumbing installed. Note that the thermal element and manual 2-1 servo assembly are removed. The lower accumulator assembly does not contain the 2-3 accumulator components. (Fig. 156)

MODIFIED FLUID PICK-UP

Fig. 157

The race unit fluid pick-up tube has been designed to work with a deep angled pan. The production filter is not used. A fine mesh screen is used on the inlet to filter the transmission fluid. (Fig. 157)

RACE TRANSMISSION PAN 22°

Fig. 158

This deep oil pan has been designed to work with a 22° rotation of the powertrain in the vehicle. When installed in the vehicle, the bottom of the pan is horizontal. Additional pan magnets are used for the race unit pan. (Fig. 158)

MODIFIED TUBE AND INDICATOR

Fig. 159

A production Grand Prix, Bonneville, Monte Carlo, etc. transmission fill tube is shortened at the fill end and lengthened at the pan end to accomodate the deeper pan. The locking dip stick is a shortened production 4L65-E GM light-duty pickup truck's fluid dip stick. (Fig. 159)

SEPARATOR PLATE

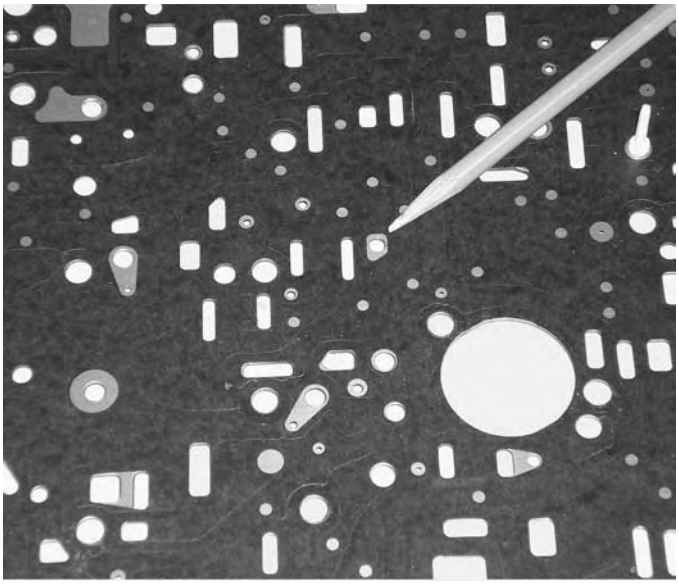


Fig. 160

The only modification to the valve body separator (spacer) plate is to enlarge the #2Y or #33 (input clutch feed) hole to a diameter of 0.160″. (Fig. 160)

VALVE BODY

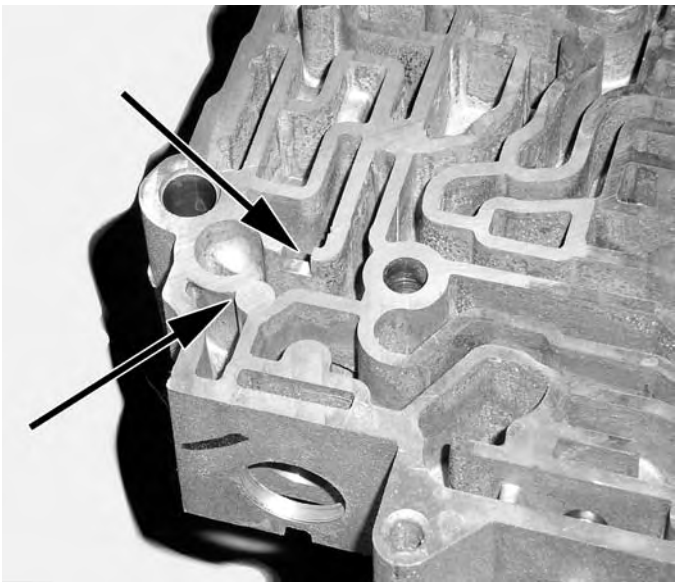


Fig. 161

Shown above is one of the two modifications to the race unit valve body. The fluid through the #5 reverse servo check ball is re-routed to act as a check valve so that when the transbrake is applied, the reverse oil does not leak through the manual valve. (Fig. 161)

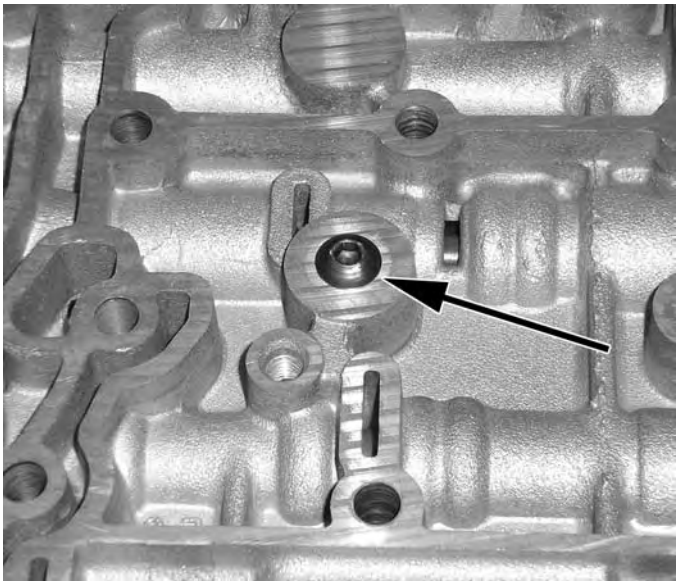


Fig. 162

The other modification to the race unit valve body is the plugging of the torque converter clutch oil port to the pressure switch manifold (PSM). The PSM is eliminated from the race unit. (Fig. 162)

PRESSURE REGULATOR

Fig. 163

A spring has been added between the line boost valve and the valve bore plug. It has to maintain a 300 psi line pressure. (Fig. 163)

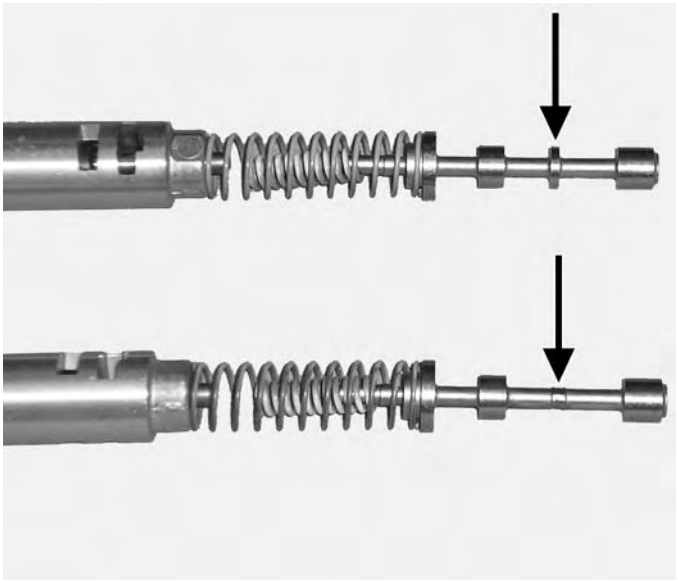


Fig. 164

The second modifications to the pressure regulator assembly is the removal of the middle spool of the pressure regulator valve. By removing the spool, oil flow to the converter is never interrupted. (Fig. 164)

CASE COVER

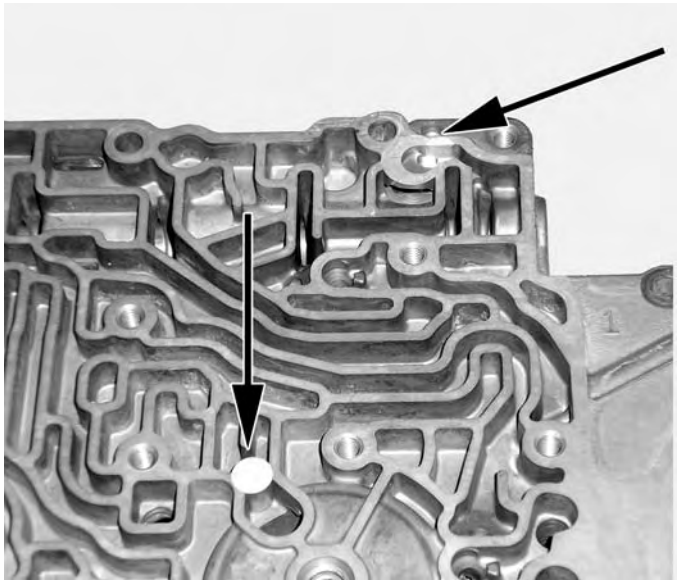


Fig. 165

Shown above are two modifications to the race unit case cover (channel plate). Shown in the upper right corner is the rerouting for the #5 reverse servo check ball. Also shown is the plug in the 4th clutch oil passage to 3-4 accumulator. (Fig. 165)

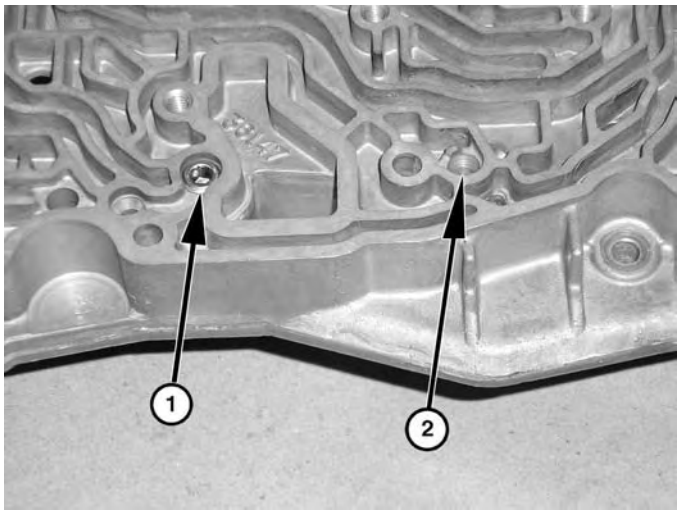


Fig. 166

1. The torque converter blow-off valve is removed and is plugged in the case cover.
2. Check ball #2 (2nd clutch) is removed.

Check ball #9 (3rd clutch) is also removed. The cooler check ball (in case cover) is removed to eliminate a flow restriction. All other check balls are used in their production location. (Fig. 166)

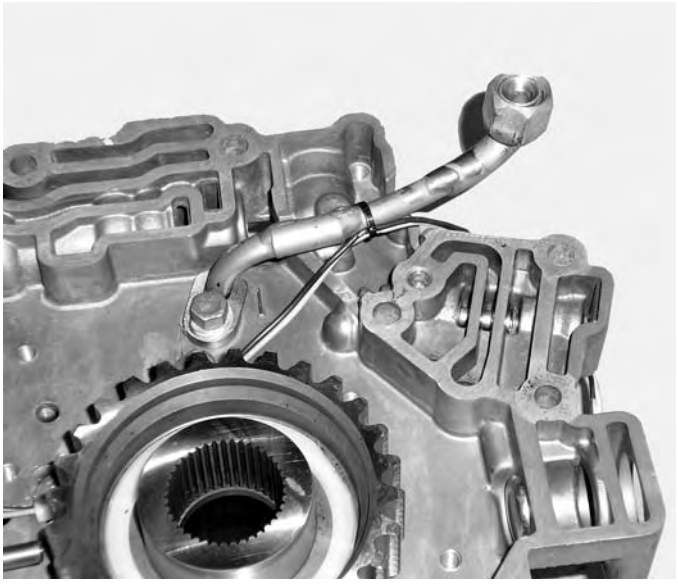


Fig. 167

Shown above is the case side of the case cover with the plumbing used to supply the trans brake with low-1st gear oil. A 1″ drive sprocket and the wire leads from the input speed sensor are also shown. The production input speed sensor and reluctor ring are removed and the sensor bore is plugged. (Fig. 167)

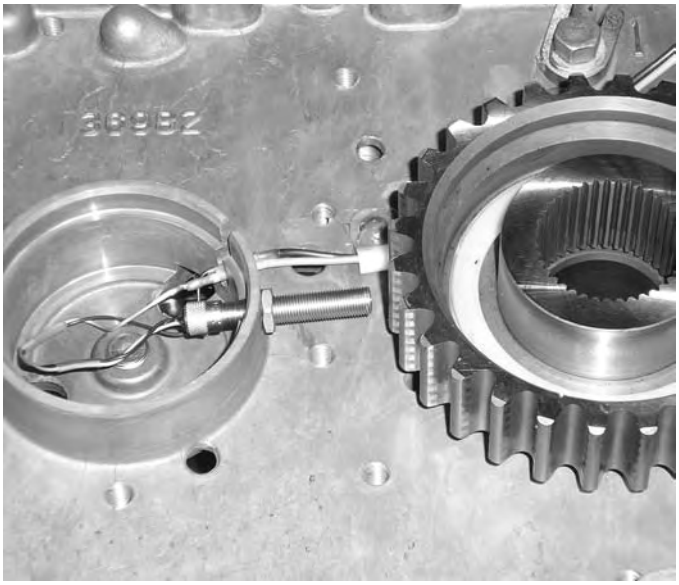


Fig. 168

The production input speed sensor reluctor wheel is not used in the race unit. Instead, the teeth of the drive sprocket are used with a Honeywell magnetic pickup. The Honeywell magnetic pickup (input speed sensor) is mounted in the 3-4 accumulator bore with the 1″ drive sprocket positioned on the case cover. The 3-4 accumulator piston pin bore is plugged because the 3-4 accumulator components are not used in the race unit. (Fig. 168)

4T65E SHIFT LOGIC

The 4T65E transmission is shifted with two shift solenoids. The ground sides of the solenoids are pin A and pin B in the pass through connector. Pin E requires switched 12V. The shift algorithm of the 4T65E is:

SHIFT ALGORITHM OF THE 4T65E		
	Solenoid A	**Solenoid B**
1st gear	on	on
2nd gear	off	on
3rd gear	off	off
4th gear	on	off

SHIFT CONTROLLERS

Fig. 169

TCI and CompuShift offer automatic shift controllers that will operate the 4T65E Transmission.

An inexpensive alternative for drag racing use is the MSD Programmable shift controller part number 7559. (Fig. 169) This controller was developed to shift a Lenco type transmission. With a little ingenuity it can easily be adapted for use on the 4T65E transmission.

Two relays are needed to convert the system for this application. The MSD controller needs two inputs: Launch/Reset and Shift Override. The Launch/Reset button resets the controller to first gear both in electrical outputs and in the shift sequence. The Shift Override button manually up-shifts the controller. In first gear the controller does not output a signal. When the 1-2 shift is made it turns on a 12v signal. When the 2-3 shift is made another 12V signal is turned on. Since the solenoid needs a ground to activate, relays are needed. Ground should be

connected to the input of the two relays. The normally closed output of the 1st relay should be connected to pin A on the transmission pass through connector. The normally closed output of the 2nd relay should be connected to pin B of the transmission pass through connector. One side of the coil of each relay should be connected to ground. The 1st shift output from the transmission controller should be connected to the other side of the coil of the 1st relay. The 2nd shift output from the transmission controller should be connected to the other side of the coil on the 2nd relay. The normally open side of the relay can be used for gear indicator lights. Two lights can be connected to power and the other side of the lights connected to the normally open side of the first and second relays.

When the transmission is in 1st both lights will be off, in second the 1st light will turn on and in 3rd the second light will come on.

TRANSMISSION FLUID INFORMATION

Fluid Type: GM Dexron® VI.

Fluid Quantity: Fluid fill quantity will depend on the transmission oil pan configuration and whether the torque converter is dry. Past experience has shown that about twelve quarts are added to the 4T65 transmission with a dry torque converter and 22° modified pan. Always check the fluid level at operating temperature and while the engine is idling. Do not overfill - keep the level below the spinning components of the transmission to reduce foaming of the fluid. Track experience has found that checking the oil level at engine idle and in first gear with brakes applied produces a consistent readable oil level indication on the dip stick.

4T65E PERFORMANCE TRANSMISSION PARTS LIST

PARTS LIST		
DESCRIPTION	**PART NUMBER**	**SOURCE**
4T65–E Assembly for Race Applications only	CPT700	GM Racing
1″x7/16″ Sprocket/Chain Set, (Ratio 1) 28 tooth drive, 32 tooth driven, 7/16″ Chain, Drive Sprocket support Assy.	CPT701	GM Racing
1″x7/16″ Sprocket/Chain Set, (Ratio 2) 29 tooth drive, 31 tooth driven, 7/16″ Chain, Drive Sprocket Support Assy.	CPT702	GM Racing
1″x3/8″ Sprocket/Chain Set, (Ratio 1) 33 tooth drive, 37 tooth driven, 3/8″ Chain, Drive Support Assy.	CPT703	GM Racing
1″x3/8″ Sprocket/Chain Set, (Ratio 2) 35 tooth drive, 35 tooth driven, 3/8″ Chain.	CPT704	GM Racing
LINK ASM–DRV (7/16″ Pitch Chain)	CPT705	GM Racing
LINK ASM–DRV (3/8″ Pitch Chain)	CPT706	GM Racing
SHAFT ASM–TURBINE (Input Shaft Assembly) Turbine Shaft and Sleeve and pump shaft	CPT708	GM Racing
3rd Gear Clutch Pack	CPT709	GM Racing
Differential and Final Drive Assembly 3.29 incl. Torsen, pinion gears, pins	88958682	GM Performance Parts
Differential and Final Drive Assembly 3.29 without gears & pins	CPT711	GM Racing
Differential and Final Drive Assembly 4.0 incl Sun and Park Gears Sungear and Sungear shaft GEAR–PARK	CPT712	GM Racing
930 CV Output Flange RH	CPT713	GM Racing
930 CV Output Flange LH	CPT714	GM Racing
Adapter Plate – **ECO**TEC to 4T65	CPT715	GM Racing
4T65–E CASE Assembly w/ increased bell–housing wall thickness	CPT717	GM Racing
Torque Converter		Coan
Planetary Assembly	24208311 & 24225849	GM Service Part

* GM Racing parts are available only by emailing us through our website at www.gmtunersource.com.

COBALT PHASE5

INTRODUCTION

Fig. 170

Cobalt Phase5 is a high-performance race car chassis built with many factory stock production parts, most with minor or no modifications. This package was designed for sportsman drag racing. The development vehicles built run in the high 11's at over 120 MPH with 22 psi of boost. (Fig. 170)

Fig. 171

POWERTRAIN

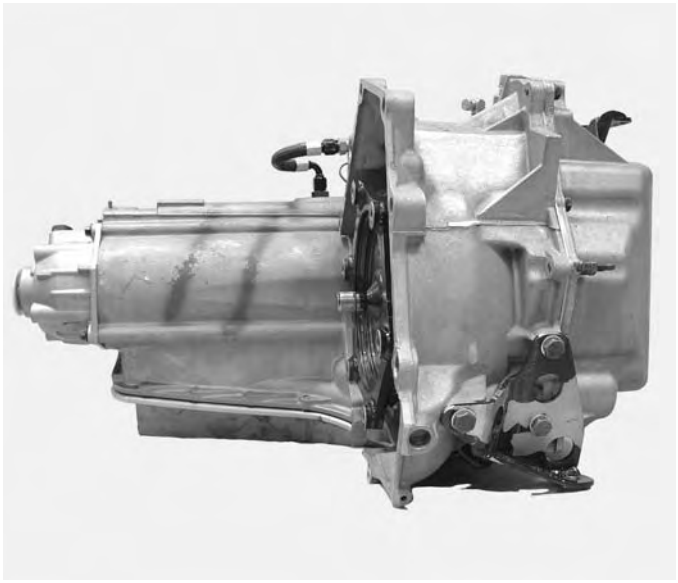


Fig. 172

The powertrain is a 550 hp **ECO**TEC turbo-charged race engine with a modified 4T65 transmission. (Figs. 171-172)

ENGINE INSTALLATION

Fig. 173

Four solid engine mounts are used at the engine and transmission. These mounts tilt the engine forward in the chassis for proper alignment with the axles when the vehicle is lowered. (Figs. 173-175) These engine mounts were fabricated by Roush Industries.

Fig. 174

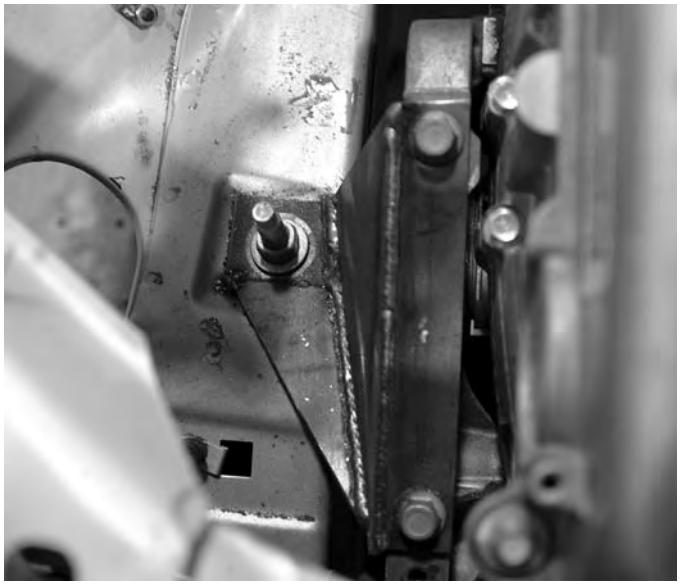


Fig. 175

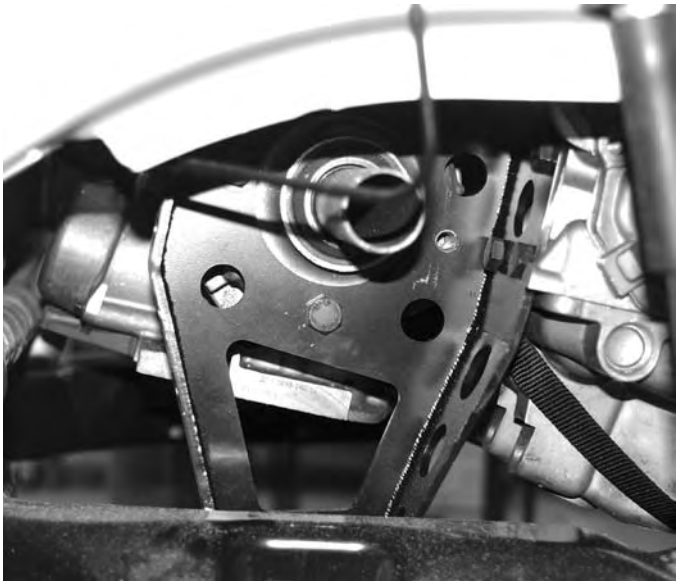


Fig. 176

The 4T65 Cobalt/**ECO**TEC mounts are used on the powertrain. (Fig. 176) A plate to adapt the **ECO**TEC engine to the 4T65 transmission completes the powertrain mounting setup.

Fig. 177

When installing the adapter plate (Fig. 177) on the engine, the production dowels must be shortened to ensure the adapter plate sits flush on the engine block. We recommend using 7/16″ studs for the transmission side of the adapter plate. This makes the assembly process much easier. Make sure there is enough clearance between the block, oil pan, and surrounding area before installing the transmission. Install the transmission blanket on the transmission BEFORE installing the transmission on the engine.

A transmission safety blanket is used on the Cobalt Phase5 Race Car. This is required safety equipment per NHRA/NDRA. It is available from Taylor Motorsports, part number GMA.

Fig. 178

A high-strength flex plate for this package is available from Bates Engineering (part number ESGR0500). (Fig. 178) Mounting the flex plate to the crank is critical. Use ARP bolts (part number 203-2802) with Red Loctite.

Use 7/16 fine ARP flex plate bolts (part number 200-2802) to secure the torque converter to the flex plate. The Bates flex plate has one tight tolerance torque converter bolt hole and five with extra clearance. Install and “snug” the tight tolerance bolt first. Be sure the torque converter is against the flex plate before turning over the engine and installing the next bolt.

COOLING SYSTEM

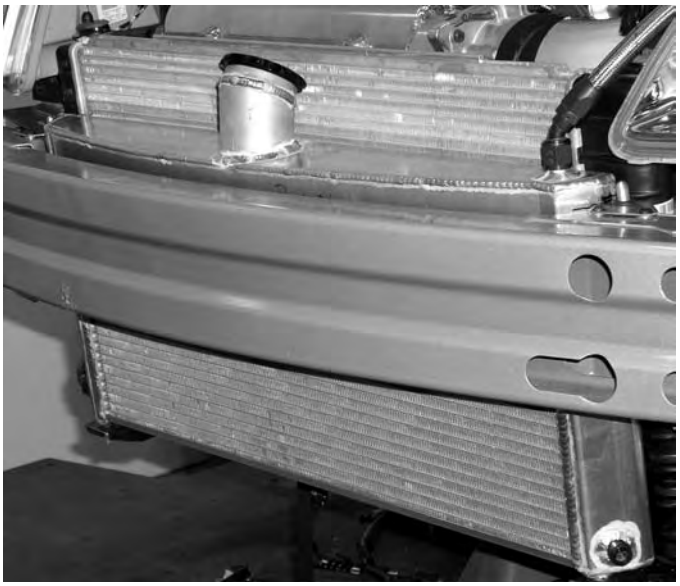


Fig. 179

The Cobalt Phase5 cooling system includes an air-to-water intercooler (Fig. 179). It uses the stock **ECO**TEC water pump with a modified plumbing to clear the transmission adapter plate. For racing applications, remove the thermostat for maximum flow.

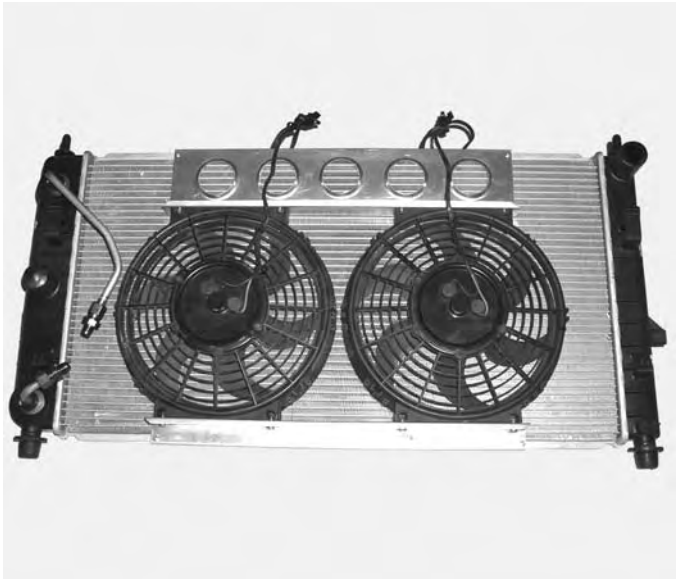


Fig. 180

The stock radiator with the stock electric cooling fan is adequate to achieve proper cooling system performance. Alternatively, aftermarket cooling fans may be used (Fig. 180). Always install a temperature-controlled switch with manual override for the cooling fan.

Fig. 181

The lower production radiator mounts can be maintained. Modify upper mounts as shown. This will allow the radiator to tilt forward and provide enough space for the intake manifold. (Fig. 181)

Fig. 182

Use the production coolant bypass system to cool the turbo. The water should run through the turbo and heater core in series. (Fig. 182)

Fig. 183

Move the coolant expansion tank to the passengers side fender well. Install a “T” in the radiator return line to allow for cooling system filling. (Fig. 183)

FUEL TANK

Fig. 184

Fig. 185

Fig. 186

Modify the production fuel tank to provide a pickup and return for the performance fuel system. In the Cobalt, remove the fuel sender assembly. Add two holes to the bottom of the sender reservoir. This assures that the aftermarket fuel pump has adequate inlet flow. Modify the production fuel sender assembly. (Figs. 184-186)

ELECTRICAL SYSTEM

The electrical system is very complicated and should be modified by an expert. Some of the items that must be considered are:

- Engine Management System
- Fuel Pump
- Transmission Controller and Transbrake
- Gauges
- Boost Control
- Engine/ Vehicle Sensors
- Injectors

The Cobalt has a Body Control Module (BCM) that controls all of the electrical components in the car (except the engine and transmission). The BCM continues to function if an aftermarket powertrain controller is installed.

The dashboard will not function because it receives information from the production ECM.

Fig. 187

If the battery is relocated, connect the 10 gauge wire that runs back to the trunk to the newly relocated battery. Be sure to fuse this line. A 50 amp fuse should be sufficient. (Fig. 187)

Fig. 188

Relocate the production under hood fuse box to the driver side fender. This makes powertrain removal easier and adds room for the intercooler and induction system. (Fig. 188)

The ignition switch can still be used to control switched power. Use a low current switched circuit from the production electrical system and use this signal to control a high current relay. This allows for control of many components from the production switch.

SWITCHES

An ideal mounting location for the electrical control switches is behind the shifter. Three switches are needed: Starter, Fuel Pump and Fan/Intercooler. Use high quality, 30 amp switches. An alternate method is to mount a switch panel on the roll cage.

EXHAUST SYSTEM

Fig. 189

One of the keys to success in FWD drag racing is boost control. The waste gate is a major key to making this work. It is critical to use a large enough waste gate to reduce the boost to control vehicle wheel spin. (Fig. 189)

Waste gates are available from Tial, Turbonetics and HKS. Contact a technical expert at one of the listed manufactures for proper waste gate application information.

The waste gate should be plumbed into a minimum of a 3″ exhaust pipe. The exhaust pipe exit should be as short as possible, without compromising vehicle components due to heat.

Fig. 190

The Hahn Racecraft Manifold is a good choice for a turbo exhaust manifold for a 500 hp **ECO**TEC. It is a short, log-type manifold that offers good flow and excellent packaging. It uses a T03 turbo flange which is adequate for this power level. (Fig. 190)

ROLL BAR KIT

Fig. 191

Fig. 192

The tubular roll-cage is safety-checked and certified, as is any other race car chassis. This six-point roll cage kit is available from Roush Industries (part number 30-412-0019). (Figs. 191-192)

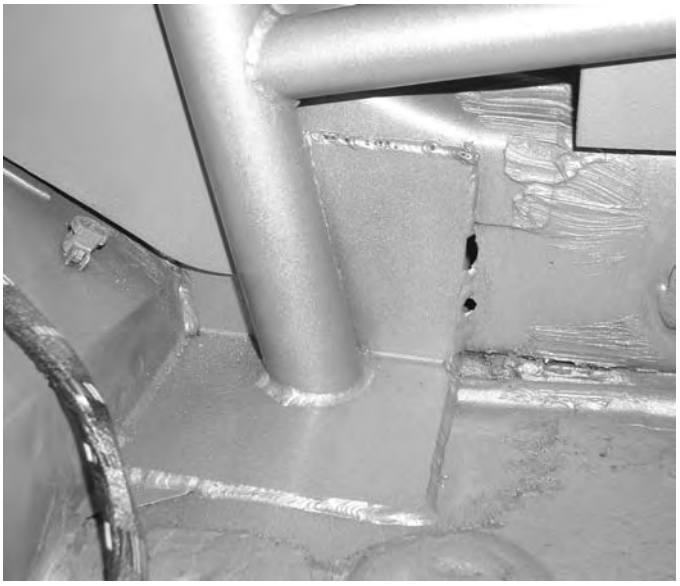


Fig. 193

We recommend that at least an 1/8″ steel plate be welded to the uni-body to attach the cage. This minimizes the risk of the cage puncturing the uni-body in case of a rollover. (Fig. 193)

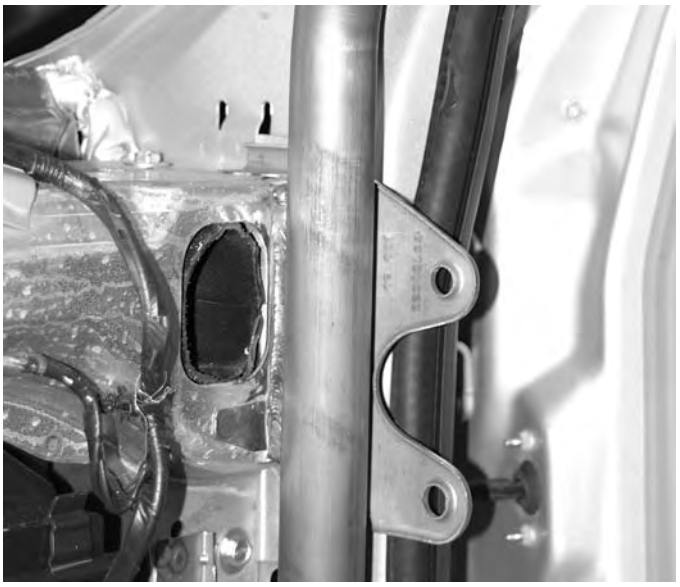


Fig. 194

To increase the strength of the cage, weld the front down tubes that go through the dash directly to the steel dash crossbrace. (Fig. 194)

SFI high-density foam roll bar padding is suggested on all bars that may contact body parts in case of an accident.

SEAT BELT HARNESS

Fig. 195

Fig. 196

A six-point (or greater) restraint system is recommended. Install brackets for the lap belts as shown. Install the shoulder belts to the cross bar of the roll cage. If the belts are wrapped around the bar, be sure to provide a way to restrain the belts from moving side-to-side on the bar. The six-point straps can be mounted to the floor using eyelets and snap-in belt ends. (Figs. 195 and 196)

BE SURE TO FOLLOW MANUFACTURERS RECOMMENDED INSTALLATION PROCEDURES ON ALL SAFETY EQUIPMENT.

SEATING

Fig. 197

Fig. 198

Aftermarket racing seats should be mounted to the floor with custom brackets available from Roush Industries. (Fig. 197 and Fig. 198)

Fig. 199

Fig. 200

Production seat sliders, modified for the aftermarket seats can also be used. The production seats and brackets are removed and stands are welded to the sliders. The seats are then mounted to the stands. (Fig. 199 and Fig. 200)

THROTTLE PEDAL ASSEMBLY

Fig. 201

The production Cobalt has a fly-by-wire system. A replacement pedal assembly is required for a cable driven throttle. Roush Industries offers a direct replacement throttle pedal assembly that bolts to the production mounts. (part number 30-412-0020) (Fig. 201)

Fig. 202

The dash is drilled to install a tube through which the throttle cable can pass. (Fig. 202)

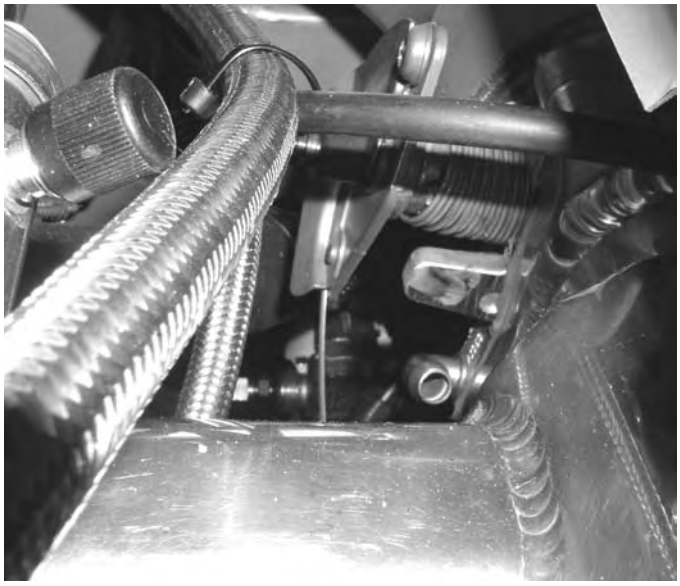


Fig. 203

The other end of the throttle cable attaches to the throttle body as shown. (Fig. 203)

STEERING WHEEL

Fig. 204

A quick release steering wheel is used for ease of entry. The steering wheel can be fitted with buttons for shifting the transmission.

To install a racing wheel on the Cobalt, we recommend buying and fabricating a steel adapter plate using the production spline insert that comes in the stock steering wheel. This adapter can then be fitted to currently available steering wheel adapters. (Fig. 204)

GAUGE PANEL

Fig. 205

Fig. 206

The production gauge panel does not function when the ECM is removed from the vehicle. The production dash can be modified to house five 2 1/6″ gauges. We recommend the following gauges: (Fig. 205 and Fig. 206)

- Oil Pressure
- Fuel Pressure
- Water Temperature
- Boost
- Voltage

We also recommend a tach with shift light and a large indicator light with a 30 psi oil pressure switch to protect the engine from major damage if there is an oil pressure problem.

As an alternative to dial gauges, an electronic PCS dash may be used. Note that the PCS dash also has a function to allow data logging.

SHIFTER

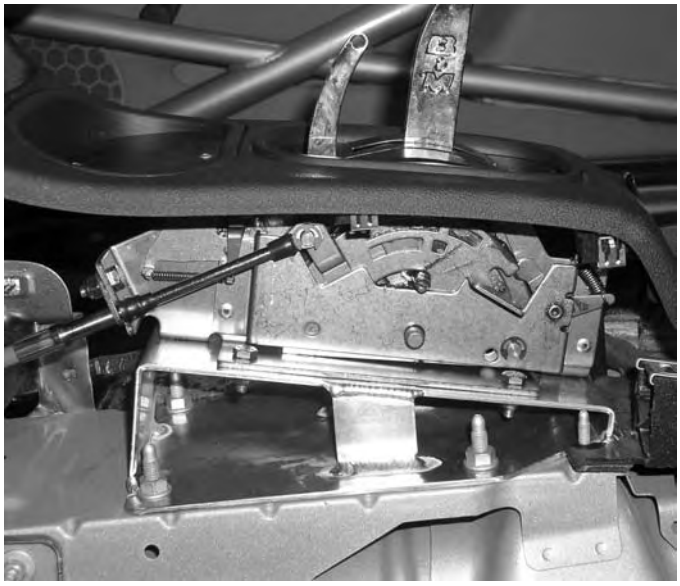


Fig. 207

A B&M Pro Ratchet Shifter is recommended. A 10 ft B&M shift cable is needed. (Fig. 207)

Roush Industries offers a Shifter Installation Kit which includes:

- Shifter Mounting Bracket
- Shift Cable Mounting Bracket for 4T65E
- Shifter Beauty Plate.

Fig. 208

FRONT SUSPENSION

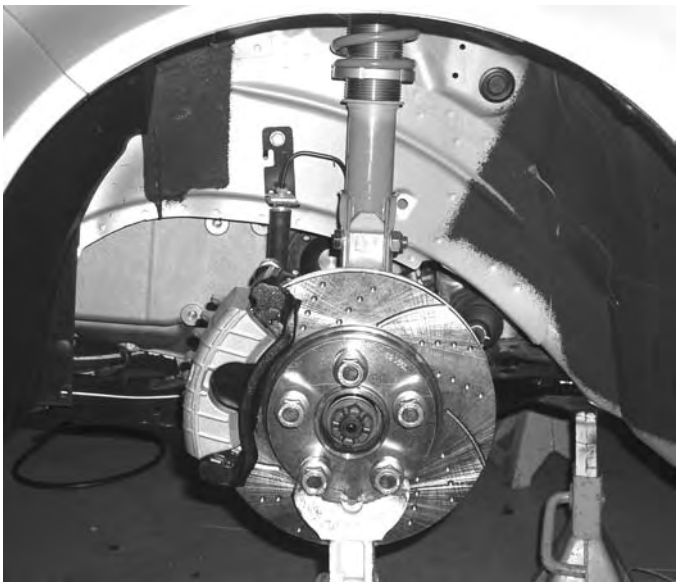


Fig. 209

The front suspension consists of the following components: (Fig. 209)

- 1998-2002 Grand Am Uprights
  RH part number 18060675
  LH part number 18060674

Fig. 210

- Adjustable KYB Struts (Fig. 210)
- Ground Control Coil Over Kit (Fig. 210)
  part number 02032515
- Bates Engineering Hub and Stub Shaft
- Ground Control Camber Caster Plate
  part number CCPVW

Fig. 211

The factory steel lower control arms are modified with the following: (Fig. 211)

- Bolt-on Captured Spherical Ball Joint
- Steel Rear Bushing with Captured Spherical Rod Ends
- Delrin Bushing Inserts for Front Mounting Point
- Welded Structural Support Brace

Fig. 212

Adjustable camber/caster weldments are installed in the shock towers. (Fig. 212)

Fig. 213

The shock towers receive the Ground Control Camber/ Caster Plates to complete the front suspension. (Fig. 213)

HALF SHAFTS

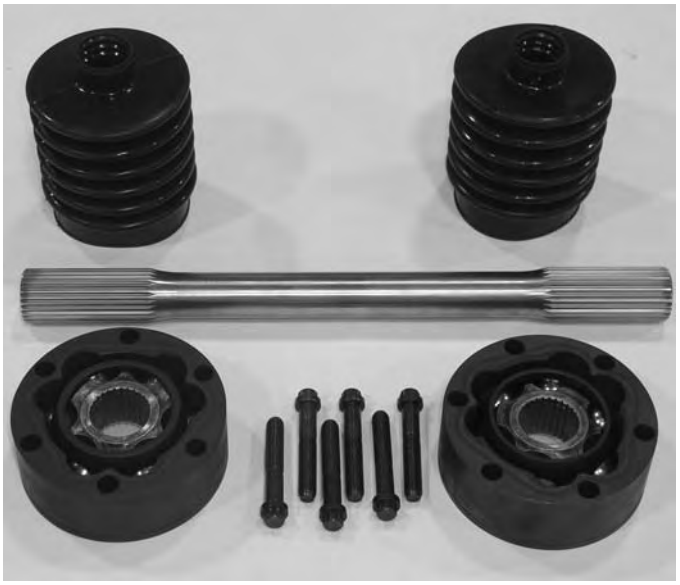


Fig. 214

The half shaft components shown are available from Bates Engineering. 930 CV joints are recommended. (Fig. 214) Contact Bates Engineering for your application. 300M and Aeromet 100 axles are also available from Bates Engineering.

Fig. 215

OUTPUT FLANGES

930 CV output flanges for the 4T65-E transmission are available from GM Racing. Part number CPT713 (RH) and CPT714 (LH) (Fig. 215)

STEERING SYSTEM

Fig. 216

The production rack is retained. (Fig. 216)

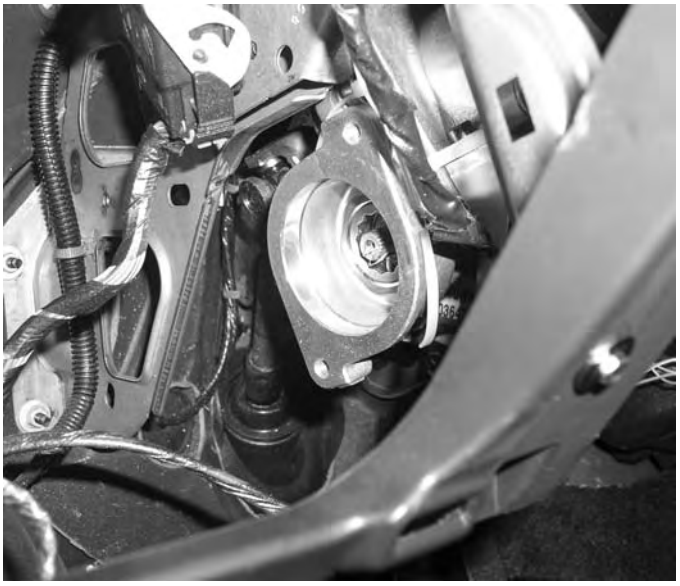


Fig. 217

The electric steering assist must be removed because inputs required for its proper operation are not available with aftermarket engine controllers. (Fig. 217)

REAR SUSPENSION

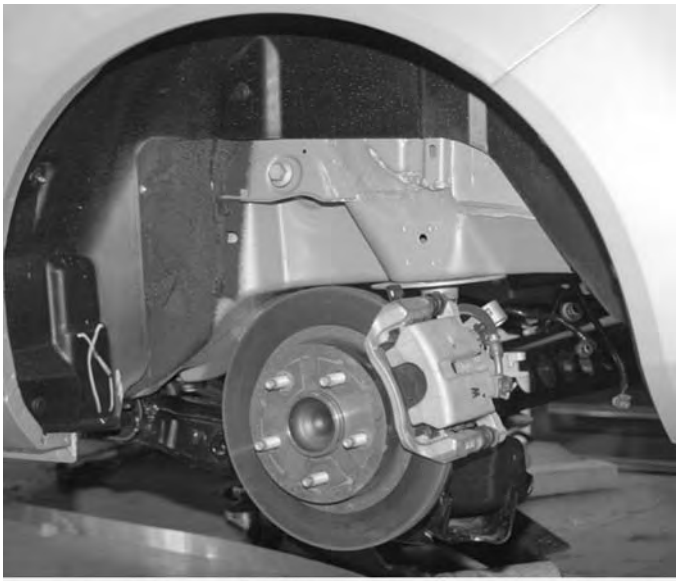


Fig. 218

Although not required for drag-strip application, A Cobalt SS Suspension Kit with five lug hubs and disc brakes may be installed in base (Non SS) Cobalt. The wheel bolt pattern can be changed by installing oversize studs. This allows for a wider wheel selection. The wheel stud pattern is 5 by 4.5 in. An upgraded sway bar is also included. (Fig. 218)

Fig. 219

Adjustable Walker Evans rear shocks with remote reservoir are available. These shocks work with production hardware (metric fasteners) and are a bolt-in. (Fig. 219)

BRAKES

Fig. 220

The front brakes used on the Phase5 Cobalt are production Grand Am calipers and rotors. (Fig. 220) The part numbers are shown below.

RH Caliper. 18026209
LH Caliper 18026208
Bridge (2 req.) 18040108
Guide Seals (4 req.). 18026151
Pins (4 req.). 18045336
Pads 18044437

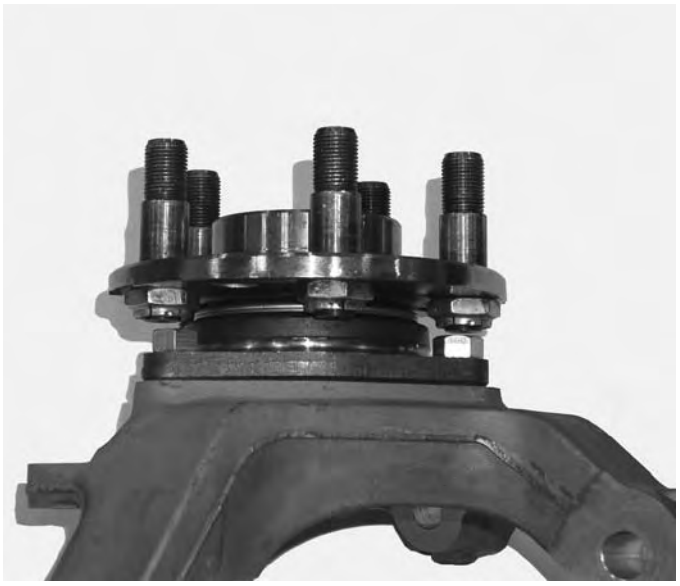


Fig. 221

Grand Am drive hubs are also used. Mark Williams 5/8″ fine thread studs with 11/16″ shank work well with most wheel combinations. (Fig. 221)

Fig. 222

The rear brakes on this car are stock Cobalt drum brakes. The hubs are re-drilled for more common wheel bolt circle. A line lock is plumbed into the rear brakes and is used only for burnouts. (Fig. 222)

Fig. 223

The master cylinder is a production unit. It is used with an adjustable proportioning valve so that rear braking can be reduced if lockup occurs. The power brake booster is retained and the production check valve performs well at keeping boost out and vacuum in. (Fig. 223)

Unless the vehicle is equipped with ABS, no modifications are necessary. If equipped with ABS, this unit should be removed for off-road use.

The front brakes should be plumbed as one system and the rear brakes as a separate system. It is recommended that an adjustable proportioning valve be installed to properly setup brake bias from front to rear.

HOOD

Fig. 224

A carbon fiber hood from RK Sport is used on this Cobalt race car. Hood pins are used to hold the hood down. The production safety latch is retained. (Fig. 224)

PHASE5 PARTS LIST

PARTS LIST		
DESCRIPTION	**PART NUMBER**	**SOURCE**
Flywheel Bolts	203-2802	ARP
Flex plate Bolts, Torque Converter to Flex Plate	200-2802	ARP
Bates Engineering Flex Plate	ESGR0500	Bates Engineering
Switches	Various	Various
Waste Gates	Various	Tial, Turbonetics, Innovative
Hahn Racecraft Exhaust Manifold	—	Hahn Racecraft
6-Point Roll cage kit	30-412-0019	Roush Industries
Racing Seat Floor Mounts	—	Roush Industries
Throttle Pedal Assembly	30-412-0020	Roush Industries
Race Seat	—	Recaro
Race Belts	—	Schroth
Steering Wheel	—	Sparko
Gauges	various	various
Shifter Installation Kit	—	Roush Industries
Race Prepped A Arm — LF	—	Roush Industries
Race Prepped A Arm — RF	—	Roush Industries
Fabricated Ball Joint Replacements	—	Roush Industries
Replacement Rear A Arm Bushing	—	Roush Industries
Knuckle to Spherical Adapter	—	Roush Industries
Grand Am Uprights	R 18060674 L 18060675	GM
Adjustable Struts	Call	KYB
Coilover Kits	02032515 (J30620)	Ground Control
Camber Caster Plates	CCPVW	Ground Control
930 CV Ouput Flanges	R CPT713 L CPT714	GM Racing
930 CV Joint	—	Bates Engineering
Uplevel (300m and Aeromet 100) Axles	—	Bates Engineering
Adjustable Rear Shocks	—	Waker Evans
Grand Am Drive Hubs	—	GM (service)
Airbags, Rear Suspension	—	Airlift
Automatic Rachet Shifter	BMM80842	B&M
Fuel Pump	11101	Aeromotive

NOTES

APPENDIX

2007 PRODUCTION ECOTEC ENGINE SPECIFICATIONS

	L61	LE5	LSJ	LNF
Displacement	2.2L / 134CID	2.4L / 146CID	2.0L / 122CID	2.0L / 122CID
Compression	10.0:1	10:01	9.5:1	9.2:1
Horsepower @ rpm	148 @ 5600	177 @ 6600	205 @ 5600	260 @ 5300
Torque @ rpm	152 @ 4200	166 @ 4800	200 @ 4400	260 @ 2500-5250
Block				
Cylinder bore diameter	85.992-86.008mm 3.3855-3.3861in.	87.992-88.008mm 3.4668-3.4675in.	85.992-86.008mm 3.3855-3.3861in.	85.992-86.008mm 3.3880-3.3887n.
Main bearing bore diameter	64.068-64.082mm / 2.5224-2.5229in.	64.068-64.082mm 2.5224-2.5229in.	64.068-64.082mm / 2.5224-2.5229in.	64.068-64.082mm / 2.5224-2.5229in.
Block Material	Lost foam cast Aluminum	Lost foam cast Aluminum	Lost foam cast Aluminum	Lost foam cast Aluminum
Crank				
Stroke	94.6mm 3.727in.	98mm 3.861in	86mm 3.388in.	86mm 3.388in.
Rod Journal Diameter	49.000-49.014mm 1.9291-1.9297in.	49.000-49.014mm 1.9291-1.9297in.	49.000-49.014mm 1.9291-1.9297in.	49.000-49.014mm 1.9291-1.9297in.
Main Journal Diameter	55.994-56.008mm 2.2045-2.2050in.	55.994-56.008mm 2.2045-2.2050in.	55.994-56.008mm 2.2045-2.2050in.	55.994-56.008mm 2.2045-2.2050in.
Main Bearing Clearance	0.031-0.067mm 0.0012-0.0026in.	0.031-0.067mm 0.0012-0.0026in.	0.031-0.067mm 0.0012-0.0026in.	0.031-0.067mm 0.0012-0.0026in.
Bolt Pattern	6	6	8	8
Material	Cast	Cast	Forged Steel	Forged Steel
Rods				
Rod Bearing Clearance	0.029-0.073mm 0.0011-0.0029in.	0.029-0.073mm 0.0011-0.0029in.	0.029-0.073mm 0.0011-0.0029in.	0.029-0.073mm 0.0011-0.0029in.
Rod Bore Diameter-Bearing	52.118-52.134mm 2.0519-2.05252in.	52.118-52.134mm 2.0519-2.05252in.	52.118-52.134mm 2.0519-2.05252in.	52.118-52.134mm 2.0519-2.05252in.
Rod Bore Diameter-Pin	20.007-20.021mm 0.7877-0.7882in.	20.007-20.021mm 0.7877-0.7882in.	23.007-23.017mm 0.9058-0.9062in.	23.007-23.017mm 0.9058-0.9062in.
Material	1019 Steel	1019 Steel	5115 Steel	1019 Steel
Piston Rings				
Piston Ring Thickness - First Compression Ring	1.170-1.190mm 0.0461-0.0469 in	1.170-1.190mm 0.0461-0.0469 in	1.170-1.190mm 0.0461-0.0469 in	1.170-1.190mm 0.0461-0.0469 in
Piston Ring Thickness - Second Compression Ring	1.471-1.490mm 0.0579-0.0587 in	1.471-1.490mm 0.0579-0.0587 in	1.471-1.490mm 0.0579-0.0587 in	1.471-1.490mm 0.0579-0.0587 in
Piston Ring Thickness - Oil Control Ring - Rail - Maximum	0.40mm 0.0157 in	0.472mm 0.0186 in	0.43mm 0.0169 in	0.472mm 0.0186 in

	L61	LE5	LSJ	LNF
Piston Ring Thickness - Oil Control Ring - Spacer	1.613 mm 0.0635 in	.968 mm 0.0380 in	1.574-1.651 mm 0.0620-0.0650 in	1.765 mm 0.06940 in
Pistons and Pins				
Pin - Piston Pin Diameter	19.995-20.000 mm 0.7872-0.7874 in	19.995-20.000 mm 0.7872-0.7874 in	22.995-23.00 mm 0.9053-0.9055 in	22.995-23.00 mm 0.9053-0.9055 in
Piston - Piston Diameter - @14.5 mm up	85.967-85.982 mm 3.3845-3.3851 in	87.967-87.982 mm 3.4633-3.4638 in	85.967-85.982 mm 3.3845-3.3851 in	85.967-85.982 mm 3.3845-3.3851 in
Piston - Piston Pin Bore Diameter	20.002-20.007 mm 0.7875-0.7877 in	20.004-20.009 mm 0.7876-0.7878 in	23.004-23.010 mm 0.9057-0.9059 in	23.004-23.010 mm 0.9057-0.9059 in
Piston - Piston Ring Grove Width - Oil Control	2.52-2.54 mm 0.0992-0.1000 in	2.51-2.53 mm 0.0988-0.0996 in	2.52-2.54 mm 0.0992-0.1000 in	2.52-2.54 mm 0.0992-0.1000 in
Piston - Piston Ring Grove Width - Second	1.52-1.54 mm 0.0598-0.0606 in	1.52-1.54 mm 0.0598-0.0606 in	1.52-1.54 mm 0.0598-0.0606 in	1.52-1.54 mm 0.0598-0.0606 in
Piston - Piston Ring Grove Width - Top	1.23-1.25 mm 0.0484-0.0492 in	1.23-1.25 mm 0.0484-0.0492 in	1.23-1.25 mm 0.0484-0.0492 in	1.23-1.25 mm 0.0484-0.0492 in
Piston - Piston to Bore Clearance	0.010-0.041 mm 0.0004-0.0016 in	0.010-0.041 mm 0.0004-0.0016 in	0.013-0.047 mm 0.0005-0.0019 in	0.010-0.041 mm 0.0004-0.0016 in
Valves				
Valves - Valve Stem Diameter - Exhaust	5.935-5.950 mm 0.2337-0.2343 in	5.935-5.950 mm 0.2337-0.2343 in	5.935-5.950 mm 0.2337-0.2343 in	5.935-5.950 mm 0.2337-0.2343 in
Valves - Valve Stem Diameter - Intake	5.955-5.970 mm 0.2344-0.2355 in	5.955-5.970 mm 0.2344-0.2355 in	5.955-5.970 mm 0.2344-0.2355 in	5.955-5.970 mm 0.2344-0.2355 in
Valves - Valve Head Diameter - Exhaust	30.09 mm 1.185 in	30.09 mm 1.185 in	30.09 mm 1.185 in	30.09 mm 1.185 in
Valves - Valve Head Diameter - Intake	35.17 mm 1.385 in	35.17 mm 1.385 in	35.17 mm 1.385 in	35.17 mm 1.385 in
Cam Shafts				
Intake Cam Peak Lift	5.9804 mm	6.2551 mm	5.9557 mm	6.1112 mm
Intake Valve Peak Lift	10.0795 mm	10.5425 mm	10.0379 mm	10.3 mm
Intake Valve Timing	116°	135 °	100°	126°
Intake Duration @1mm lash	198.4°	210.3°	196.5°	203.6°
Intake Valve area @1mm lash	1112.9 mm^2	1253.3 mm^2	1117.7 mm^2	1171.3 mm^2
Exhaust Cam Peak Lift	5.9752 mm	5.9514 mm	5.9543 mm	6.1061 mm
Exhaust Valve Peak Lift	10.0792 mm	10.0391 mm	10.0439 mm	10.3 mm
Exhaust Valve Timing	-108°	-125°	-115°	-120°
Exhaust Duration @1mm lash	193.3°	195.4°	191.7°	194°
Exhaust Valve area @1mm lash	1078 mm^2	1092.7 mm^2	1076.4 mm^2	1106 mm^2

	L61	LE5	LSJ	LNF
Cam Signal Source	Through 2006 - none (waste spark) 2007 - wheel on on intake cam	wheel on both cams	hex bushing in exhaust cam	wheel on both cams
Head				
Valve Guide Bore - Exhaust	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in
Valve Guide Bore - Intake	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in	6.000-6.012 mm 0.2362-0.2367 in
Valve Lifter Bore Diameter - Stationary Lash Adjusters	12.013-12.037 mm 0.4730-0.4739 in	12.013-12.037 mm 0.4730-0.4739 in	12.013-12.037 mm 0.4730-0.4739 in	12.013-12.037 mm 0.4730-0.4739 in
Material	Lost foam cast Aluminum	Lost foam cast Aluminum	Sand Cast Aluminum	Sand Cast Aluminum
Injectors				
Flow Rate	28 lbs/hr @ 58 PSI	28 lbs/hr @ 58 PSI	34 lbs/hr @ 58 PSI	20cc/min @ 1450 PSI
Brand	Delphi	Delphi	Siemens	Bosch
Ignition System				
Type	Through 2006: Waste spark, dual coil 2007:Coil-On-Plug	Coil-On-Plug	Coil-On-Plug	Coil-On-Plug
Firing Order	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2
Spark Plug	part number 12598004	part number 12598004	part number 12610757	part number 12590701
Spark Plug Gap	1.1-0.95 mm 0.043-0.037 in	1.1-0.95 mm 0.043-0.037 in	1.1-0.85 mm 0.043-0.033 in	0.9-0.75mm 0.035-0.030 in.
Rating	Heat Range 5	Heat Range 5	Heat Range 5	Heat Range 5
Brand	NGK	NGK	NGK-R	NGK

ECOTEC COMPONENT UPGRADE MATRIX

UPGRADES BY HORSEPOWER

Failure Mode	Fix	250	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
L61/LE5 Rods	Upgrade to aftermarket or LSJ/LNF rods	X												
L61/LE5 Pistons	Upgrade to aftermarket piston set	X												
Spark Plugs	Upgrade to aftermarket spark plugs		X											
Fuel Injectors	Use high-flow injectors (and/or add injectors)		X											
Fuel Pump	Upgrade to aftermarket fuel pump		X											
LSJ/LNF Pistons	Upgrade to aftermarket piston set		X											
L61/LE5 Valves	Upgrade to aftermarket or LSJ/LNF valves		X											
Cylinder liners	Replace with solid iron liners			X										
LSJ/LNF Rods	Upgrade to aftermarket rods			X										
LSJ/LNF Valves	Upgrade to aftermarket valves			X										
Head gasket	Copper w/ O-rings or aftermarket multi-layer				X									
Crank	Upgrade to steel crank				X									
L61/LE5 combustion chamber seal	Stake combustion chamber or use LSJ head					X								
Exhaust rocker arm	Upgrade to billet rocker arm						X							
21mm wrist pin (including aftermarket)	Upgrade to 22mm wrist pin						X							
Multi-layer gasket (aftermarket)	Use copper headgasket with O-rings							X						
L61/LE5 Head casting	Use LSJ head casting								X					
Block Casting	Use uni-bolt block upgrade									X				
Aftermarket Rods	Upgrade to 300M Manley rods									X				
Aftermarket Rods	Upgrade to 300M 675 gram Manley rods												X	
Timing chain guide	Use billet timing chain guide & tensioner													X

UPGRADES BY RPM

Failure Mode	Fix	7000	7500	Extended time on rev limiter
Valve springs	Upgrade to aftermarket valve springs	X		
Balance shafts	Use neutral balance shafts or elimination kit		X	
Production Oil Pump (for wet sump)	Upgrade to billet pump gears			X
Front hub assembly	Upgrade to billet hub assembly			X

TORQUE SPECIFICATIONS

Component Description	Ft.Lbs.	In.Lbs.	Lubrication
Unibolt Stud Straps	Max Thread		609 Green Loctite
Piston Oil Squirters	15		242 Blue Loctite
Crankshaft Main Stud Nuts	65		#3 Extreme pressure lube CMD
Girdle to Block Peripheral Bolts	15		#3 Extreme pressure lube CMD
Connecting Rod Bolts	65		51609 Anti-Sieze Molly
Balance Shaft Chain Guide Bolts		89	242 Blue Loctite
Balance Shaft Drive Sprocket Bolts	41		271 Red Loctite
Balance Shaft Retaining Bolts		89	242 Blue Loctite
Head Strap Nuts	120		51609 Anti-Sieze Molly
Timing Chain Guide Bolts		89	242 Blue Loctite
Timing Chain Guide Bolts Access Plug	30		#3 Extreme pressure lube CMD
Timing Chain Guide Fixed Bolt		89	242 Blue Loctite
Timing Chain Oil Nozzle Bolt		89	242 Blue Loctite
Timing Chain Tensioner Bolts		89	242 Blue Loctite
Timing Chain Guide Adjustment Bolt	20		242 Blue Loctite
Water Pump Bolts	18		242 Blue Loctite
Water Pump Sprocket Bolts		89	242 Blue Loctite
Water Pump Cover Bolts		89	242 Blue Loctite
Intake Camshaft Rear Bearing Cap Bolt	18		#3 Extreme pressure lube CMD
Camshaft Bearing Cap Bolts		89	#3 Extreme pressure lube CMD
Camshaft Timing Chain Tensioner	44		#3 Extreme pressure lube CMD
Camshaft Sprocket Adjusting Bolts	15		271 Red Loctite
Camshaft Sprocket Center Bolt	70		271 Red Loctite
Camshaft Cover Bolts		89	#3 Extreme pressure lube CMD
Oil Pan Bolts	18		Grey Silicone
Oil Drain Plug (Wet Sump)	18		#3 Extreme pressure lube CMD
Oil Pump Gear Cover Plate Screws (Wet Sump)		53	242 Blue Loctite
Oil Pump Pressure Relief Valve Plug (Wet Sump)	35		242 Blue Loctite
Front Cover Bolts	22		242 Blue Loctite
Dry Sump Oil Pump Mount Bolts	20		242 Blue Loctite
Crankshaft Damper Bolt	150		271 Red Loctite
Trigger Wheel Bolts	25		271 Red Loctite
Mandrel Bolt	70		271 Red Loctite
Spark Plugs	15		51609 Anti-Sieze Molly
Flywheel and Flexplate Bolts	100		271 Red Loctite
Exhaust Manifold Studs to Head		89	Dry
Exhaust Manifold Nuts	13		Dry
Intake Manifold Bolts	22		242 Blue Loctite
Fuel Rail Bolts		89	242 Blue Loctite
Throttle Body Bolts/Nuts		89	242 Blue Loctite
Throttle Position Sensor Screws		25	242 Blue Loctite

PROFESSIONAL ENGINE BUILDER INSTRUCTIONS

PREPARATION

Engine Block

1. Using a 3.500″ bore race block, (GM Racing part number XGB679), verify that the sleeves stand proud of the deck by 0.007″ – 0.010″. If not, machine aluminum deck surface to achieve this measurement.
2. Tap front oil galley holes to 9/16-18 thread.
3. Plug or weld factory crank sensor hole shut
4. Remove oil filter boss from block with a mill. Weld -10 O-ring boss fittings for oil in and oil out.
5. For dry sump engines utilizing an external pump, the alternator boss may need to be removed from the side of the block.
6. Drill and tap main girdle for -10 AN turbo oil drain back, depending on dry sump or wet sump.
7. Deburr block and sump as desired. Notch rear of block and sump for flywheel clearance. This varies with flywheel and clutch being used.
8. If not already complete, machine block for uni-bolt upgrade and weld plugs in place for #5 unibolt.
9. Wash block and sump thoroughly to clean out debris and machining chips.
10. Install engine block on engine stand, fill five center oil drain backs with aluminum Devcon (part number 10720). Pour from bottom side of engine to top of balance shaft tunnels. Ensure that block is level and let Devcon set up overnight.
11. Install main studs with blue Loctite and torque to 8 ft. lbs.
12. Install main girdle and torque to 20 ft. lbs. and let Loctite set up.
13. Install stainless steel 0.041″ thick O-rings, by Bates Engineering (Available through GM Performance Parts part number XGH674). Ensure they are 0.009″-0.011″ proud of sleeve surface
14. Install 3.540″ head gasket (GM Racing P.N. XGH616).
15. Install main girdle and torque to 65 ft. lbs. with EPL #3 on studs and nuts.
16. Install torque plate and torque to 120 ft. lbs. with moly on threads of studs and nuts.
17. Re-torque mains to 65 ft. lbs.
18. Hone cylinder walls to meet piston manufacturer's specifications. With JE pistons we are currently at 0.0095″ piston to wall.
19. Line hone crankshaft housing bore to 2.5230″ – 2.5240″
20. Remove rear balance shaft bearings and install aluminum plugs.
21. Modify OEM balance shafts to use as plugs in front of block.
22. Tap water pump chain tensioner oil galley hole for 5/16″ set screw, careful to not go too deep.
23. Add threaded hole for extra water pump blockoff plate support.
24. Mill down front water pump bolt hole 0.400″ and use shorter bolt.
25. Tap & plug 1/8″ NPT in deck surface to block off oil to tensioner, ensure plug is installed flush or below deck.

Crankshaft

1. Crankshaft is a 3.505″ stroke, 4340 billet steel Bryant Racing (Available through GM Performance Parts part number 88958620).
2. Measure and record all main and rod journal diameters.
3. Look over all oil feed holes and deburr if necessary.
4. Polish crankshaft and wash for assembly.
5. Install freeze plug and snap ring in rear of crankshaft with epoxy or silicone (Hollow main only).
6. Slightly lap the four sides of the thrust bearings to deburr and achieve 0.003″ of crankshaft end play.
7. Install the main bearings in the block and girdle, using production main bearings.
8. Install main girdle and torque to 65 ft. lbs. with EPL #3 on studs and nuts.
9. Install torque plate and torque to 120 ft. lbs. with moly on threads of studs and nuts.
10. Re-torque mains to 65 ft. lbs.
11. Check main bearing clearance (0.0028″ – 0.0032″).
12. Crankshaft fillet clearance must be checked on both sides of each journal.

Connecting Rods

1. Inspect and deburr as necessary ensuring to deburr inside oil hole in bushing on small end.
2. Chamfer both sides of rod bearings for crank fillet clearance. Clevite part number 1663H or 1663HX
3. Install bearings in clean connecting rods. Measure and record sizes. Rod bearing clearance should be 0.0028″ – 0.0032″.

4. Current professional-level connecting rods used are Manley part number 15499GR-4 with larger section area and made from 300M material. Big end clearance is 0.0028″ to 0.0032″ and small end clearance is 0.0015″ – 0.0017″. Length is 5.888″, big end width is 0.940″, we are currently grinding 0.003″ off each side to achieve this. Big end bore is 2.0150″ – 2.0155″.

Pistons and Wrist Pins

1. Wrist pins (Precision Products part number MC-86622462005-TC).
   Specs: 0.866″/ 22mm diameter, 2.246″ long, 0.200″ wall thickness, Casidium coated, C-350 steel.
2. Wrist pin clips are supplied with pistons (deburr before installation)
3. Pistons are JE or Arias, 3.500″ Bore, 1.055″ Compression Height. Lay back valve reliefs for additional valve clearance. Deburr pistons and pin fit to 0.0016″ clearance. Note: Pistons are commonly ordered as pop-ups to allow us to control compression ratio to around 10:1.
4. Piston rings are JE, Arias, or Total Seal parts. For JE pistons, top ring end gap is 0.032″, second ring is 0.035″, Rails 0.020″ minimum. File to fit and deburr both ends of each ring and rails. Also deburr both ends of groove loc spacers

Camshafts and Drive Components

1. Water pump crank gear and cam drive crank gear are stock production parts.
2. Surface grind or lap both sides of both gears to ensure good fit against one another to prevent galling under high rpm use.
3. Chamfer back of water pump gear for clearance on crankshaft radius.
4. Adjustable cam drive gears (GM Performance part number 88958613). Disassemble and deburr slots to ensure full range of adjustability. Wash for assembly.
5. Grind heads of cam bolts flat for cam cover clearance.
6. If not already done, install distributor hex drive in intake camshaft with 0.0005″ to 0.010″ press and weld a couple spots for reliability.
7. Dry run distributor hex fit.
8. Polish all cam journals and wash for assembly.

Head Gasket

1. Current head gasket is a 0.043″ thick, heat treated copper by SCE (Available through GM Performance Parts part number XGH616).
2. Ensure that head gasket does not protrude into cylinders. Bore gasket out to 3.540″ to ensure no overhang. Deburr both sides of cylinder bores, make sure gasket sits on deck properly. It will be tight on the dowels and will likely need to be relieved by hand with a grinder.
3. If using an older design gasket create a bowtie shaped support piece and install in gasket between #4 cylinder and back edge of gasket (to prevent cylinder pressure from pushing gasket outward)

Miscellaneous

1. For turbo oil feed, use a small side oil galley plug, remove aluminum washer, drill 11/64″ hole from bottom of 6mm hex through the bottom of the plug. Weld a -4 AN fitting with 9/16″ O.D. hex on to plug. A second one of these fittings could serve as oil pressure measurement point.
2. Use LSJ Saab Valve Cover. Remove stock baffle (save). Determine where and what oil breather is to be located. Weld on, cut and fit stock baffle to mount over fitting. Drill and tap stock rivet pads for screws. Install baffle. Install screws with red Loctite. Silicone over screws so they cannot turn out. Weld oil fill hole shut or it can be hard capped with O-ring Pro Werks style cap if desired.
3. Mechanical timing chain tensioner. Make one as described elsewhere in this publication. Use the Billet tensioner and guide as described elsewhere in this publication for applications exceeding 1400 hp.
4. Bates or Stefs oil pan. Clearance rear of oil pan for flywheel bolts and possibly the front to clear front plate. Dry test pan on engine. Slot bolt holes if necessary.
5. Front oil galley plugs. Either 9/16″x 18 set screws trimmed to 0.375″ or 9/16″ x 18 threaded rod cut approximately 0.375″ with screwdriver slot machined in one end and radius the other end. Deburr and wire wheel threads.
6. Make crankshaft keyway from 3/16″ square key stock.

ENGINE ASSEMBLY

Block and Crankshaft

Now that all the components are prepped and washed for assembly, use a flashlight and inspect all of the oil galley holes for debris. Install the water galley, water pump chain tensioner elimination set screws and front oil galley plugs with epoxy. Install oil galley plugs, the oil feed to the turbo and the oil pressure gage fitting with thread sealant. Next, install the upper main bearings in the block and coat with Clevite Bearing Guard. Install the lower main bearings into the sump and coat with Clevite Bearing Guard. Use red gasket sealant on block surface and sump surface where O.D. of rear main seal is located. Oil the rear main seal where it rides on crankshaft and install onto crankshaft. Now lower the crankshaft with the seal on it into the block. Push rear main seal into block until it stops. Use grey silicone (Loctite #5699) between block and sump. Go around both square oil drain backs and both sides of oil pressure channels. Install sump on block. DO NOT hit sump onto block as this will dislodge the bearings. Instead, install uni-bolts and straps, being sure to apply silicone between the strap and the sump, and use the nuts for the main studs and washers with EPL #3 to draw sump down. Torque in two stages to 65 ft. lbs. Pay attention to the rear main seal as sometimes it will back out of its housing, to prevent this a washer can be made to bolt to the crank flange. Install peripheral bolts with EPL #3 and torque to 15 ft. lbs. Smear silicone on the outside of block if desired. Check crankshaft end play (spec is 0.003″ – 0.008″). Install crankshaft key into end of crank. Inspect threaded holes in front of block, install screws in the ones which intersect the unibolt holes to prevent oil bleed off.

Rods and Pistons

Assemble the rods and pistons with STP / LL55 Lube. Check and record wrist pin end play (0.025″ – 0.035″). Install rings and groove loc spacers on pistons. Pay attention so that end gaps are not aligned. Next, install the rod bearings in the rods and also the rod caps. Coat with Clevite Bearing Guard and make sure there is rod bolt lube in the threads of the rods, on the threads of the bolts and under the heads of the bolts. Coat the piston skirts and rings, and cylinder walls with oil. Install rods and pistons, making sure your valve notches are on the correct sides. Look over bearings to make sure they are still in place. Install rod cap and bearings and torque to manufacturer's specification. Check rod side clearance (0.008″ – 0.012″). Measure and record piston deck heights, sleeve to deck heights, steel o-ring to sleeve height, and stroke. Double check compression ratio at this point.

Chains, Guides and Pumps

Install the water pump crankshaft gear, insure that it is clearanced for the crank chamfer, and the cam drive crank gear. Install the water pump plate onto block with silicone. Install the chain oil squirter to block with blue Loctite and torque to 89 in. lbs. Install balance shaft plugs in front journals making sure bolt doesn't run into uni-bolt stud torque with blue Loctite to 89 in. lbs.

Deck Preparation and Head Installation

The next step is to install rubber o-rings in deck surfaces of block from bulk 0.070″ rubber o-ring material. Install cylinder head dowels, either custom made or available from Bates Engineering, and apply a thin layer of grey silicone (Loctite #5699) to deck of block. Use some 0.005″ thick sewing thread and lay it out in the silicone around both rear oil drain backs, around the rear oil pressure feed, around the square water hole and around center (6) unibolts. Set head gasket on block. Apply a thin layer of grey silicone on the deck of cylinder head. Be careful not to plug the oil pressure feed to the head or water passages. Place all cylinder head straps, with grey silicone on bottom side, in position and set the head on the block. Coat top of straps, washers, threads, and nuts with moly and torque in 3 stages to 120 ft. lbs. Install the 4 front chain case bolts with EPL #3 and torque to 18 ft. lbs. Install both chain guides and torque with blue Loctite to 89 in. lbs. Install the front plug into the cylinder head with thread sealant. When finished with head torques, re-torque main studs to 65 ft. lbs.

Camshaft Installation & Timing

Set camshafts in saddles of cylinder head with lifters and followers. Set rough lash on base circle to 0.005″ – 0.007″ on all 16 valves. Lube saddles, cams, cam caps with STP / LL55 Lube. Install exhaust cam #1 lobe nose at approximately 8 o'clock. Install intake cam #1 lobe nose at approximately 4 o'clock. Run down the caps with a speed handle evenly, and then torque cam caps to 89 in. lbs. Install rear cam caps with sealant underneath and torque to 18 ft. lbs. Install cam chain on crank gear. Align mark on gear to pink link on chain. Align blue link of chain on mark of intake cam gear, and pink link on mark of exhaust cam gear. Install cam gear bolts. Red Loctite on threads, EPL #3 between head and washer. Torque to 70 ft. lbs. Install mechanical chain tensioner making sure that the end lines up with chain guide. Tighten to the cylinder head and adjust chain tension by laying straight edge over cam gears and chain. Rotate engine so chain slop is between gears, approximately 90 degrees after TDC of overlap. Adjust tensioner to about 0.200″ of slack (measured from straightedge between cam gears). Run through lash 0.005″-0.007″. Perform cam timing at 117 degrees intake and 117 degrees exhaust. Remove one bolt at a time, of the three in the adjustable cam gear, and torque with red Loctite to 15 ft. lbs. Re-verify cam timing. Rotate engine to #1 TDC of overlap and mark cams to caps for reference.

Install cylinder head chain guide. Torque bolts to 89 in. lbs. with blue Loctite. Install the valve cover.

Front Cover and Drive Hub

Apply a layer of grey silicone (Loctite #5699) to block where front plate seals to and install front plate and bolts using blue Loctite and torque to 18 ft. lbs. Lube front seal and seal area of front hub. Put anti-seize on I.D. of hub and put a dab of grey silicone in key-way slot. Install front hub with no more than 0.0008″ press and install crank bolt with red Loctite on threads and EPL #3 between bolt head and washer. Torque to 160 ft. lbs. Install water pump block off plate bolt with grey silicone under head and blue Loctite on threads and torque to 18 ft. lbs.

Oil Pan

Double check rod, main and peripheral bolt torques. Lay grey silicone #5699 on oil pan rail and around pick up tube area. Install oil pan. Put grey silicone on oil pan bolt threads and under heads. Torque bolts to 18 ft. lbs. Install drain plug in oil pan with grey silicone and tighten up.

Injectors and Covers

Install water block off plate with grey silicone and blue Loctite on bolts. Install injectors in fuel rails with Parker O-ring lube. Install injector wiring harness. Next, put the rails and injectors into the head and intake manifold with Parker O-ring lube. Install bolts with blue Loctite and tighten up.

Exhaust Header

Before installation of exhaust header be sure to fill in holes in exhaust flange on the head with red high temp silicone, smear flush and let set up. Install exhaust header with red high temp silicone and tighten up.

Flexplate

Install Flexplate. Use EPL #3 under the heads and red Loctite on the threads. Torque bolts to 100 ft. lbs.

Final Check and Peripherals

Install front dress, pickup wheel, crank sensor, pointer, oil and fuel pumps and lines, turbo of choice, and alternator. Check and verify all oil and water passages are sealed. Verify all bolts are torqued to specification.

ECOTEC HIGH HP CYLINDER HEAD

1. Use cylinder head, GM Performance Parts part number XGH614.
2. Ensure O-ring groove is for a 3.500″ bore block, Groove dimensions are 0.007″ deep, 0.060″ wide, and the inner and out radius are 3.650″ & 3.770″ respectively.
3. Run a spark plug tap through all of the spark plug holes and tap 1/8″ NPT in water out for air bleed.
4. Deburr cylinder head and cam caps.
5. Wash entire cylinder head.
6. Install hat washers, available from either Bates Engineering or B&B.
7. Install cam caps and torque to 89 in. lbs. Measure guides, no more than 0.003″ larger, and cam bores, 0.0016″ – 0.0030″ and document.
8. Install head on torque plate for valve job procedure, at 120 ft. lbs.
9. Using a SERDI 100 machine, cut the valve seats at 45 degree angle
10. Blend seats to port with a carbide grinder and blend the chamber to the 3.500″ bore
11. Using Ferrea valves, 1.400″ intake Valarz VV50 high temp nickel based material, and 1.200″ exhaust, Neumonic 90 Nickel Vac 800 custom blend, touch grind the angles, on the intake use 30 degree (0.040″-0.060″ backangle) and verify run-out numbers
12. Measure the valve stem diameters (6 mm).
13. Wash all of the valvetrain parts
14. Check spring pressure on all 16 springs at open, 250-260 lbs., and closed, 90-95 lbs., and record numbers. For the PSI 1530 spring, use 1.210″ installation heights.
15. Using tip gage, measure the valve tip to spring pocket and record on each valve.
16. Measure from bottom of retainer to valve tip on each valve.
17. Calculate proper installation height.
18. Assemble all valves, springs etc, into the cylinder head.
19. Check the volume of all four combustion chambers and record.
20. Use Miller-Stephenson epoxy on all plugs in the cylinder head.
21. Measure camshaft journals to verify that they are within specification.
22. Rough lash the cylinder head. Use the stock Ecotec rocker arm on the intake and a Jesel Ecotec rocker arm part number OCF-8100 on the exhaust side.
23. Install cylinder head on engine.
24. Lash to 0.005″-0.007″ Note: under lifter shims cannot be used with the LSJ/SAAB sand cast cylinder head.

COBALT PRO RACING BODY COMPONENTS

PARTS LIST		
DESCRIPTION	**PART NUMBER**	**SUPPLIER**
Cobalt Hotrod FWD Front Clip — Fiberglass	30-047-0092	Roush Industries (734) 779-7385
Cobalt Hotrod FWD Front Clip — Carbon Fiber	30-047-0093	Roush Industries (734) 779-7385
Cobalt Pro FWD Front Clip — Fiberglass	30-047-0094	Roush Industries (734) 779-7385
Cobalt Pro FWD Front Clip — Carbon Fiber	30-047-0095	Roush Industries (734) 779-7385
Cobalt Dashboard — Fiberglass	30-071-0049	Roush Industries (734) 779-7385
Cobalt Dashboard — Carbon Fiber	30-071-0050	Roush Industries (734) 779-7385
Cobalt Pro Stock Body	CCS-0591	GM Racing (810) 239-4122

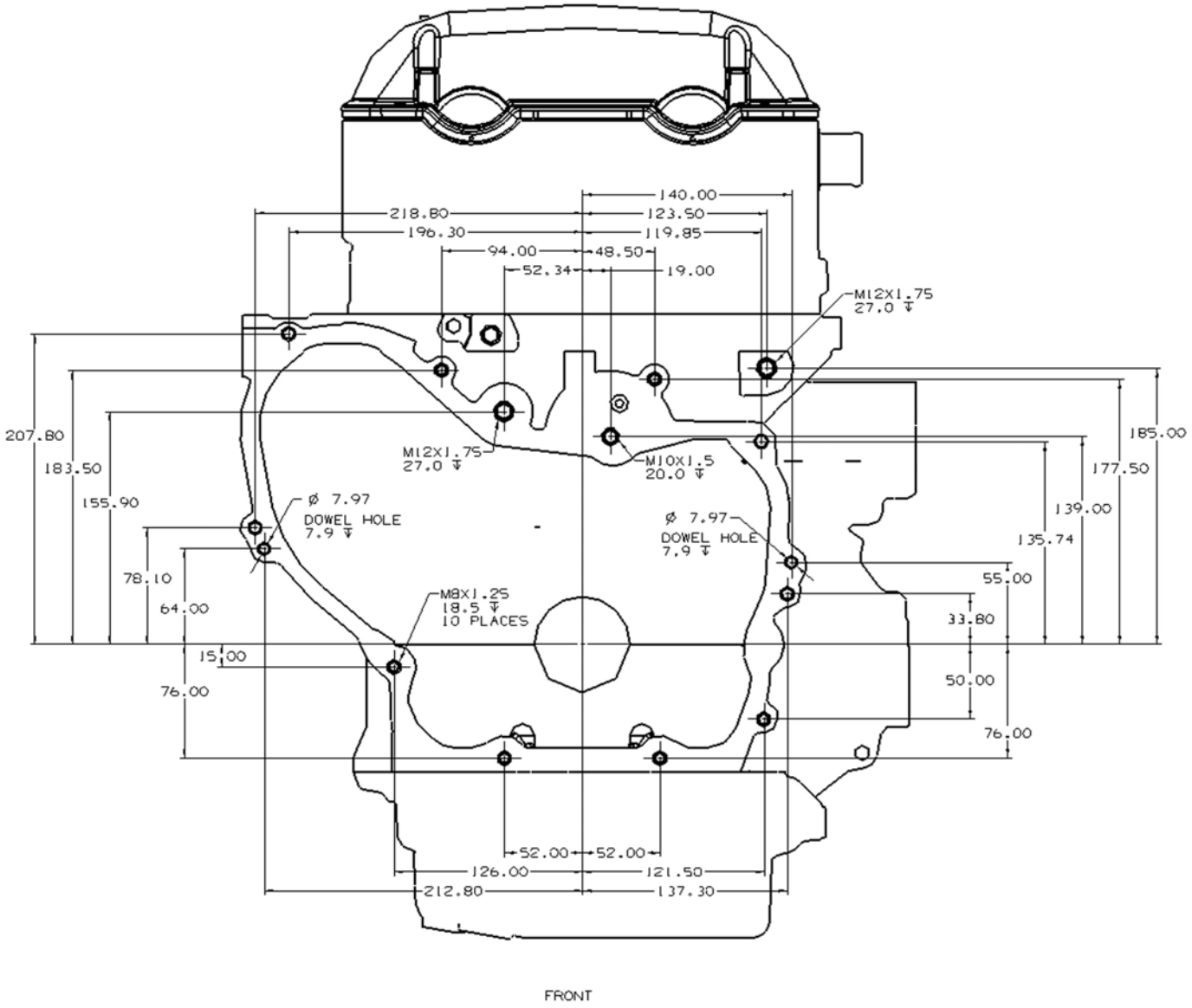
SUPPLIER CONTACT LIST

SUPPLIERS LIST			
SUPPLIER	**WEB ADDRESS**	**PHONE NUMBER**	**Component**
ACE Racing	www.ace-mfg.com	(800) 844-9294	Race Clutch
Arias Pistons	www.ariaspistons.com	(310) 532-9737	Pistons
Accufab	www.accufabracing.com	(909) 930-1753	Throttle Body
Aeromotive	www.aeromotiveinc.com	(913) 647-7300	Fuel Systems
Air Lift/Easy Street	www.airliftcompany.com	(800) 248-0892	Airbags
ARP	www.arp-bolts.com	(805) 339-2200	Fasteners
ATI	www.atiperformanceproducts.com	(800) 284-3433	Crank Dampers
Autometer	www.autometer.com	(815) 899-0801	Gauges
B&M	www.bmracing.com	(818) 882-6422	Shifter
Bates Engineering	www.batesengineering.info	(714) 545-0159	Engine and Suspension Components
Borg Warner	www.turbodriven.com	(828) 684-4000	Turbochargers
Bullseye Power	www.bullseyepower.com	(877) 784-0379	AirWerks Turbos
Carrillo	www.carrilloind.com	(949) 498-1800	Connecting Rods
Chapman Racing Heads	www.chapmanracingheads.com	(801) 292-3909	Cylinder Parts
Coan Converters	www.coanracing.com	(765) 456-3957	Torque Converters
Cometic	www.cometic.com	(800) 752-9850	Stock Crank Bolt
Comp Cams	www.compcams.com	(800) 999-0853	Cams
Compushift	www.compushift.com	(310) 465-0220	Transmission Controller
Corsa	www.corsaperf.com	(900) 486-0999	Exhaust
Crower	www.crower.com	(619) 661-6477	Connecting Rods
CV Products	www.cvproducts.com	(800) 448-1223	Valve Springs
DFI	www.accel-dfi.com	(248) 380-2780	Engine Management
Diamond Racing Pistons	www.diamondracing.net	(877) 552-2112	Pistons
Eagle	www.eaglerod.com	(662) 796-7373	Connecting Rods
Enginuity		(310) 901 0132	Xtrac Shift Controller
FAST	www.fuelairspark.com	(877) 334-8355	Engine Controllers
Ferrea	www.ferrea.com	(888) 733-2505	Valves and Valve train
Full Race	www.full-race.com	(866) full-race	Turbos and Turbo Manifolds
General Motors Performance Parts	www.gmperformanceparts.com	GM Performance Parts	GM Performance Parts
General Motors Racing	www.gmtunersource.com	—	GM Racing Parts and technical assistance
General Motors Goodwrench	www.gmgoodwrench.com	Local Dealer	Production Parts
Ground Control	www.ground-control.com	(530) 677-8600	Camber Caster Plates
Hahn Racecraft	www.hahnracecraft.com	(630) 553-6830	Turbochargers
HKS	www.hksusa.com	(310) 491-3300	Waste Gates

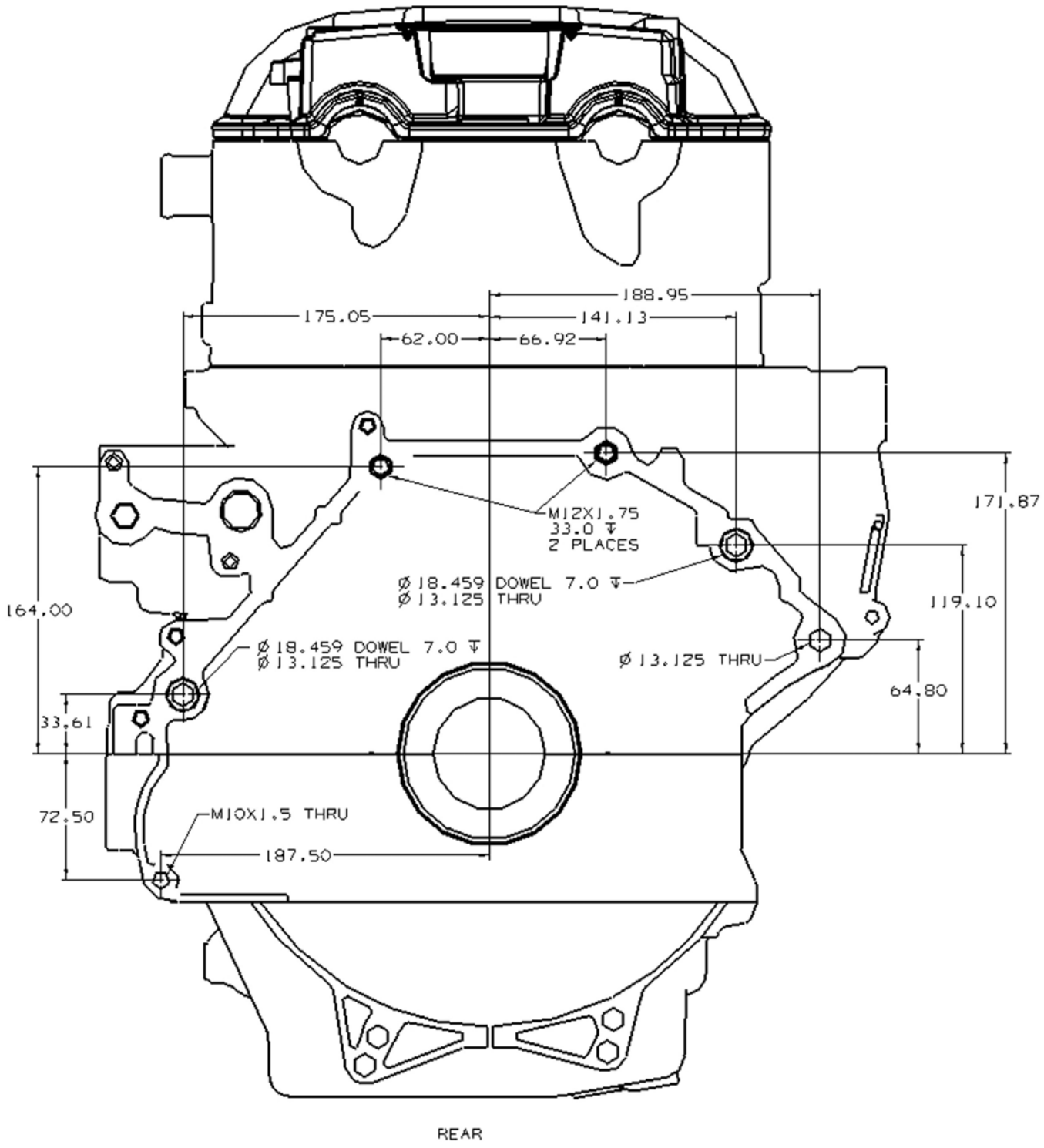
SUPPLIERS LIST			
SUPPLIER	**WEB ADDRESS**	**PHONE NUMBER**	**Component**
HP Tuners	www.hptuners.com	—	Production ECM reflash
Innovative	www.innovativeturbo.com	(805) 526-5400	Turbos, Waste Gates and Intercoolers
Intense	www.intense-racing.com	(614) 873-6499	4T65-E Transmission Upgrades, 2.0L LSJ Upgrades
JE	www.jepistons.com	(714) 898-9763	Pistons and Rings
Jesel	www.jesel.com	(732) 901-1800	Valvetrain Components
Justice Racing Engines	www.justiceracingengines.com	(301) 624-1000	Engine Building
Kroyer Racing Engines		(702) 651-2071	Engine Building
KYB	www.kyb.com	(630) 620-5555	Struts
Manley	www.manleyperformance.com	(732) 905-3366	Connecting Rods
Mickey Thompson East Coast	www.mickeythompsontires.com	(330) 928-9092	Tires
Mickey Thompson West Coast	www.mickeythompsontires.com	(951) 817-0101	Tires
Moroso	www.moroso.com	(203) 458-0542	Engine Components
Motegi Racing Wheels	www.motegiracing.com	(866) 466-8344	Wheels
MSD	www.msdignition.com	(915) 857-5200	Ignition, Shift Controller and Boost Controller
NGK	www.ngksparkplugs.com	(877) 473-6767	Spark Plugs
Nitrous Express	www.nitrousexpress.com	(940) 767-7694	Nitrous
Precision Products Performance Center	www.pppcenter.com	(800) 421-9150	Wrist Pins
Precision Turbos	www.precisionturbo.net	(219) 996-7832	Turbos
RC Engineering	www.rceng.com	(310) 320-2277	Fuel Injectors and Replacement Parts
Recaro	www.recaro.com	(248) 364-3818	Racing Seats
Raybestos	www.raybestosproducts.com	(765) 362-3500	Transmission Clutches
RK Sport	www.rksport.com	(800) 214-8030	Body Kits and Suspension Components
Roush Industries	www.roushperformance.com	(734) 779-7331	Engines and Electronics
SCE Gaskets	www.scegaskets.com	(888) 427-5381	Head Gaskets
Schroth	www.schroth.com	(888) 536-8550	Safety Equipment
Shaver Specialties	www.shaverengines.com	(310) 370-6941	Engine Building
Sonny Bryant	www.bryantracing.com	(714) 535-2695	Crankshaft
Stef's Performance	www.stefs.com	(732) 367-8700	Oil Pans and T-Washers
Taylor Motorsports	www.taylormotorsports.com	(714) 630-7875	Trans Blanket
TCI	www.tciauto.com	(662) 224-8972	Transmission Cooler
Total Seal	www.totalseal.com	(632) 587-7400	Piston Rings
Trick Titanium	www.tricktitanium.com	(248) 588-9433	Spring Retainers
Turbo's By Garrett	www.turbobygarrett.com	—	Turbos

SUPPLIERS LIST			
SUPPLIER	**WEB ADDRESS**	**PHONE NUMBER**	**Component**
Turbonetics	www.turboneticsinc.com	(805) 584-1913	Turbos, Waste Gates and Intercoolers
UMI Racing	www.umiracing.com	(800) 275-1615	Engine Management
Walker Evans Racing	www.weracing.com	(888) 933-7223	Shocks
Weldon	www.weldonracing.com	(440) 232-2282	Fuel Systems
Wiseco	www.wiseco.com	(440) 951-6660	Pistons
Xtrac	www.xtrac.com	(317) 472-2454	Race Transmissions

LSJ ECOTEC PACKAGING DRAWINGS



Note: Measurements in millimeters



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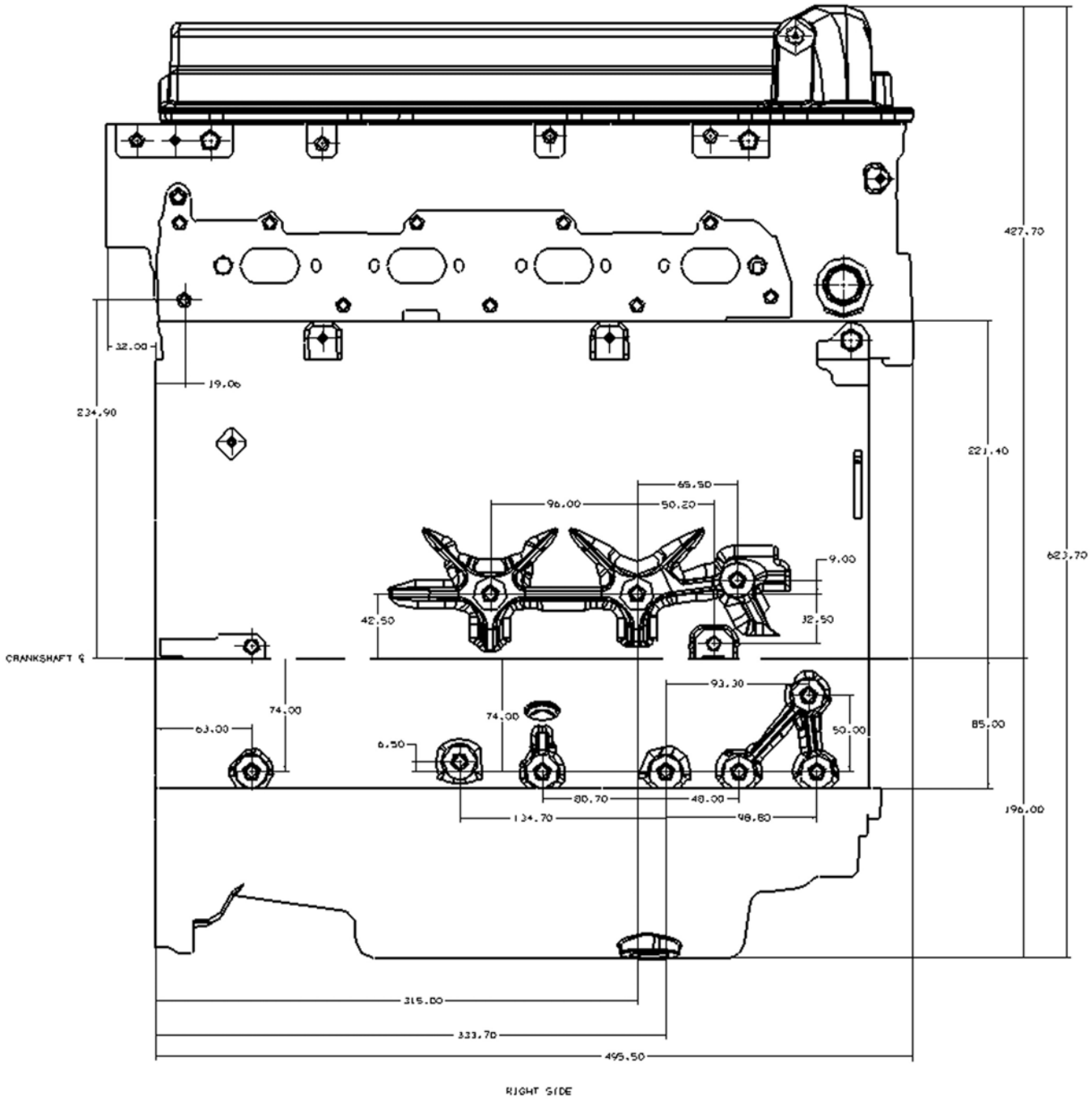

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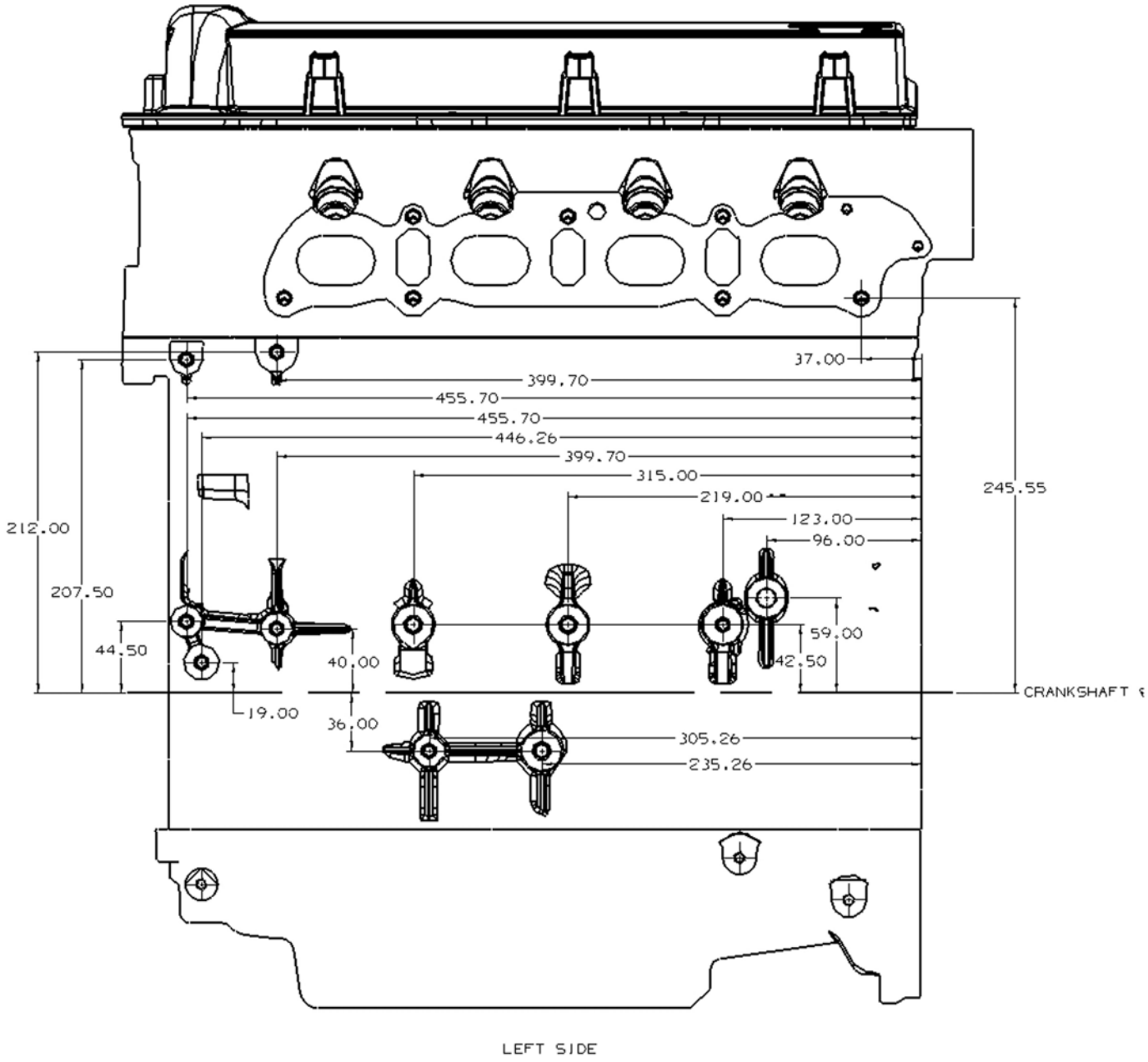
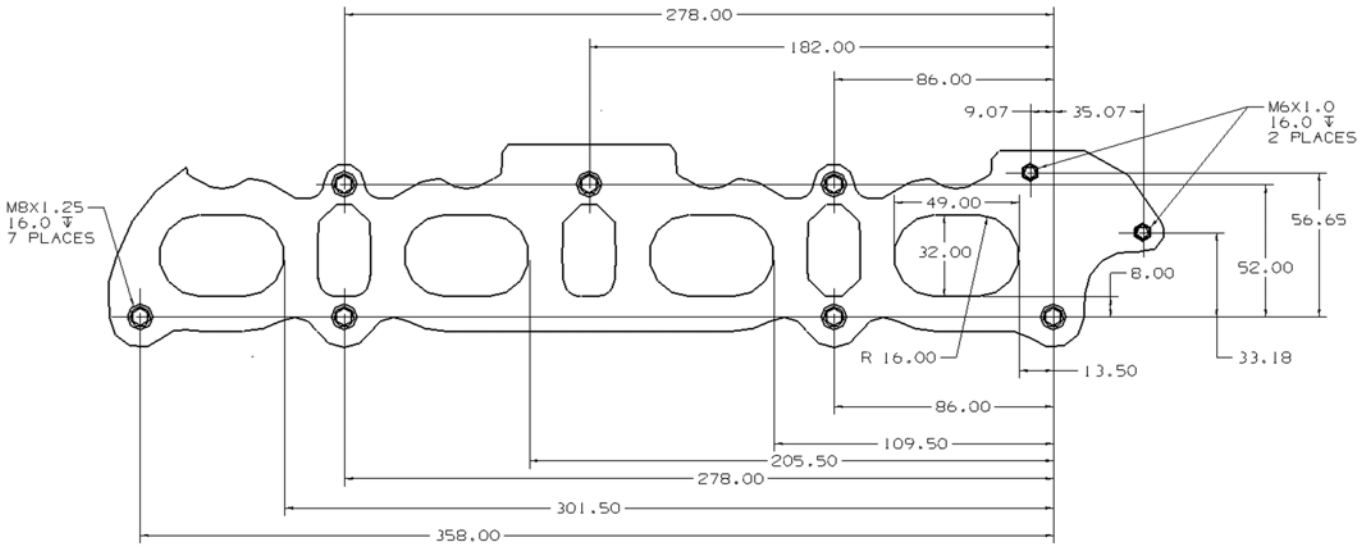
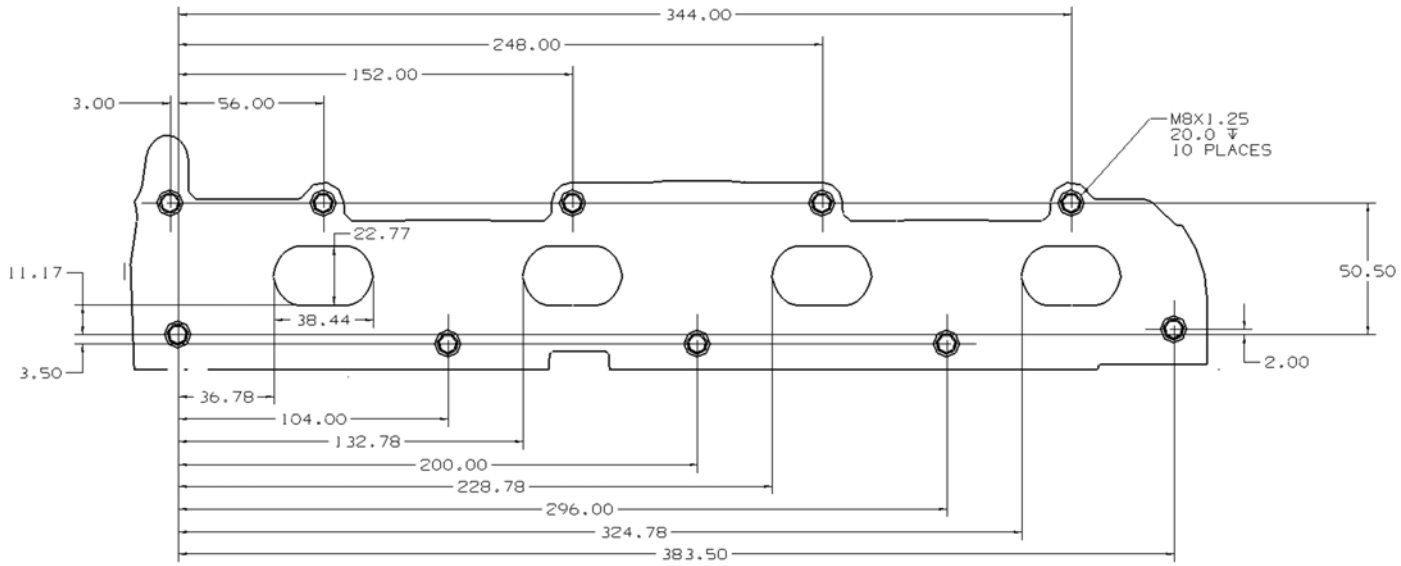


Note: Measurements in millimeters



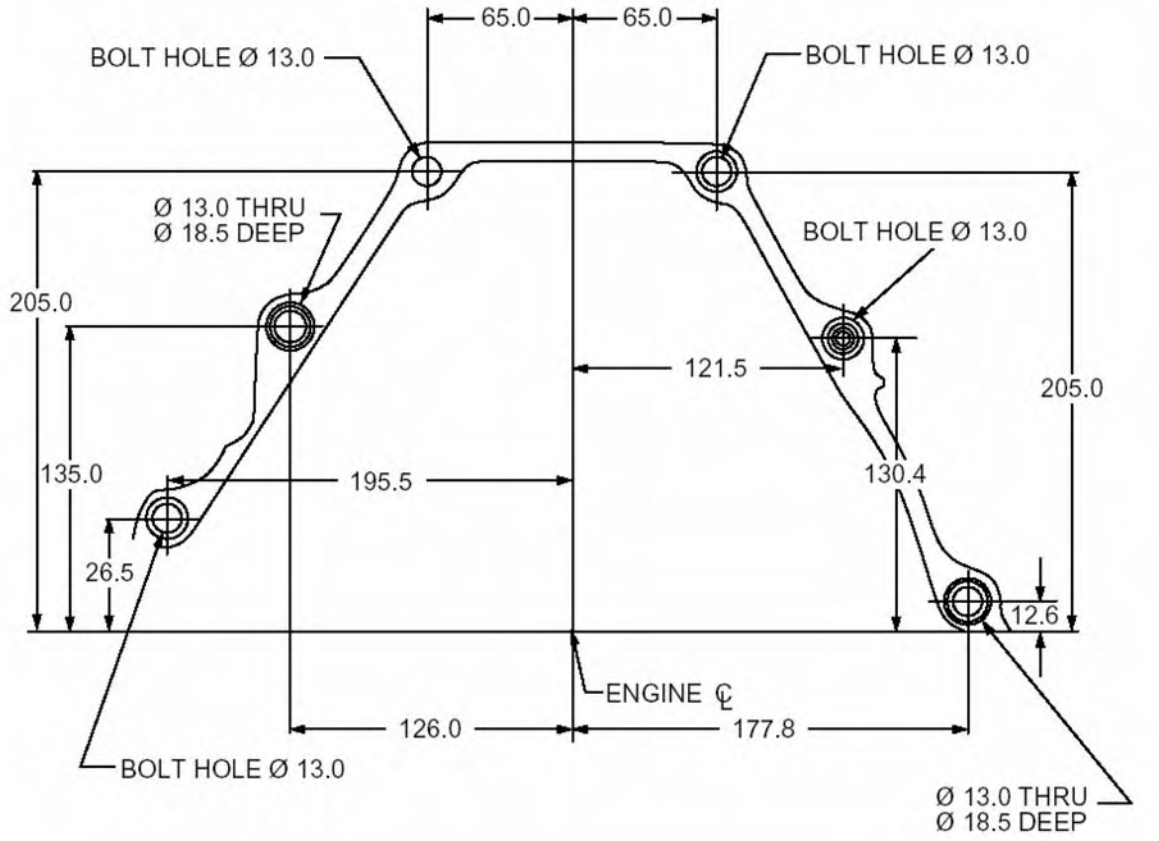
INTAKE MOUNTING FACE AT 12.5°

Note: Measurements in millimeters

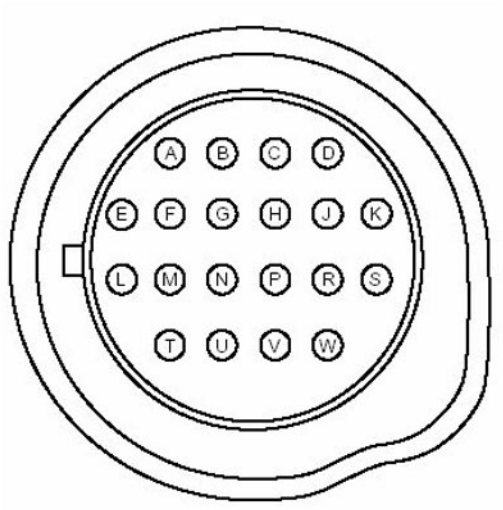


EXHAUST FACE

Note: Measurements in millimeters



4T65 Hyrda-matic bolt pattern
All dimensions in millimeters



TRANSMISSION CONNECTOR

CAV	FUNCTION	WIRE*
A	PCM TO TRANS SHIFT SOL "A"	1222
B	PCM TO TRANS SHIFT SOL "B"	1223
C	PCM TO FM HIGH (VBS)	1228
D	PCM TO FM LOW (VBS)	1229
E	12 VOLT +, IGN "CRANK ON"	839
F		
G		
H		
J		
K		
L	TRAN TEMP SENSOR SIGNAL	1227
M	SENSOR RETURN	452
N	PSM MODE A	1224
P	PSM MODE C	1226
R	PSM MODE B	1225
S	TRANS INPUT SPD SENSOR HIGH	1230
T	TCC PWM TO PCM	418
U	TCC RELEASE SIGNAL	1804
V	TRANS INPUT SPD SENSOR LOW	1231
W		

NOTES

Mobil 1

The Oil of Choice for Top GM Sport Compact Drag, Drift Teams, & Tuners

Every day, the GM drag and Drifting teams push the envelope of compact racing, so they require a motor oil that can withstand the extreme engine conditions their sport generates. And that's why they run only Mobil 1 5W-30 synthetic engine oil.

GM Racing team members have won their divisions in the NDRA Drag Race circuit running Mobil 1 synthetic in their GM Ecotec motors.

In the Pro Outlaw Front Wheel Drive, Charlie Schafer, crew chief and team owner of CSI Racing, watched one of his star drivers, Jason Hunt, finish top of the class for the third year in a row.

"CSI Racing relies exclusively on Mobil 1 for the protection and lubrication we require for record setting performances. We would not have been able to earn 3-peat championships without Mobil 1," Schafer said.

Hunt's CSI Racing team-mate, Brian Ballard, provided team owner Schafer with another victory, by topping The Turbo Street class.

And, Don Nase Jr., in his Pro Extreme Dragster, scored top honors and his times will only be getting faster with Mobil 1 synthetic oil in his GM Ecotec motor.

Each of those remarkable performances happened with Mobil 1 synthetic oil in the Ecotec engines.

Hunt, Ballard and Nase Jr. are among the many professional drivers who know to put their faith in Mobil 1.

Jason Whitfield of Whitfield Racing is also part of the GM Sport Compact Drag Race Team, as well as owner and operator of Whitfield Racing, a shop that builds top tuner cars in southern California. He also uses Mobil 1 exclusively, and for good reason. "Reaching over 900 HP in our cars is no longer a dream for us at Whitfield Racing," he says. "Mobil 1 has made it a reality."

GM Sport Compact Drag cars are not the only cars relying on Mobil 1.

The Pontiac Drift Solstice GXP running in the Formula D Drift Circuit is also using it, as well as Rhys Millen of Millen Motorsports. Millen, in fact, won a Formula D drifting title in his Pontiac GTO with Mobil 1 in the engine. And although he has recently switched to running the new Pontiac Solstice GXP, he continues to rely on Mobil 1 to help him get to the front of the finish line.

Maximizing performance parameters

The reasons why these teams choose to work with Mobil 1 products is better understood by reviewing testing and race conditions. Mobil 1 products have long held a reputation for performing in extreme conditions, a reputation built through participation in many of the world's most arduous racing series, including Formula 1, NASCAR, ALMS, SCCA Speed World Challenge, Grand AM Rolex GT, and now Formula D Drifting and Sport Compact Drag Racing.

What distinguishes Mobil 1 from other products is its unique combination of base stocks and additives. Mobil 1 contains high-performance synthetic fluids, with superior low and high temperature performance properties (as a result of their higher viscosity index). A proprietary formulation of high performance additives is then added. This component blended system contains additives designed to maximize all around engine performance.

As these high-performance engine upgrades have proven, Mobil 1 has the ability to withstand extremely high temperatures, including demanding Supercharged and Turbocharged engines. Mobil 1 provides the same level of engine protection and performance from a street version Ecotec Engine to a modified 1000 HP high performance Ecotec race engine.

The bottom line is this: if Mobil 1 is good enough for championship racing teams, it's good enough for any engine – including yours.

NOTES