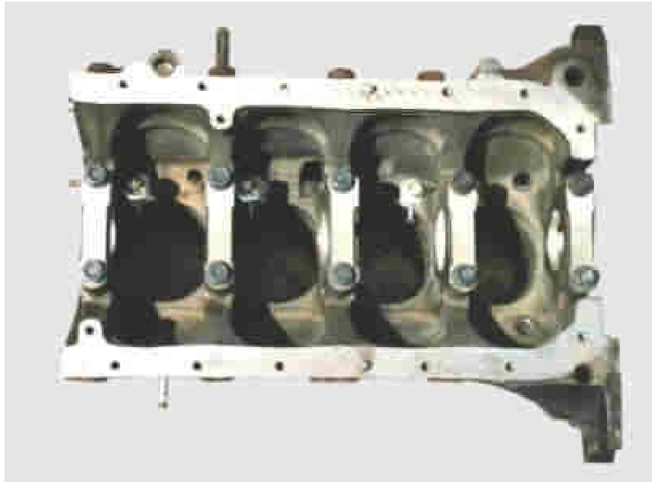
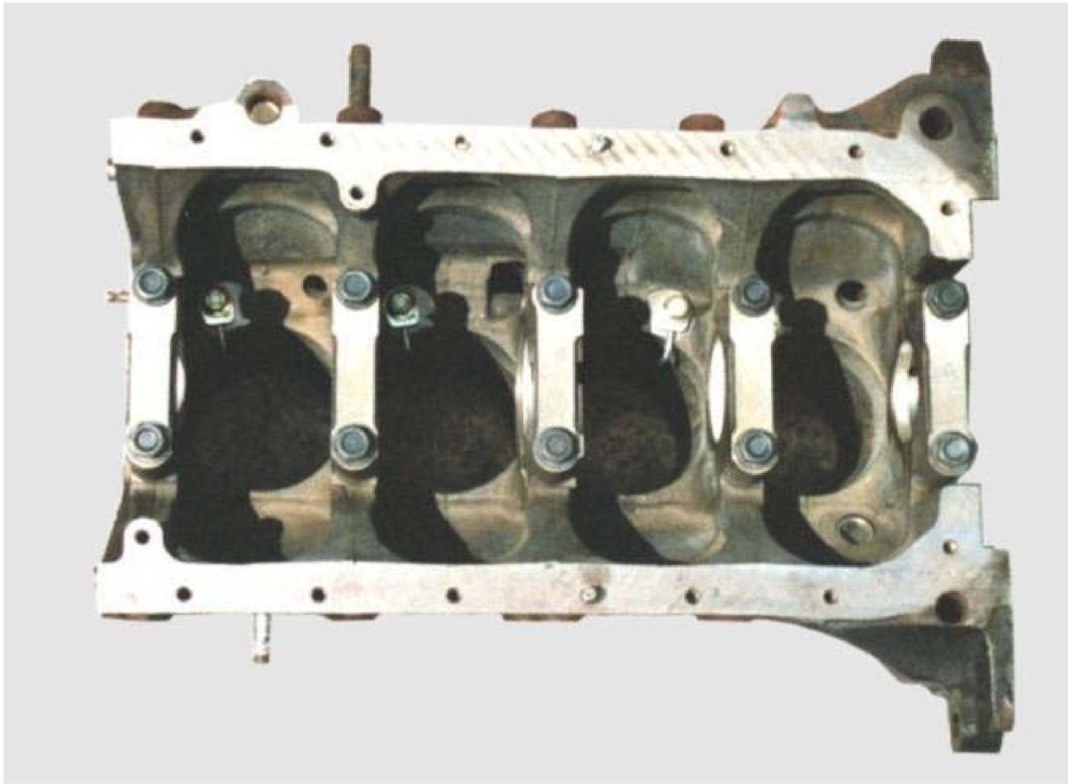


The 4A-GE Block

A **Submission By Richard White**

There are basically two configurations on the 4A-G cylinder block with some minor variations with the five vale versions. In all cases they have these characteristics in common. The cylinder block on the 4A-G is made of cast iron alloy. There are five main bearings held with two bolts each that are 2.70 inches apart. The bores are 87.5mm center to center apart. The weight of the bare block with main bearing and bolts are approx. 76Lbs. (late model 4A-GELU with Oil squirter/coolers) and 67.5Lbs. (4AC type). The stock bore diameter is 81mm. It can be bored out to as much as 83mm. However it is not recommended beyond 82mm because the siamese bore arrangement leaves very little head gasket material between combustion chambers for sealing high combustion pressures and the cylinder wall thickness begins to thin. These thin areas also increase the likely hood that cracking could develop under high thermal loads. Likewise the maximum stroke will not only be limited by the rod lengths (122mm) and deck height (191mm); it will also be limited by the connecting rod bolt to block clearances. Using any stroked crank over 79mm will require grinding on the block with a maximum stroke approaching 81~ 82mm. Note for those using the 7A block and crank you will have 85.5mm of stroke and 206mm deck height.

Blocks from the high compression AE92 (4A-GELU) and supercharged MR2 (4AGEZ) are stiffer/stronger than the other normally aspirated blocks and have proven to hold up well over 200hp. Blocks from earlier engines should be capable of handling anything less than »130hp., since this appears to be where Toyota decided to redesign its blocks for higher output models. I suspect the margin of safety will decrease as output increases. Moreover, the AE92 (4A-GELU) with the high compression pistons have piston oil squirter/coolers, while US model AW11, 4A-GEZ (supercharged MR2s), did not come with them. See photos



Internal view of an AE92 Hi-comp. 4A-GELU block. Notice the oil squirter placement. Each oil squirter is tapped into the main oil galley. Notice the location difference on #3 oil squirter. This necessitates a configuration difference with the angle of the nozzle and placement of the anti-rotation device. The others are identical to each other. #4 oil spuirter is hidden from view.

Close up of oil squirter. It is composed of a nozzle and special anti-rotation“stud” and a hollow screw with a special internal check valve. The spring pressure on the check valve is just enough to keep oil from draining back into the sump. Unlike some other engines that operate them at higher RPMs the 4A-GELU squirter is in constant operation, aiding in cooling and lubrication.

It is now common practice for high performance Japanese engines to come standard with oil squirters. These items aid in piston cooling and lubrication, especially under heavy loads. The one pictured from a high compression AE92 (4A-GELU) has a 0.0540 ~ 0.0550 inch dia. orifice, and its check valve has only enough spring pressure to keep oil from draining back into the sump. Many other engines have greater check valve spring pressure that are only activated at high engine RPMs, i.e., at high oil pressure.

Each squirter is mounted as far forward or backward in the block to clear the piston skirt. Therefore, using a stroked crank may necessitate notching the piston skirts. However one should use caution and only notch a forged piston. Notching a cast piston creates a stress raiser where cracking could occur. Nevertheless once notched, the piston should also be shot peened. (It is not the same as bead blasting) (The correct procedure is per AMS-S-13165)

Though “old school” as compared to the “modern” aluminum blocks, the cast iron block does have its advantages. Even though heavier, it is much stiffer and stronger and is just about bullet proof for very high combustion chamber pressures. It is also common practice in racing circles to take advantage of the block’s strength, i.e., the engine is used as a stress member in the formula Atlantic cars (I’ve heard they use the late model supercharged block and have seen the use of special TRD cam covers that bolt to the chassis just behind the driver’s head). The 4A-G iron block has also proved itself in many off road, Baja, competitions with out worries. Another advantage, especially with high performance applications, is the cylinder bore and block material homogeneity. Being of the same material, the engine builder does not have to worry about the cylinder bores shifting or the use of special jigs or equipment for boring/horing aluminum cylinder walls. However it is highly recommended to use a deck plate which is identically torqued (like the head) to the block during boring/horing and during align-horning. Moreover, the block should be bored and honed with the main bearing caps torqued in place. And if you are using a metal head gasket, many of the older well know high performance engine builders will even torque the head gasket in place during the boring/horning of the block. This is because even the metal gasket will apply a certain amount of “un-even” pressure on the cylinder walls, distorting the final round dimension they wish to achieve.

The deck plate is usually a thick heavy piece of precision ground steel (minimum 2 inches) or thicker piece of aluminum plate with holes cut into it for access to the cylinder bores. It is ground flat and is extremely rigid. Since deck plates are the results of the performance world, they are custom made. Each deck plate is unique due to the head bolt-hole pattern to that particular engine. The deck plate was invented by engine builders who demanded perfectly straight, round bores after their cylinder heads were installed. However there are engine builders who feel this is unnecessary for good ring sealing since modern rings conform very well and their “experience” may bear them out. However, unless they are named TRD or Paul Hasselgen (98’ formula Atlantic engine builder of the year), I would insist on the use of a deck plate. It is just one of those little extra performance tips that is done by people who are serious about performance, workmanship and quality.

After the block has been bored you will need to ask the machine shop if the cylinder bore lip was radiused. They should do this as a matter of course. It will be quite difficult if not impossible to slide the assembled pistons and rings into the bore against a 90 degree lip. It always pays to ask.

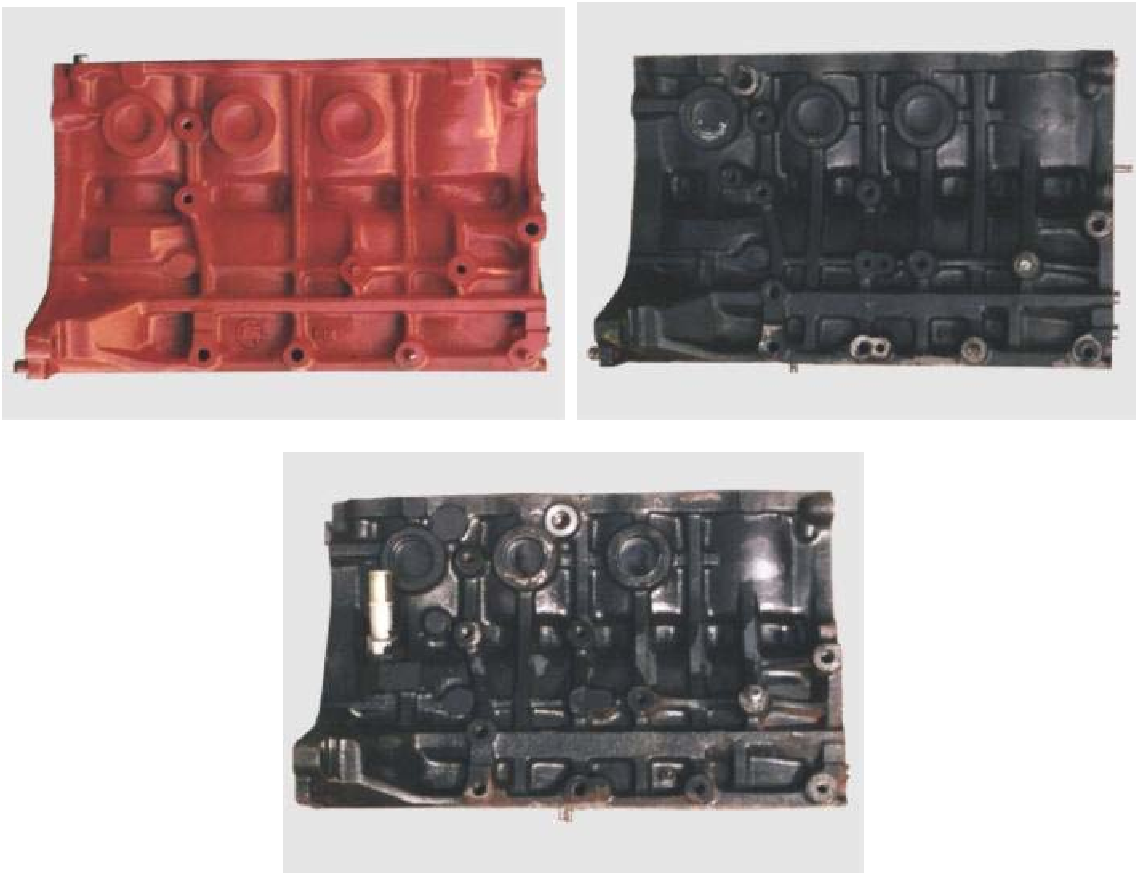
The basic requirements for a cylinder block, whether it is new or used, is that it should be clean, crack-free, with reasonably straight, round cylinder bores and reasonably aligned round main bearing bores and tight fitting main caps. However some old time sprint car racers have preferred a well “seasoned” block, i.e., a block that has been left in the elements to stress relieve itself. Since Toyota is no longer making the block most of you will be using used (pre-run/owned) blocks anyway, I think a discussion on green engine blocks is not necessary.

The following are the basic steps that should be followed in the preparation of your block.

- Checking of original dimensions to determine required machining.
- Check bore size to determine how much needs to be bored or honed to give you the required finished piston to bore clearance. Note, always have the pistons (and their actual measurements) in hand, do not assume this value, and there will be a difference if you plan to use a cast piston versus a forged one. (Forged require larger clearance)
- Check main bearing bores for roundness and size.

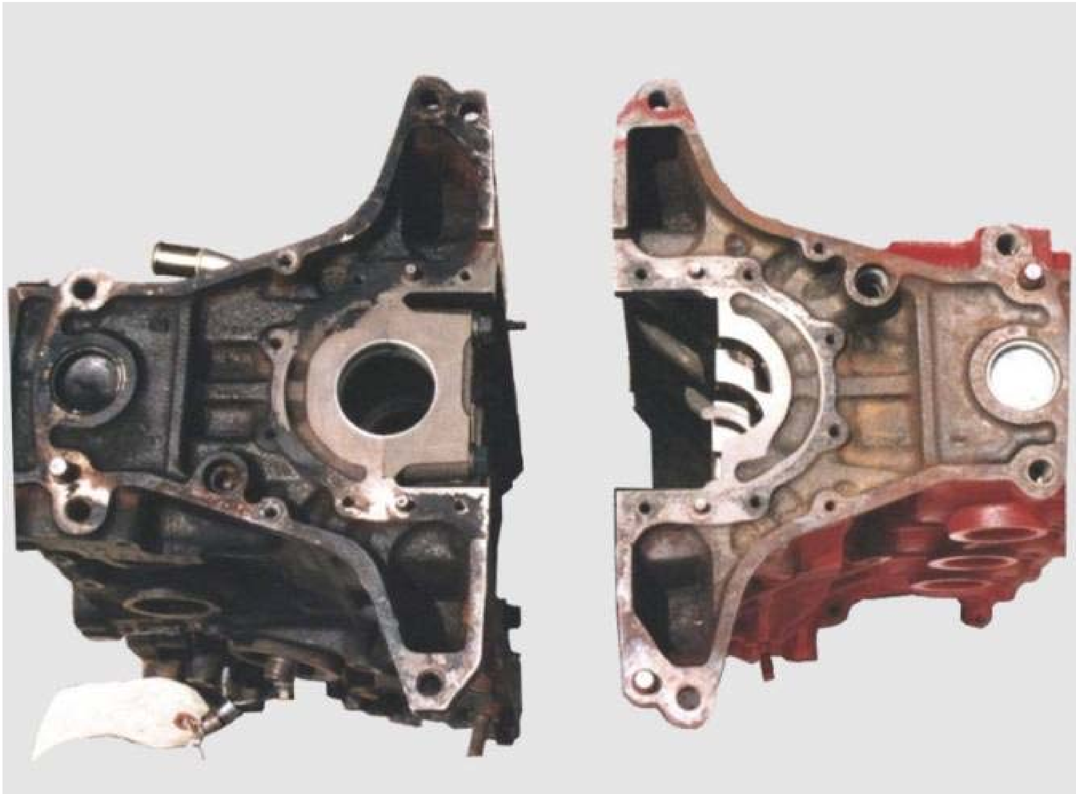
To determine how much material must be removed from the cylinder block deck surfaces, a machinist straight edge is used across the surface. Any gap between the straight edge and the block greater than .002” should be milled flat. The deck height can further be reduced after measuring the difference in height between the pistons and block deck, with the rods and crank bearings installed. The final dimension you want after machining from the deck surfaces is a clearance of .035 ~ .040” between the piston top and the completed head. The compressed thickness of the head gasket must also be considered in the calculation. Note, the compression ratio should be determined by the use (or not) of piston doming and combustion chamber volume, i.e., milling the head and not the block deck. This keeps the rings below the upper end of the block where there is temperature/mechanical instability.

After all machining operations, the block should be deburred. A hand grinder or rotary file is fine for the job. How much time spent here depends on how important you value your hands. The main bearing saddles are quite sharp. But be careful and not mar the bearing saddles or the bores. The oil drain back areas in the center of the block can at this time be cleaned up and deburred, since they are rather rough and are often partially blocked, slowing the oil from draining back into the sump. Note, the Hi compression AE92 (4A-GELU) engine has an external oil drain back tube that helps in returning oil to the sump. See photo. If the tube is not needed it can be removed and plugged if the builder wishes.

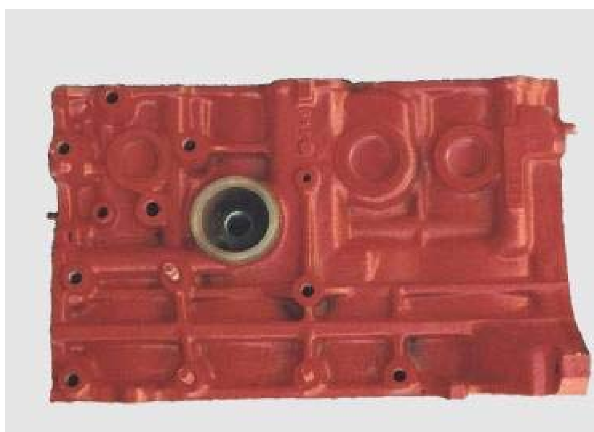


Intake side of 4A-G engine block. Top, 4A-GE, painted and cleaned ready for assembly; Middle, 4A-GEZ, U.S. model AW11; Bottom, 4A-GELU, Hi-comp. AE92, with its additional oil return tube. Notice the additional vertical stiffening ribs at each freeze plug and the thicker horizontal rib above the block oil pan interface. They are added for strength and stiffness.

Front view comparison between a 4A-G normally aspirated block, right; with a later version AE92 Hi-comp 4A-GELU block, left. Notice the vertical stiffening rib extending from the water inlet opening to the main bearing saddles. Also notice the thicker main bearing saddles to give additional strength and stiffness.



Rear view comparison between a 4A-G normally aspirated block, right; with a later version AE92 Hi-comp 4A-GELU block, left. Notice the thicker main bearing saddles to give additional strength and stiffness. Not shown, the main bearing caps are nearly identical in size and configuration.



Exhaust side of 4A-G engine block. Top, 4A-GE, painted and cleaned ready for assembly; Middle, 4A-GEZ, U.S. model AW11; Bottom, 4A-GELU, Hi-comp. AE92. Notice the thicker horizontal stiffening rib just above the engine oil pan interface and the stiffening rib between the freeze plugs for added strength and stiffness.

As part of block preparation, but often times over looked, is the inspection and determination to use the old nuts and bolts, i.e., the main bearing and head bolts. Many if not all Hi performance engine builders will throw away all the old fasteners. They will not take a chance on the old fasteners, while the guy down the street who rebuilds engines (stock) for a living has little knowledge about fatigue, UTS, thread engagement etc. and will use anything available that will fit. Note this determination should be made prior to having any machine work done, since you will want to use these same fasteners properly torqued while the machining is being done. That way, when the engine is fully assembled it will have the round bores it was designed to have.

The first rule when determining to use any nut or bolt is that it must not be damaged and it must fit properly. After all threaded areas have been cleaned (assuming no corrosion) the bolts should easily screw into the block and there should be no damage to the threads, otherwise replace the bolts (assuming you have not damaged the threads in the block). Second is no bolt/screws should be cleaned using a die. Cutting into the threads will only weaken it. If the thread is damaged, do not use it. Only use a brush and solvent to clean the threads. The corollary is that threaded holes should only be "chased" with a special tap (smaller pitch diameter). However I have never been able to verify nor obtain a metric "chase tap". Unlike American standard inch sizes where the thread root may vary in dimension, the metric standard has only one thread root configuration.

As a note ARP (Automotive Racing Products) has available for the 4A-GE high strength, forged, heat treated 8740 chrome moly bolts and studs for the head and mains. The stock 4A-GE uses 10mm- 1.25 bolts. Though a little more expensive, converting to head and/or main studs will not only give added strength and reliability but provide more accurate torque readings because studs don't "twist" into the block. All clamping forces are on one axis, and there is less force exerted on the block threads, increasing its life. This would be well worth considering especially if you are planning to run very high combustion pressures and high RPMs and/or plan to tear down the engine often.

Regardless, if you are using studs or bolts ensure they are installed (torqued) correctly, i.e. threads wet with lubricant. There will be nothing worse than spending all that time and money to have it all come apart. Moreover, any time new fasteners are used for the connecting rods, head or main bearing caps it is highly recommended that the bores be re-machined/honed with the new fasteners torqued to the recommended specifications.

Blueprinting

After you have received your cylinder block and all the moving components back from the machine shop, check all the critical running clearances. That means you should carefully measure the dimensions of each mating surface to verify, 1) the machinist did a good job and 2) each feature of every component are within tolerance. If they are not within tolerances, you must adjust the dimensions with subtle machine work to bring them into specification. Prepare for a time consuming effort to do the job right. Like the old craftsman said, it is better to measure twice and cut once than measure once and start all over again.

TRD blueprint tolerances for main bearing bore diameter are 52 +.050/+.020mm (1.9685 +.0020/+.0008 inch.) with the resulting combination of crank diameter and bearing thickness equaling a .050 ~ .065mm oil clearance (AE92 Hi-Comp. Group A configuration: .055 ~ .070mm).

If a straight crankshaft will spin freely in new main bearings with clearances of .002" ~ .0025", it does not need to be align bored. The main bearing saddles can also be checked for alignment using a machinist's straight edge and feeler gauge. With the straight edge in place (bearing removed) you should not be able to place or move a .0015" feeler gauge between the main bearing saddles and straight edge. Factory crank pin oil clearance spec. is only .0020 inches.

For proper piston clearances, the cylinder bore measurements should be taken in the thrust and axial direction at 10mm from the top, bottom, and in the middle of the block. The exact area to measure the bore diameter on a piston varies between manufacturers and their recommendation on where to measure should be followed. Usually some where on the lower part of the piston skirt. Cylinder taper should be £.02mm (.0008inch.) and out of round limit is also £.02mm (.0008inch.).

The factory specification for crank thrust is 0.02 ~ 0.22mm (0.0008 ~ 0.0087inch.) with a max of .0.30mm (0.0118 inches) and the max. rod thrust is 0.3mm (0.012 inches). Nominal rod thrust should be 0.15 ~ 0.25mm (.0059 ~ .0098inch.) for adequate oil flow.

If the block has to be align bored/honed, the proper honing procedures should accurately reduce the inside of each bore to the minimum acceptable dimensions, which provides maximum bearing crush. The hone also leaves a very smooth finish in the bore. The Machine shop doing the align horning must know the brand of bearing that will be used in order to hone the block to the smallest acceptable diameter. Maximum bearing crush is desirable not because it retains the bearing in the block and cap but because it provides good bedding for the backside of the bearing to transfer heat to the block and away from the crank.

Note there is a difference between align honing and boring. Boring can and will change the crank spin axis by removing material on any bearing saddle and cap, while honing can only remove very little material at the average crank spin axis. Know what your machinist is using and why.

Cleaning

After all the grinding and machining the block should be thoroughly cleaned again. Remove the front and rear oil gallery plug with an 8mm allen wench. Before cleaning inspect the depth of the plug into the block. The entrance to the #1 and #4 main bearing should allow full unobstructed oil passage. (Don't forget to re-install and seal them after cleaning) Use a 410 shot gun-cleaning bush to scrub the main oil passage. Smaller 25 ~ 30 caliber rifle bushes can be used to clean the main bearing oil passages. Use a degreaser and solvent followed with hot soapy water to flush all metal particles and coat immediately with oil to prevent rust. Use compressed air to drive away the water and small metal particles that may have been trapped in the block. Note WD40 is not the product to use for long term storage. It contains and will attract moisture. I would recommend Boeshield. It was developed by the Boeing Co. for long term protection on aircraft and works extremely well in the marine environment and especially on cast iron.

Moreover, if there is excessive rust and scale in the water passages, the freeze plugs should be pulled and the coolant passages thoroughly cleaned. It maybe necessary to chemically boil the block, but steam cleaning and solvent wash is probably all that it needs. Carefully check for cracks.

Note, if you are using a stroked crankshaft you may have to make allowance for the connecting rod bolt ends, and as a result several cleanings may become necessary between each crank fitting and grinding operations so as not to scratch the crankshaft or bearings. It is a general practice to have 0.050" minimum clearance between the block and the top of rod bolts. Note all grinding are on the engine block, and care should be exercised on the intake side of the block. This is the thinnest section of the block. 4A-GEZ & 4A-GELU, the Japanese Hi-Comp. blocks, have added extra material to help. See photo.

To clean the main bearing cap and head bolt holes, a 9mm-hand gun bore brush and plenty of cotton swabs will be needed. Any airesol carburetor cleaner will work to flush out the hole and de-lube any residual cutting fluid used (Wear eye protection).

It can not be stressed enough that any amount of dirt in the block will be sucked up by the oil pump, causing wear and have the potential of leading to premature engine failure.

After cleaning, one of the nicer touches is to paint the block. Note all Toyota blocks are painted black to hide the dirt and oil. A good "engine" paint and surface prep. is all that is necessary, but be sure and mask the oil filter area and any of the mating surfaces. Paint or paint flakes inside the engine is not a good idea. Note some hot rodders recommend coating the inner surfaces of a cast iron block with an epoxy paint or Glyptal made by General Electric for a slick surface for the oil to run off and to trap any potential loose grains of casting sand or block granules. But I would wonder about loose pieces of epoxy or Glyptal? Moreover the use of such material does not have very good heat transfer to the oil to aid in its cooling. I'll leave coating the inside up to you.

The following table is a comparison of some of the configuration differences between blocks and their major components.

For Toyota Part number references and noted differences:

Part	**Engine designation**	**Vehicle**	**Toyota part number**	**Comments**
Oil squirters	4A-GELU (Hi-Comp.)	AE92, (Hi Comp.)	#1,2 & 4: 1570816010 #3: 1570816020	#3 is configured differently because of its placement in the block
Block	4A-GEU	85~87 Corolla (GTS US market)	11401-19216	Part No. Same as 4AC engine block
Block	4A-GEU	Nat. Asp. MR2	11401-19267	
Block	4A-GEZU	87 Supercharged AW11 (MR2)	11401-19456	More stiffening ribs, more metal under bearings, than 4AC block
Block	4A-GEU	90~91, AE92, Hi compression	11401-19476	More stiffening ribs (7 on the intake side vs. 3), more metal under bearings, than 4AC block, identical to # 11401-19456, but w/ oil squirters
Block	4A-GEU	88~89, AE92	11401-19420	
Crankshaft	4A-GEU	85~87 Corolla	134011610	Ø39.985~40mm. connecting rod journals (forged)
Crankshaft	4A-GE & Z	AW11 (MR2)	134011620	42mm dia. connecting rod journals (forged)
Crankshaft	4A-GEU	88~91, AE92	134011620	42mm dia. connecting rod journals (forged)
Oil pump	4A-GEU	85~87 Corolla	15100-19025 (15100-19026)	Note the stock inner pump gears are the same. Drive gear: p/n, 15121-16010; Driven gear: p/n, 15122-16010

Oil pump	4A-GE & Z	AW11 (MR2)	15100-19025 (15100-19026)	Note the stock inner pump gears are the same. Drive gear: p/n, 15121-16010; Driven gear: p/n, 15122-16010
Oil pump	4A-GEU	88~89, AE92	15100-19025 (15100-19026)	Note the stock inner pump gears are the same. Drive gear: p/n, 15121-16010; Driven gear: p/n, 15122-16010
Oil pump	4A-GEU	90~91, AE92, Hi compression	15100-19035 (15100-19036)	Though typically not stocked the late model oil pump gears are only available as a matched set. p/n, 15103-16030

Listing of part numbers illustrate factory differences. Part numbers and years may vary depending on original country of sale. Part numbers are subject to change without notice and may not be available. Consult your supplier for proper application.

1. **Some block differences are the result of outside configuration differences in hanging different accessories, i.e., power steering, Air Cond., Alternator, etc. and mounting the engine into a FWD or RWD chassis.**

2. **The specification for the crankshaft main journals are Ø47.988 ~ 48.00mm (1.8893 ~ 1.8898inch.)**

References:

Joji & Joel Luz, Toysport, Gardena, CA.

ARP, Automotive Racing Products, Oxnard, CA

***1985 Toyota Corolla FR Repair Manual*, Toyota Motor Corp. 1984**

***Corolla, Levin, Sprinter, Trueno, Special Edition Bible*, TRD, 1996**

***AE86 Best Setting*, Tatsumi Mook Perfect Series, Tatsumi Publishing Co. 1996**

Moto-P likes to thank Richard for supplying this information and countless hours of help he puts toward Club4AG...

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