

USF2000 Tube Frame Van Diemen

Powered by the Mazda MZR LF-DE 2.0L

This document is assembled to support the inclusion of USF2000 Tube Frame Van Diemen car powered by the Mazda MZR LF-DE 2.0L in FC

It includes the following sections:

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ARTICLE 2:

F1600/F2000

2018 TECHNICAL SPECIFICATIONS



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ARTICLE 2.2: MAZDA MZR F2000 TECHNICAL SPECIFICATIONS- 2018

These specifications are part of Formula Race Promotions (FRP) Competition Rules and all automobiles shall conform with these Specifications and FRP Pro Racing Rules (PRR).

F2000 is intended to provide competitors and interested manufacturers with the opportunity to compete in purpose built, highly modified open wheel single seat cars. FRP may alter or adjust specifications and require, permit, or restrict certain specific components to equate competitive potential as deemed necessary.

In an effort to control shock/damper technology and cost to a level reasonable for competitive racing, any fluid dampers are allowed, with the following restrictions:

1. Maximum of 4 dampers/shock absorbers per vehicle.
2. Dampers must be independent from each other with no interconnectivity. However, data acquisition is permissible, as long as it serves no other purpose.
3. Dampers must be manually adjustable only.
4. Mechatronic valves, G valves, hybrid inerters, inerters and mass dampers are prohibited.
5. Electro/Magnetic shock fluid is prohibited.

TECHNICAL SPECIFICATIONS FOR MAZDA MZR POWERED CARS (formally used in USF2000) for COMPETITION in Formula Race Promotion F2000

2.2.1: General

- 1.1 For avoidance of doubt these rules currently provide for no modification of any component.
- 1.2 All original Manufacturer identification markings and/or tags must remain as supplied unless otherwise stated in these rules.
- 1.3 The current Bill of Materials (BOM) will be recognized as the only authorized document which references required specification of parts.
- 1.4 The 2010+ Elan Motorsports Technologies DP-08 and the 2001-2009 Van Diemen Chassis (with the exception of the 1999 and 2000 chassis that have been updated to 2001 specification) are the only approved chassis.

2.2.2: Reference planes and '0' coordinates

- 2.1 All measurements shall be taken from the reference plane or '0' coordinates. These shall be established by the chassis Manufacturer and cannot be modified.
- 2.2 References will be measured using the following coordinates:
 - (1) Bottom of the cockpit frame rails.
 - (2) Machined surface on the top of the gear box.

2.2.3: Vehicle Dimensions

All dimensions are measured in the listed units and must remain within the following tolerances.

- (1) Front Track – As measured between the wheel centerline – 164 cm

- (2) Rear Track – as measured between wheel centerline- 147 cm
- (3) Wheelbase – 257 cm
- (4) Maximum Total Length – 436 cm
- (5) Maximum Width – as measured at the outer wheel rim – 180cm

2.2.4: Wings & Wickers

4.1 Both front and rear wings must be run at all events in the locations and configuration determined by the chassis manufacturer.

The only approved aero configurations are:

- Front nose Assembly: ADP08-4008
- Front Wing Assembly: ADP08-45001
- Rear Wing Assembly: ADP08-47001

4.2 Wickers may only be added to the trailing edge of the front flaps and the center of the rear diffuser. All front flap wickers must measure 0.500 inches tall and the diffuser wickers must be a maximum 3.0 cm inches tall (measured as total height) and fastened 90 degrees to the mounting surface. The rear vertical face of the wickers must be positioned on the trailing edge. All wickers are optional.

4.3 Permitted Wing Dimensions

4.3.1 All dimensions are measured in inches and must remain within the following tolerances:

4.3.1.1 Front wing mainplane angle:

+7.2° +/- 0.5 degree. Shims are permitted. The maximum shim thickness is .120 inches.

4.3.1.2 Front wing flaps may be adjusted within the range provided. Front flap mounting brackets must be fastened to the upper side of the flaps.

4.3.1.3 Overall width of the Front wing assembly is: 1325 mm, minimum chord length of mainplane is 245 mm, and minimum chord length of flaps is 225 mm.

4.3.1.4 Cars may be fitted with a 4 mm thick replaceable jabrock plank (skid) on the end plate foot.

4.3.1.5 The Rear mainplane elements are fixed.

4.3.1.6 The Rear wing flap may be adjusted within the range provided. Captive nuts (nut plates) on end flanges of Rear wing flaps are permitted. Captive nuts must be positioned in accordance with the original holes and must maintain original fastener sizing.

4.3.1.7 The slot gap between the rear wing upper flap and the second element must measure 0.312 – 0.437 inches.

4.3.1.8 Rear wing Flap Separator (P/N 01-B-2005) as supplied by Carl Haus Auto or SERIES approved supplier may be used as supplied.

4.3.1.9 Overall width of the Rear mainplane including endplates is a maximum 93 – 91.7 cm.

4.3.1.10 Rear wing setback as measured from the forward most face of the mounting clevis (DP08-20-/022RH) to the forward most edge of the lower wing element is 457 mm +/- 5.0 mm

4.3.1.11 The leading edge of any Rear wing component must be rearward of a vertical plane tangent to the rearward most point of the Rear tire.

4.3.1.12 Stabilizer stays are permitted and must be installed according to TB012.

4.3.1.13 The Minimum height of the uppermost rear airfoil is 75 cm.

4.3.1.14 The Rear wing fence angle as measured on the trailing vertical edge of the end fence must be 90 degrees +/- 1.0 degree.

2.2.5: Underwing/Underfloor

5.1 The Rear diffuser must be utilized at all Events in the location and configuration determined by the chassis manufacturer. The only approved diffuser is ADP08-40-030.

5.2 Cars must incorporate a floor, extending from the front bulkhead to the main roll hoop bulkhead with a maximum deviation of 5 mm. Openings are not permitted. This floor must also form the interior floor of the cockpit. Removable heel rests and equipment covers are permitted, subject to approval from the Technical Director. Material is free but must retain the original component silhouette.

5.3 The floor must lie on a single plane. Designs which do not meet the spirit of the "flat bottom" will not be permitted.

5.4 The area of the floor is measured from rearward of the vertical plane tangent to the rear of the front tire and to the fore of the vertical plane tangent to the fore of the rear tires.

5.5 Cars must be fitted with a 4 mm (-1.5 mm Tolerance) thick replaceable jabrock plank (skid) measuring a minimum 30 cm and a maximum 40 cm rearward from the front of the forward bulkhead.

5.6 It is permitted to install a 4 mm (-1.5 tolerance) jabrock panel to the underside of the side pods. The panel may only be one piece per side without holes and cover the entire underside of the side pod. Fasteners must not be less than six inches on center.

5.7 Surface contact (bottoming) blocks on the chassis must be installed with fasteners recessed about the bottom reference plane. Blocks must be non-deformable material and must not produce sparks or cause particles to be directed toward other cars.

5.8 Blocks must be mounted in two planes in the following locations:

- 1) Maximum of six blocks parallel to the longitudinal centerline of the chassis and not less than 6.0 inches apart. The dimension of each block must not exceed 12.0 inches in length, 1.0 inch wide and 0.5 inches in height from the cars flat bottom.
- 2) Maximum of three blocks perpendicular to the centerline of the chassis, not exceeding the chassis width at the point of attachment. The dimension of each block must not exceed 2.0 inches in length and 0.25 inches from the cars flat bottom. These blocks may be located in any proximity to the longitudinal blocks.
- 3) Maximum two blocks permitted on the Rear undertray. The dimension of each block must not exceed 1.0 inch in length, 1.5 inches in width and 0.5 inches in height.

2.2.6: Aerodynamics

6.1 Attachments or devices that are moveable or adjustable while the car is in motion and which may affect airflow are not permitted.

6.2 Maximum height of any device is 962 mm as measured from the ground as raced.

6.3 Only the 2010 Van Diemen Aero Package is permitted. Components must be used as delivered. Subject to BOM and part number.

2.2.7: Bodywork

7.1 Bodywork must be the as-delivered Van Diemen components bearing the intact seal as applied by the authorized distributor or approved by the Series.

7.2 Fit and finish is permitted provided it does not alter the components internal or external shape in any way.

7.3 Use of composite materials containing carbon and/or aramids (Kevlar) as reinforcement is prohibited except as permitted herein.

7.4 It is permitted to modify the engine cover in accordance with the description as posted in Competitor Bulletin 11-04.

7.5 It is permitted to fasten or bond the damper cover and dashboard cover into a single component. The fastening of the combined components must be accomplished by using the fastening method of the two individual parts or the addition of two (2) camlocs at the rear of the combined component.

7.6 No sprung part of the bodywork is permitted below the plane of the lower surface of the underfloor.

7.7 Stress bearing devices, including but not limited to body panels and engine compartment stiffening kits are prohibited.

7.8 Van Diemen nosebox crush structure (DP08-40-026) is required, or similar as approved by the SERIES.

7.9 Van Diemen side intrusion panels (DP08-40-039/040) are required.

7.10 Maximum height of the bodywork is 724 cm, as measured from the bottom of the chassis reference plane.

7.11 Maximum Rear overhang including Rear airfoils and endplates is 805 mm, as measured from the Rear wheel axis.

7.12 Maximum Front overhang including airfoils and endplates is 955 mm, as measured from the Front wheel axis.

7.13 Maximum width of bodywork behind the front wheel is 94 cm.

7.14 Minimum lateral cockpit bodywork opening is 45 cm.

7.15 Maximum longitudinal cockpit bodywork opening is 30 cm.

7.16 Maximum longitudinal cockpit opening is 83 cm (measured without the head surround).

2.2.8: Bodywork Repairs

8.1 All repairs must conform to the Manufacturers original design criteria including weight.

8.2 Repairs to other remaining body components not listed above may be performed by Teams or by alternate repair companies provided the original shape and design is maintained.

8.3 Remanufacturing of any component around the RFID tag is not permitted. Completely re- skinning or manufacturing a new part from a mold is not permitted.

2.2.9: Fasteners

9.1 All fasteners must be used and remain in the locations as delivered.

9.2 Fasteners, washers, nuts, spacers, rod-ends, bearings, spherical bearings, electrical wiring, switches, fittings and hoses are free, provided they are commercially available and the dimensions, grade material and installation remain as originally fitted unless otherwise specified herein.

9.3 Cables of alternate source are permitted provided they are of similar specification and weight to the original supplied components and are routed through existing holes.

9.4 In all cases titanium and ceramic are prohibited materials.

9.5 Replacement bearings must retain the same number of balls as originally manufactured and the outer seals remain in place.

2.2.10: Radiators/Coolers

10.1 Only the approved radiators and intercooler as supplied may be used without modification. Water and oil pipes must remain as supplied except for fitment related issues. Bungs for heaters or bleed fittings may be welded to the inlet and outlet pipes. Such items are not permitted on the radiator or components supplied by the engine manufacturer.

10.2 Glycol based additives or coolants are prohibited.

2.2.11: Cockpit

11.1 Cockpit regulations are intended for the best interests of the driver's safety, comfort and posture. These must be adhered to in the fullest. Minor changes in the cockpit configuration in order to accommodate driver comfort and operation of the Car controls is permitted with approval from the Technical Director.

11.2 Steering wheels must be fitted with a quick disconnect device. Both the steering wheel and the quick disconnect device are free.

2.2.12: Headrests

12.1 Headrests must be used as supplied (DP08-40-029 or otherwise approved by the SERIES) and may not be painted, filled or finished with any products except for decals.

12.2 All headrests must be inspected and approved by the SERIES before use.

12.3 Headrests must be attached by the chassis Manufacturer supplied mechanism. The headrest must be in place during the technical inspection process and during all on-track activity.

12.4 Additional side padding if used, must not exceed the height of the headrest as viewed from the side. Rear padding must not exceed the height or width of the headrest as viewed from the front. All additional padding must be contained in the headrest dimensions as viewed in plan view.

12.5 Additional padding must be removable independent of each other and without the use of tools. All padding must be manufactured completely of foam although each piece may have a single layer Kevlar backing to assist in the mounting provided that it remains flexible and does not interfere with the original function of the as delivered headrest.

12.6 Any covering used on the additional padding must remain flexible and be approved by the Series. Additional padding may not be taped along any surface. All additional pads and coverings must be inspected and approved by the SERIES before use.

2.2.13: Mirrors

13.1 Mirrors must be used as supplied by the chassis manufacturer. The minimum glass dimension is 6.50 square inches.

2.2.14: Electronics

14.1 Any modification to the main wiring harness or the engine control unit (ECU) must be approved in writing by the Technical Director.

14.2 ECU's are under control of Formula Race Promotions (the SERIES), mapped and sealed by the engine supplier. Tampering of ECU's is not permitted.

14.3 Data systems are permitted and must only include the following sensors:

- Engine RPM
- Front Wheel speed (one per side)
- Throttle Position
- Steering Input
- Longitudinal, Lateral and Vertical G-loads
- Water Temperature
- Engine Oil Temperature
- Engine Oil Pressure
- Exhaust Gas Temperature
- Gearbox Oil Pressure
- Gearbox Oil Temperature
- Brake Fluid Pressure
- Fuel Pressure
- Battery Voltage
- Gear Position
- Suspension Travel (4)

14.4 Data systems must have a separate wiring harness with visible wire traceability.

14.5 It is permitted to fit a hydraulic signal damper to the Car to dampen the fuel and oil pressure signals to the data system. The installation must be approved in writing by the Technical Director.

2.2.15: Suspension

15.1 All suspension as provided by the chassis manufacturer must be used within the range of adjustment provided and without modification. Components must bear the intact approved seal applied by the authorized Van Diemen distributor.

15.2 Rod ends on suspension and steering components must be retained by either the design of the mounting brackets or by the later area captive washer or by inherent mechanical design of the unit.

15.3 Threaded fittings, as installed, must have a 2X diameter thread engagement inside the suspension component.

15.4 Roll centers and suspension geometry are only adjustable via the rod ends attached to the control arms. Any attempt to alter any pickup location using shims, spacers, washers or any other method is prohibited.

15.5 Suspension bushings (hats, spacers) for dampers, push-rods, anti-roll bars and bell cranks must remain without modification, with the exception of surfacing the outer face for the fitting into each specific location.

15.6 Suspension must not be offset. Track must be equally disposed to the longitudinal centerline of the chassis within a tolerance of +/- .250 inch.

15.7 Ride control – the use of front and rear ride control (example – 3rd springs, dampers) systems are not permitted.

15.8 Anti-Roll Bars and Blades– Only Van Diemen roll bars with standard drop links permitted. The following are permitted for use:

- Front diameter: 0.625 or 0.875 inches
- Rear Diameter: 0.500 inches

15.9 Rockers – Rockers must be run as supplied by chassis Manufacturer without modification, except to add nut-plates, and this modification is to add no other purpose.

15.10 Steering – The rack must be used as supplied by the chassis Manufacturer except:

- The rack bar and pinions may be de-burred, shot peened or polished.
- A 0.125" diameter hole may be drilled for purposes of installing an alignment pin.

15.11 Uprights – Uprights must be used as specified by the chassis Manufacturer.

2.2.16: Brakes and Ducts

16.1 Performance Friction is the only approved supplier for calipers (including seals & pistons) rotors and pads.

16.2 Brake Rotors must be used as supplied and have the USF2000 markings intact.

16.3 Brake calipers must be used as supplied, including seals. Any devices designed to push or pull back pistons (other than knock back springs) are not permitted. Caliper seals must be used as supplied by PFC without modification.

16.4 Brake pads must be used as supplied, PFC part number 7832.11.14.54 (11 Compound) or 7832.08.14.54 (08 Compound). Officials may require the use of alternative or specific compounds in specific locations at certain Events. Pads may be siliconed to the piston if desired.

16.5 Master cylinders are a team sourced option.

16.6 Brake fluid is a team sourced option although PFC #0250037/38 is recommended.

2.2.17: Dampers and Springs

- 17.1 The only approved damper is the Dynamics 1640. Dampers must be run without modification as supplied by the Manufacturer.
- 17.2 Dampers are sealed and may only be rebuilt by the Manufacturer or SERIES authorized supplier.
- 17.3 Damper length (center of each eye +/- 2.0 mm. Front=320 mm, Rear=286 mm.
- 17.4 Packers and bump rubbers are not permitted.
- 17.5 Dampers must be externally adjustable only and cannot be adjusted by the driver. Damper canister pressure shall not be less than 50 PSI.
- 17.6 One (1) thrust bearing per spring is permitted.
- 17.7 Only linear rate steel springs are permitted.
- 17.8 Only approved springs may be used, 5 inches long, 2.0 inches ID. The following spring rates are approved: 400, 500, 600, 700, 800, 900 and 1000. All +/- 4%.

2.2.18: Driveshafts & Hubs

- 18.1 Only parts provided by the Chassis Manufacturer are permitted. These must be used as supplied without modification.
- 18.2 Driveshafts are free but must be approved in writing by the Technical Director.

2.2.19: Wheels

- 19.1 Material must be metal. The approved sizes are: Front: 13 X 6 inches, Rear: 13X 8 inches.
- 19.2 Positive type wheel-nut locking devices (pins) are required.
- 19.3 Inner wheel covers are **NOT** permitted.

2.2.20: Minimum Weight

- 20.1 Minimum weight for All Events is 1220 pounds.
- 20.2 The minimum weight shall include all fuel, lubricants, coolants and camera, as raced. Driver weight is included.
- 20.3 All ballast must be securely fastened, approved by Officials.

2.2.21: Fuel & Fuel System

- 21.1 The fuel system must remain as supplied by the chassis manufacturer, with the exception of the fuel pump and filter, which are free.
- 21.2 Plumbing of fuel cell lines is free provided the internal hose diameters are not changed.
- 21.3 The maximum capacity of the fuel cell is 7.0 US gallons.

2.2.22: Exhaust

- 22.1 The exhaust system (ECVD1015S) must be used without modification as homologated by the engine manufacturer. Internal or external coatings or wraps are permitted.

2.2.23: Clutch Assembly

23.1 Tilton is the only approved clutch supplier. Part numbers are:

Cover and Pressure Plate: 66-002-HBF

Twin disc pak w/offset hub: 64185-2-
HJ-30

23.2 The clutch master cylinder is a Team sourced item – the manufacturer is not mandated.

2.2.24: Hoses & Fittings

24.1 Hoses, fittings, nuts and bolts may be individually sourced by teams. Hoses may be replaced with hard lines provided the original internal diameter remains in place.

2.2.25: Gearbox and Differential

25.1 The only gearbox approved for use is the Hewland JL200 5-speed. The gearbox and all internal components are intended to be used as supplied without additions or changes.

25.2 Only seals provided by Hewland are permitted. Low-friction seals are not permitted.

25.3 The two (2) adjacent studs of the gearbox differential cover and of the real selector cover must be drilled to permit fitting of the seals. These holes (maximum 0.050 inch) must be outboard of properly fitted nuts and fit 0.032 inch safety wire.

25.4 Coatings of any kind are not permitted.

25.5 The REM process of gearbox components is permitted. Coatings are not permitted.

25.6 All five (5) speeds must remain in the gearbox during on track activity. Reverse must be operational and the driver must be able to engage it from the cockpit.

25.7 The following ratios may be used in any combination in their designated locations only, unless otherwise specified by Officials:

1st: 15-29

2nd-5th: 17-27, 18-25, 19-23, 24-26

25.8 Differential – The differential must be unmodified nor influenced in any way to limit or change its normal operation. The only permitted ring and pinion is the 12-34. Only the standard steel differential carrier is permitted.

25.9 Accessories – Filters, screens and magnetic plugs are allowed provided they serve no other purposes.

25.10 Bell Housing – The bell housing must be used as designed and supplied without modification.

25.11 The starter motor as supplied by the chassis manufacturer is the only approved system for use.

2.2.26: ENGINE REGULATIONS

26.1 The Mazda MZR 2.0 liter engine as supplied by Elite Engines must be used without any modification. No variation from specifications regarding installation, oil and filters, fuel, or exhaust are allowed. Teams are to follow the operating manual as provided by the Engine Manufacturer.

26.2 The engines alternator and drive belts must always be connected and in working order. Positive terminals must be insulated.

26.3 Spark Plugs – Mazda p/n 0000-18-L3Y1

26.4 Air Box – The air box must not be modified in any way. No material or substance of any kind may be placed / added inside the air box.

The following is permitted:

- (1) The spec Zetek airbox
- (2) Mazda MZR ECVD1021 airbox
- (3) Maximum airbox opening 3.20 X
2.250 inches

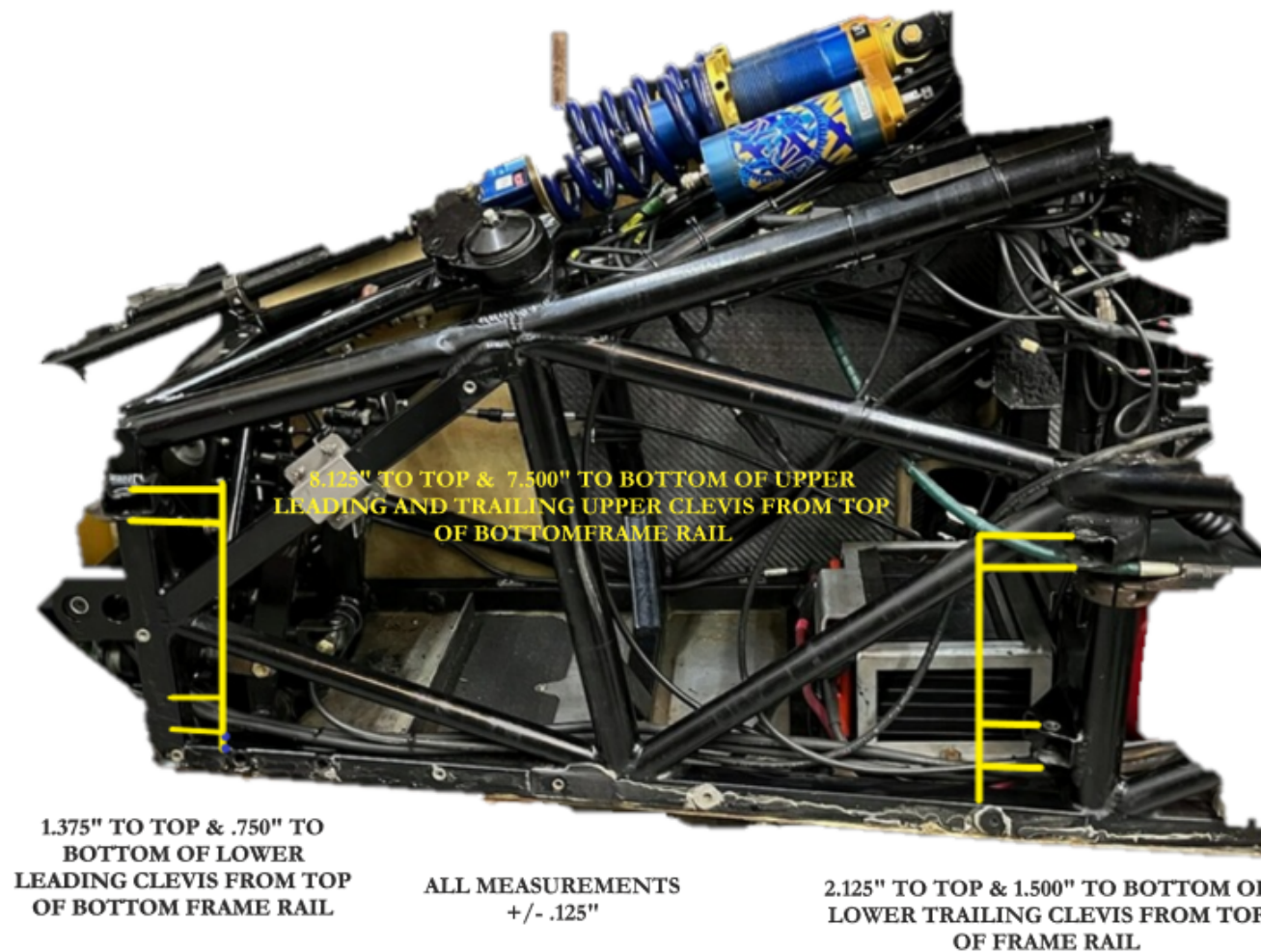
26.5 All air entering the Engine must pass through the air filter and restrictor plate before entering the throttle body.

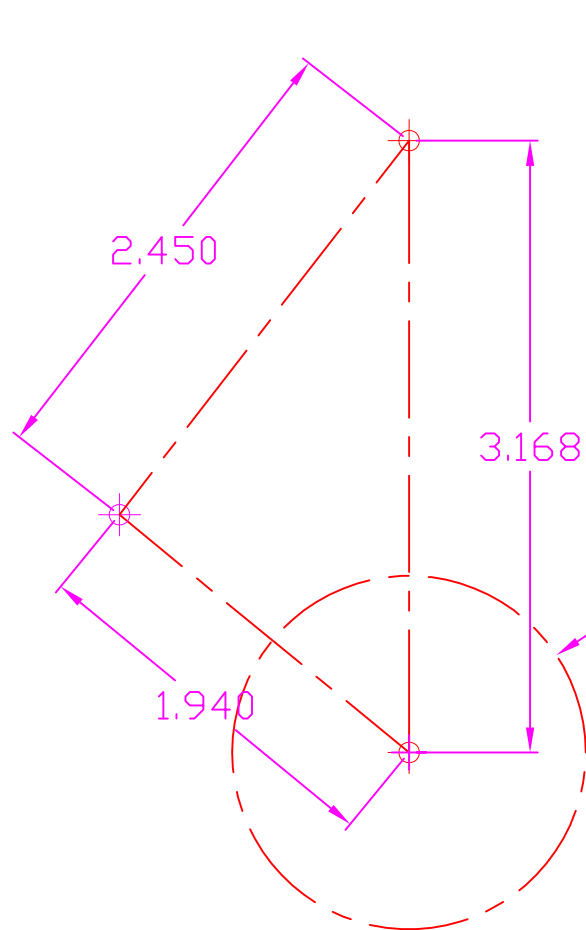
26.1.6 ECU – The ECU is controlled, administered and provided by Elite Engines as approved by the SERIES. Any software changes will take place under the direction of the Technical Director only. Officials may inspect or replace an ECU or ECU map at any time.

26.1.7 Oil Filter - Oil filter brand, size and type are unrestricted, provided filter can be installed as substitute for the original oil filter without modification. In-line oil filters are permitted.

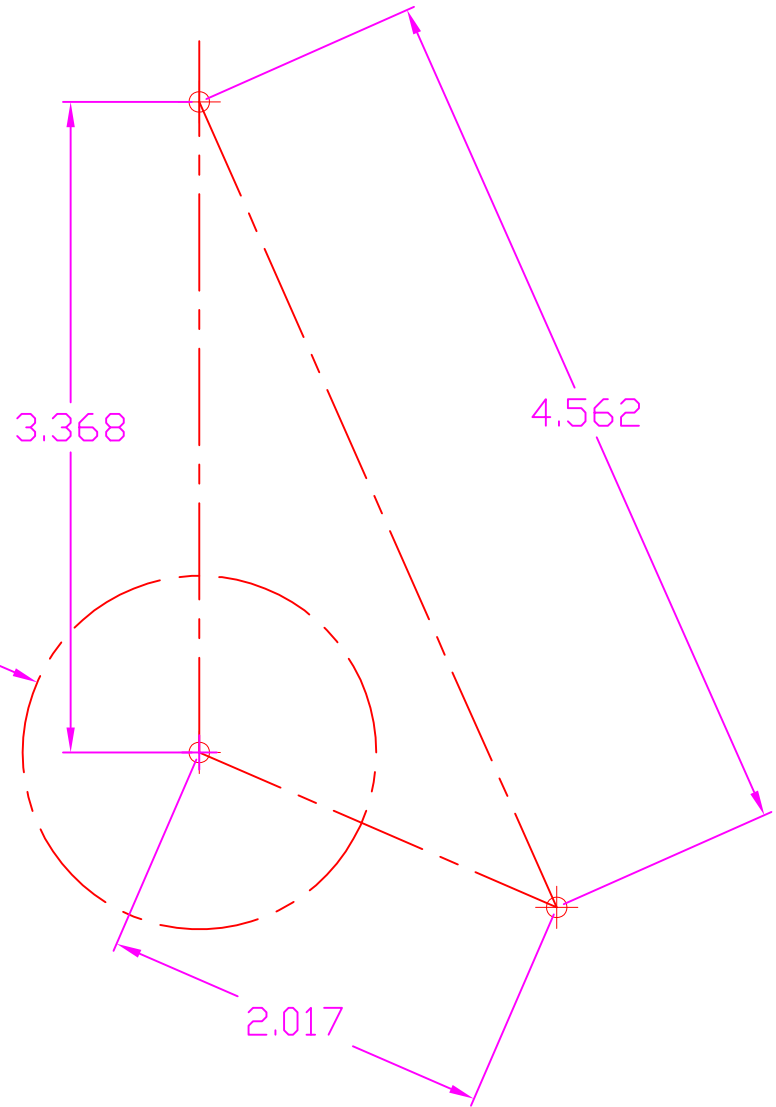
26.1.8 Catch Tanks - Oil catch tanks must be fitted to the Engine, radiator coolant and transmission breathers venting to atmosphere in such a way as to decrease the likelihood of oil spilling on the Track. Minimum capacity is (1) liter.

26.1.9 The Elite Engines restrictor part # is EEMR1.23 and measure 1.230" is required.



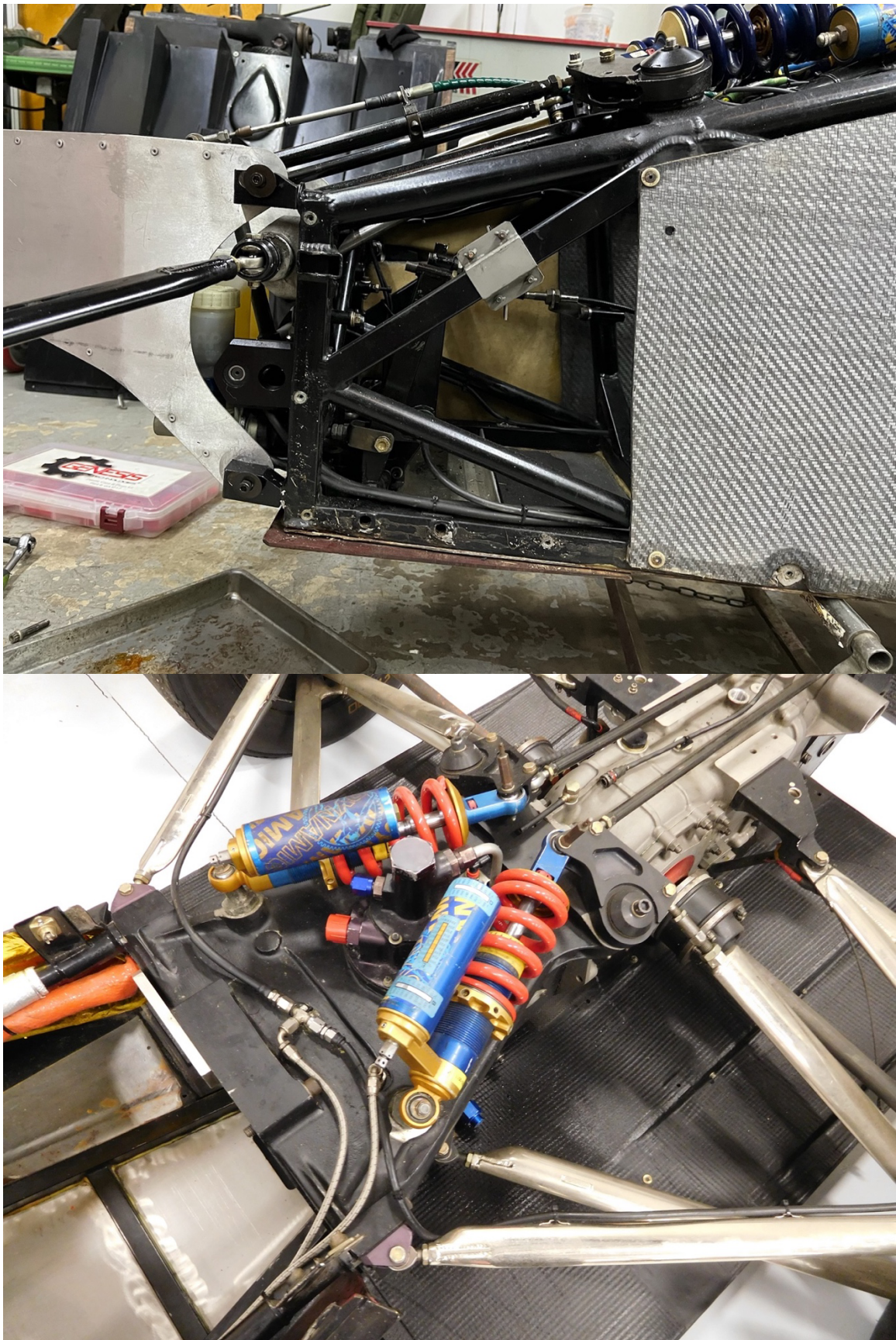


Front Bell Crank

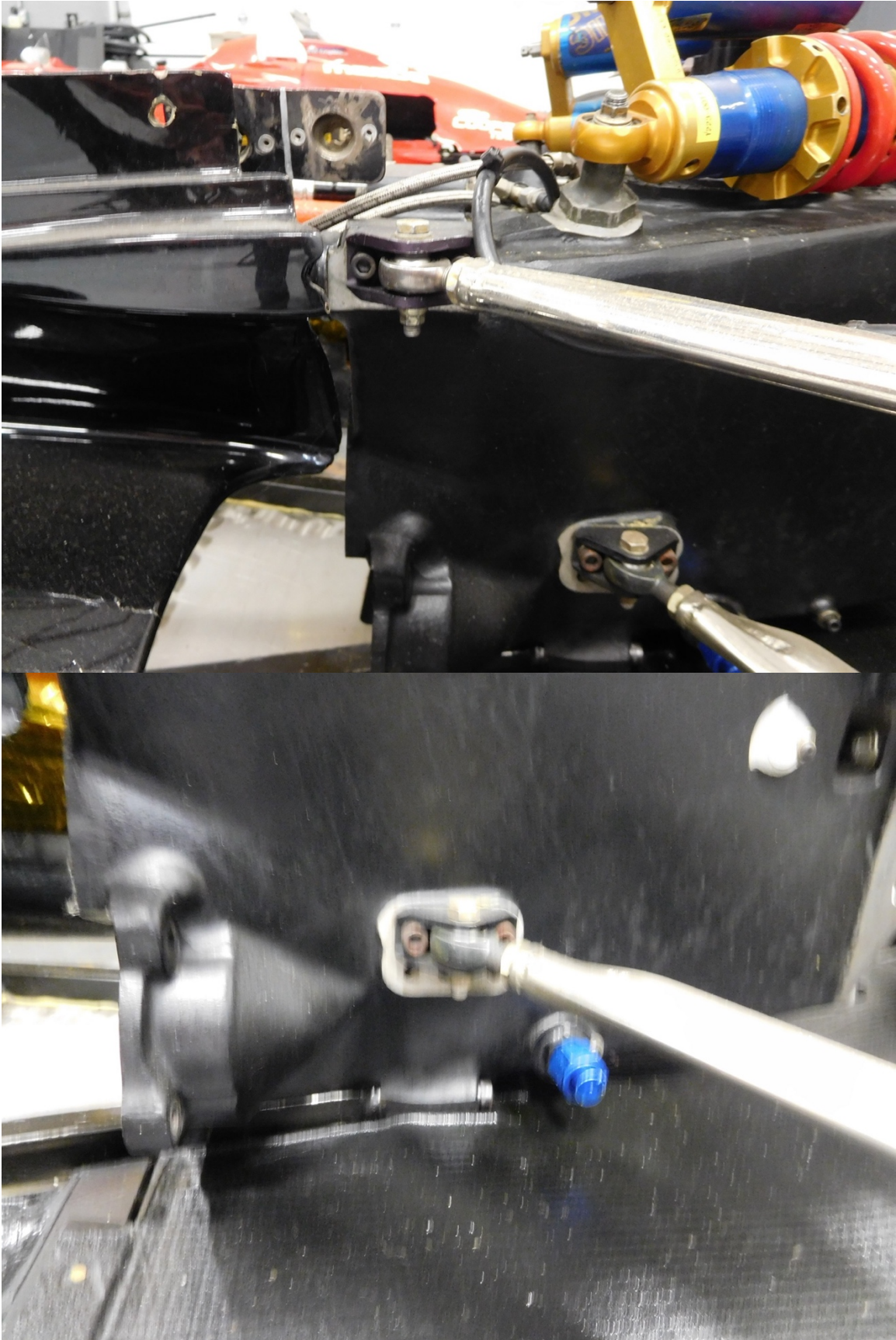


Rear Bell Crank

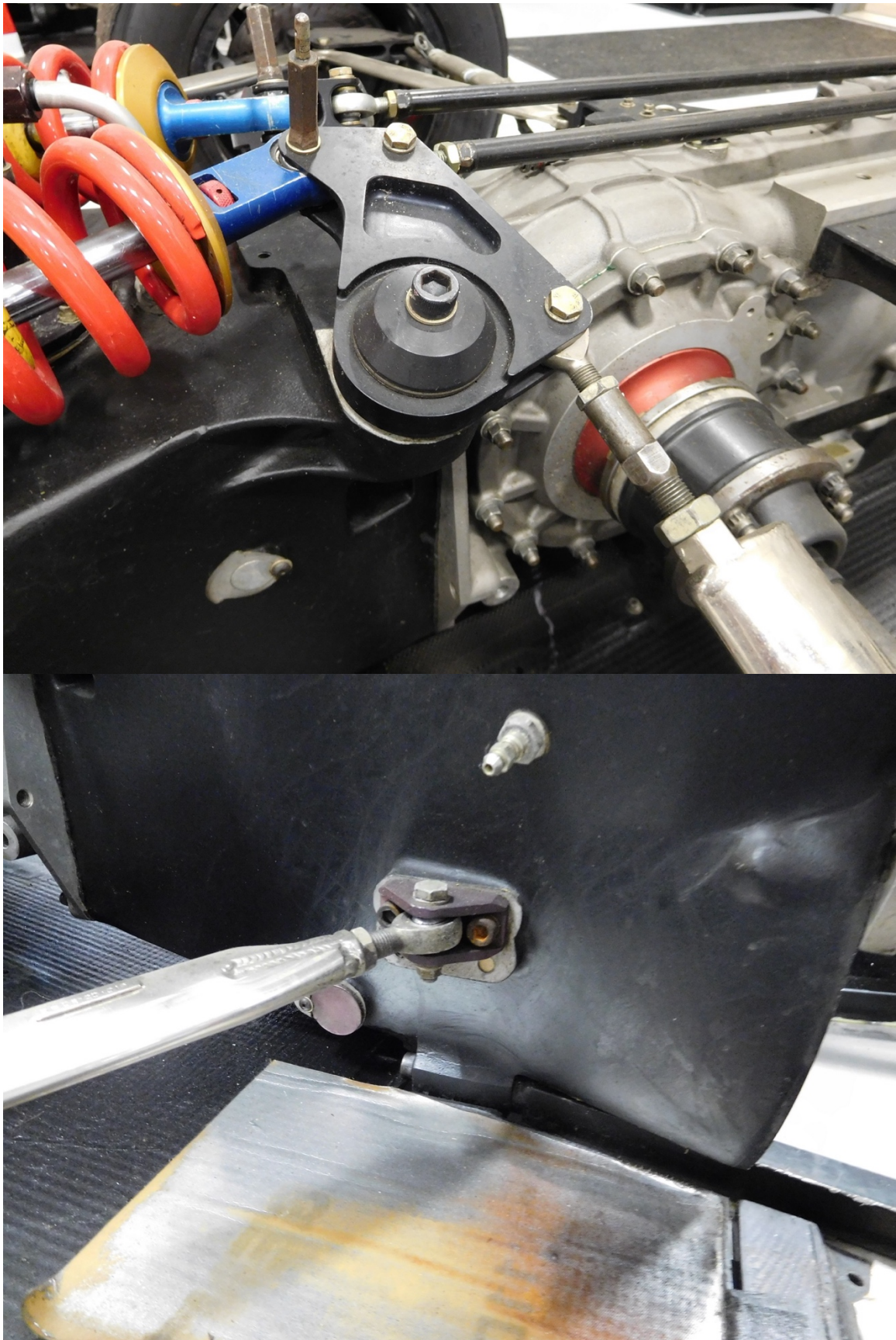
Chassis Illustration Pictures



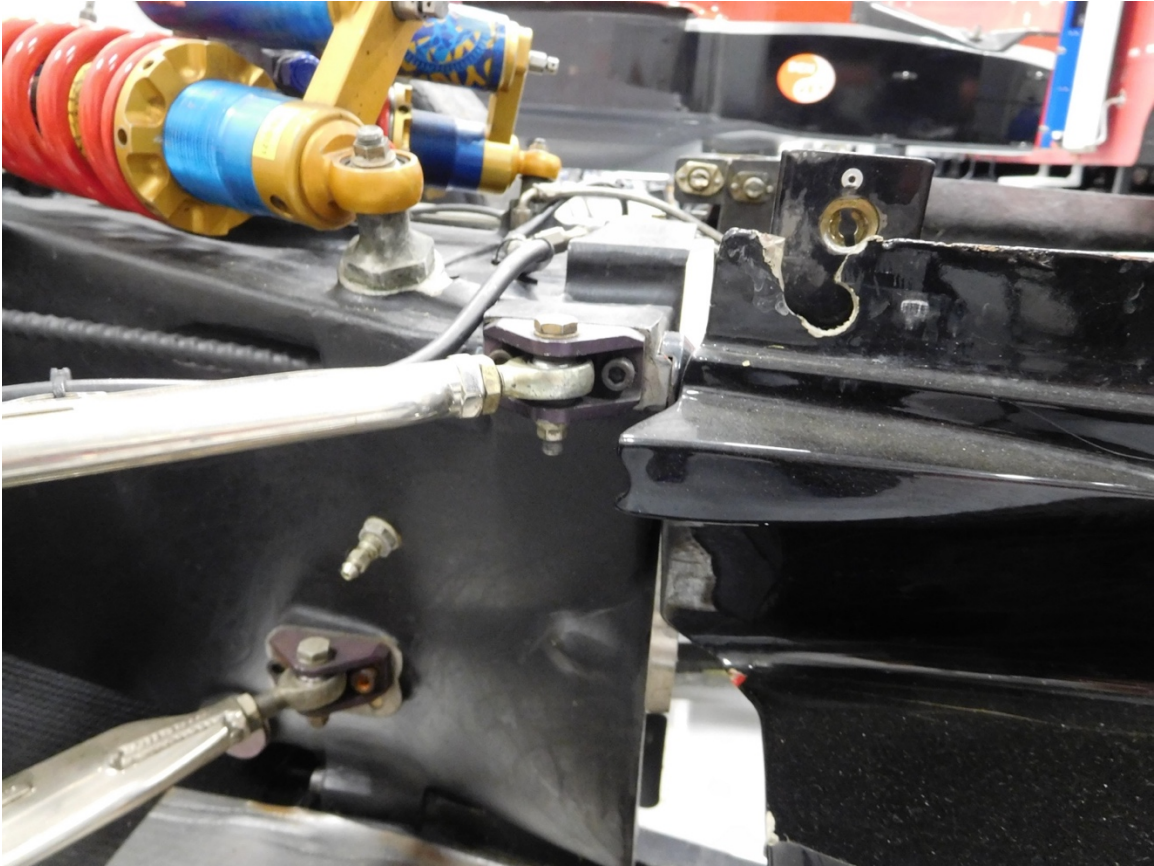
Chassis Illustration Pictures



Chassis Illustration Pictures



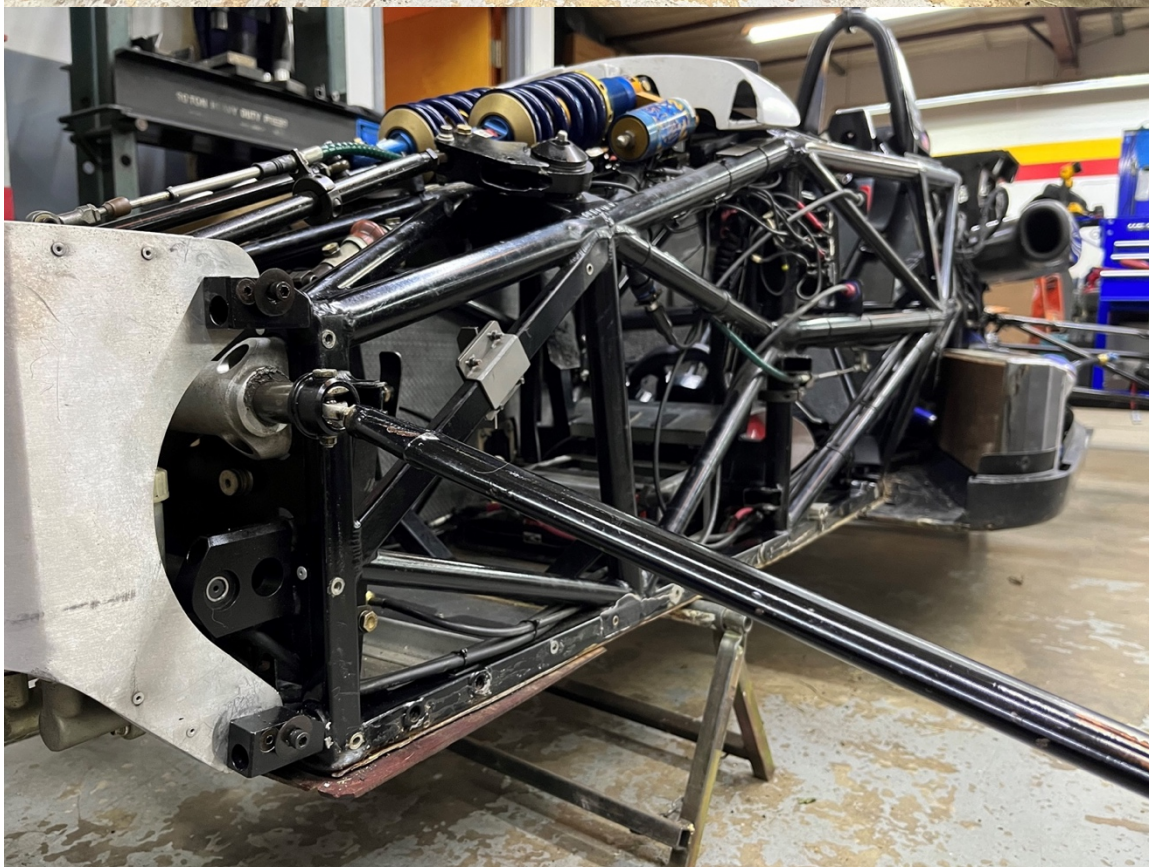
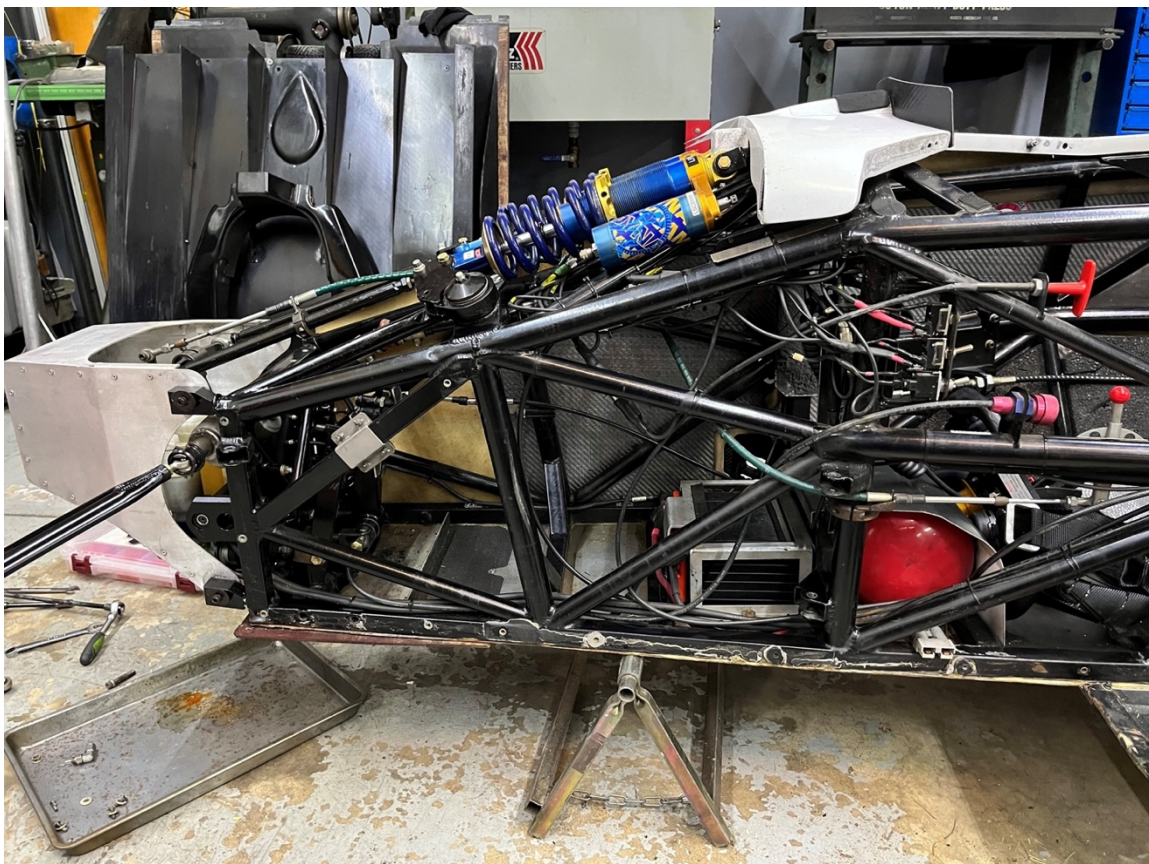
Chassis Illustration Pictures



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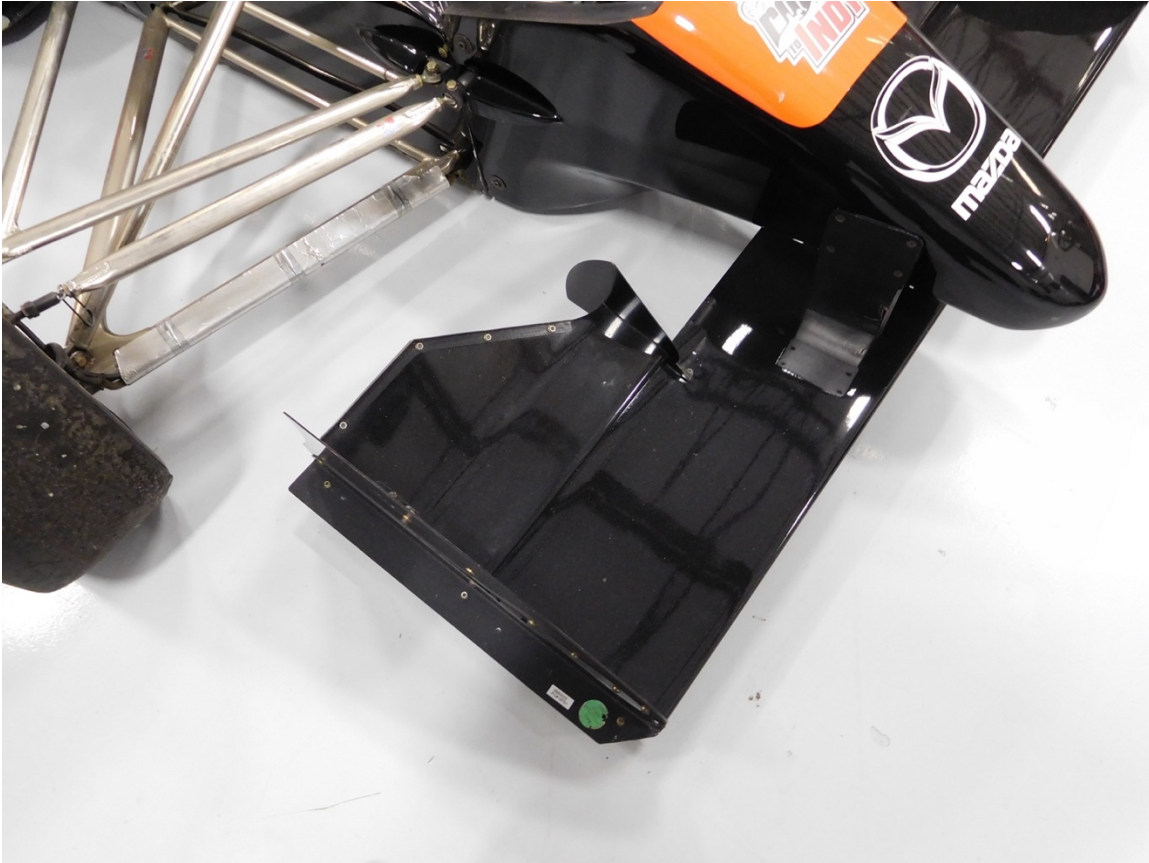
Chassis Illustration Pictures



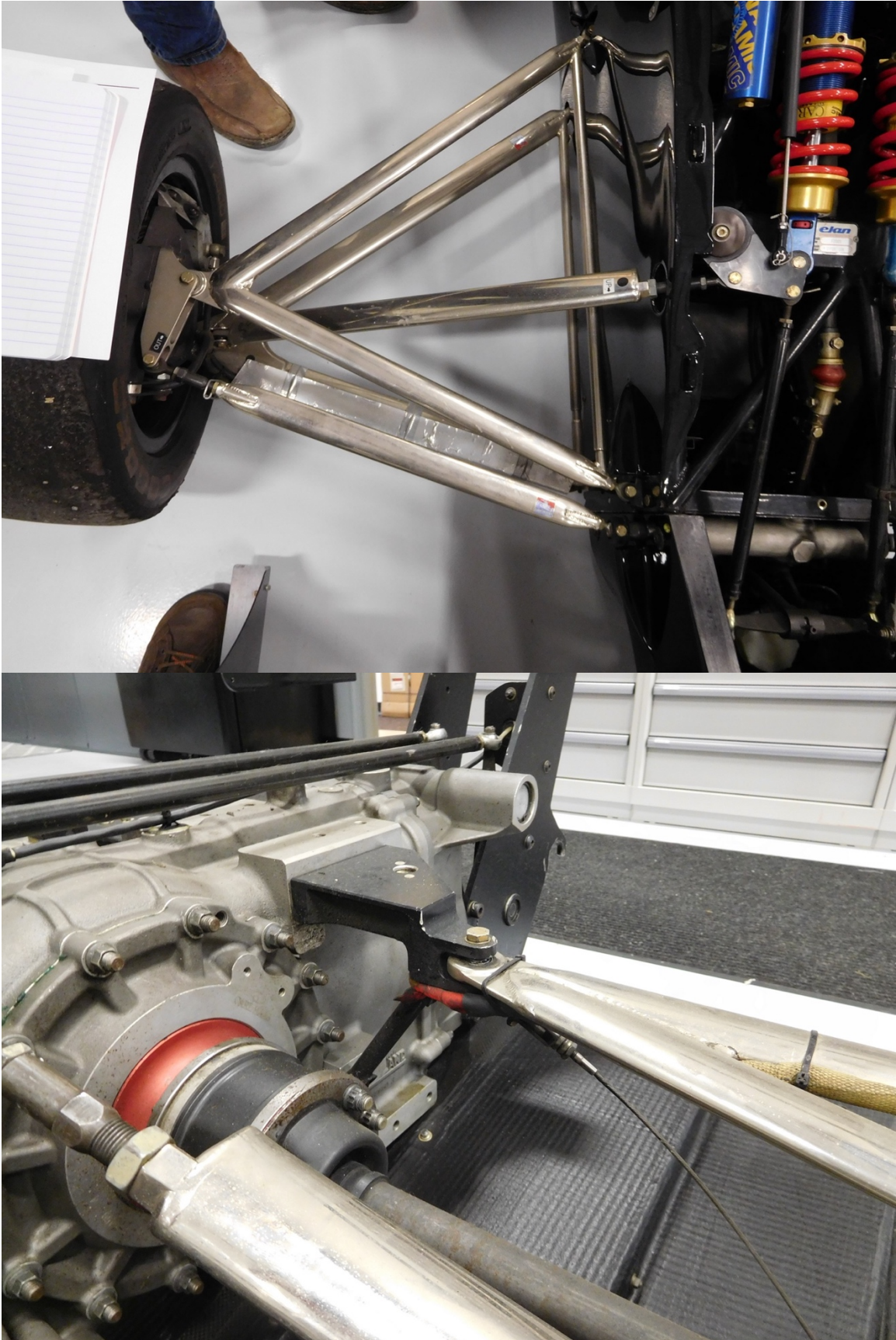
Chassis Illustration Pictures



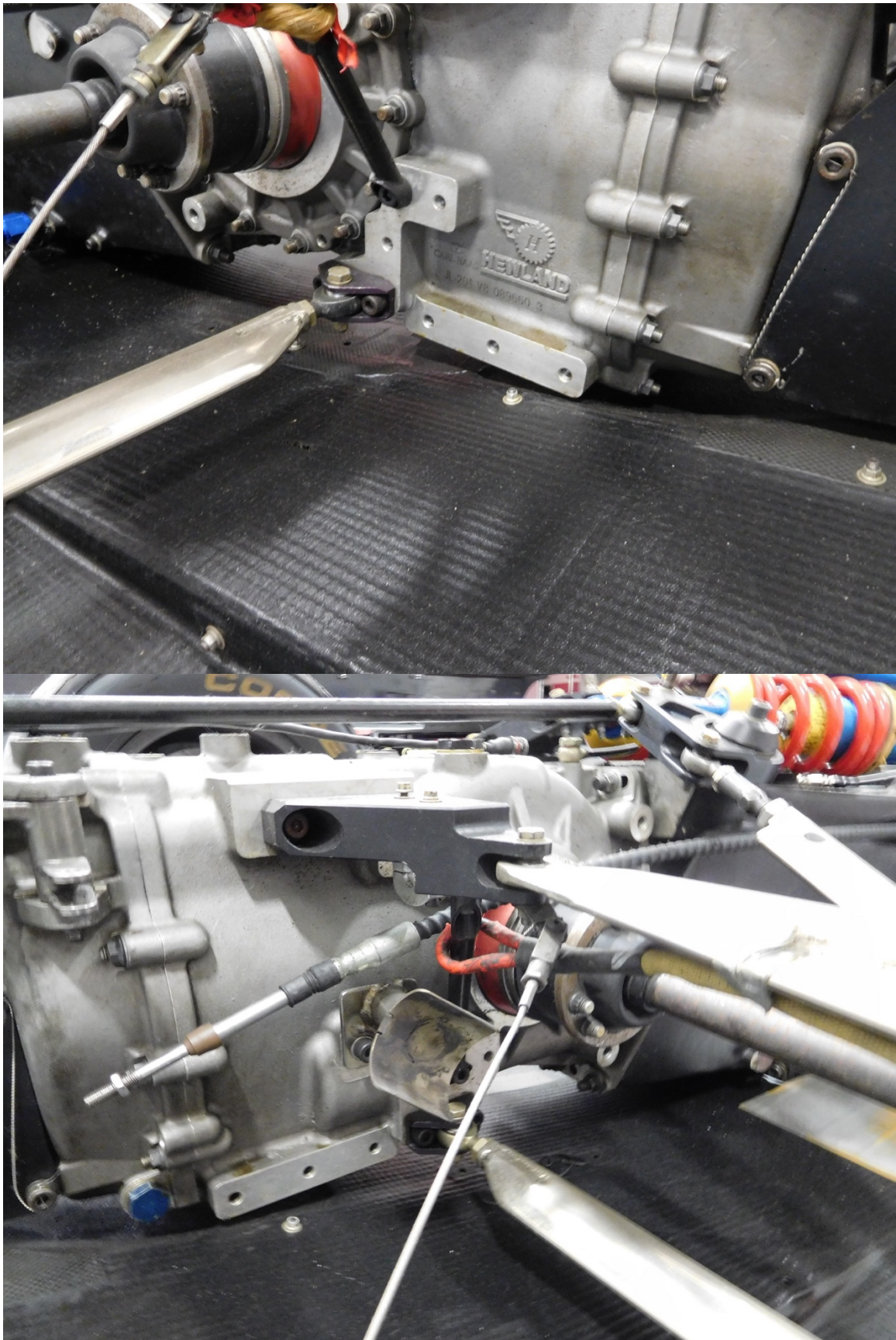
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Chassis Illustration Pictures



Mazda MZR LF-E2 2.0L Engine (USF2000)

Mazda MZR LF-E2 2.0L Engine (USF2000)

a. General

1. No modifications to this engine are permitted except where specifically authorized within these rules. This includes, but is not limited to, all fuel injection and engine management components, electrical, cooling and lubrication systems. All systems are subject to test procedures and must conform to OEM specifications as set forth in the Mazda Factory Service Manual. The appropriate Mazda Factory Service Manual or its equivalent is required to be in the possession of each entrant and readily available in a readable format at all times during an event.
2. Any measurement not specifically defined herein shall conform with the Mazda Factory Service Manual Technical Data (L3).
3. Permitted engine maintenance includes the replacement, but not modification, of external engine and system parts. Overhaul procedures that in the slightest way would increase performance are prohibited.
4. All rubber fluid lines may be replaced with a motorsport type equivalent.
5. No balancing, lightening, polishing, or other modification of moving parts of the engine is permitted.
6. Gaskets and seals are free except for the following:
 - i. Mazda head gasket, as described in Mazda MZR LF-E2 section g. Cylinder Head.
 - ii. O-ring fitted to each intake runner groove, as described Mazda MZR LF-E2 section j. Intake Manifold.
7. For all Mazda part numbers listed in these specifications, superseding part numbers are considered equivalent.

b. Block

1. Mazda block, part number LF9G-10-300, must be used with no modification. Block must be embossed with LF95.
2. All surfaces must remain as machined from Mazda with no modification given the following exceptions:
 - i. Machining the block on the intake side for fitment of the starter motor.
 - ii. Machining around the water pump housing for clearance to the chassis.
 - iii. Removing the stock "rivet type" oil galley plugs and replacing them with pipe plugs.
 - iv. Plugging the hole above the water inlet.
 - v. Removal of the Intake side "loop" on Pan Surface near the front to clear oil sump.

Mazda MZR LF-E2 2.0L Engine (USF2000)

vi. Machining of the exhaust side of the block at the bellhousing face for clearance to the shift rod/cable.

3. Minimum block height is 11.920 inches.

4. Maximum compression ratio is 10.8:1.

5. Cylinder bore shall be no larger than 3.4484 inches as measured 1.500 inches below the deck. The maximum bore is intended to allow for cylinder wear only; cylinders should not be honed to this maximum dimension.

6. Block must use the stock block girdle and main bolts as supplied by Mazda with no modification.

c. Crankshaft

1. Mazda crankshaft, part number LF01-11-301A or LF02-11-301, must be used with no modification, balancing, or lightening, except as is permitted herein for fitment of undersized bearings.

i. Minimum weight: 31.75 lbs without hardware.

ii. Maximum stroke at the piston: 3.272 inches.

2. Mazda or OE equivalent bearings must be used with no modification from within the standard range as allowed in the Mazda Factory Service Manual.

3. Crankshaft dimensions shall conform with the Mazda Factory Service Manual Technical Data (L3).

4. Crankshaft main and rod journals may be polished as part of the normal rebuild process.

5. Mazda L501-11-316A or L501-11-316B crank timing gear must be used with no modification.

6. Both crankshaft timing gear friction washers must be installed, part number L3H5-11-407.

7. A flywheel dowel may be installed.

8. Elite crank trigger wheel, part number 050105, must be used with no modification and positioned as described in the Mazda Factory Service Manual when timing the engine.

9. Elite auxiliary drive pulley, part number 050106, must be used with no modification.

10. Mazda crank bolt, part number LF01-11-406, must be used with no modification.

d. Connecting Rods

1. Mazda connecting rod, part number LF9G-11-210 , must be used with no modification.

2. Minimum weight: 528 g with cap and stock Mazda rod bolts.

3. Maximum length center to center: 5.761 inches.

4. Rod dimensions shall conform with the Mazda Factory Service Manual Technical Data (L3).

Mazda MZR LF-E2 2.0L Engine (USF2000)

e. Pistons

1. Mazda piston, part number L3Y2-11-SHO or LFY0-11-SA0A , must be used with no modification.
2. Piston dimensions shall conform with the Mazda Factory Service Manual Technical Data (L3).
3. Maximum piston diameter: 3.4454 inches as measured at a point 0.410 inch from the bottom of the skirt.
4. Maximum distance from centerline of wrist pin to crown: 1.120 inches.
5. Maximum overall height from skirt to crown edge: 2.012 inches.
6. Ring groove widths: 0.0505 inches Top; 0.055 inches Second; 0.1005 inches Oil.
7. Minimum weight of bare piston: 288 g.
8. Minimum weight of piston pin: 82 g.
9. Piston pin dimensions shall conform with the Mazda Factory Service Manual Technical Data (L3).
10. Combined minimum weight of piston, pin, and connecting rod with bolts: 898 g.

f. Piston Rings

1. Mazda piston rings, part number LFY1-11-SC0A, must be used with no modification.
2. End gaps may not be altered.
3. All rings must be installed in their factory locations, including the oil scraper assembly.
4. Rings shall not be relieved of tension.

g. Cylinder Head

1. Mazda cylinder head, part number LF9G-10-090a (2009) must be used with no modification.
2. All surfaces must remain as machined from Mazda with no modification, give the following exceptions:
 - i. The oil galley feed hole from the timing chain tensioner must be plugged at the deck surface of the cylinder head.
 - ii. The stock "rivet type" oil galley plugs may be replaced with pipe plugs.
 - iii. The EGR circuit from the exhaust shall be plugged.
 - iv. The #1 intake cam cap oil supply holes to and from the variable valve timing solenoid shall be plugged.

Mazda MZR LF-E2 2.0L Engine (USF2000)

3. The cylinder head deck surface may be resurfaced. The minimum cylinder head thickness is 4.875 inches.
4. Ports may not be altered in any way and must have their original cast finish.
5. An oiling hole must be drilled in the number 1 intake cam journal down to the oil galley below. The drill size shall be no larger than 3/32 inch.
6. A chain oiling hole may be drilled into the front oil galley.
7. Head dimensions shall conform with the Mazda Factory Service Manual Technical Data (L3).
8. Mazda head gasket, part number L3G2-10-271A, must be used with no modification.
9. Mazda cylinder head bolts, part number LF01-10-135, must be used with no modification.

h. Camshafts

1. Mazda camshafts, part numbers L3E3-12-420 (intake) and LF17-12-441 (exhaust), must be used with no modification.
2. Mazda camshafts sprockets, part number LF94-12-4X0B (intake) and LF94-12-42YA (exhaust), must be used with no modification.
3. Both camshafts must have camshaft friction washers installed, part number L3K9-12-429. Stock camshaft bolts must be used, part number LF17-12-428.
4. Intake variable cam timing must be locked using Elite intake cam lockout, part number 059905.
5. Exhaust camshaft function must remain unaltered.
6. Timing chain crank sprocket, tensioner, and cover must be installed in accordance with the Mazda Factory Service Manual. These must be the stock unmodified components. The bottom of the timing cover may be relieved to clear the oil pan.

i.6

8. Cam lobe heights: 42.44 mm/1.671 inches (intake) and 41.18 mm/1.621 inches (exhaust).
9. Cam journal: 24.96-24.98 mm/0.9827-0.9834 inch.
10. Camshaft profile and lobe centers shall be checked using the official procedure published by the SCCA.
11. Mazda valve tappet, part numbers LF01-12-542 through LF01-12-578, must be used with no modification.

i. Valves

1. Mazda Valves, part numbers LF01-12-111 (intake) and LF02-12-121F (exhaust), must be used.
2. Valve, valve seat, and valve guide dimensions shall be within the specifications set forth in the Mazda Factory Service Manual Technical Data (L3).

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3. Valve location or angle must not be modified.
4. Reshaping of valves is strictly prohibited. The valve may be refaced but must be at a 45-degree angle only. No polishing or back cut angles are allowed.
5. Valve guides may be replaced provided that the position of the valve is not changed, and the replacements are Mazda guides, part number LFY1-10-281, which must be used with no modification.
6. It is permitted to replace or re-cut the valve seats provided the valve seat angles remain as per the Mazda Factory Service Manual Technical Data (L3). The valve seat must be of a ferrous material. Intake valve seat angles must be 35°, 45°, and 70°; the 45° seat must be a minimum 0.048 inch wide. Exhaust valve seat angles must be 30°, 45°, and 65°; the 45° seat must be a minimum of 0.048 inch wide.
7. Mazda valve stem seals, part number LF01-10-1F5, must be used without modification.
8. Mazda valve springs, part number LF50-12-125A (intake and exhaust) must be used without modification. Valve springs shall not exceed 112 lbs at a height of 1.094 inches.
9. Mazda valve spring retainers, part number LF01-12-113, must be used without modification.
10. Valve spring shims are not permitted.
11. Mazda valve spring locks, part number LF01-12-114, must be used with no modification.

j. Intake Manifold

1. Elite intake USF2000 manifold, part number EEM2015, must be used with no modification.
2. A continuous O-ring of cross-section of 0.100 inch must be fitted to each intake runner groove between the intake manifold and the head, which is to ensure that no air by-passes the O-ring seal or the required flat plate restrictor.
3. A single flat plate air inlet restrictor, Elite part number EEMR 1.23, must be used without modification. It shall have four round holes measuring 1.230 inches, each of which shall be on the centerline of the intake manifold. The air inlet restrictor shall be mounted against the intake manifold. All air entering the engine must pass through the restrictor.
4. Mazda fuel injectors, part number L3Y2-13-250 or L3G5-13-250, or Bosch fuel injector, part number 0 280 155 868, must be used without modification.
5. The fuel rail, attached fuel pressure regulator, and fuel rail brackets as supplied by Elite must be used with no modification.
6. No insulation, coating, or treatment of the intake manifold is permitted.
7. Air inlet trumpets must be used as supplied with no modification. No chokes or other devices (*other than the single flat plate restrictor*) may be inserted upstream or downstream of the trumpet.

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8. Elite air box, part number MZR ECVD 1021, (maximum air inlet opening 3.20 x 2.25 inches) or Quicksilver Zetec air box are permitted without modification.

- i. Air boxes must have an operable bleed tube with a minimum inner diameter of 0.430 inch installed at the rear.
- ii. Air box must be used with the K&N style filter without modification.
- iii. No foreign objects or substances may be placed inside of the air box.
- iv. The air temp sensor hole in the Elite air box must be plugged if the sensor is not present.

k. Lubrication System

1. Elite oil pump, part number 059910 must be used with no modification.

- i. Pump shall have 2 scavenge rotors and 1 pressure rotor.
- ii. Scavenge rotor maximum length: 1.375 inches.
- iii. Scavenge rotor maximum outside diameter: 1.600 inches.
- iv. Pressure rotor minimum length: 0.860 inches.
- v. Pressure rotor maximum outside diameter: 1.600 inches
- iv. Auxiliary belt drive must be as supplied by Elite with no modification. Elite oil pump pulley part number 002401.
- v. Hoses/plumbing/filters are unrestricted.

2. Elite oil pan, part number 051801, must be used without modification.

- ii. No device in the oil pan may be contoured to the crankshaft assembly to function as an oil scraper.

3. Elite oil filter housing, part number 050004, must be used with no modification.

l. Cooling System

1. The original Mazda water pump must be used with an Elite water pump impeller, part number 051403B, with no modification.

2. Elite water pump pulley, part number 051402, must be used with no modification.

3. Electronic water pumps are prohibited.

4. Water pump drive must be used as supplied by Elite with no modification.

5. Hoses/plumbing/thermostat are unrestricted.

6. Radiators must be of traditional manufacture but are otherwise unrestricted.

7. Oil coolers are unrestricted.

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8. Cooling fans are prohibited.
9. Radiator caps are free.
10. Elite thermostat housing/coil mount, part number ECVD1011, must be used with no modification.
11. Elite swirl pot, part number ECVD1013, must be used with no modification.

m. Electrical Equipment

1. Either the Pectel T2 ECU or the Performance Electronics PE3-8400 may be used. Only one (1) ECU is permitted. Cars that utilize the Pectel T2 must have an accessible and operable communications port (stereo jack) for the ECU. Cars utilizing the Performance Electronics must have an accessible and operable ethernet communications port.
2. The SCCA approved MAP or Tune File as found at <https://www.scca.com/pages/technicalforms-and-downloads> must be installed in the ECU at all times. SCCA Officials may require the car to be turned off at the master switch or other points to “cycle” the ECU at any time.
3. Ford OEM coil P/N 988Z12029A or any other single OEM type replacement coil is allowed.
4. Spark plug wires are free.
5. Ignition/crank sensor must remain in its original position as supplied by Elite Engines.
 - i. Elite crank position sensor bracket, part number 059903, must be used with no modification.
6. Mazda spark plug, part number LFJR-18-110, or a direct equivalent that is dimensionally the same must be used.
7. Elite generator, part number 052301, and rectifier, part number 052302, or a direct equivalent for the rectifier, must be installed, connected, and operable at all times with no modification.
8. The starter motor must be attached to the block in its original location using Elite starter nose bracket, part number 179912. Tilton starter, part number 54-5110, or an equivalent may be used.
9. Pressure and temperature sensors are free provided no modification to the engine is required for fitment.
10. The air temperature sensor is not required provided the hole in the backing plate for the airbox is completely sealed.

n. Flywheel and Clutch

1. Elite flywheel, part number 050701, must be used with no modification except the surfacing or grinding of the friction surface for repair. The ring gear may be replaced.
 - i. No material may be removed from other areas of the flywheel.

Mazda MZR LF-E2 2.0L Engine (USF2000)

- ii. Minimum flywheel weight with ring gear: 12.8 lbs without bolts.
- 2. Flywheel bolts must be of ferrous material but are otherwise unrestricted.
- 3. Any non-carbon 7.25-inch diameter twin plate clutch may be used. Carbon clutches are prohibited.

o. Exhaust

1. Exhaust system part number ECVD101SS is required without modification except for the allowance of a muffler which may be added in the tail pipe. Alternative exhaust systems may be used provided they comply with the following dimensions/specifications and exhaust over the rear axle of the car. An alternate exhaust system may be used and must fit within the existing space of the ECVD exhaust; no modifications are permitted to the chassis/body work or other components for fitment.

- i. Primary tubes shall have a maximum outer diameter of 1.625 inches as measured 1.5 inches from the header flange.
- ii. Primary tubes shall be a minimum length of 25 inches.
- iii. Primary tubes shall terminate into a 4 into 1 collector with standard 15° angle bends (30° included angle) with a maximum 2.0-inch diameter exit.
- iv. Tail pipe shall have a maximum outer diameter of 2.0 inches and be a minimum of 41 inches long inclusive of muffler measured from the front edge of the collector.
- v. 4 into 2 into 1 collectors and venturi style headers are prohibited.
- vi. Headers may be wrapped and/or coated.

p. Miscellaneous

- 1. 93 octane gasoline or such other fuel as is specifically identified for use in this engine per SCCA event supps is required.
- 2. Oils, additives, and lubricants are unrestricted.
- 3. Mechanical tachometer and analog gauges are permitted.
- 4. Mazda valve cover, part number LFE2-10-210C, must be used with no modification given the following exceptions:
 - i. The stock plastic breather tube may be removed and replaced with Elite part number 059904 and a dash -6 fitting. A restrictor may be placed in the breather fitting.
 - ii. The camshaft position sensor hole may be plugged with Elite part number 059902, or the Mazda camshaft position sensor may be used provided its only function is that of a plug. The camshaft position sensor may not be used as a sensor.

Mazda MZR LF-E2 2.0L Engine (USF2000)

iii. The variable intake cam timing solenoid may be removed provided that the hole in the valve cover is completely blocked off and that the number 1 intake cam cap is modified so that any oiling hole to or from the solenoid is blocked off.

Engine Workshop Manual L8 LF L3

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1731-1E-02C

FOREWORD

This manual explains the disassembly, inspection, repair, and reassembly procedures for the above-indicated engine. In order to do these procedures safely, quickly, and correctly, you must first read this manual and any other relevant service materials carefully.

The information in this manual is current up to March, 2002. Any changes that occur after that time will not be reflected in this particular manual. Therefore, the contents of this manual may not exactly match the mechanism that you are currently serving.

Mazda Motor Corporation
HIROSHIMA, JAPAN

WARNING

Servicing a vehicle can be dangerous. If you have not received service-related training, the risks of injury, property damage, and failure of servicing increase. The recommended servicing procedures for the vehicle in this workshop manual were developed with Mazda-trained technicians in mind. This manual may be useful to non-Mazda trained technicians, but a technician with our service-related training and experience will be at less risk when performing service operations. However, all users of this manual are expected to at least know general safety procedures.

This manual contains "Warnings" and "Cautions" applicable to risks not normally encountered in a general technician's experience. They should be followed to reduce the risk of injury and the risk that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that the "Warnings" and "Cautions" are not exhaustive. It is impossible to warn of all the hazardous consequences that might result from failure to follow the procedures.

The procedures recommended and described in this manual are effective methods of performing service and repair. Some require tools specifically designed for a specific purpose. Persons using procedures and tools which are not recommended by Mazda Motor Corporation must satisfy themselves thoroughly that neither personal safety nor safety of the vehicle will be jeopardized.

The contents of this manual, including drawings and specifications, are the latest available at the time of printing, and Mazda Motor Corporation reserves the right to change the vehicle designs and alter the contents of this manual without notice and without incurring obligation.

Parts should be replaced with genuine Mazda replacement parts or with parts which match the quality of genuine Mazda replacement parts. Persons using replacement parts of lesser quality than that of genuine Mazda replacement parts must satisfy themselves thoroughly that neither personal safety nor safety of the vehicle will be jeopardized.

Mazda Motor Corporation is not responsible for any problems which may arise from the use of this manual. The cause of such problems includes but is not limited to insufficient service-related training, use of improper tools, use of replacement parts of lesser quality than that of genuine Mazda replacement parts, or not being aware of any revision of this manual.

GENERAL INFORMATION

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HOW TO USE THIS MANUAL

HOW TO USE THIS MANUAL

RANGE OF TOPICS

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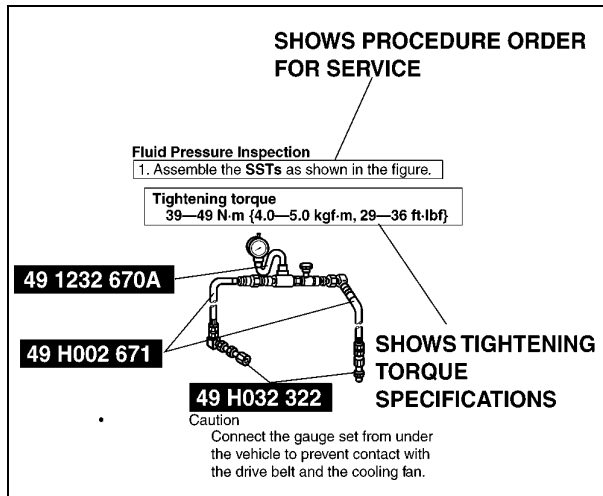
- This manual contains procedures for performing all required service operations. The procedures are divided into the following five basic operations:
 - Removal/Installation
 - Disassembly/Assembly
 - Replacement
 - Inspection
 - Adjustment
- Simple operations which can be performed easily just by looking at the vehicle (i.e., removal/installation of parts, jacking, vehicle lifting, cleaning of parts and visual inspection) have been omitted.

SERVICE PROCEDURE

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Inspection, adjustment

- Inspection and adjustment procedures are divided into steps. Important points regarding the location and contents of the procedures are explained in detail and shown in the illustrations.









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Repair procedure

1. Most repair operations begin with an overview illustration. It identifies the components, shows how the parts fit together and describes visual part inspection. However, only removal/installation procedures that need to be performed methodically have written instructions.
2. Expendable parts, tightening torques and symbols for oil, grease, and sealant are shown in the overview illustration. In addition, symbols indicating parts requiring the use of special service tools or equivalent are also shown.
3. Procedure steps are numbered and the part that is the main point of that procedure is shown in the illustration with the corresponding number. Occasionally, there are important points or additional information concerning a procedure. Refer to this information when servicing the related part.

HOW TO USE THIS MANUAL

Symbol	Meaning	Kind
	Apply automatic transaxle/transmission fluid	New appropriate automatic transaxle/transmission fluid
	Apply grease	Appropriate grease
	Apply sealant	Appropriate sealant
	Apply petroleum jelly	Appropriate petroleum jelly
	Replace part	O-ring, gasket, etc.
	Use SST or equivalent	Appropriate tools

ADVISORY MESSAGES

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- You'll find several **Warnings**, **Cautions**, **Notes**, **Specifications** and **Upper and Lower Limits** in this manual.

Warning

- A Warning indicates a situation in which serious injury or death could result if the warning is ignored.

Caution

- A Caution indicates a situation in which damage to the vehicle or parts could result if the caution is ignored.

Note

- A Note provides added information that will help you to complete a particular procedure.

Specification

- The values indicate the allowable range when performing inspections or adjustments.

Upper and lower limits

- The values indicate the upper and lower limits that must not be exceeded when performing inspections or adjustments.

UNITS

UNITS

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UNITS

Electrical current	A (ampere)
Electric power	W (watt)
Electric resistance	ohm
Electric voltage	V (volt)
Length	mm (millimeter)
	in (inch)
Negative pressure	kPa (kilo pascal)
	mmHg (millimeters of mercury)
	inHg (inches of mercury)
Positive pressure	kPa (kilo pascal)
	kgf/cm ² (kilogram force per square centimeter)
	psi (pounds per square inch)
Torque	N·m (Newton meter)
	kgf·m (kilogram force meter)
	kgf·cm (kilogram force centimeter)
	ft·lbf (foot pound force)
	in·lbf (inch pound force)
Volume	L (liter)
	US qt (U.S. quart)
	Imp qt (Imperial quart)
	ml (milliliter)
	cc (cubic centimeter)
	cu in (cubic inch)
	fl oz (fluid ounce)
Weight	g (gram)
	oz (ounce)

Conversion to SI Units (Système International d'Unités)

- All numerical values in this manual are based on SI units. Numbers shown in conventional units are converted from these values.

Rounding Off

- Converted values are rounded off to the same number of places as the SI unit value. For example, if the SI unit value is 17.2 and the value after conversion is 37.84, the converted value will be rounded off to 37.8.

Upper and Lower Limits

- When the data indicates upper and lower limits, the converted values are rounded down if the SI unit value is an upper limit and rounded up if the SI unit value is a lower limit. Therefore, converted values for the same SI unit value may differ after conversion. For example, consider 2.7 kgf/cm² in the following specifications:

210—260 kPa {2.1—2.7 kgf/cm², 30—38 psi}
270—310 kPa {2.7—3.2 kgf/cm², 39—45 psi}

- The actual converted values for 2.7 kgf/cm² are 264 kPa and 38.4 psi. In the first specification, 2.7 is used as an upper limit, so the converted values are rounded down to 260 and 38. In the second specification, 2.7 is used as a lower limit, so the converted values are rounded up to 270 and 39.

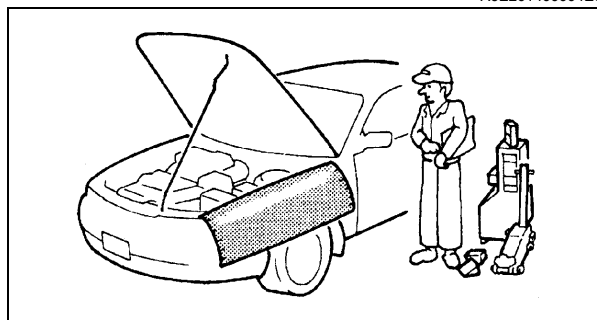
FUNDAMENTAL PROCEDURES

FUNDAMENTAL PROCEDURES

PREPARATION OF TOOLS AND MEASURING EQUIPMENT

- Be sure that all necessary tools and measuring equipment are available before starting any work.

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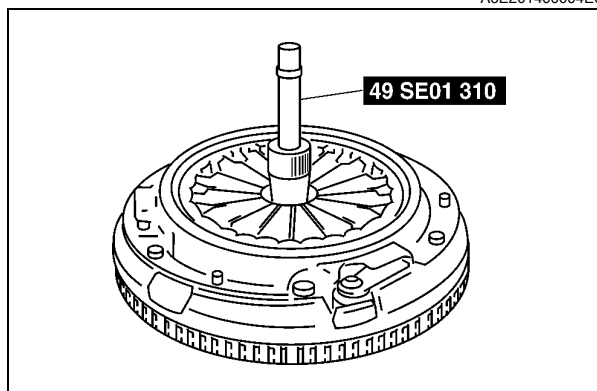


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SPECIAL SERVICE TOOLS

- Use special service tools or equivalent when they are required.

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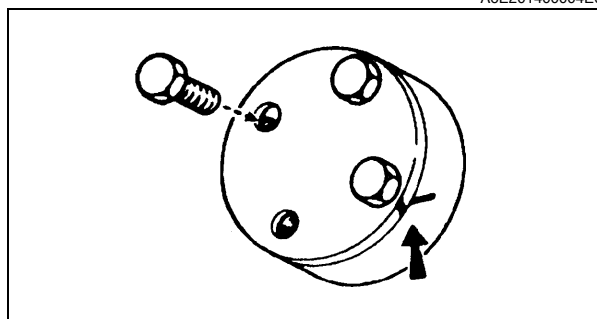


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DISASSEMBLY

- If the disassembly procedure is complex, requiring many parts to be disassembled, all parts should be marked in a place that will not affect their performance or external appearance and identified so that reassembly can be performed easily and efficiently.

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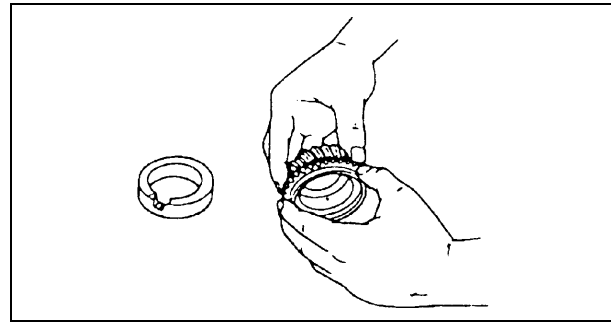
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FUNDAMENTAL PROCEDURES

INSPECTION DURING REMOVAL, DISASSEMBLY

- When removed, each part should be carefully inspected for malfunction, deformation, damage, and other problems.

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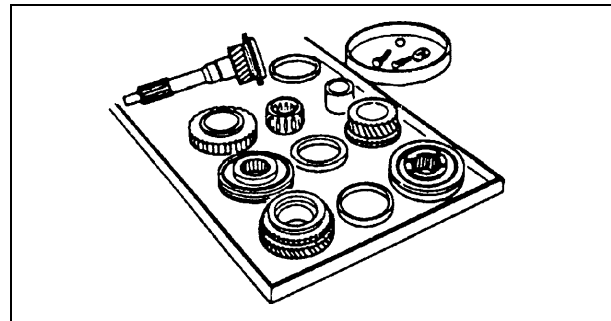
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ARRANGEMENT OF PARTS

- All disassembled parts should be carefully arranged for reassembly.
- Be sure to separate or otherwise identify the parts to be replaced from those that will be reused.

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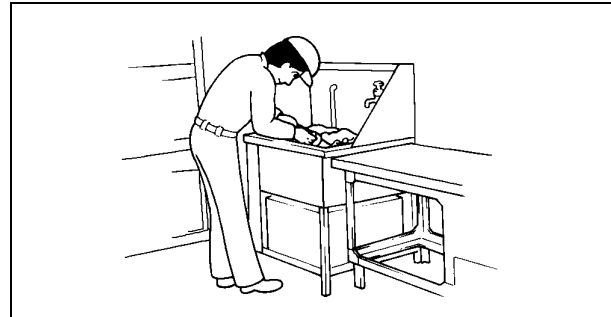
CLEANING OF PARTS

- All parts to be reused should be carefully and thoroughly cleaned in the appropriate method.

Warning

- **Using compressed air can cause dirt and other particles to fly out causing injury to the eyes. Wear protective eye wear whenever using compressed air.**

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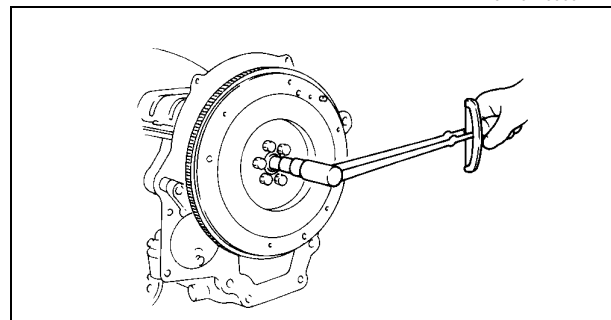


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REASSEMBLY

- Standard values, such as torques and certain adjustments, must be strictly observed in the reassembly of all parts.
- If removed, these parts should be replaced with new ones:
 - Oil seals
 - Gaskets
 - O-rings
 - Lockwashers
 - Cotter pins
 - Nylon nuts

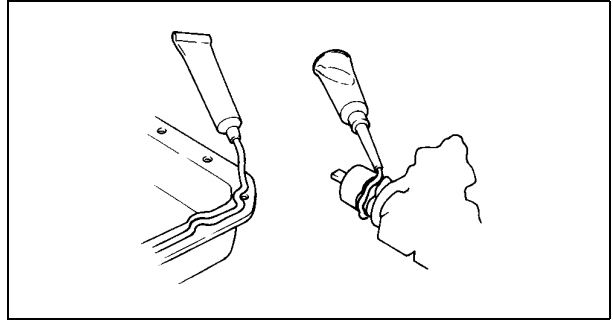
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FUNDAMENTAL PROCEDURES

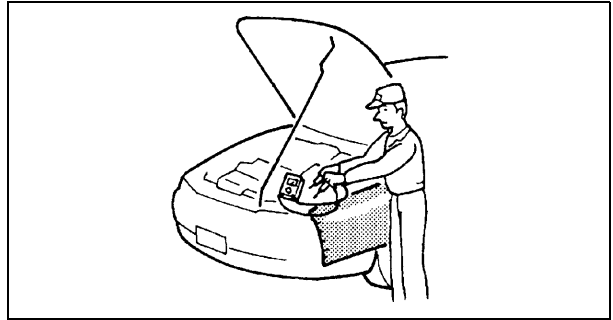
- Depending on location:
 - Sealant and gaskets, or both, should be applied to specified locations. When sealant is applied, parts should be installed before sealant hardens to prevent leakage.
 - Oil should be applied to the moving components of parts.
 - Specified oil or grease should be applied at the prescribed locations (such as oil seals) before reassembly.



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ADJUSTMENT

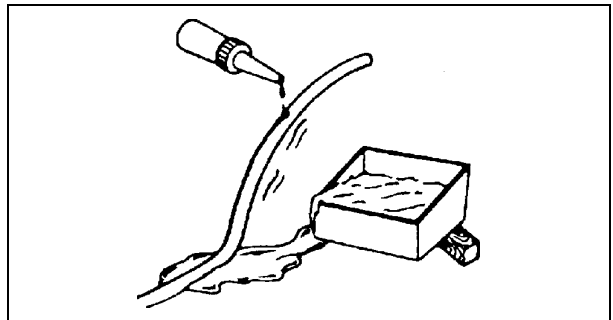
- Use suitable gauges and/or testers when making adjustments.



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RUBBER PARTS AND TUBING

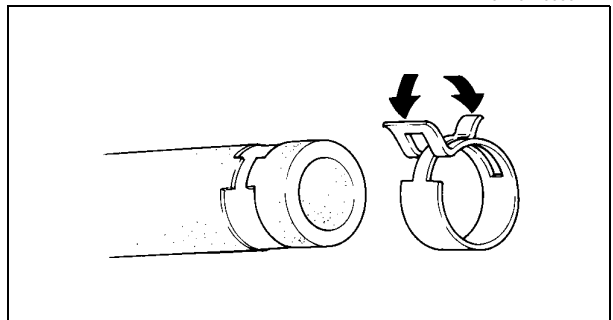
- Prevent gasoline or oil from getting on rubber parts or tubing.



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HOSE CLAMPS

- When reinstalling, position the hose clamp in the original location on the hose and squeeze the clamp lightly with large pliers to ensure a good fit.



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FUNDAMENTAL PROCEDURES

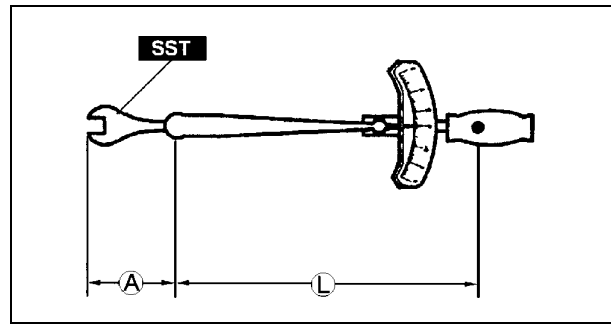
TORQUE FORMULAS

- When using a torque wrench-**SST** or equivalent combination, the written torque must be recalculated due to the extra length that the **SST** or equivalent adds to the torque wrench. Recalculate the torque using the following formulas. Choose the formula that applies to you.

Torque Unit	Formula
N·m	$N\cdot m \times [L/(L+A)]$
kgf·m	$kgf\cdot m \times [L/(L+A)]$
kgf·cm	$kgf\cdot cm \times [L/(L+A)]$
ft·lbf	$ft\cdot lbf \times [L/(L+A)]$
in·lbf	$in\cdot lbf \times [L/(L+A)]$

A : The length of the **SST** past the torque wrench drive

L : The length of the torque wrench

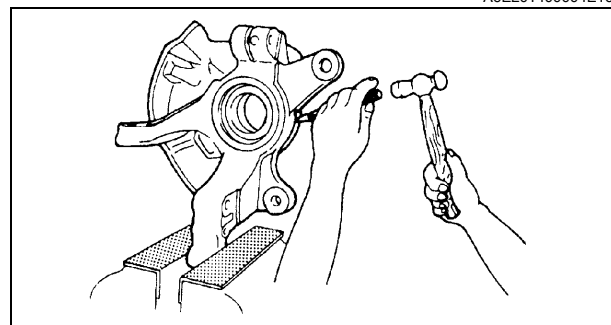


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WISE

- When using a vise, put protective plates in the jaws of the vise to prevent damage to parts.

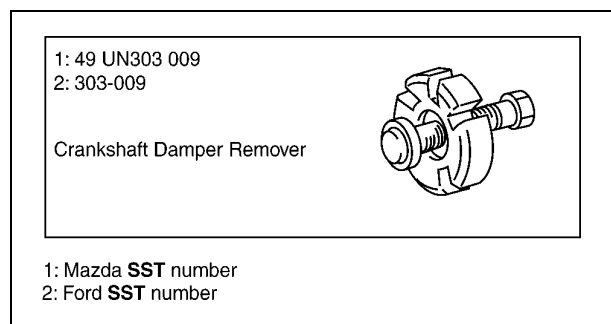


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SST

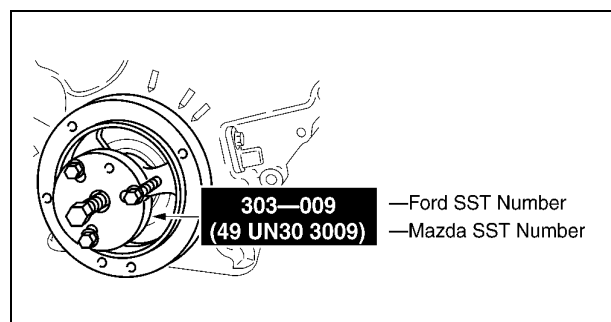
- Some Ford **SST** or equivalent are used as **SSTs** necessary for engine repair. Note that these **SSTs** are marked with Ford **SST** numbers.
- Note that a Ford **SST** number is written together with a corresponding Mazda **SST** number as shown below.

Example (section ST)



XME2014002

Example (except section ST)



ELECTRICAL SYSTEM

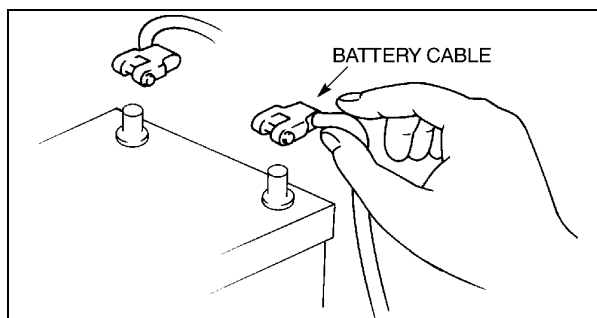
ELECTRICAL SYSTEM

ELECTRICAL PARTS

A6E201700006E01

Battery cable

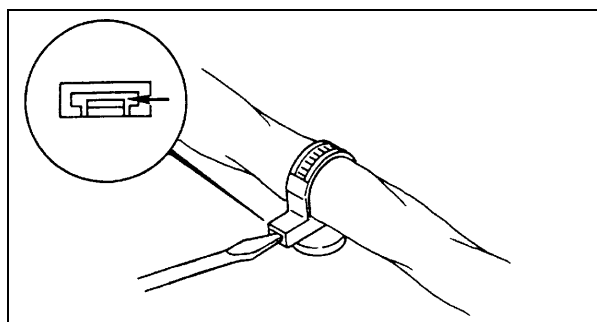
- Before disconnecting connectors or removing electrical parts, disconnect the negative battery cable.



WGIWXX0007E

Wiring Harness

- To remove the wiring harness from the clip in the engine room, pry up the hook of the clip using a flathead screwdriver.



X3U000WBU

CONNECTORS

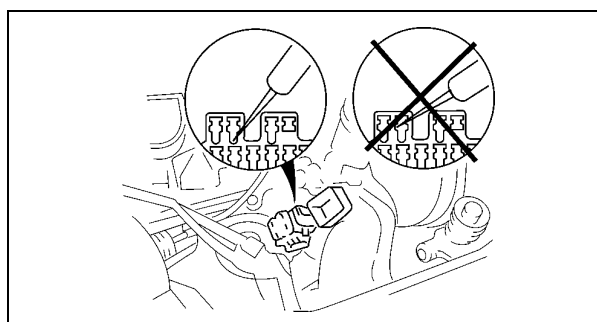
A6E201700006E02

Data link connector

- Insert the probe into the terminal when connecting a jumper wire to the data link connector.

Caution

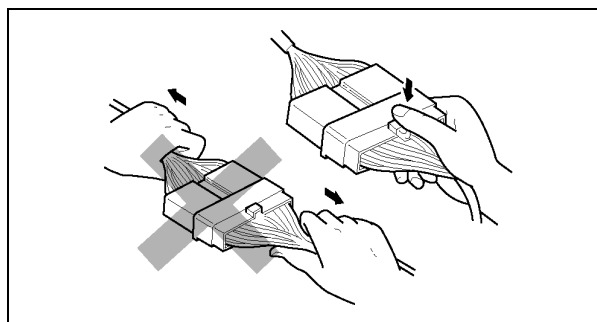
- Inserting a jumper wire probe into the data link connector terminal may damage the terminal.



X3U000WAY

Disconnecting connectors

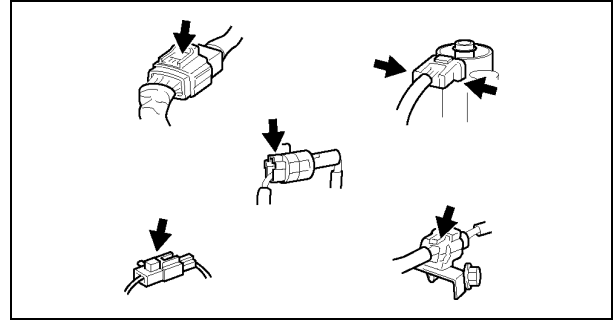
- When disconnecting connector, grasp the connectors, not the wires.



WGIWXX00041E

ELECTRICAL SYSTEM

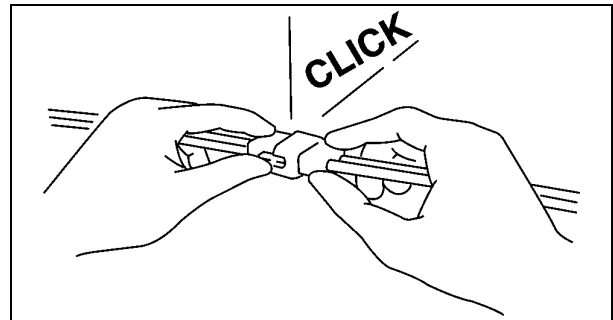
- Connectors can be disconnected by pressing or pulling the lock lever as shown.



WGIWXX0042E

Locking connector

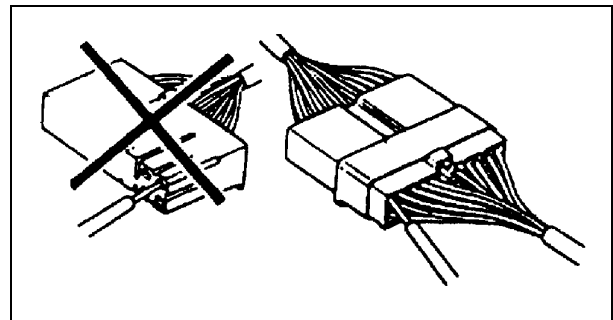
- When locking connectors, listen for a click indicating they are securely locked.



X3U000WB1

Inspection

- When a tester is used to inspect for continuity or measuring voltage, insert the tester probe from the wiring harness side.

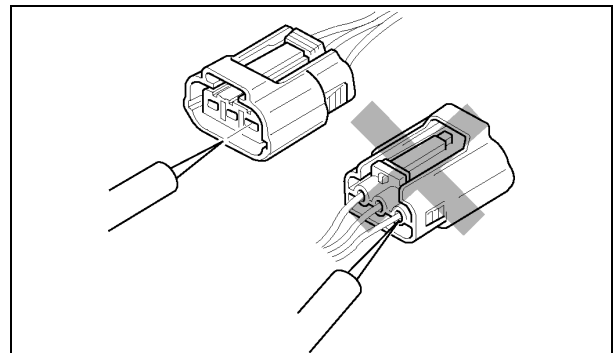


X3U000WB2

- Inspect the terminals of waterproof connectors from the connector side since they cannot be accessed from the wiring harness side.

Caution

- To prevent damage to the terminal, wrap a thin wire around the tester probe before inserting into terminal.



WGIWXX0045E

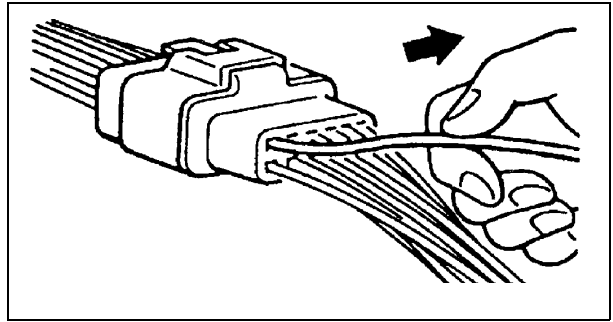
GI

ELECTRICAL SYSTEM

Terminals

Inspection

- Pull lightly on individual wires to verify that they are secured in the terminal.



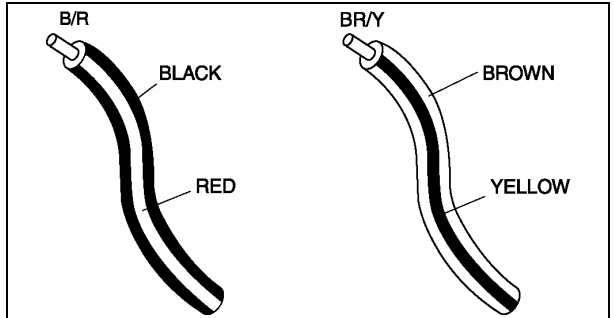
X3U000WB4

Wiring Harness

Wiring color codes

- Two-color wires are indicated by a two-color code symbol.
- The first letter indicates the base color of the wire and the second the color of the stripe.

CODE	COLOR	CODE	COLOR
B	Black	O	Orange
BR	Brown	P	Pink
G	Green	R	Red
GY	Gray	V	Violet
L	Blue	W	White
LB	Light Blue	Y	Yellow
LG	Light Green		



X3U000WB7

NEW STANDARDS

NEW STANDARDS

NEW STANDARDS

A6E202800020E01

- Following is a comparison of the previous standard and the new standard.

New Standard		Previous Standard		Remark
Abbreviation	Name	Abbreviation	Name	
AP	Accelerator Pedal	—	Accelerator Pedal	
ACL	Air Cleaner	—	Air Cleaner	
A/C	Air Conditioning	—	Air Conditioning	
BARO	Barometric Pressure	—	Atmospheric Pressure	
B+	Battery Positive Voltage	Vb	Battery Voltage	
—	Brake Switch	—	Stoplight Switch	
—	Calibration Resistor	—	Corrected Resistance	#6
CMP sensor	Camshaft Position Sensor	—	Crank Angle Sensor	
CAC	Charge Air Cooler	—	Intercooler	
CLS	Closed Loop System	—	Feedback System	
CTP	Closed Throttle Position	—	Fully Closed	
CPP	Clutch Pedal Position	—	Idle Switch	
CIS	Continuous Fuel Injection System	—	Clutch Position	
CS sensor	Control Sleeve Sensor	CSP sensor	Control Sleeve Position Sensor	#6
CKP sensor	Crankshaft Position Sensor	—	Crank Angle Sensor 2	
DLC	Data Link Connector	—	Diagnosis Connector	
DTM	Diagnostic Test Mode	—	Test Mode	#1
DTC	Diagnostic Trouble Code(s)	—	Service Code(s)	
DI	Distributor Ignition	—	Spark Ignition	
DLI	Distributorless Ignition	—	Direct Ignition	
EI	Electronic Ignition	—	Electronic Spark Ignition	#2
ECT	Engine Coolant Temperature	—	Water Thermo	
EM	Engine Modification	—	Engine Modification	
—	Engine Speed Input Signal	—	Engine RPM Signal	
EVAP	Evaporative Emission	—	Evaporative Emission	
EGR	Exhaust Gas Recirculation	—	Exhaust Gas Recirculation	
FC	Fan Control	—	Fan Control	
FF	Flexible Fuel	—	Flexible Fuel	
4GR	Fourth Gear	—	Overdrive	
—	Fuel Pump Relay	—	Circuit Opening Relay	#3
FSO solenoid	Fuel Shut Off Solenoid	FCV	Fuel Cut Valve	#6
GEN	Generator	—	Alternator	
GND	Ground	—	Ground/Earth	
HO2S	Heated Oxygen Sensor	—	Oxygen Sensor	With heater
IAC	Idle Air control	—	Idle Speed Control	
—	IDM Relay	—	Spill Valve Relay	#6
—	Incorrect Gear Ratio	—	—	
—	Injection Pump	FIP	Fuel Injection Pump	#6
—	Input/Turbine Speed Sensor	—	Pulse Generator	
IAT	Intake Air Temperature	—	Intake Air Thermo	
KS	Knock Sensor	—	Knock Sensor	
MIL	Malfunction Indicator Lamp	—	Malfunction Indicator Light	
MAP	Manifold Absolute Pressure	—	Intake Air Pressure	
MAF sensor	Mass Air Flow Sensor	—	Airflow Sensor	
MFL	Multiport Fuel Injection	—	Multiport Fuel Injection	
OBD	On-Board Diagnostic	—	Diagnosis/SelfDiagnosis	
OL	Open Loop	—	Open Loop	

NEW STANDARDS

New Standard		Previous Standard		Remark
Abbreviation	Name	Abbreviation	Name	
—	Output Speed Sensor	—	Vehicle Speed Sensor 1	
OC	Oxidation Catalytic Converter	—	Catalytic Converter	
O2S	Oxygen Sensor	—	Oxygen Sensor	
PNP	Park/Neutral Position	—	Park/Neutral Range	
—	PCM Control Relay	—	Main Relay	#6
PSP	Power Steering Pressure	—	Power Steering Pressure	
PCM	Powertrain Control Module	ECU	Engine Control Unit	#4
—	Pressure Control Solenoid	—	Line Pressure Solenoid Valve	
PAIR	Pulsed Secondary Air Injection	—	Secondary Air Injection System	Pulsed injection
—	Pump Speed Sensor	—	NE Sensor	#6
AIR	Secondary Air Injection	—	Secondary Air Injection System	Injection with air pump
SAPV	Secondary Air Pulse Valve	—	Reed Valve	
SFI	Sequential Multipoint Fuel Injection	—	Sequential Fuel Injection	
—	Shift Solenoid A	—	1-2 Shift Solenoid Valve	
		—	Shift A Solenoid Valve	
—	Shift Solenoid B	—	2-3 Shift Solenoid Valve	
		—	Shift B Solenoid Valve	
—	Shift Solenoid C	—	3-4 Shift Solenoid Valve	
3GR	Third Gear	—	3rd Gear	
TWC	Three Way Catalytic Converter	—	Catalytic Converter	
TB	Throttle Body	—	Throttle Body	
TP sensor	Throttle Position Sensor	—	Throttle Sensor	
TCV	Timer Control Valve	TCV	Timing Control Valve	#6
TCC	Torque Converter Clutch	—	Lockup Position	
TCM	Transmission (Transaxle) Control Module	—	ECAT Control Unit	
—	Transmission (Transaxle) Fluid Temperature Sensor	—	ATF Thermosensor	
TR	Transmission (Transaxle) Range	—	Inhibitor Position	
TC	Turbocharger	—	Turbocharger	
VSS	Vehicle Speed Sensor	—	Vehicle Speed Sensor	
VR	Voltage Regulator	—	IC Regulator	
VAF sensor	Volume Air Flow Sensor	—	Air flow Sensor	
WUTWC	Warm Up Three Way Catalytic Converter	—	Catalytic Converter	#5
WOT	Wide Open Throttle	—	Fully Open	

#1 : Diagnostic trouble codes depend on the diagnostic test mode

#2 : Controlled by the PCM

#3 : In some models, there is a fuel pump relay that controls pump speed. That relay is now called the fuel pump relay (speed).

#4 : Device that controls engine and powertrain

#5 : Directly connected to exhaust manifold

#6 : Part name of diesel engine

ABBREVIATIONS

ABBREVIATIONS

ABBREVIATIONS

A6E203000011E01

GI

MTX	Manual transaxle
ATX	Automatic transaxle
ATDC	After top dead center
TDC	Top dead center
IN	Intake
EX	Exhaust
EGR	Exhaust gas recirculation
OCV	Oil control valve
SST	Special service tool

ENGINE

B

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CYLINDER HEAD (II) ASSEMBLY	B-39
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ENGINE

ENGINE

ENGINE OVERHAUL SERVICE WARNING

A6E242402000E01

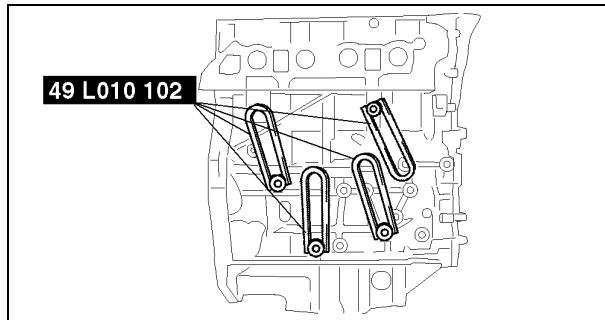
Warning

- Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

ENGINE MOUNTING/DISMOUNTING

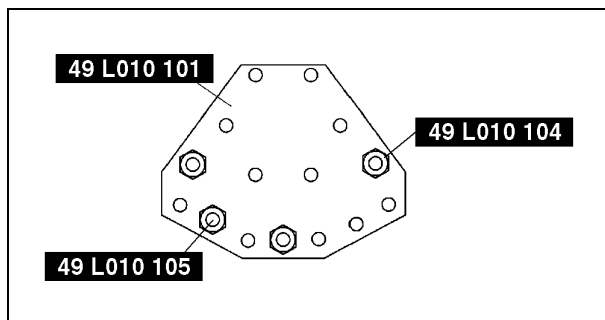
A6E242402000E02

1. Install the **SSTs** (arms) to the cylinder block holes as shown, and hand-tighten the bolts (part No.: **9YA20-1003**) or **M10×1.5T** length 90 mm {3.55 in}.



AME2224E065

2. Assemble the **SSTs** (bolts, nuts and plate) to the specified positions.
3. Adjust the **SSTs** (bolts) so that less than **20 mm {0.79 in}** of thread is exposed.
4. Make the **SSTs** (arms and plate) parallel by adjusting the **SSTs** (bolts and nuts).

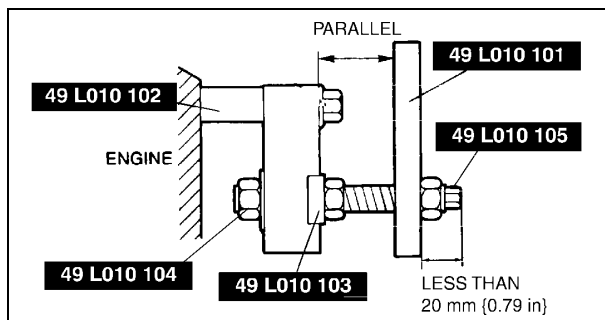


AME2224E300

5. Tighten the **SSTs** (bolts and nuts) to affix the **SSTs** firmly.

Warning

- Self-locking brake system of the engine stand may not be effective when the engine is held in an unbalanced position. This could lead to sudden, rapid movement of the engine and mounting stand handle and cause serious injury. Never keep the engine in an unbalanced position, and always hold the rotating handle firmly when turning the engine.



AME2224E301

6. Mount the engine on the **SST** (engine stand).
7. Drain the engine oil into a container.
8. Clean the flange surface (seal rubber) of the oil pan drain plug, then install the oil pan drain plug.

Tightening torque

20—30 N·m {2.1—3.0 kgf·m, 15—22 ft·lbf}

DISMOUNTING

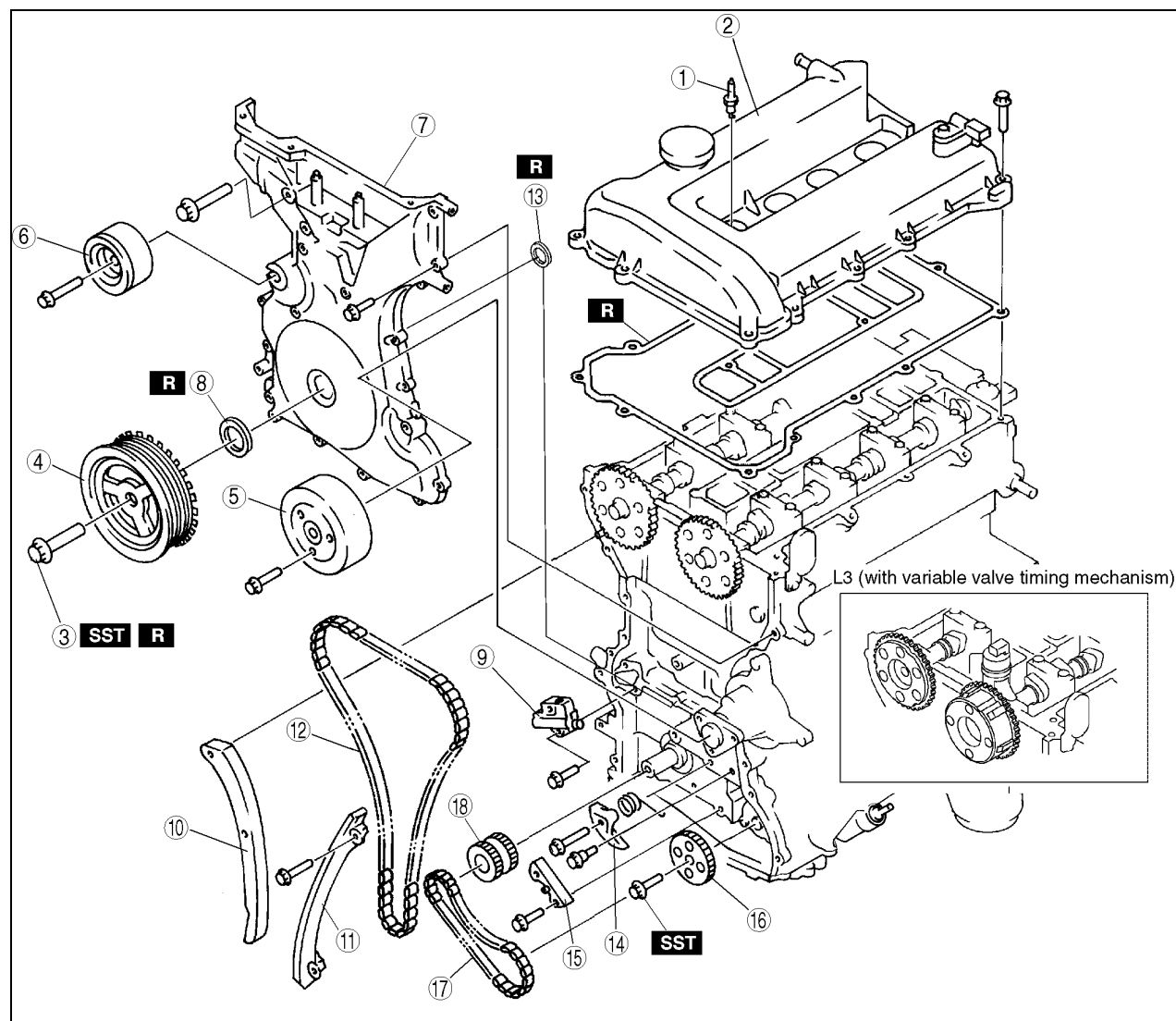
- Dismount in the reverse order of mounting.

ENGINE

TIMING CHAIN DISASSEMBLY

A6E242402000E04

1. Disassemble in the order indicated in the table.



AME2224E337

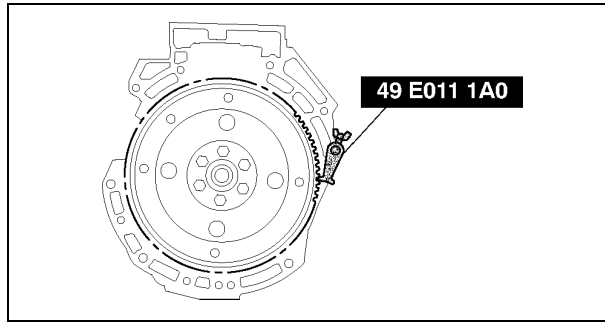
1	Spark plug
2	Cylinder head cover
3	Crankshaft pulley lock bolt (See B-4 Crankshaft Pulley Lock Bolt Disassembly Note)
4	Crankshaft pulley
5	Water pump pulley
6	Drive belt idler pulley
7	Engine front cover
8	Front oil seal (See B-4 Front Oil Seal Disassembly Note)

9	Chain tensioner (See B-4 Chain Tensioner Disassembly Note)
10	Tensioner arm
11	Chain guide
12	Timing chain
13	Seal (L3 (with variable valve timing mechanism))
14	Oil pump chain tensioner
15	Oil pump chain guide
16	Oil pump sprocket (See B-4 Oil Pump Sprocket Disassembly Note)
17	Oil pump chain
18	Crankshaft sprocket

ENGINE

Crankshaft Pulley Lock Bolt Disassembly Note

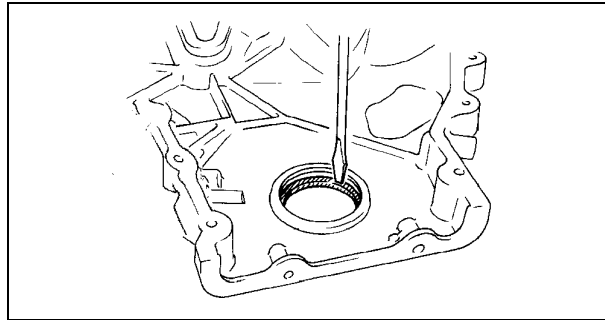
1. Hold the crankshaft using the SST.
2. Remove the crankshaft pulley lock bolt.



AME2224E106

Front Oil Seal Disassembly Note

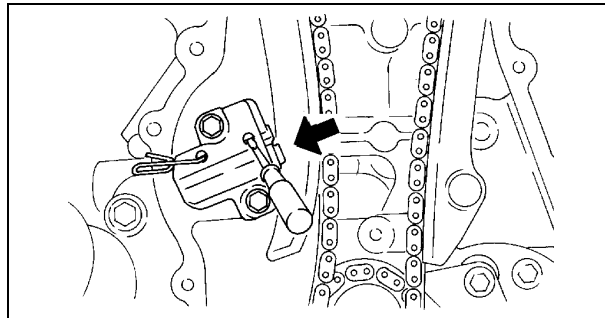
1. Remove the oil seal using a screwdriver.



AME2224E338

Chain Tensioner Disassembly Note

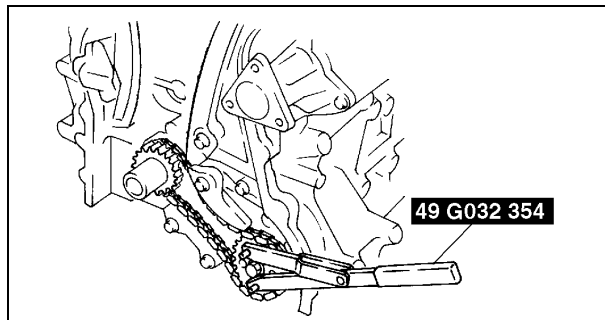
1. Hold the chain tensioner ratchet lock mechanism away from the ratchet stem with a thin screwdriver.
2. Slowly press the tensioner piston.
3. Hold the chain tensioner piston with a 1.5 mm {0.06 in} wire or paper clip.



AME2224E339

Oil Pump Sprocket Disassembly Note

1. Hold the oil pump sprocket using the SST.



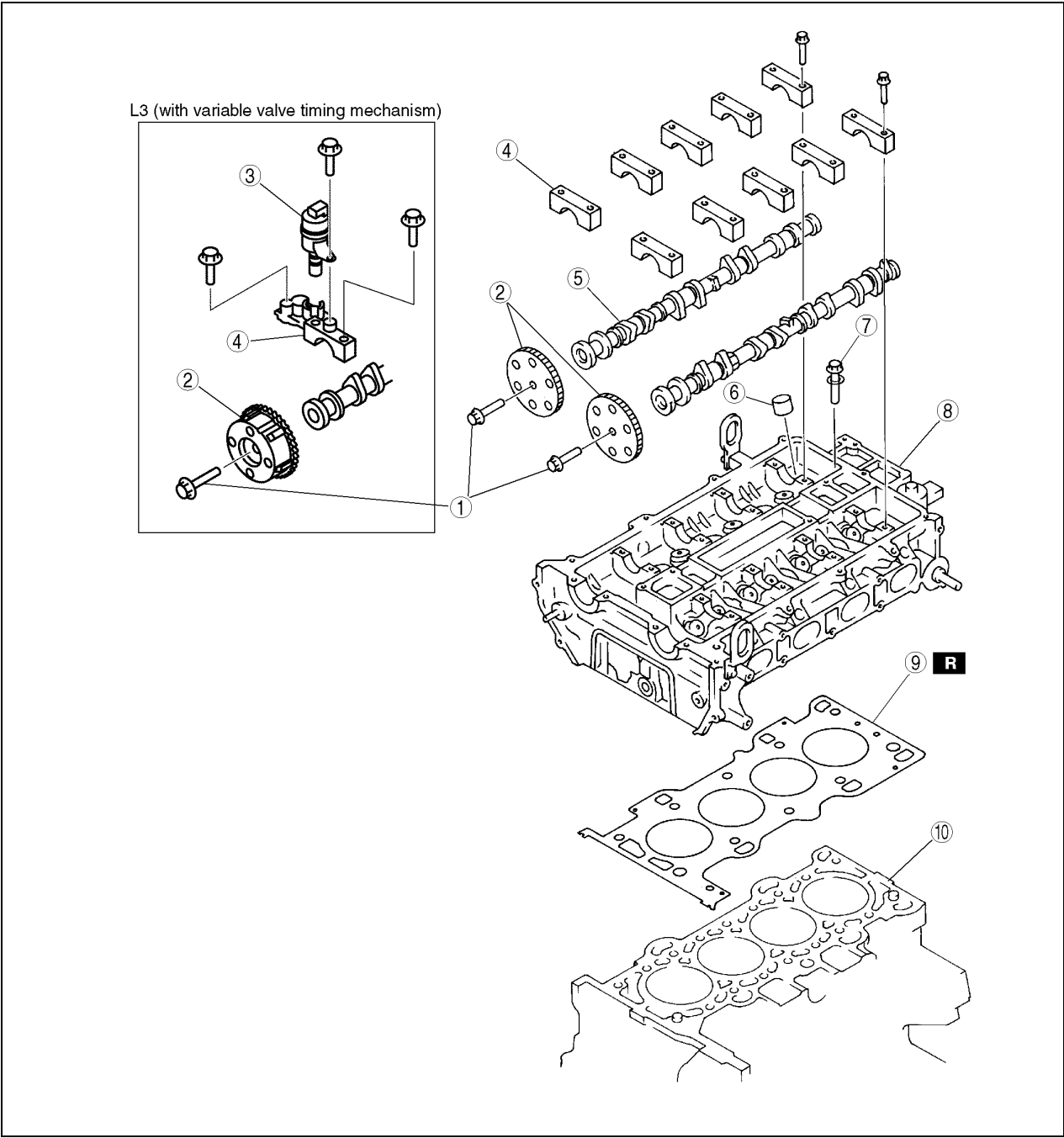
AME2224E340

ENGINE

CYLINDER HEAD (I) DISASSEMBLY

A6E242402000E05

1. Disassemble in the order indicated in the table.



AME2224E001

1	Camshaft sprocket lock bolt, Variable valve timing actuator lock bolt (L3 (with variable valve timing mechanism)) (See B-6 Camshaft Sprocket Lock Bolt, Variable Valve Timing Actuator Lock Bolt (L3 (with variable valve timing mechanism)) Disassembly Note)
2	Camshaft sprocket, Variable valve timing actuator (L3 (with variable valve timing mechanism))
3	Oil control valve (OCV) (L3 (with variable valve timing mechanism))

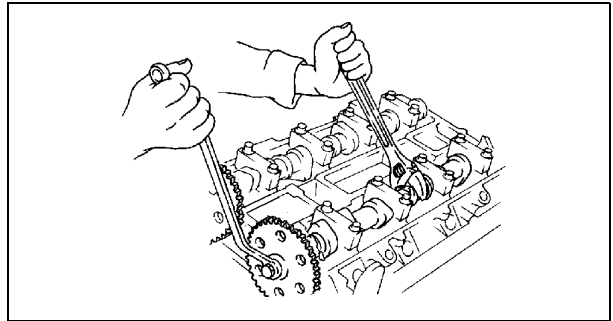
4	Camshaft cap (See B-6 Camshaft Cap Disassembly Note)
5	Camshaft
6	Tappet (See B-7 Tappet Disassembly Note)
7	Cylinder head bolt (See B-7 Cylinder Head Bolt Disassembly Note)
8	Cylinder head
9	Cylinder head gasket
10	Cylinder block

ENGINE

Camshaft Sprocket Lock Bolt, Variable Valve Timing Actuator Lock Bolt (L3 (with variable valve timing mechanism)) Disassembly Note

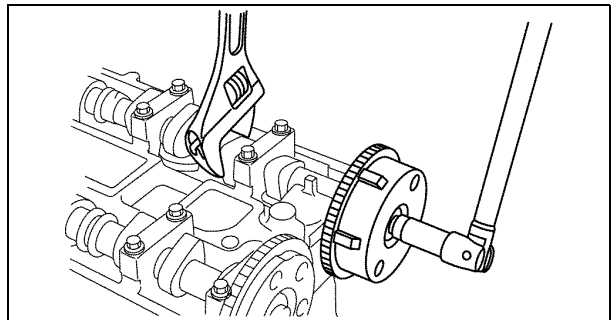
1. Hold the camshaft by using a wrench on the cast hexagon as shown, and loosen the camshaft sprocket lock bolt or variable valve timing actuator lock bolt (L3 (with variable valve timing mechanism)).

L8, LF, L3



AME2224E077

L3 (with variable valve timing mechanism)



AME2224E078

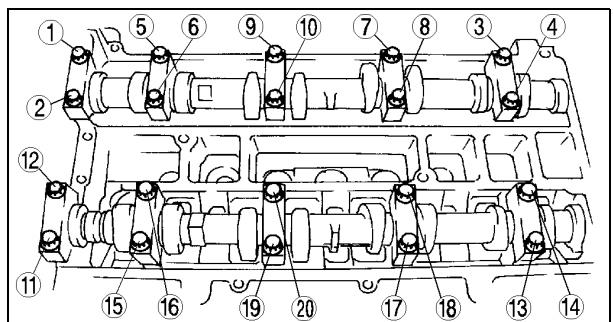
Camshaft Cap Disassembly Note

1. Before removing the camshaft caps, inspect the following.
 - Camshaft end play and camshaft journal oil clearance (See [B-16 CAMSHAFT INSPECTION.](#))

Note

- The camshaft caps are numbered to make sure they are assembled in their original positions. When removed, keep the caps with the cylinder head they were removed from. Do not mix the caps.

2. Loosen the camshaft caps bolts in two or three steps in the order shown.



AME2224E006

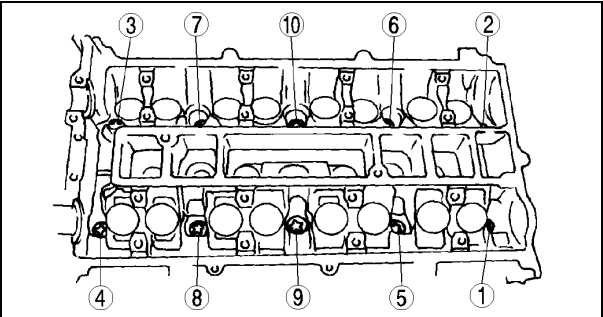
ENGINE

Tappet Disassembly Note

- Note**
- The tappets are numbered to make sure they are assembled in their original positions. When removed, keep the tappets with the cylinder head they were removed from. Do not mix the tappets.

Cylinder Head Bolt Disassembly Note

1. Loosen the cylinder head bolts in two or three steps in the order shown.

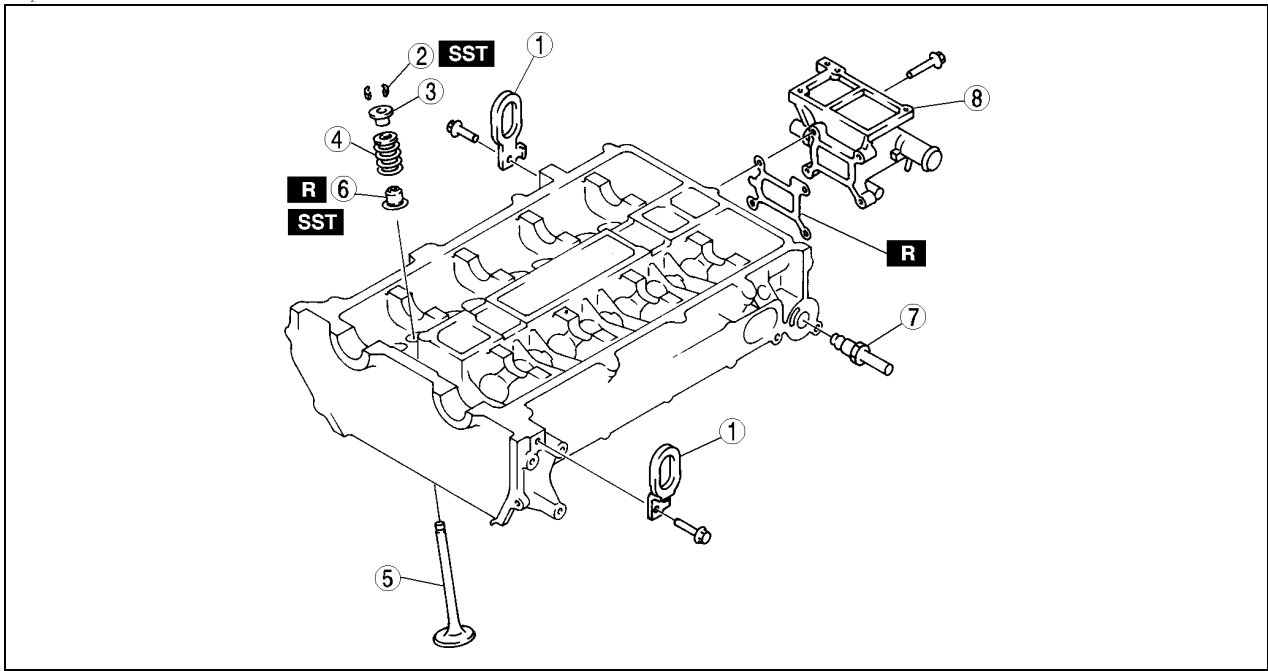


AME2224E005

CYLINDER HEAD (II) DISASSEMBLY

1. Disassemble in the order indicated in the table.

A6E242402000E06



AME2224E008

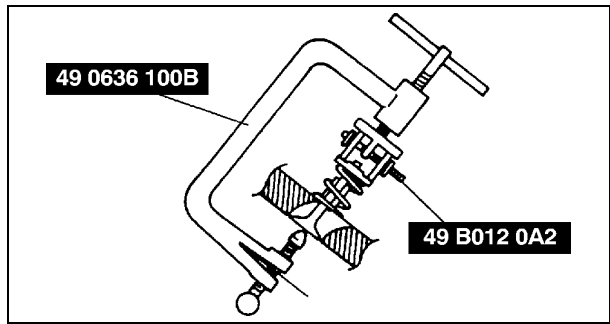
1	Engine hanger
2	Valve keeper (See B-8 Valve Keeper Disassembly Note)
3	Upper valve spring seat
4	Valve spring

5	Valve
6	Valve seal (See B-8 Valve Seal Disassembly Note)
7	EGR pipe
8	Water outlet case

ENGINE

Valve Keeper Disassembly Note

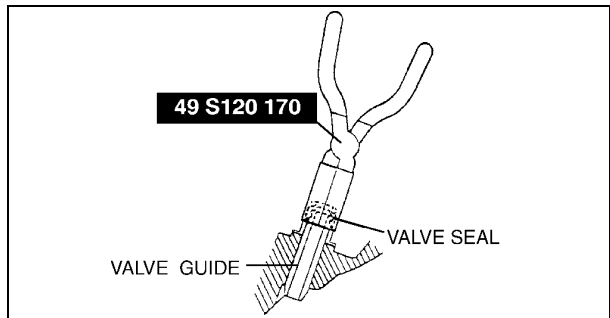
1. Remove the valve keeper using the SSTs.



AME2224E302

Valve Seal Disassembly Note

1. Remove the valve seal using the SST.



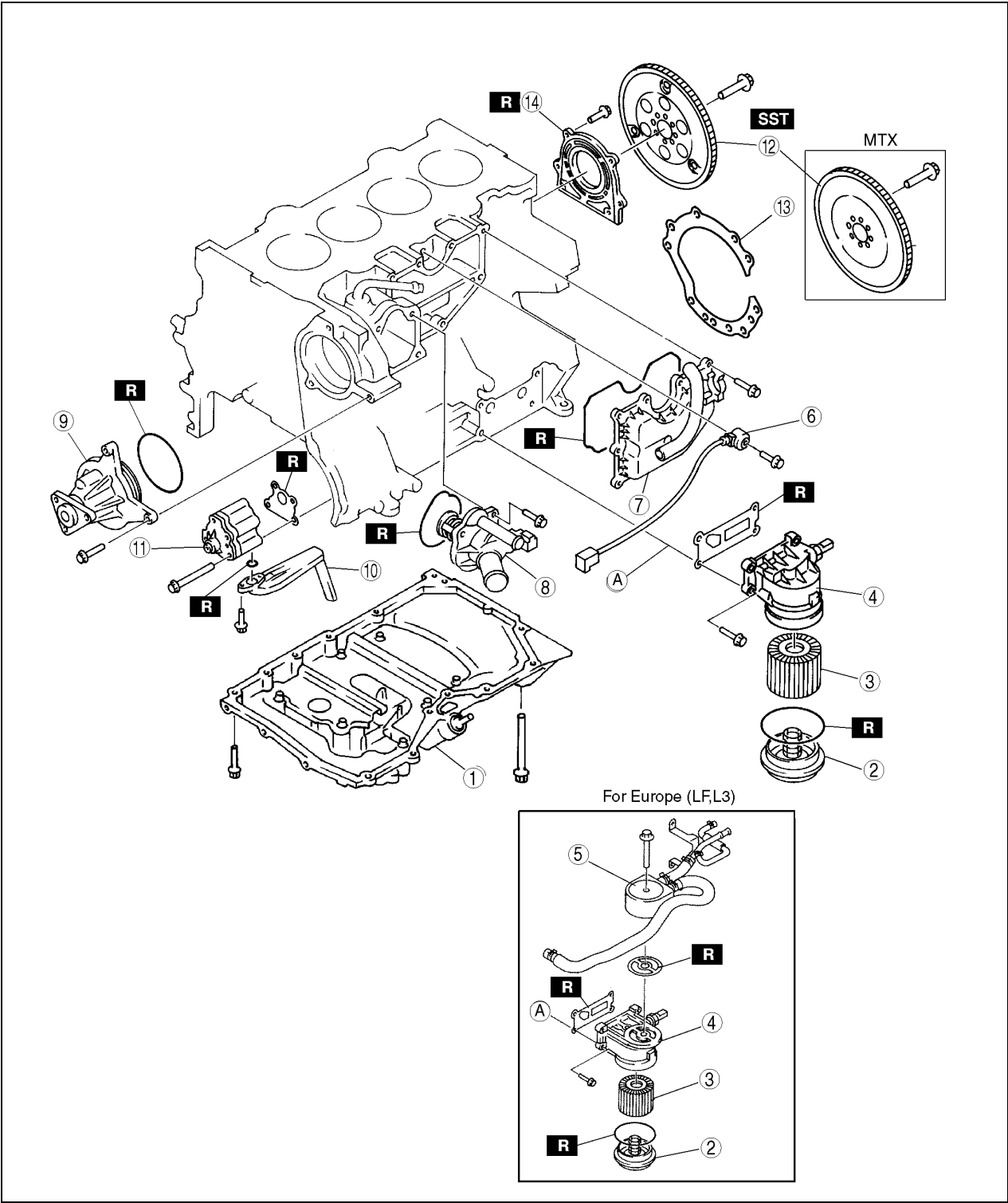
AME2224E303

ENGINE

CYLINDER BLOCK (I) DISASSEMBLY

A6E242402000E07

1. Disassemble in the order indicated in the table.



1	Oil pan
2	Oil filter cover
3	Oil filter
4	Oil filter adapter
5	Oil cooler

6	Knock sensor
7	Oil separator
8	Thermostat
9	Water pump
10	Oil strainer

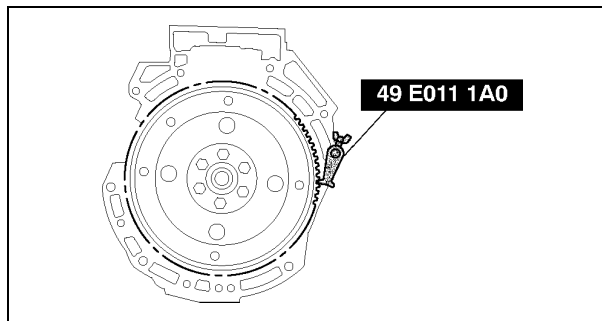
AME2224E011

ENGINE

11	Oil pump
12	Flywheel (MTX), Drive plate (ATX) (See B-10 Drive Plate (ATX), Flywheel (MTX) Disassembly Note)
13	End plate (MTX)
14	Rear oil seal

Drive Plate (ATX), Flywheel (MTX) Disassembly Note

1. Hold the crankshaft using the SST.
2. Remove the bolts in several passes.

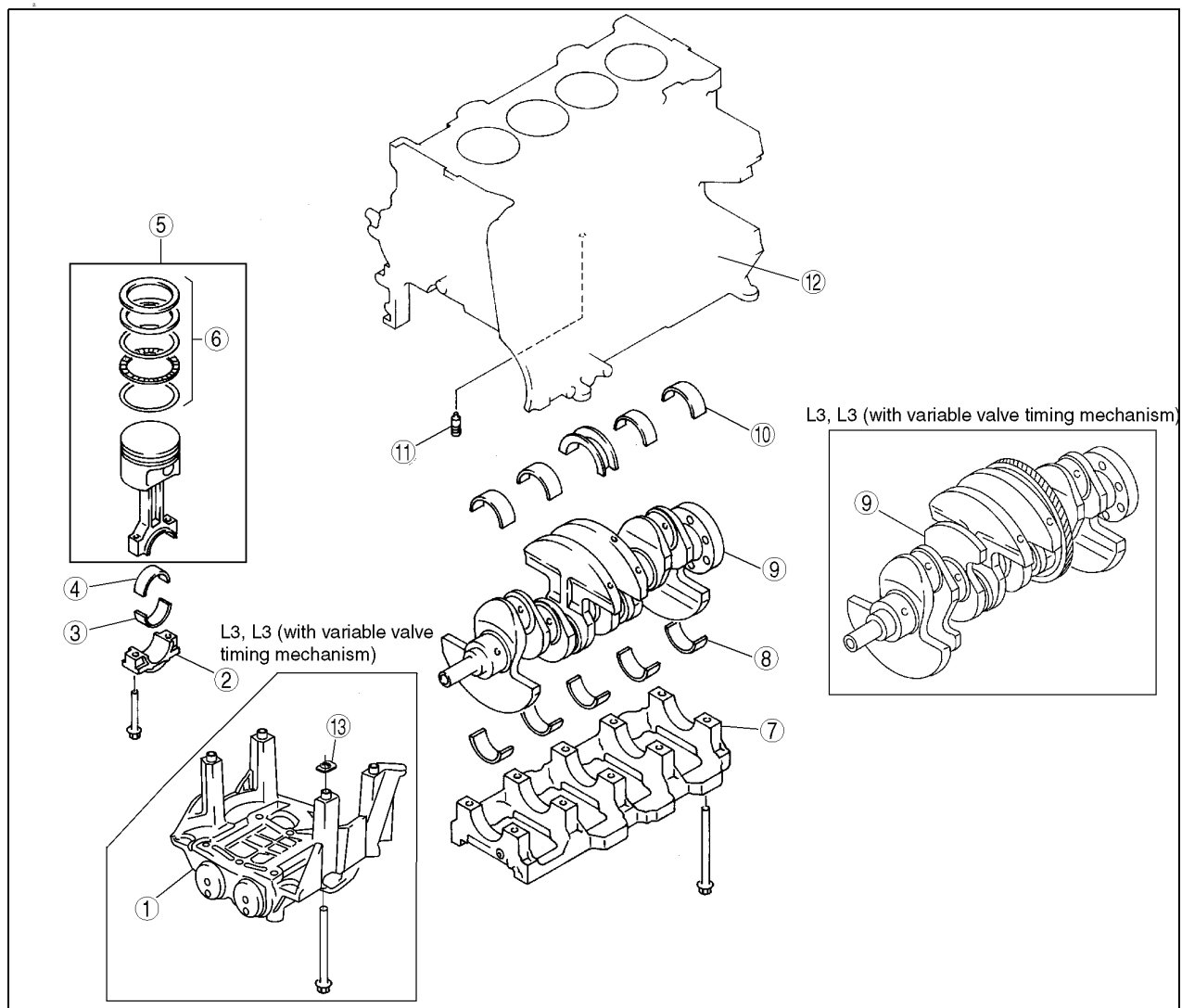


AME2224E106

CYLINDER BLOCK (II) DISASSEMBLY

A6E242402000E08

1. Disassemble in the order indicated in the table.



AME2224E012

ENGINE

1	Balancer unit (L3, L3 (with variable valve timing mechanism))
2	Connecting rod cap (See B-11 Connecting Rod Cap Disassembly Note)
3	Lower connecting rod bearing
4	Upper connecting rod bearing
5	Connecting rod, Piston assembly
6	Piston ring

7	Main bearing cap (See B-11 Main Bearing Cap Disassembly Note)
8	Lower main bearing, thrust bearing
9	Crankshaft
10	Upper main bearing, thrust bearing
11	Oil jet valve
12	Cylinder block
13	Adjustment shim

B

Connecting Rod Cap Disassembly Note

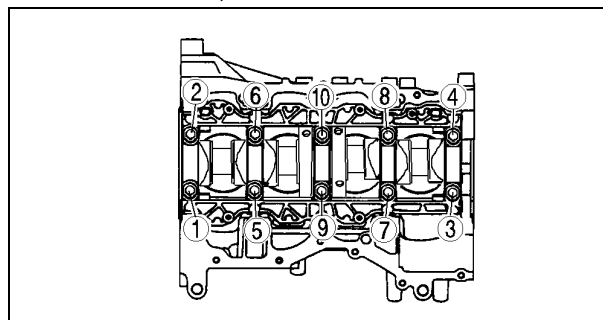
1. Inspect the connecting rod side clearance. (See [B-22 CONNECTING ROD INSPECTION](#) .)
2. Remove the connecting rod bolt from the connecting rod cap by tapping the bolt with a plastic hammer.

Note

- The tappets are numbered to make sure they are assembled in their original positions. When removed, keep the tappets with the cylinder head they were removed from. Do not mix the tappets.

Main Bearing Cap Disassembly Note

1. Inspect the crankshaft end play. (See [B-20 CRANKSHAFT INSPECTION](#) .)
2. Loosen the main bearing cap bolts in two or three steps in the order shown.



AME2224E341

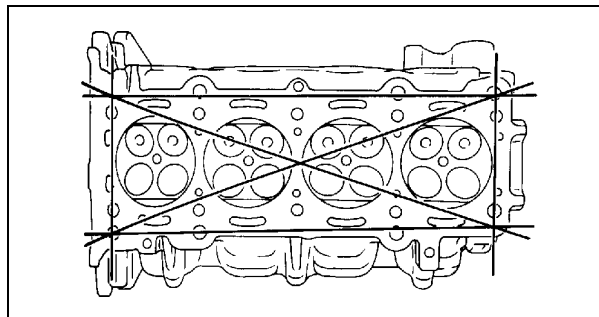
ENGINE

CYLINDER HEAD INSPECTION

A6E242410100E01

1. Carry out color contrast penetrate examination on the cylinder head surface.
 - Replace the cylinder head if necessary.
2. Inspect for the following and repair or replace if necessary.
 - (1) Sunken valve seats
 - (2) Excessive camshaft oil clearance and end play
3. Measure the cylinder head for distortion in the six directions as shown.
 - If the distortion exceeds the maximum, replace the cylinder head.

Maximum distortion:
0.10 mm {0.004 in}

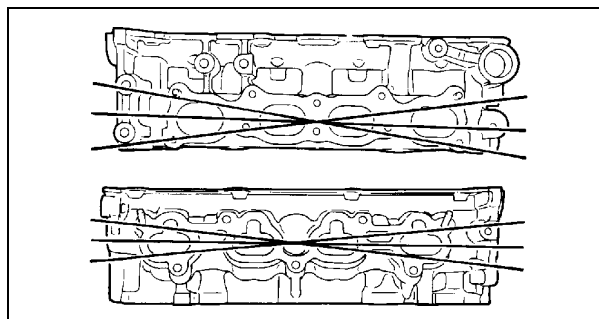


AME2224E317

4. Measure the manifold contact surface distortion as shown.
 - If the distortion exceeds the maximum, grind the surface or replace the cylinder head.

Maximum distortion:
0.10 mm {0.004 in}

Maximum grinding:
0.15 mm {0.006 in}



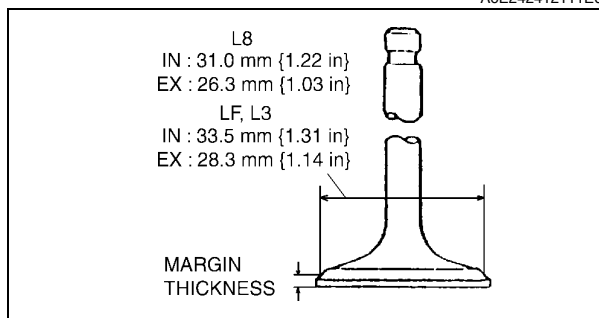
AME2224E318

VALVE, VALVE GUIDE INSPECTION

1. Measure the valve head margin thickness of each valve.
 - If not specified, replace the valve.

Margin thickness:
IN: 1.62 mm {0.0637 in}
EX: 1.82 mm {0.0716 in}

A6E242412111E01

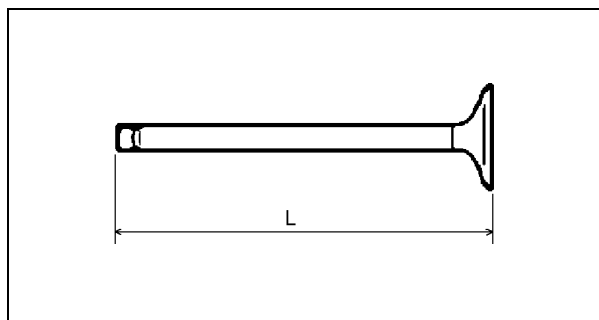


AME2224E070

2. Measure the length of each valve. Replace the valve if necessary.
 - If not specified, replace the valve.

Standard length L:
IN: 102.99—103.79 mm {4.055—4.086 in}
EX: 104.25—105.05 mm {4.105—4.135 in}

Minimum length L:
IN: 102.99 mm {4.055 in}
EX: 103.79 mm {4.086 in}



AME2224E071

ENGINE

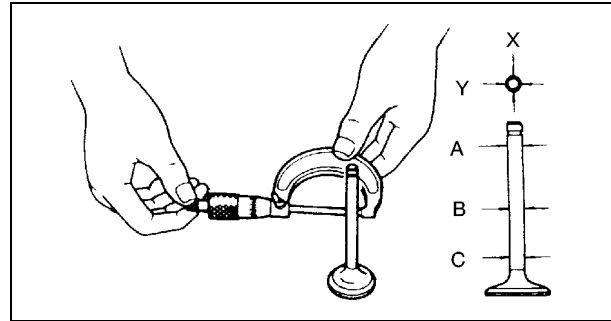
3. Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) as indicated in the figure.
- If not as specified, replace the valve.

Standard diameter:

IN: 5.470—5.485 mm {0.2154—0.2159 in}
EX: 5.465—5.480 mm {0.2152—0.2157 in}

Maximum diameter:

IN: 5.440 mm {0.2142 in}
EX: 5.435 mm {0.2140 in}

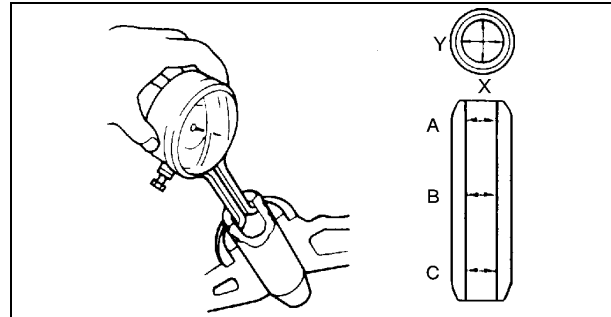


AME2224E313

4. Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) as indicated in the figure.
- If not as specified, replace the valve guide.

Standard Inner diameter:

IN: 5.509—5.539 mm {0.2169—0.2180 in}
EX: 5.509—5.539 mm {0.2169—0.2180 in}



AME2224E314

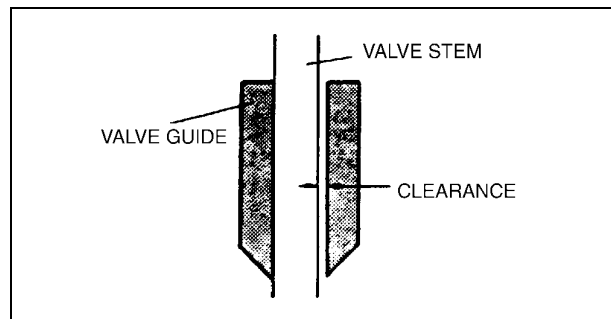
5. Calculate the valve stem to guide clearance by subtracting the outer diameter of the valve stem from the inner diameter of the corresponding valve guide.
- If not as specified, replace the valve and/or the valve guide.

Standard clearance:

IN: 0.024—0.069 mm {0.0009—0.0027 in}
EX: 0.029—0.074 mm {0.0012—0.0029 in}

Maximum clearance:

0.10 mm {0.004 in}

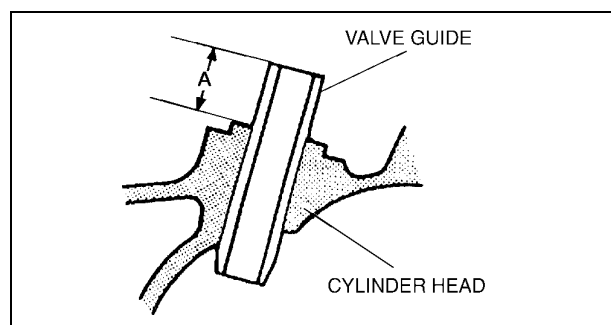


AME2224E315

6. Measure the protrusion height (dimension A) of each valve guide without lower valve spring seat.
- If not as specified, replace the valve guide.

Standard diameter:

IN: 12.2—12.8 mm {0.481—0.503 in}
EX: 12.2—12.8 mm {0.481—0.503 in}



AME2224E073

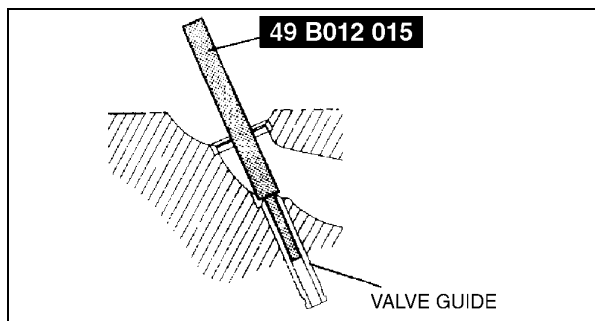
ENGINE

VALVE GUIDE REPLACEMENT

A6E242412111E04

Valve Guide Removal

1. Remove the valve guide from the combustion chamber side using the **SST**.



AME2224E312

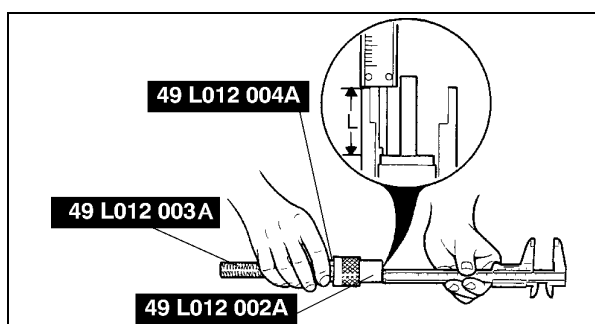
Valve Guide Installation

1. Assemble the SSTs so that depth L is as specified.

Depth L:

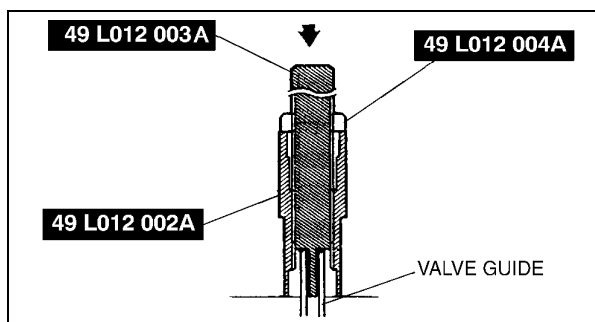
IN: 12.2—12.8 mm {0.481—0.501 in}

EX: 12.2—12.8 mm {0.481—0.501 in}



AME2224E107

2. Tap the valve guide in from the side opposite the camshaft side until the **SSTs** contacts the cylinder head.



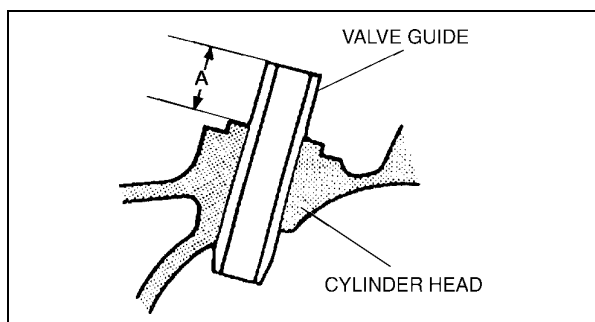
AME2224E018

3. Verify that the valve guide projection height (dimension A) is within the specification.

Standard height:

IN: 12.2—12.8 mm {0.481—0.501 in}

EX: 12.2—12.8 mm {0.481—0.501 in}



AME2224E073

ENGINE

VALVE SEAT INSPECTION/REPAIR

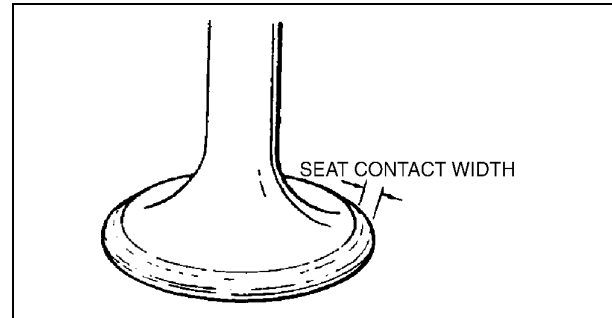
A6E242410102E01

1. Measure the seat contact width.
 - If necessary, resurface the valve seat using a 45° valve seat cutter and/or resurface the valve face.

Standard width:

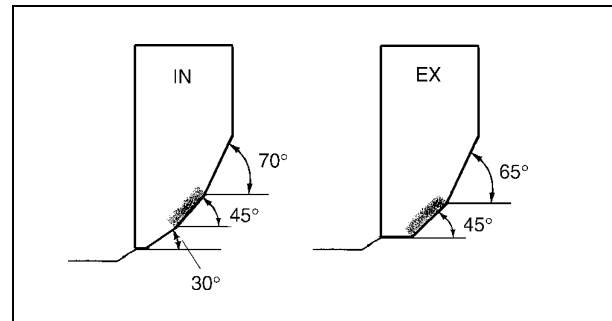
1.2—1.6 mm {0.048—0.062 in}

2. Verify that the valve seating position is at the center of the valve face.



AME2224E316

- (1) If the seating position is too out side, correct the valve seat using a 70° (IN) or 65° (EX) cutter, and a 45° cutter.
- (2) If the seating position is too inner side, correct the valve seat using a 30° (IN) cutter, and a 45° cutter.



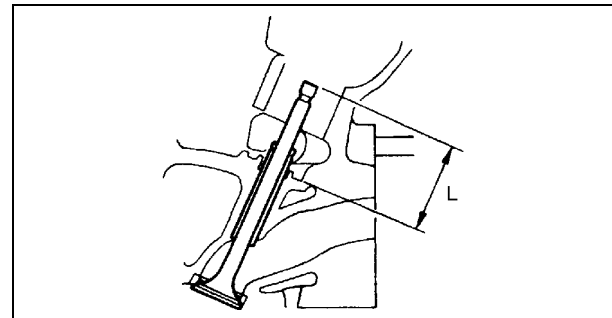
AME2224E020

3. Inspect the sinking of the valve seat. Measure the protruding length (dimension L) of the valve stem.
 - If not specified, replace the cylinder head.

Standard dimension L:

IN: 40.64—42.24 mm {1.600—1.662 in}

EX: 40.50—42.10 mm {1.595—1.657 in}



AME2224E079

VALVE SPRING INSPECTION

A6E242412125E01

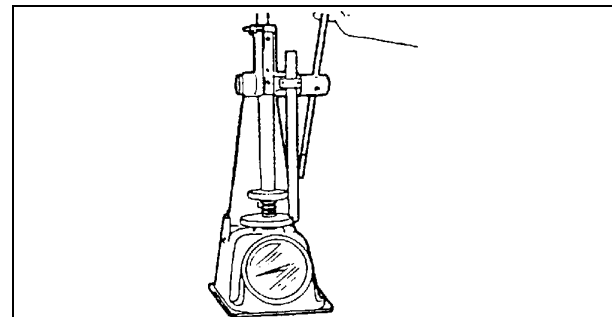
1. Apply pressing force to the pressure spring and inspect the spring height.
 - If not as specified, replace the valve spring.

Pressing force:

494.9 N {50.47 kgf, 111.2 lbf}

Standard height:

27.80 mm {1.094 in}

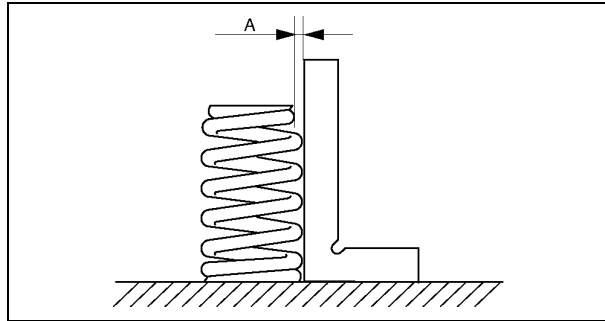


AME2224E308

ENGINE

2. Measure the out-of-square of the valve spring, using a square, as shown.
 - (1) Rotate the valve spring one full turn and measure "A" at the point where the gap is the largest.
 - If not as specified, replace the valve spring.

Valve spring maximum out-of-square:
1% (2.10 mm {0.0826 in})

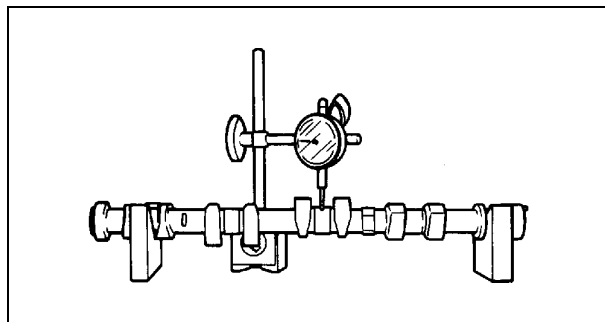


AME2224E309

CAMSHAFT INSPECTION

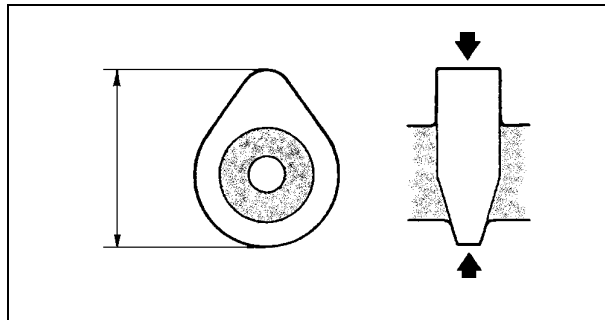
1. Set the No.1 and No.5 journals on V-blocks.
2. Measure the camshaft runout.
 - If not as specified, replace the camshaft.

Maximum runout:
0.03 mm {0.0012 in}



AME2224E082

3. Measure the cam lobe height at the two points as shown.
 - If not as specified, replace the camshaft.



AME2224E343

Standard height (mm) {in}

Camshaft	L8	LF, L3	L3 (with variable valve timing mechanism)
INT	40.79 {1.606}	42.12 {1.659}	42.44 {1.671}
EXH	41.08 {1.618}	41.08 {1.618}	41.18 {1.622}

Minimum height (mm) {in}

Camshaft	L8	LF, L3	L3 (with variable valve timing mechanism)
INT	40.692 {1.603}	42.022 {1.655}	42.342 {1.667}
EXH	40.982 {1.614}	40.982 {1.614}	41.082 {1.618}

ENGINE

4. Measure the journal diameters in X and Y directions at the two points (A and B) as indicated in the figure.
- If not as specified, replace the camshaft.

Standard diameter:

24.96—24.98 mm {0.9827—0.9834 in}

Minimum diameter:

24.95 mm {0.982 in}

5. Remove the tappet.
6. Position plasticgag atop the journals in the axial direction.
7. Install the camshaft cap. (See [B-40 Camshaft Assembly Note](#).)
8. Remove the camshaft cap. (See [B-6 Camshaft Cap Disassembly Note](#).)
9. Measure the oil clearance.
- If not as specified, replace the cylinder head.

Standard clearance:

0.04—0.08 mm {0.002—0.003 in}

Maximum clearance:

0.09 mm {0.0035 in}

10. Install the camshaft cap. (See [B-40 Camshaft Assembly Note](#))

11. Measure the camshaft end play.
- If not as specified, replace the cylinder head or camshaft.

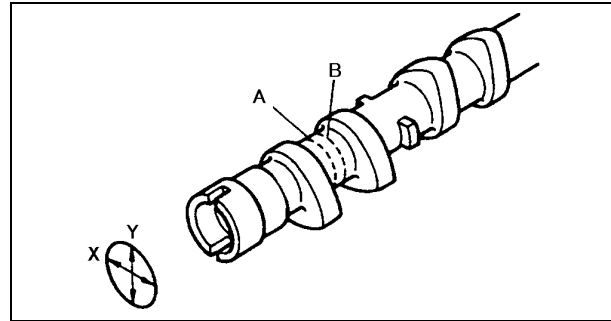
Standard end play:

0.09—0.24 mm {0.0035—0.0094 in}

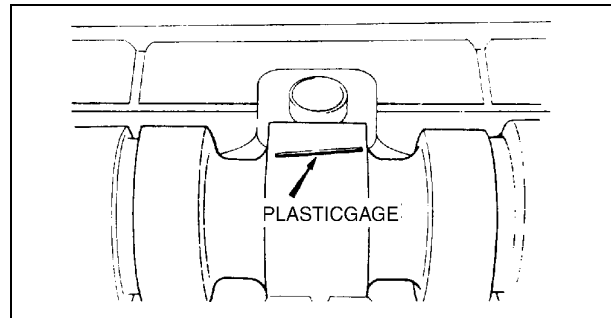
Maximum end play:

0.25 mm {0.0099 in}

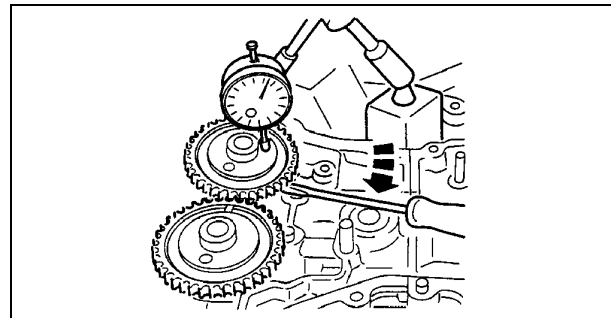
12. Remove the camshaft cap. (See [B-6 Camshaft Cap Disassembly Note](#).)



AME2224E344



AME2224E307



AME2224E025

B

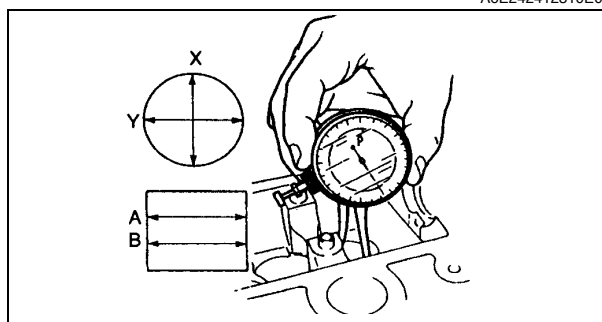
ENGINE

TAPPET INSPECTION

1. Measure the tappet hole inner diameter in X and Y directions at the two points (A and B) shown.

Inner diameter:

31.000—31.030 mm {1.2205—1.2216 in}



AME2224E319

2. Measure the tappet body outer diameter in X and Y directions at the two points (A and B) shown.

Outer diameter:

30.970—30.980 mm {1.2193—1.2196 in}

3. Subtract the tappet body outer diameter from the tappet hole inner diameter.
 - If not as specified, replace the tappet or cylinder head.

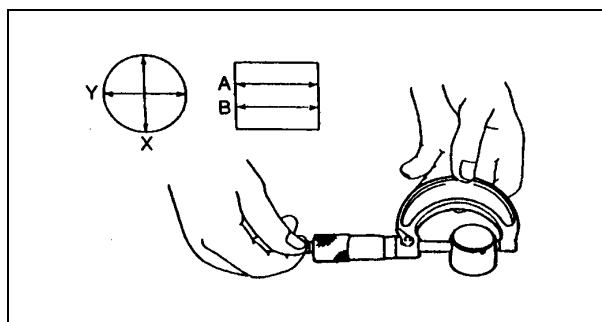
Clearance

Standard:

0.02—0.06 mm {0.0008—0.0023 in}

Maximum:

0.15 mm {0.006 in}



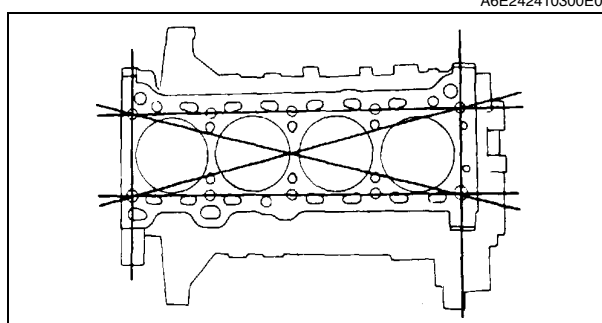
AME2224E320

CYLINDER BLOCK INSPECTION

1. Measure the distortion of the cylinder block top surface in the six directions as indicated in the figure.
 - If the distortion exceeds the maximum, replace the cylinder block.

Maximum cylinder block distortion:

0.10 mm {0.004 in}



AME2224E089

2. Measure the cylinder bores in X and Y directions at 42 mm {1.65 in} below the top surface.
 - If the cylinder bore exceeds the wear limit, replace the cylinder block.

Standard diameter limit

L8:

83.000—83.030 mm {3.2677—3.2689 in}

LF, L3, L3 (with variable valve timing mechanism):

87.500—87.530 mm {3.4449—3.4460 in}

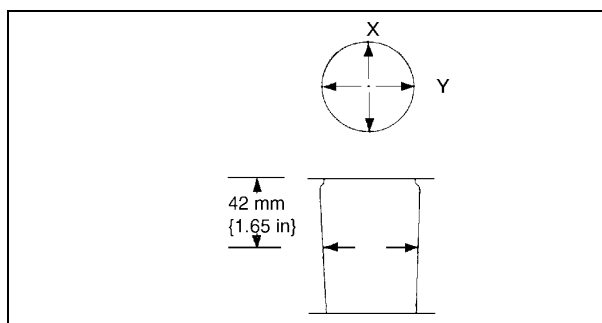
Minimum / maximum bore diameter limit

L8:

82.940—83.090 mm {3.2653—3.2712 in}

LF, L3, L3 (with variable valve timing mechanism):

87.440—87.590 mm {3.4425—3.4484 in}



AME2224E090

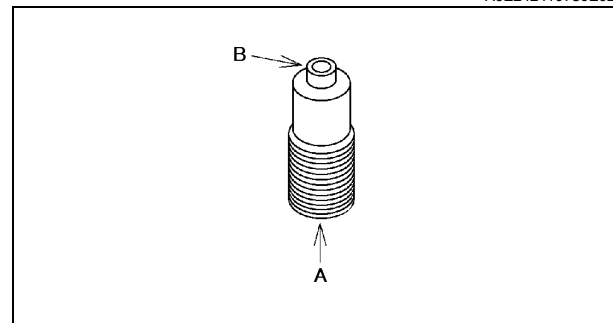
ENGINE

OIL JET VALVE INSPECTION

1. Apply compressed air to oil jet valve A and verify that air passes through oil jet valve B.
 - If not ventilation, replace the oil jet valve.

Air pressure:

216—274 kPa {2.2—2.7kgf·cm² 31.4—39.7 psi}



AME2224E105

B

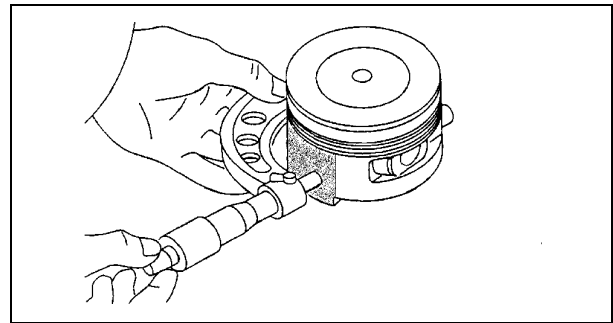
PISTON INSPECTION

A6E242411010E01

Caution

- The piston, piston ring and connecting rod cannot be disassembled.
- When replacing the piston, piston pin, piston ring and connecting rod, replace them together as a single unit.

1. Measure the outer diameter of each piston at right angle 90° to the piston pin, 10.0 mm {0.40 in} above the under of the piston.
 - If the piston diameter is below the standard diameter, replace the piston, piston pin, piston ring and connecting rod as a single unit.



AME2224E030

Piston diameter

L8:

82.965—82.995 mm {3.2664—3.2675 in}

LF, L3, L3 (with variable valve timing mechanism):

87.465—87.495 mm {3.4435—3.4446 in}

2. Measure the piston-to-cylinder clearance.
 - If not as specified, replace the piston, piston pin, piston ring and connecting rod as a single unit.

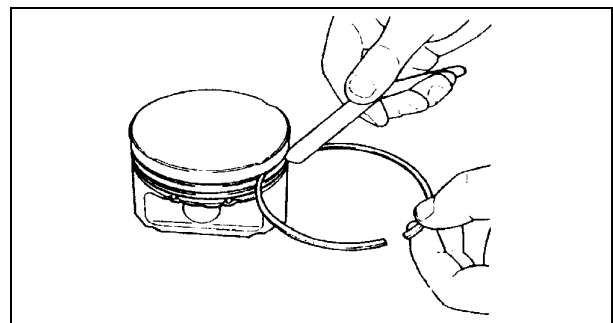
Standard clearance:

0.025—0.045 mm {0.0010—0.0017 in}

Maximum clearance:

0.11 mm {0.0043 in}

3. Measure the piston ring-to-ring groove clearance around the entire circumference.
 - If the piston ring-to-ring groove clearance exceeds the maximum clearance, replace the piston, piston pin, piston ring and connecting rod as a single unit.



AME2224E029

Standard clearance:

Top: 0.03—0.08 mm {0.0012—0.0031 in}

Second: 0.03—0.07 mm {0.0012—0.0027 in}

Oil: 0.03—0.07 mm {0.0012—0.0027 in}

Maximum clearance:

Top: 0.17 mm {0.0067 in}

Second, Oil: 0.15 mm {0.0059 in}

ENGINE

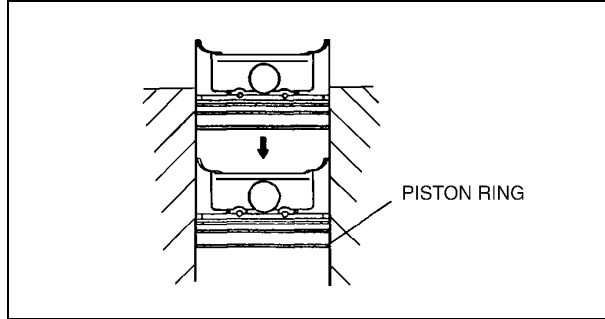
4. Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
5. Measure each piston ring end gap with a feeler gauge.
 - If the piston ring end gap exceeds the maximum end gap, replace the piston, piston pin, piston ring and connecting rod as a single unit.

Standard end gap:

Top: 0.16—0.31 mm {0.0063—0.012 in}
Second: 0.33—0.48 mm {0.0130—0.0189 in}
Oil (rail): 0.20—0.70 mm {0.0079—0.0275 in}

Maximum end gap:

1.0 mm {0.0393 in}



AME2224E104

CRANKSHAFT INSPECTION

1. Install the main bearing cap. (See [B-30 Main Bearing Caps Assembly Note.](#))
2. Measure the crankshaft end play.
 - If not as specified, replace the thrust bearing or crankshaft so that the specified end play is obtained.

Standard end play:

0.22—0.45 mm {0.0087—0.0177 in}

Maximum end play:

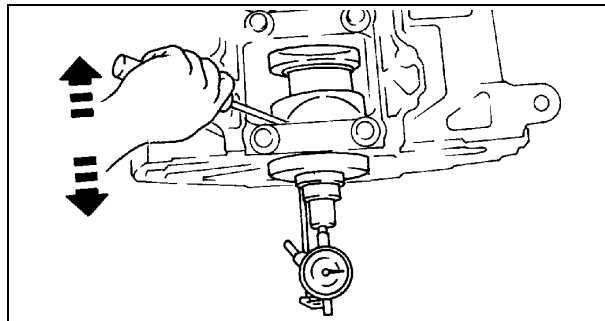
0.55 mm {0.022 in}

3. Remove the main bearing cap. (See [B-11 Main Bearing Cap Disassembly Note.](#))
4. Measure the crankshaft runout.
 - If the crankshaft runout exceeds the maximum runout, replace the crankshaft.

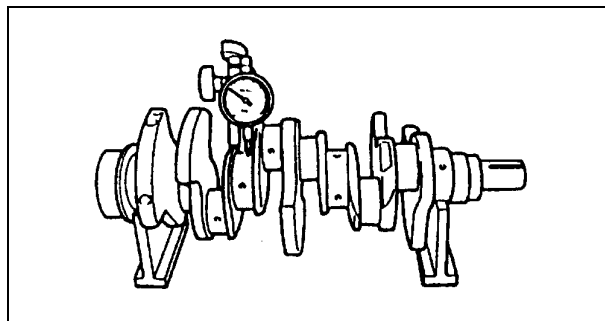
Maximum runout:

0.05 mm {0.0019 in}

L8, LF

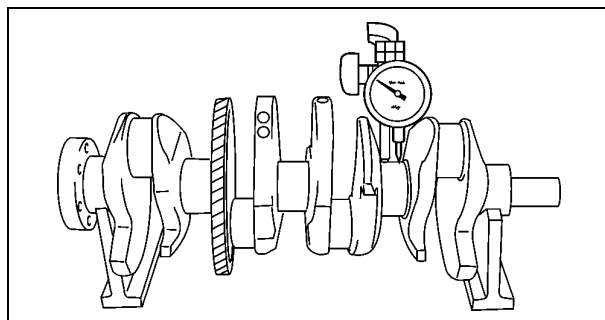


AME2224E034



AME2224E035

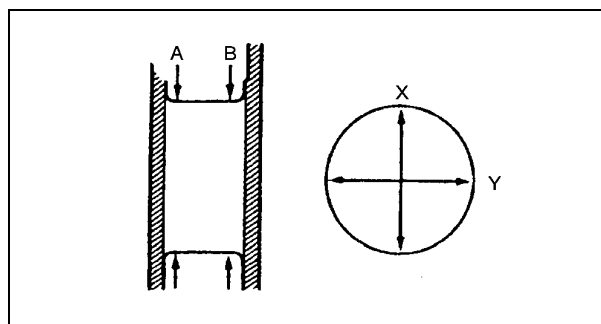
L3, L3 (with variable valve timing mechanism)



AME2224E311

ENGINE

5. Measure the journal diameter in X and Y directions at the two points (A and B) as indicated in the figure.
 - If not as specified, replace the crankshaft or grind the journal and install the undersize bearing.



AME2224E036

Main journal

mm {in}

Bearing size	Standard diameter
Standard	51.980—52.000 {2.0464—2.0472}
0.25 {0.01} undersize	51.730—51.750 {2.0366—2.0373}

Maximum out-of-round:
0.05 mm {0.0019 in}

Crank pin

mm {in}

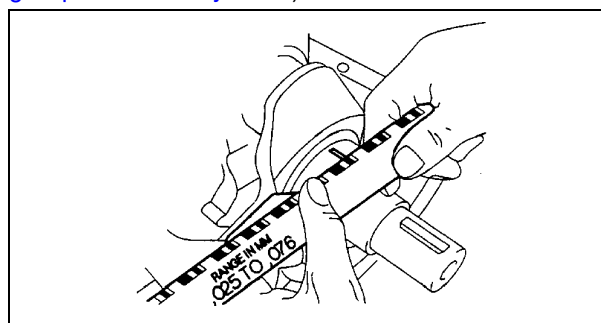
Bearing size	Standard diameter
Standard	49.980—50.000 {1.9677—1.9685}
0.25 {0.01} undersize	49.730—49.750 {1.9579—1.9586}

Maximum out-of-round:
0.05 mm {0.0019 in}

6. Install the main bearing caps and crankshaft.
7. Position a plastigage atop the journals in the axial direction.
8. Install the main bearing caps and cylinder block. (See [B-30 Main Bearing Caps Assembly Note](#).)
9. Remove the main bearing caps. (See [B-11 Main Bearing Cap Disassembly Note](#).)
10. Measure the main journal oil clearance.
 - If the clearance exceeds the maximum, replace the main bearing using the main bearing selection table or grind the main journal and install the oversize bearings so that the specified oil clearance is obtained.

Standard clearance:
0.019—0.035 mm {0.0007—0.0013 in}

Maximum clearance:
0.10 mm {0.0039 in}



AME2224E038

mm {in}

Bearing size	Color	Bearing thickness
Standard	Green	2.506—2.509 {0.0987—0.0988}
0.25 {0.01} oversize		2.628—2.634 {0.1034—0.1037}
0.50 {0.02} oversize		2.753—2.759 {0.1084—0.1086}

ENGINE

CONNECTING ROD INSPECTION

A6E242411211E01

Caution

- The piston, piston ring and connecting rod cannot be disassembled.
- When replacing the piston, piston pin, piston ring and connecting rod, replace them together as a single unit.

1. Install the connecting rod cap. (See [B-31 Connecting Rod Cap Assembly Note](#).)
2. Measure the connecting rod large end side clearance.

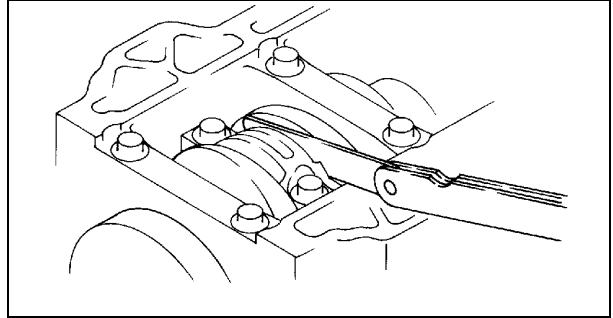
- If the connecting rod large end side clearance exceeds the maximum clearance, replace the piston, piston pin, piston ring and connecting rod as a single unit.

Standard clearance:

0.14–0.36 mm {0.0056–0.0141 in}

Maximum clearance:

0.435 mm {0.0172 in}



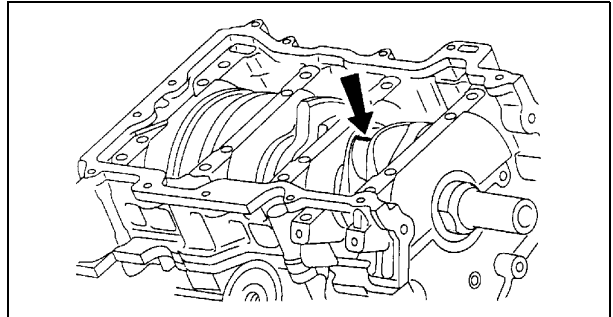
3. Remove the connecting rod cap.
4. Position plastigage atop the journals in the axial direction.
5. Install the connecting rod bearing and connecting rod cap. (See [B-31 Connecting Rod Cap Assembly Note](#).)
6. Remove the connecting rod cap.
7. Measure the connecting rod oil clearance.
 - If not as specified, replace the connecting rod bearing or grind the crank pin and use oversize bearings so that the specified clearance is obtained.

Standard clearance:

0.026–0.052 mm {0.0011–0.0020 in}

Maximum clearance:

0.1 mm {0.0039 in}



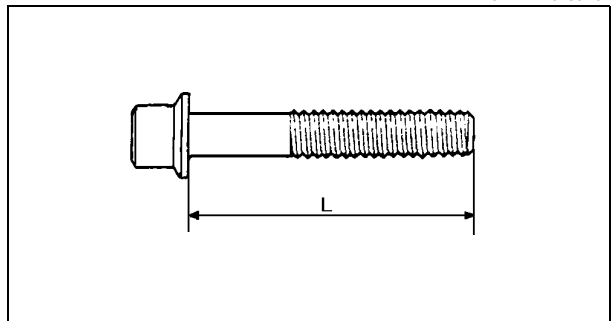
mm {in}

Bearing size	Color	Bearing thickness
Standard	Green	1.496–1.502 {0.0589–0.0591}
0.50 {0.02} oversize		1.748–1.754 {0.0688–0.0690}
0.25 {0.01} oversize		1.623–1.629 {0.0639–0.0641}

BOLT INSPECTION

A6E242410135E01

1. Measure the length of each bolt.
 - Replace any that exceeds maximum length.



ENGINE

Length L

bolt	Standard (mm) {in}	Maximum (mm) {in}
Cylinder head bolt	149.0—150 {5.86—5.90}	150.5 {5.92}
Connecting rod bolt	44.7—45.3 {1.75—1.78}	46.0 {1.81}
Main bearing cap bolt	110.0—110.6 {4.33—4.35}	111.3 {4.38}

B

VARIABLE VALVE TIMING ACTUATOR INSPECTION

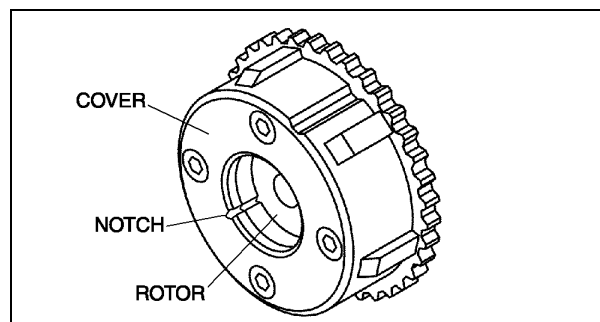
A6E242400142E02

L3 (with variable valve timing mechanism)

Caution

- Variable valve timing actuator can not be disassembled it is a precision unit /

- Confirm that notch of the rotor and bump of the cover at the variable valve timing actuator are aligned and fitted.
 - If the notch and the bump are not aligned, rotate the rotor toward the bulb timing retard position by hand until they are in place.
 - If the rotor and cover are not secured even though their notch and groove are aligned, replace the variable valve timing actuator.



A6E2224E342

OIL CONTROL VALVE (OCV) INSPECTION

A6E242414420E02

L3 (with variable valve timing mechanism)

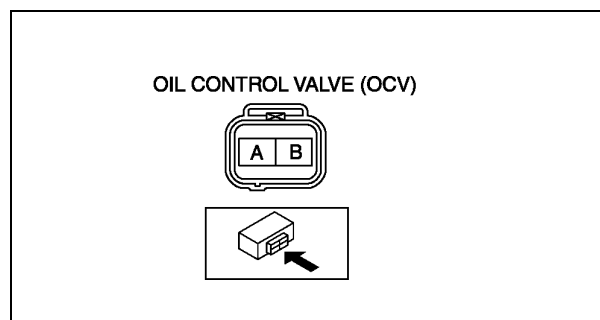
Coil resistance inspection

- Disconnect the negative battery cable.
- Disconnect the oil control valve (OCV) connector.
- Measure the resistance between terminals A and B using an ohmmeter.
 - If not as specified, replace the oil control valve (OCV).

Specification

6.9—7.9 ohms

- Connect the oil control valve (OCV) connector.

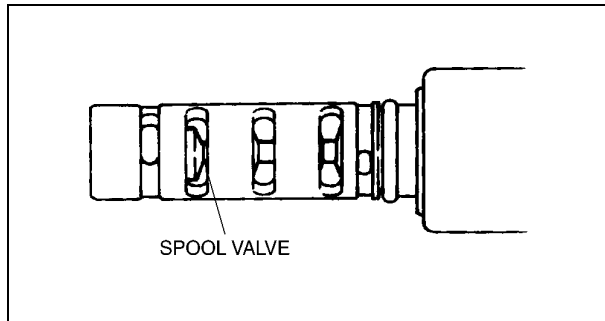


A6E2226W002

ENGINE

Spool valve operation inspection

1. Disconnect the negative battery cable.
2. Remove the oil control valve (OCV).
3. Verify that the spool valve in the oil control valve (OCV) is in the maximum valve timing retard position as indicated in the figure.
 - If not as specified, replace the oil control valve (OCV).
4. Verify that the battery is fully charged.
 - If not as specified, recharge the battery.

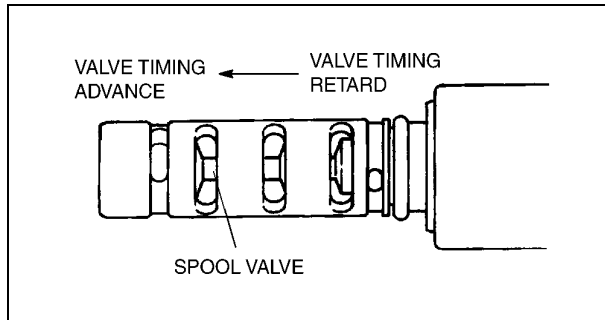


AME2226W003

5. Apply battery positive voltage between the oil control valve (OCV) terminals and verify that the spool valve operates and moves to the maximum valve timing advance position.
 - If not as specified, replace the oil control valve (OCV).

Note

- When applying battery positive voltage between the oil control valve (OCV) terminals, the connection can be either of the following:
 - Positive battery cable to terminal A, negative battery cable to terminal B
 - Positive battery cable to terminal B, negative battery cable to terminal A



AME2226W004

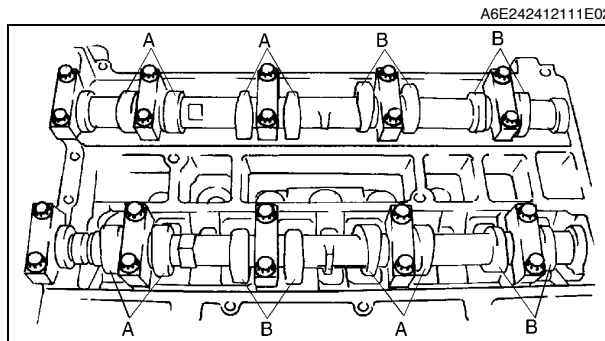
6. Stop applying battery positive voltage and verify that the spool valve returns to the maximum valve timing retard position.
 - If not as specified, replace the oil control valve (OCV).

VALVE CLEARANCE INSPECTION

1. Measure the valve clearance as follows.
 - (1) Turn the crankshaft clockwise so that the No.1 piston is at TDC of the compression stroke.
 - (2) Measure the valve clearance at A in the figure.
 - If the valve clearance exceeds the space the tappet. (See [B-25 VALVE CLEARANCE ADJUSTMENT](#).)

Note

- Make sure to note the measured values for choosing the suitable replacement tappets.



AME2212W001

Standard [Engine cold]

IN: 0.22—0.28 mm {0.0087—0.0110 in} (0.25±0.03 mm {0.0098±0.0011 in})

EX: 0.27—0.33 mm {0.0106—0.0130 in} (0.30±0.03 mm {0.0118±0.0011 in})

- (3) Turn the crankshaft 360° clockwise so that the No.4 piston is at TDC of the compression stroke.
- (4) Measure the valve clearance at B in the figure.
 - If the valve clearance exceeds the standard, replace the tappet. (See [B-25 VALVE CLEARANCE ADJUSTMENT](#).)

Note

- Make sure to note the measured values for choosing the suitable replacement tappets.

Standard [Engine cold]

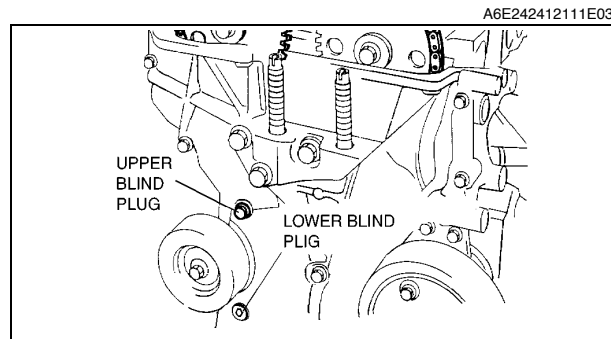
IN: 0.22—0.28 mm {0.0087—0.0110 in} (0.25±0.03 mm {0.0098±0.0011 in})

EX: 0.27—0.33 mm {0.0106—0.0130 in} (0.30±0.03 mm {0.0118±0.0011 in})

ENGINE

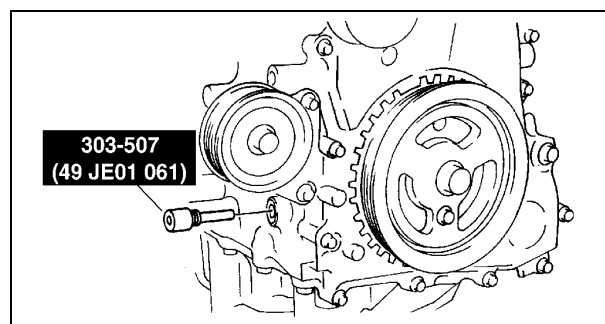
VALVE CLEARANCE ADJUSTMENT

1. Remove the engine front cover lower blind plug.
2. Remove the engine front cover upper blind plug.
3. Remove the cylinder block lower blind plug.



B

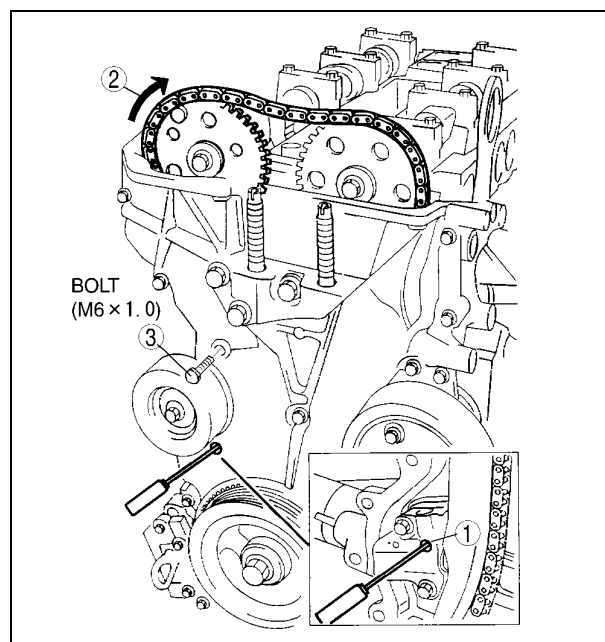
4. Install the SST as shown.
5. Turn the crankshaft clockwise the crankshaft is in the No.1 cylinder TDC position.



AMJ2212E004

AME2212W004

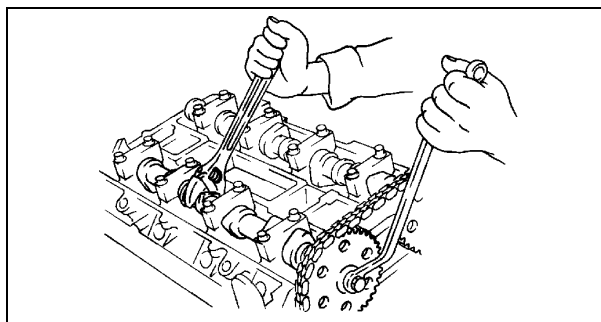
6. Loosen the timing chain.
 - (1) Using a suitable screwdriver or equivalent tool, unlock the chain tensioner ratchet.
 - (2) Turn the exhaust camshaft clockwise using a suitable wrench on the cast hexagon and loosened the timing chain.
 - (3) Placing the suitable bolt (**M6 X 1.0 Length 25—35 mm {0.9—1.3 in}**) at the engine front cover upper blind plug, secure the chain guide at the position where the tension is released.



AME2212W005

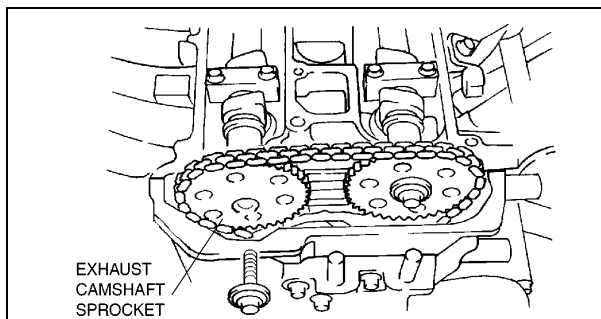
ENGINE

7. Hold the exhaust camshaft using a suitable wrench on the cast hexagon as shown.



AME2212W006

8. Remove the exhaust camshaft sprocket.

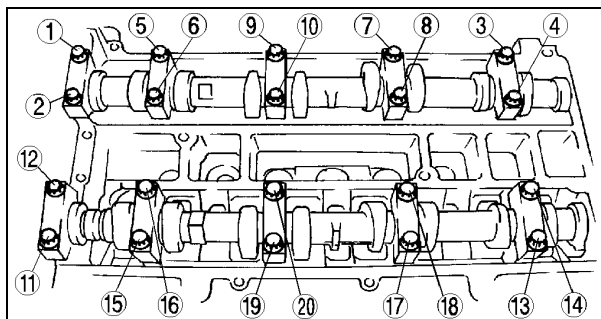


AME2212W007

9. Loosen the camshaft cap bolts in several passes in the order shown.

Note

- The cylinder head and the camshaft caps are numbered to make sure they are reassembled in their original position. When removed, keep the caps with the cylinder head they were removed from. Do not mix the caps.



AME2212W008

10. Remove the camshaft.
11. Remove the tappet.
12. Select proper adjustment shim.

New adjustment shim

= Removed shim thickness + Measured valve clearance - Standard valve clearance (IN: 0.25 mm {0.0098 in}, EX: 0.30 mm {0.0118 in})

Standard [Engine cold]

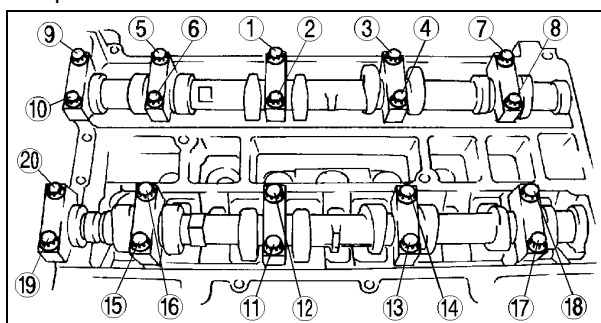
IN: 0.22—0.28 mm {0.0087—0.0110 in} (0.25±0.03 mm {0.0098±0.0011 in})

EX: 0.27—0.33 mm {0.0106—0.0130 in} (0.30±0.03 mm {0.0118±0.0011 in})

13. Install the camshaft with No.1 cylinder aligned with the TDC position.

14. Tighten the camshaft cap bolt using the following two steps.

- (1) Tighten to 5.0—9.0 N·m {51.0—91.7 kgf·cm, 44.3—79.5 in·lbf}.
- (2) Tighten to 14.0—17.0 N·m {1.5—1.7 kgf·m, 10.4—12.5 ft·lbf}.



AME2212W009

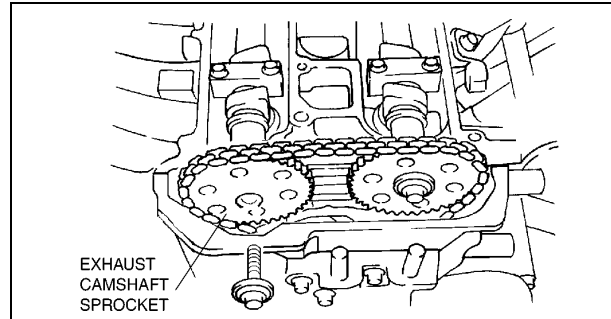
ENGINE

15. Install the exhaust camshaft sprocket.

Note

- Do not tighten the bolt for the camshaft sprocket during this step. First confirm the valve timing, then tighten the bolt.

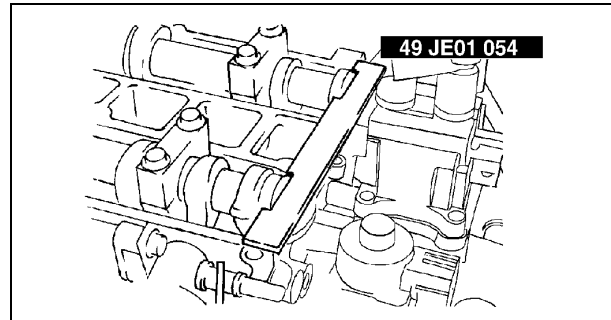
16. Install the **SST** to the camshaft as shown.



AME2212W007

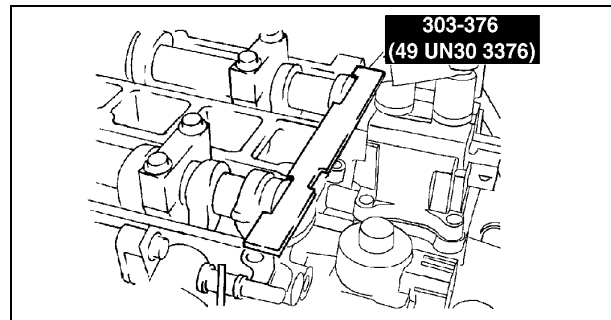
B

Europe



AME2212W010

Except Europe



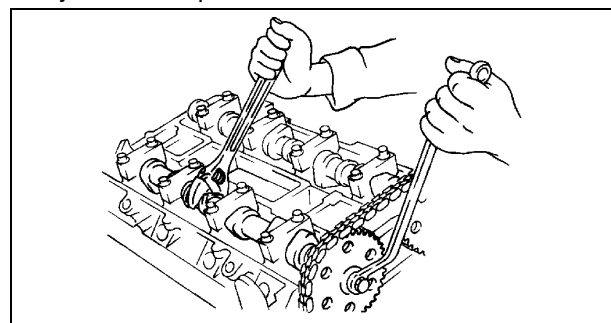
AME2212W011

17. Remove the M6 x 1.0 bolt from the engine front cover to apply tension to the timing chain.
18. Turn the crankshaft clockwise the crankshaft is in the No.1 cylinder TDC position.
19. Hold the exhaust camshaft using a suitable wrench on the cast hexagon as shown.
20. Tighten the exhaust camshaft sprocket lock bolt

Tightening torque

69—75 N·m {7.10—7.6 kgf·m,
50.9—55.3 ft·lbf}

21. Remove the **SST** from the camshaft.
22. Remove the **SST** from the block lower blind plug.
23. Rotate the crankshaft clockwise two turns until the TDC position.
• If not aligned, loosen the crankshaft pulley lock bolt and repeat from Step 14.
24. Apply silicone sealant to the engine front cover upper blind plug.

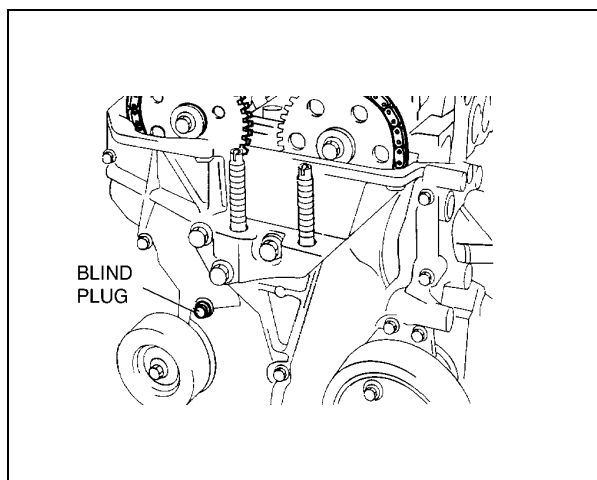


AME2212W006

ENGINE

25. Install the engine front cover upper blind plug.

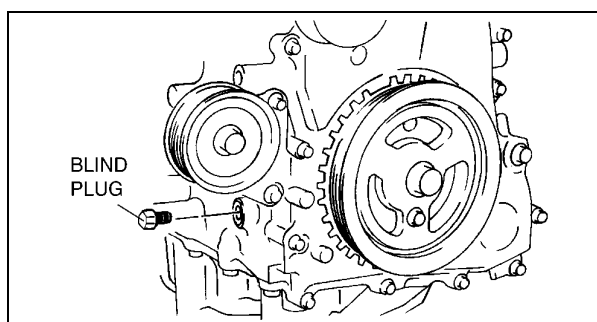
Tightening torque:
10 N·m {1.0 kgf·m, 7.4 ft·lbf}



AME2212W003

26. Install the cylinder block lower blind plug.

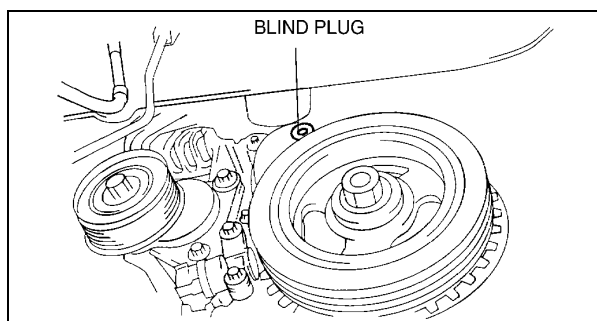
Tightening torque:
20 N·m {2.0 kgf·m, 14.8 ft·lbf}



AME2212W012

27. Install the new engine front cover lower blind plug.

Tightening torque:
12 N·m {1.2 kgf·m, 8.9 ft·lbf}



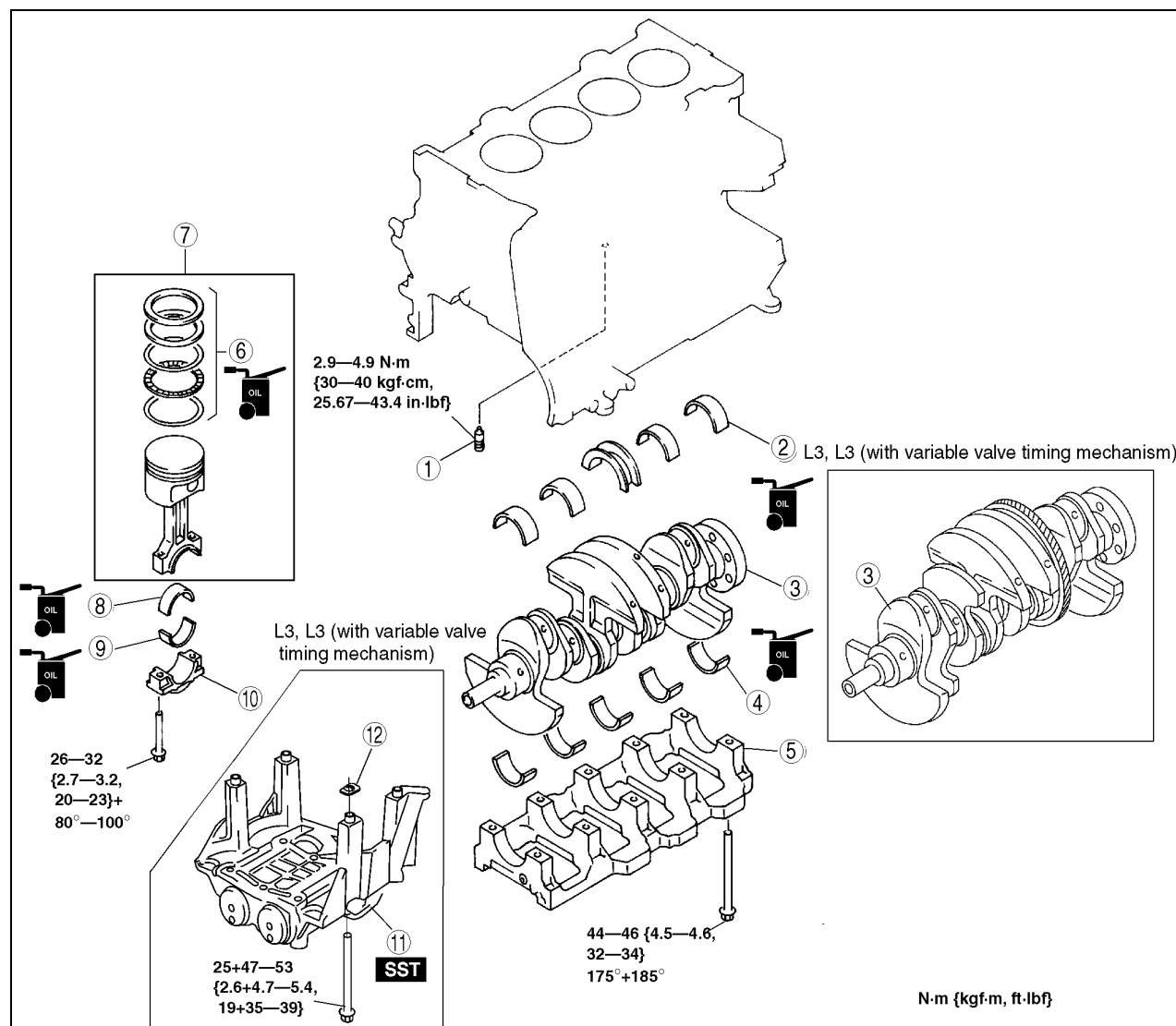
AME2212W002

ENGINE

CYLINDER BLOCK (I) ASSEMBLY

A6E242402000E09

1. Assemble in the order indicated in the table.



AME2224E039

1	Oil jet valve
2	Upper main bearing, thrust bearing
3	Crankshaft
4	Lower main bearing, thrust bearing
5	Main bearing cap (See B-30 Main Bearing Caps Assembly Note)
6	Piston ring (See B-30 Piston Ring Assembly Note)
7	Connecting rod, Piston assembly (See B-30 Piston Assembly Note)

8	Upper connecting rod bearing (See B-31 Connecting Rod Bearing Assembly Note)
9	Lower connecting rod bearing (See B-31 Connecting Rod Bearing Assembly Note)
10	Connecting rod cap (See B-31 Connecting Rod Cap Assembly Note)
11	Engine balancer (L3 (with variable valve timing mechanism)) (See B-31 Balancer Unit Assembly Note)
12	Adjustment shim

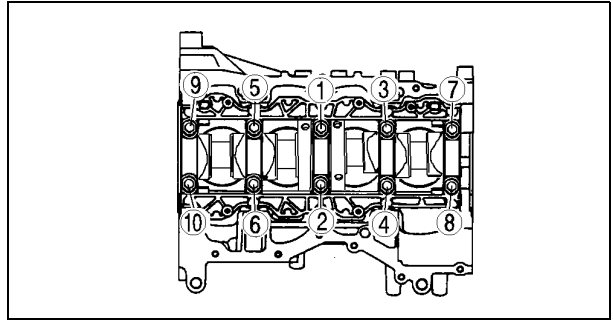
ENGINE

Main Bearing Caps Assembly Note

1. Install the main bearing caps in the order indicated in the figure.

Tightening torque:

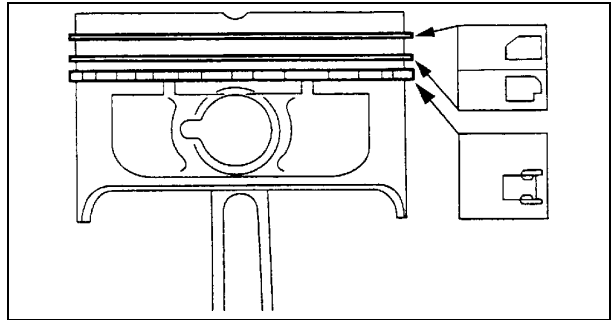
- (1) 44—46 N·m
{4.5—4.6 kgf·m, 32.5—33.9 ft·lbf}
- (2) 175°—185°



AME2224E052

Piston Ring Assembly Note

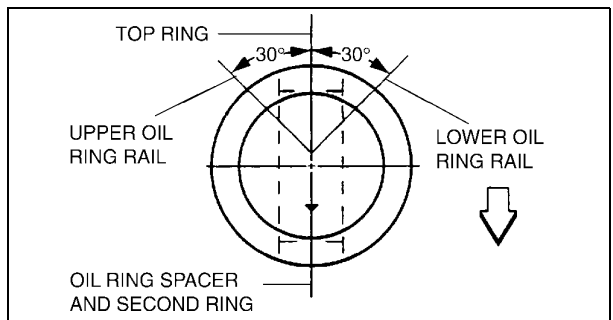
1. Install the two oil control ring segments and spacer.
2. Verify that the second ring is installed with scraper face side downward.
3. Verify that the top ring is installed with scraper face side inner of upper.



AME2224E322

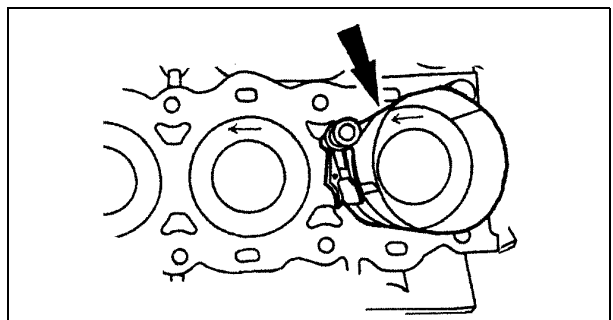
Piston Assembly Note

1. Position the end gap of each ring as indicated in the figure.



AME2224E323

2. Insert the piston and connecting rod into the cylinder with the arrow mark to front of the engine.

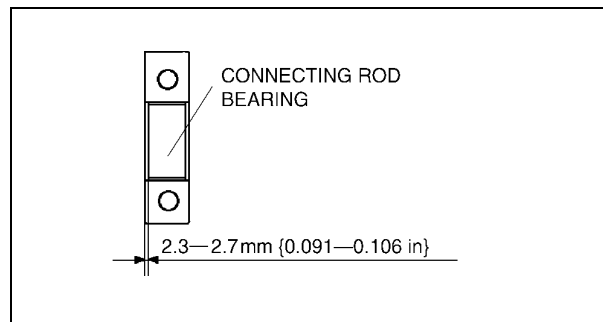


AME2224E042

ENGINE

Connecting Rod Bearing Assembly Note

1. Install the connecting rod bearing to the connecting rod and connecting rod caps, as shown in the figure.



AME2224E053

Connecting Rod Cap Assembly Note

Caution

- When assembling the connecting rod caps, align the broken, rough faces of the connecting rods and connecting rod caps.

1. Tighten the connecting rod bolts in two steps.

Tightening torque:

- (1) 26—32 N·m
{2.7—3.2 kgf·m, 19.2—23.6 ft·lbf}
- (2) 80°—100°

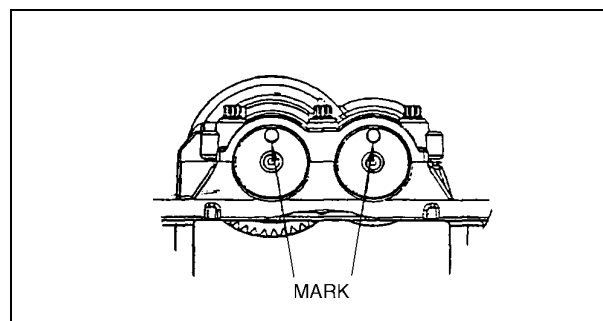
Balancer Unit Assembly Note

1. Confirm by visual inspection that there is no damage to the balancer unit gear and verify that the shaft turns smoothly.
 - If there is any damage or malfunction, replace the balancer unit.

Caution

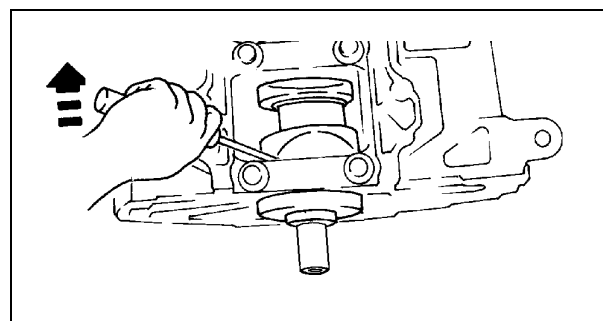
- Due to the precision interior construction of the balancer unit, it cannot be disassembled.

2. Rotate the crankshaft clockwise and align the No. 1 cylinder to the TDC.
3. Install the adjustment shim to the seat face of the balancer unit.
4. With the balancer unit marks at the exact top center, assemble the unit to the cylinder block.



AME2224E061

5. Insert a screwdriver into the crankshaft No. 1 crankweight area and set both the rotation and the thrust direction with the screwdriver, using a prying action, as shown.

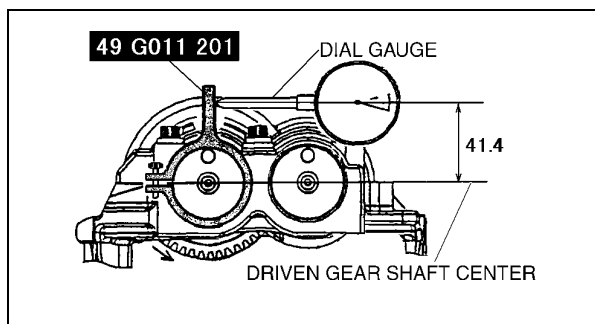


ENGINE

6. Set the SST as shown, then measure the gear backlash using a dial gauge.
- If the backlash exceeds the specified range, remeasure the backlash and, using the adjustment shim selection table, select the proper shim, according to the following procedure.

Caution

- When measuring the backlash, rotate the crankshaft one full rotation and verify that it is within the specified range at all of the following six positions: 10°, 30°, 100°, 190°, 210°, 280° ATDC.



AME2224E060

Value range:

0.005—0.101 mm {0.00019—0.0039 in}

- Using master adjustment shim (No.50), assemble the balancer unit to the cylinder block, then measure the backlash.
- Select the proper adjustment shim according to the measured value.
- Install the selected adjustment shim to the balancer unit, then assemble the balancer unit to the cylinder block.

Adjustment shim selection table

Backlash mm {in}	Selection shim (No.)	Shim thickness mm {in}	Backlash mm {in}	Selection shim (No.)	Shim thickness mm {in}
0.256—0.262 {0.0100—0.01031}	15	1.15 {0.0452}	0.116—0.122 {0.00456—0.00480}	35	1.35 {0.0531}
0.249—0.255 {0.0098—0.010039}	16	1.16 {0.0456}	0.109—0.115 {0.00429—0.00452}	36	1.36 {0.0535}
0.242—0.248 {0.0096—0.00976}	17	1.17 {0.0460}	0.102—0.108 {0.00401—0.00425}	37	1.37 {0.0539}
0.235—0.241 {0.0093—0.00948}	18	1.18 {0.0464}	0.095—0.101 {0.00374—0.00397}	38	1.38 {0.0543}
0.228—0.234 {0.00897—0.00921}	19	1.19 {0.0468}	0.088—0.094 {0.00346—0.00370}	39	1.39 {0.0547}
0.221—0.227 {0.00870—0.00893}	20	1.20 {0.0472}	0.081—0.087 {0.00318—0.00342}	40	1.40 {0.0551}
0.214—0.220 {0.00842—0.00874}	21	1.21 {0.0476}	0.074—0.080 {0.00291—0.00314}	41	1.41 {0.0555}
0.207—0.213 {0.00814—0.00838}	22	1.22 {0.0480}	0.067—0.073 {0.00263—0.00287}	42	1.42 {0.0559}
0.200—0.206 {0.00787—0.00811}	23	1.23 {0.0484}	0.060—0.066 {0.00236—0.00259}	43	1.43 {0.0562}
0.193—0.199 {0.00759—0.00783}	24	1.24 {0.0488}	0.053—0.059 {0.00208—0.00232}	44	1.44 {0.0566}
0.186—0.192 {0.00732—0.00755}	25	1.25 {0.492}	0.046—0.052 {0.00181—0.00204}	45	1.45 {0.0570}
0.179—0.185 {0.00704—0.00728}	26	1.26 {0.496}	0.039—0.045 {0.00153—0.00177}	46	1.46 {0.0574}

ENGINE

Backlash mm {in}	Selection shim (No.)	Shim thickness mm {in}	Backlash mm {in}	Selection shim (No.)	Shim thickness mm {in}
0.172—0.178 {0.00677— 0.00700}	27	1.27 {0.499}	0.032—0.038 {0.00125— 0.00149}	47	1.47 {0.0578}
0.165—0.171 {0.00649— 0.00673}	28	1.28 {0.503}	0.025—0.031 {0.000984— 0.00122}	48	1.48 {0.0582}
0.158—0.164 {0.00622—0.00645}	29	1.29 {0.507}	0.018—0.024 {0.000708— 0.000944}	49	1.49 {0.0586}
0.151—0.157 {0.00594— 0.00618}	30	1.30 {0.511}	0.011—0.017 {0.000433— 0.000669}	50 (master)	1.50 {0.0590}
0.144—0.150 {0.0566—0.0590}	31	1.31 {0.515}	0.004—0.010 {0.00015— 0.000393}	51	1.51 {0.0594}
0.137—0.143 {0.00539— 0.00562}	32	1.32 {0.519}	0.000—0.004 {0.000—0.000157}	52	1.52 {0.0598}
0.130—0.136 {0.00511— 0.00535}	33	1.33 {0.523}	0.000—0.000 {0.000—0.000}	53	1.53 {0.0602}
0.123—0.129 {0.00484— 0.00507}	34	1.34 {0.527}	0.000—0.000 {0.000—0.000}	54	1.54 {0.0606}

B

ENGINE

1	Rear oil seal (See B-35 Rear Oil Seal Assembly Note)
2	End plate (MPV)
3	Flywheel (MTX), Drive plate (ATX) (See B-36 Drive Plate (ATX), Flywheel (MTX) Assembly Note)
4	Oil pump
5	Oil strainer
6	Water pump
7	Thermostat

8	Oil separator
9	Knock sensor
10	Oil cooler
11	Oil filter adapter
12	Oil filter
13	Oil filter cover
14	Oil pan (See B-36 Oil pan Assembly Note)
15	MTX

B

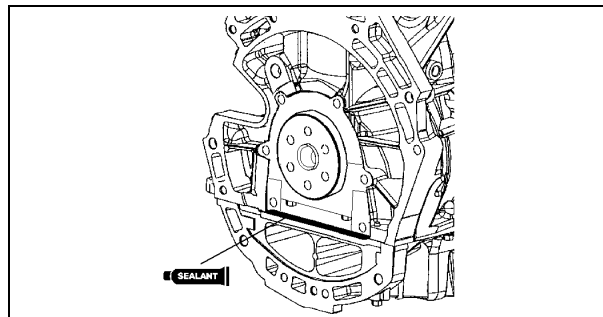
Rear Oil Seal Assembly Note

1. Apply silicone sealant to the mating faces as shown.

Dot diameter:

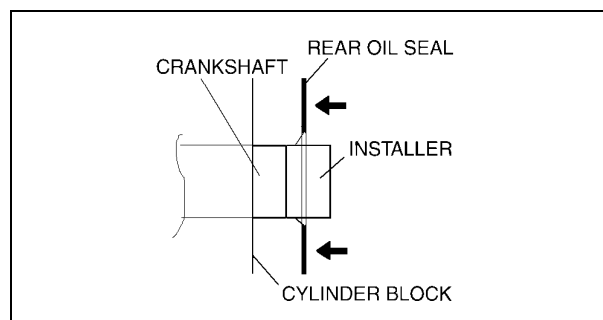
4.0—6.0 mm {0.16—0.23 in}

2. Apply clean engine oil to the new oil seal lip.



AME2224E325

3. Install the rear oil seal using the installer as shown.

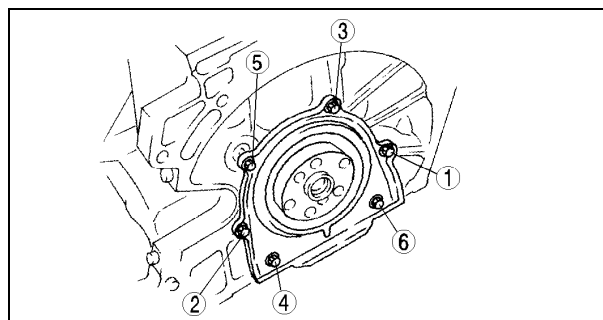


AME2224E326

4. Tighten the rear oil seal bolts in the order as shown.

Tightening torque:

8.0—11.5 N·m {81.6—117.2 kgf·m, 70.9—101.7 in·lbf}

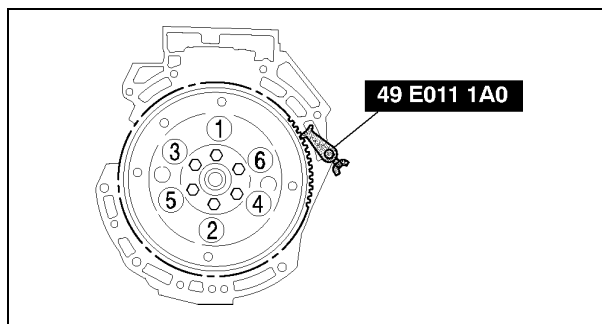


AME2224E002

ENGINE

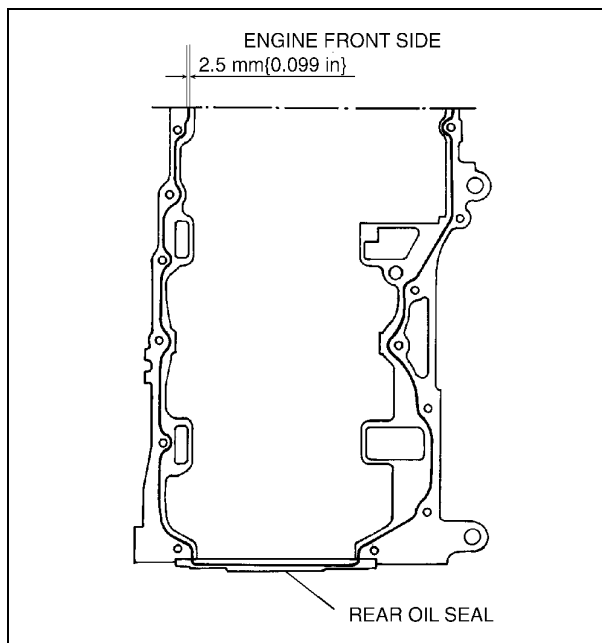
Drive Plate (ATX), Flywheel (MTX) Assembly Note

1. Hold the crankshaft using the **SST**.
2. Tighten the bolts in the order indicated in the figure in several passes.

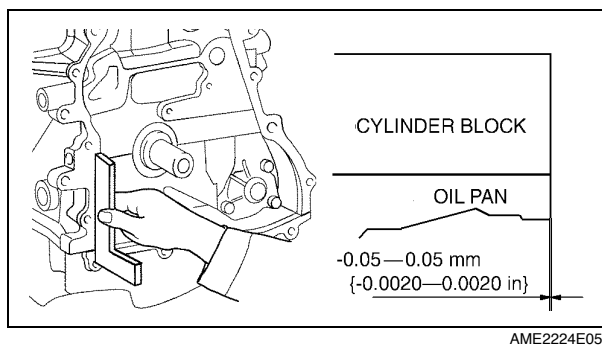


Oil pan Assembly Note

1. Apply a continuous bead of silicone sealant to the oil pan as indicated in the figure.



2. Use a square ruler to unite the oil pan and the cylinder block junction side on the engine front cover side.

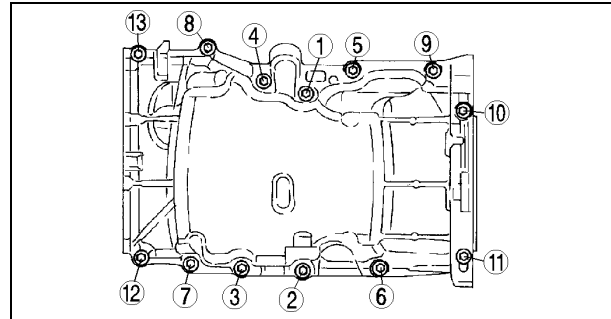


ENGINE

3. Tighten the rear oil pan bolts in the order as shown.

Tightening torque:

20—30 N·m {2.1—3.0 kgf·m, 15.2—21.6 in·lbf}



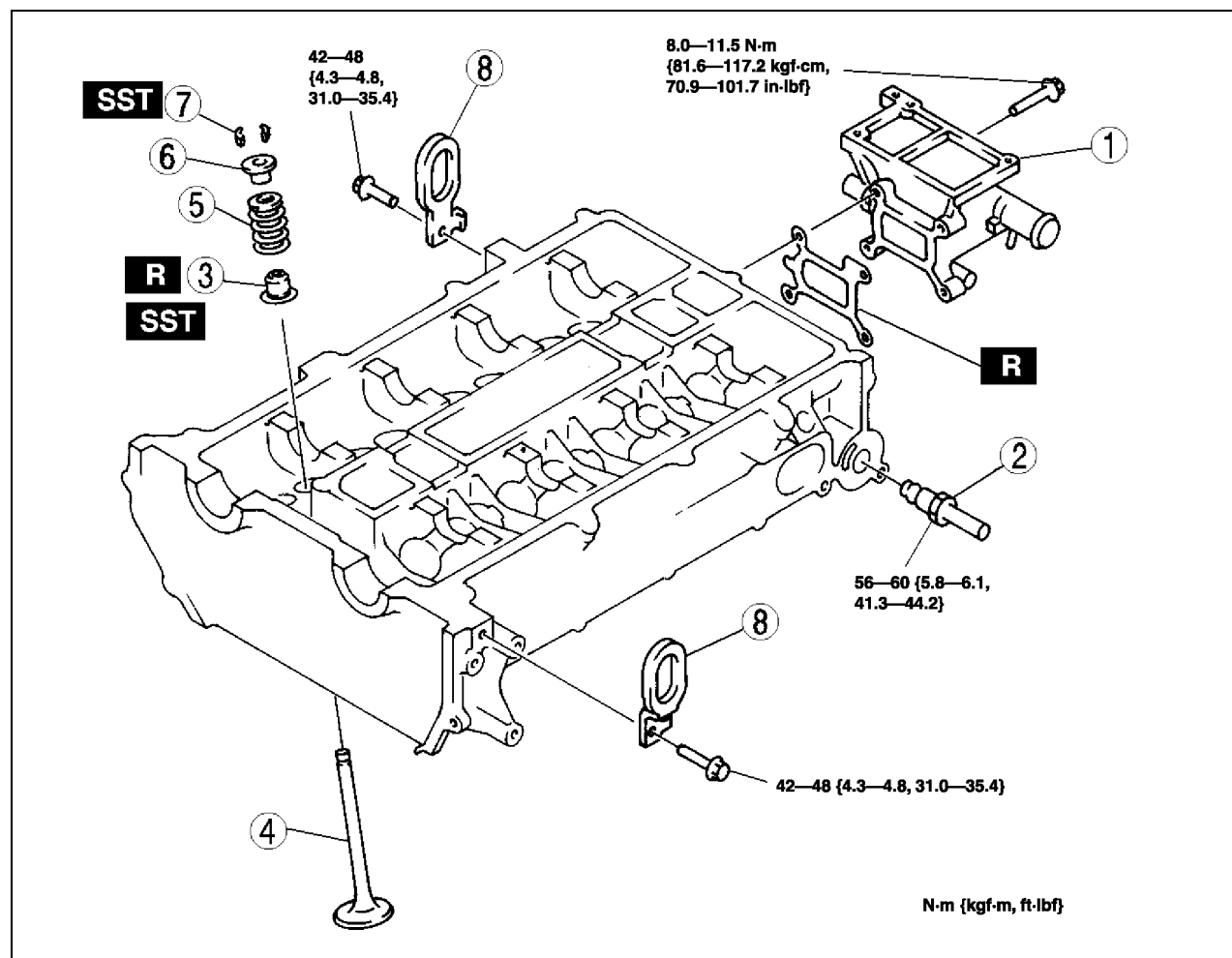
AME2224E056

B

CYLINDER HEAD (I) ASSEMBLY

A6E242402000E11

1. Assemble in the order indicated in the table.



AME2224E044

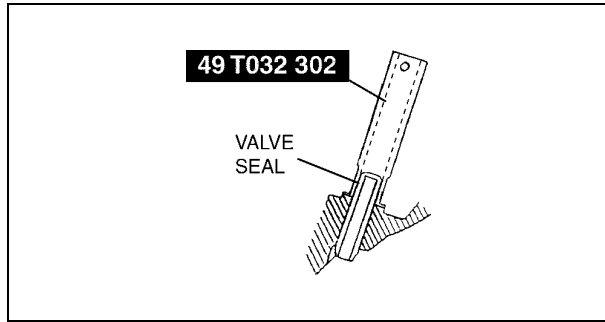
1	Water outlet case
2	EGR pipe
3	Valve seal (See B-38 Valve Seal Assembly Note)
4	Valve

5	Valve spring
6	Upper valve spring seat
7	Valve keeper (See B-38 Valve Keeper Assembly Note)
8	Engine hanger

ENGINE

Valve Seal Assembly Note

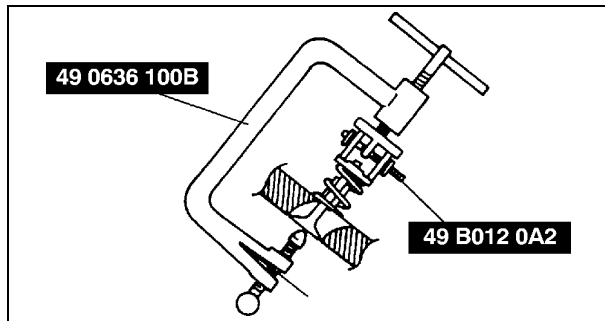
1. Press the valve seal onto the valve guide by hand.
2. Lightly tap the **SST** using a plastic hammer.



AME2224E321

Valve Keeper Assembly Note

1. Install the valve keeper using the **SSTs**.



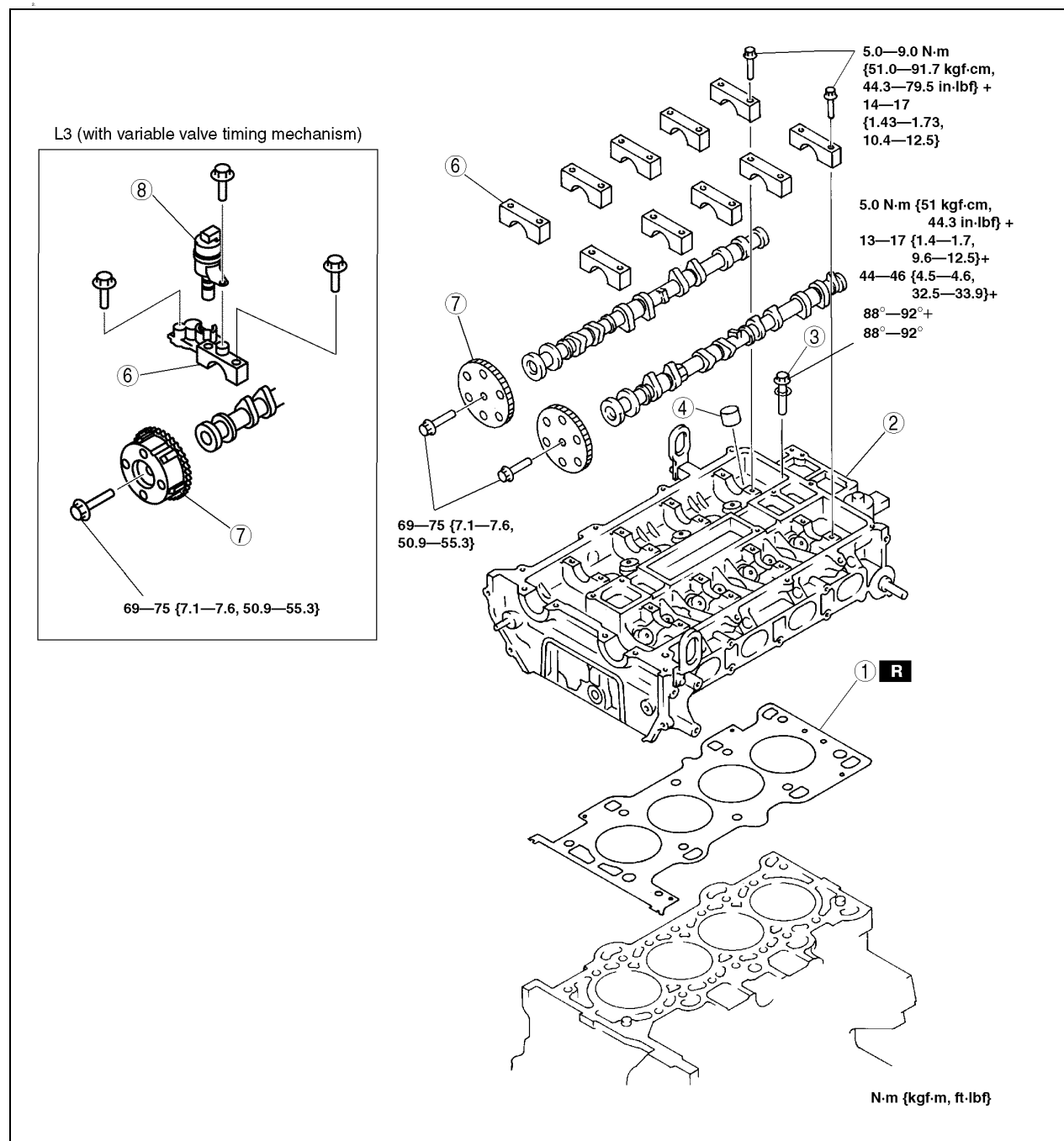
AME2224E302

ENGINE

CYLINDER HEAD (II) ASSEMBLY

A6E242402000E12

1. Assemble in the order indicated in the table.



AME2224E046

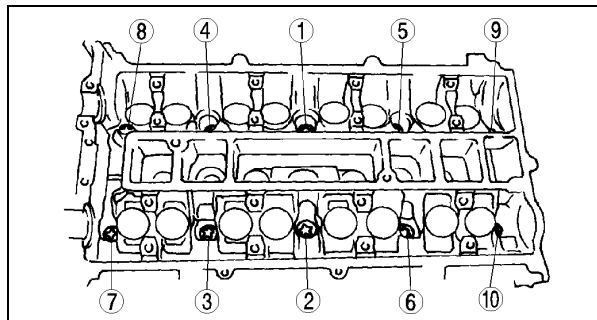
1	Cylinder head gasket
2	Cylinder head
3	Cylinder head bolt (See B-40 Cylinder Head Bolt Assembly Note)
4	Tappet
5	Camshaft (See B-40 Camshaft Assembly Note)

6	Camshaft cap
7	Camshaft sprocket, Variable valve timing actuator (L3 (with variable valve timing mechanism)) (See B-40 Camshaft Sprocket, Variable Valve Timing Actuator (L3 (with variable valve timing mechanism)) Assembly Note)
8	Oil control valve (OCV) (L3 (with variable valve timing mechanism))

ENGINE

Cylinder Head Bolt Assembly Note

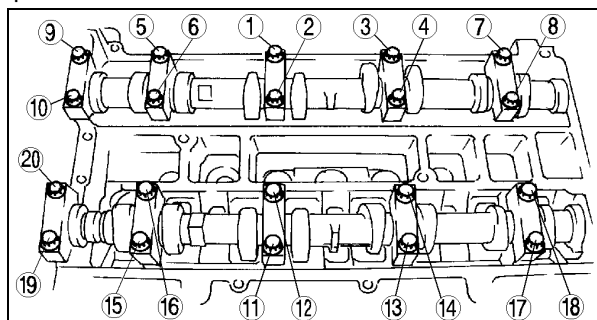
1. Tighten the cylinder head bolts in the order indicated in the figure in six steps.
- (1) Tighten to **5.0 N·m {51 kgf·cm, 44.3 in·lbf}**.
- (2) Tighten to **13— 17 N·m {1.4 —1.7 kgf·m, 9.6—12.5 ft·lbf}**.
- (3) Tighten to **44— 46 N·m {4.5 —4.6 kgf·m, 32.5—33.9 ft·lbf}**.
- (4) Tighten **88°—92°**.
- (5) Tighten **88°—92°**.



AME2224E047

Camshaft Assembly Note

1. Install the camshaft with No.1 cylinder aligned with TDC position.
2. Tighten the camshaft cap bolt using the following two steps.
- (1) Tighten to **5.0—9.0 N·m {51.0—91.7 kgf·cm, 44.3—79.5 in·lbf}**.
- (2) Tighten to **14.0—17.0 N·m {1.5—1.7 kgf·m, 10.4—12.5 ft·lbf}**.



AME2224E048

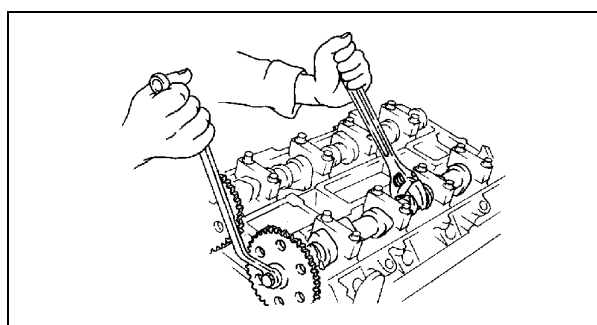
Camshaft Sprocket, Variable Valve Timing Actuator (L3 (with variable valve timing mechanism)) Assembly Note

1. Camshaft sprocket or variable valve timing actuator (L3 (with variable valve timing mechanism)) attachment bolt is changed into the state of a temporary bundle by hand until it attaches timing chain.
2. The attachment bolt of camshaft sprocket or variable valve timing actuator (L3 (with variable valve timing mechanism)) is bound tight for timing chain after attachment.

Tightening torque

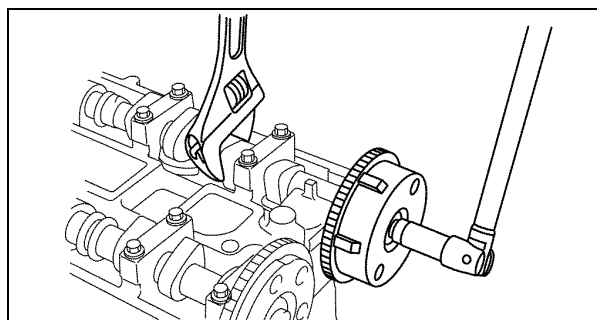
69—75 N·m {7.10—7.60 kgf·m, 50.9—55.3 ft·lbf}

L8, LF, L3



AME2224E077

L3 (with variable valve timing mechanism)

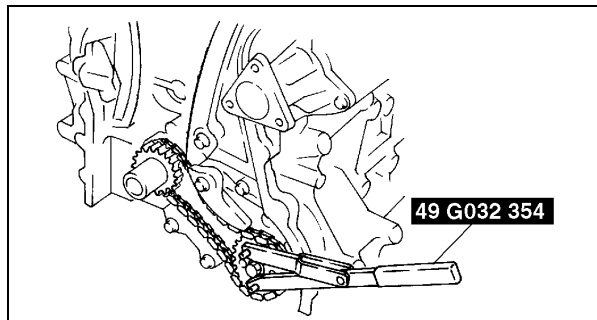


AME2224E078

ENGINE

Oil Pump Sprocket Assembly Note

1. Hold the oil pump sprocket using the **SST**.

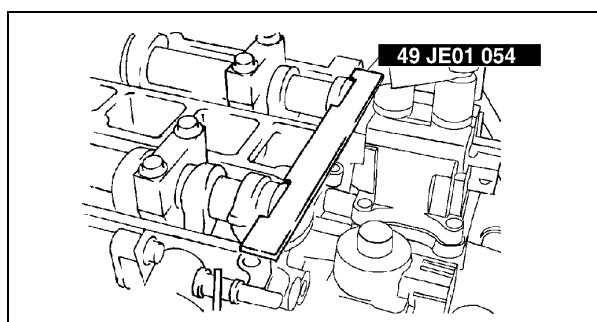


AME2224E340

Timing Chain Assembly Note

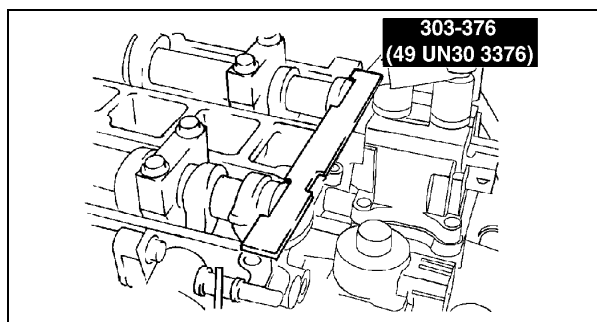
1. Install the **SST** to the camshaft, then align the No. 1 camshaft position with the TDC.

Europe



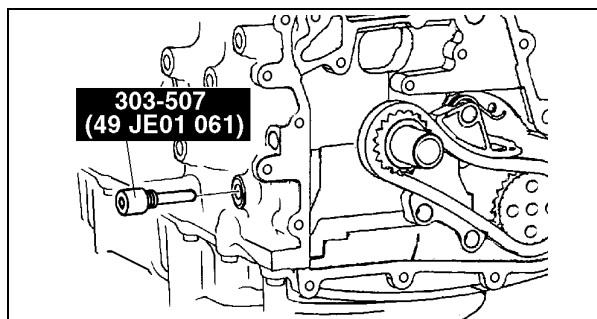
AME2224E329

Except Europe



AME2224E328

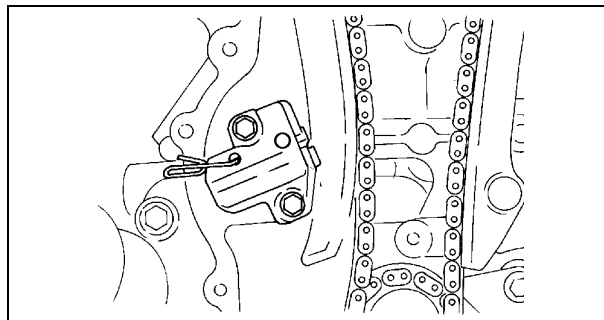
2. Remove the cylinder block lower blind plug.
3. Install the **SST** as shown.
4. Turn the crankshaft clockwise so that the crankshaft is in the No.1 cylinder TDC position.
5. Install the timing chain.



AMJ2224E666

ENGINE

6. Install the chain tensioner and remove the retaining wire.



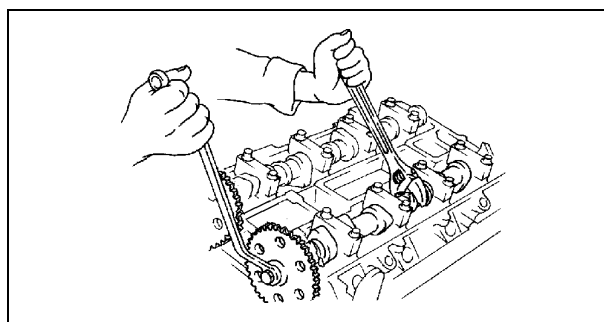
B

Camshaft Sprocket, Variable Valve Timing Actuator (L3 (with variable valve timing mechanism)) Assembly

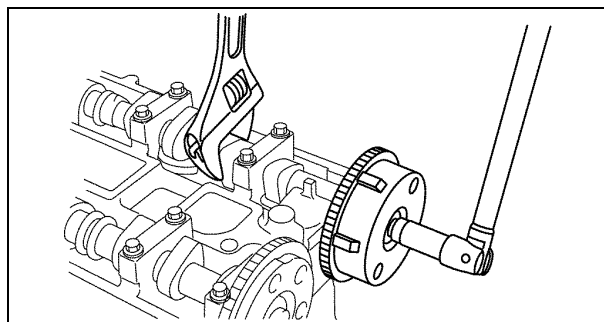
Note

1. Hold the camshaft using a suitable wrench on the cast hexagon as shown.

L8, LF, L3



L3 (with variable valve timing mechanism)



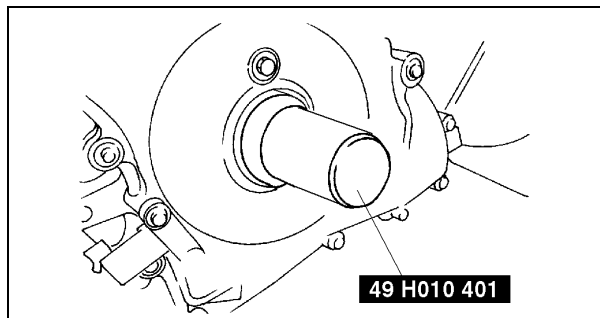
2. Tighten the camshaft sprocket lock bolt.

Tightening torque: 69—75 N·m {7.10—7.6 kgf·m, 50.9—55.3 ft·lbf}

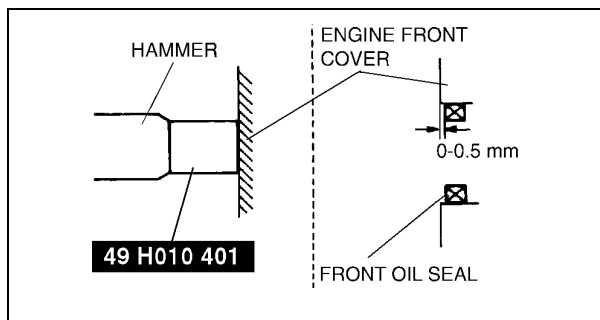
ENGINE

Front Oil Seal Assembly Note

1. Apply clean engine oil to the oil seal.
2. Push the oil seal slightly in by hand.
3. Compress the oil seal using the SST and a hammer.



AME2224E331



AME2224E332

Engine Front Cover Assembly Note

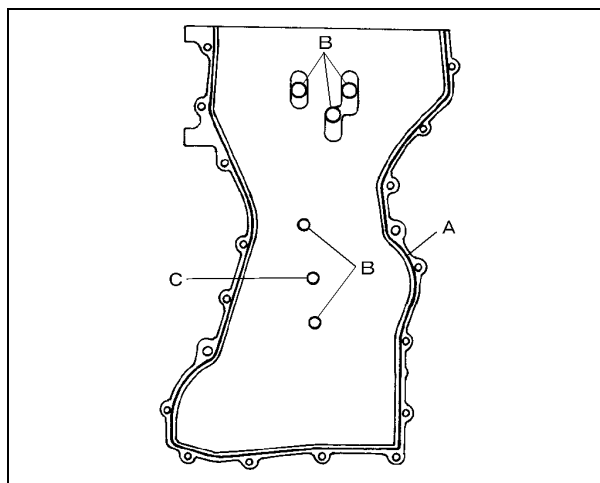
1. Apply silicone sealant to the engine front cover as shown.

Caution

- Install the cylinder head cover within 10 minutes of applying the silicone sealant.
- Silicone sealant is not need in area C as indicated below due to an existing. (L3 (with variable valve timing mechanism))

Thickness

- A: 2.0—3.0 mm {0.079—0.118 in}
B: 1.5—2.5 mm {0.059—0.098 in}

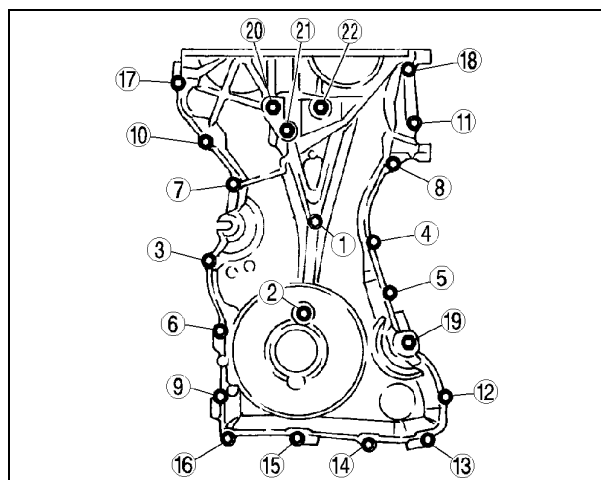


AME2224E333

ENGINE

2. Install the cylinder head cover bolts in the order as shown.

Bolt No.	Tightening torque N·m {kgf·m, ft·lbf}
1—18	8.0—11.5 N·m {81.6—117.2 kgf·cm, 70.9—101.7 in·lbf}
19—22	40—55 {4.1—5.6, 29.7—40.5}

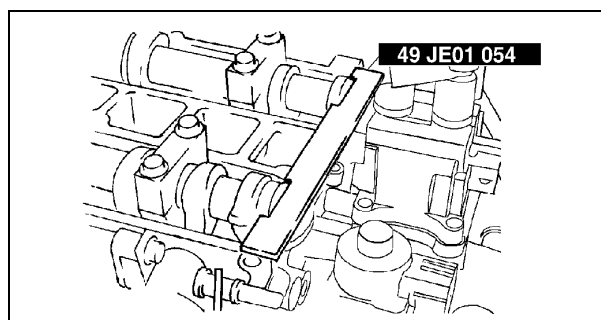


AME2224E334

Crankshaft Pulley Lock Bolt Assembly Note

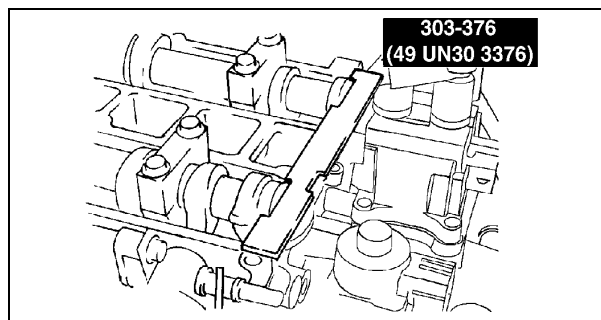
1. Install the SST to the camshaft as shown.

Europe



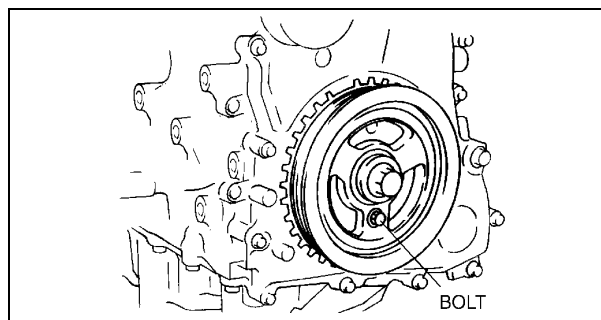
AME2224E329

Except Europe



AME2224E328

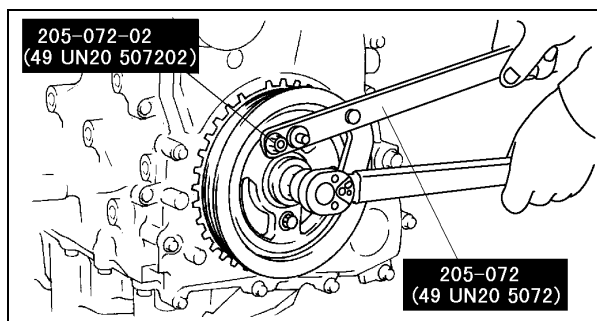
2. Install the M6 x 1.0 bolt in by hand.
3. Turn the crankshaft clockwise so that the crankshaft is in the No.1 cylinder TDC position.



AME2224E009

ENGINE

4. Hold the crankshaft pulley using the **SST**.
5. Tighten the crankshaft pulley lock bolt in the following two steps.
 - (1) Tighten to **96—104 N·m {9.8—10.6 kgf·m, 70.9—76.7 ft·lbf}**
 - (2) Tighten **87°—93°**.
6. Remove the M6 x 1.0 bolt.
7. Remove the **SST** from the camshaft.
8. Remove the **SST** from the block lower blind plug.
9. Rotate the crankshaft clockwise two turns until the TDC position.
 - If not aligned, loosen the crankshaft pulley lock bolt and repeat from Step 1.
10. Install the cylinder block lower blind plug.



AME2224E015

Tightening torque: 20 N·m {2.0 kgf·m, 14.8 ft·lbf}

Cylinder Head Cover Assembly Note

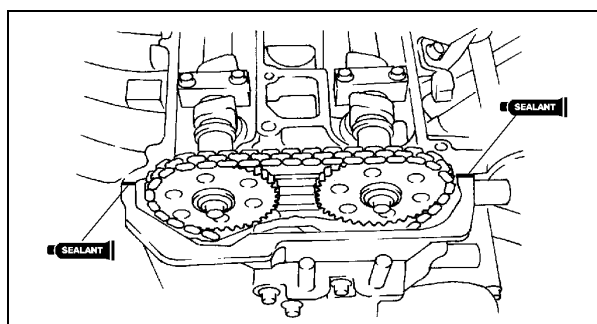
1. Apply silicone sealant to the mating faces as shown.

Caution

- Install the cylinder head cover within 10 minutes of applying the silicone sealant.

Dot diameter: 4.0—6.0 mm {0.16—0.23 in}

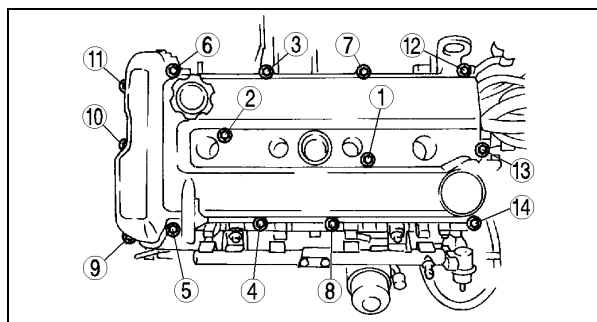
2. Install the cylinder head cover with a new gasket.



AME2224E335

3. Tighten the bolts in the order shown.

Tightening torque: 8.0 — 12 N·m {81.6—122.3 kgf·cm, 70.9—106.2 in·lbf}



AME2224E336

TECHNICAL DATA

TECHNICAL DATA	TD-2
ENGINE TECHNICAL DATA	TD-2

TD

TECHNICAL DATA

TECHNICAL DATA

ENGINE TECHNICAL DATA

A6E931001001E01

Item				Engine		
				L8	LF	L3, L3 (with variable valve timing mechanism)
Cylinder head						
Cylinder head gasket contact surfaces distortion	(mm {in})	Maximum		0.10 {0.004}		
Manifold contact surfaces distortion	(mm {in})	Maximum		0.10 {0.004}		
		Maximum grinding		0.15 {0.006}		
Valve clearance [Engine cold]	(mm {in})	IN		0.22—0.28 {0.0087—0.0110}		
		EX		0.27—0.33 {0.0106—0.0130}		
Valve and valve guide						
Valve stem diameter	(mm {in})	Standard	IN	5.470—5.485 {0.2154—0.2159}		
			EX	5.465—5.480 {0.2152—0.2157}		
		Minimum	IN	5.440 {0.2142}		
			EX	5.435 {0.2140}		
Valve stem to guide clearance	(mm {in})	Standard	IN	0.024—0.069 {0.0009—0.0027}		
			EX	0.029—0.074 {0.0012—0.0029}		
		Maximum	IN	0.10 {0.004}		
			EX	0.10 {0.004}		
Valve length	(mm {in})	Standard	IN	102.99—103.79 {4.055—4.086}		
			EX	104.25—105.05 {4.105—4.135}		
		Minimum	IN	102.99 {4.055}		
			EX	103.79 {4.086}		
Valve guide inner diameter	(mm {in})	Standard	IN	5.509—5.539 {0.2169—0.2180}		
			EX	5.509—5.539 {0.2169—0.2180}		
Valve guide protrusion height	(mm {in})	IN EX		12.2—12.8 {0.481—0.503}		
				12.2—12.8 {0.481—0.503}		
Valve head margin thickness	(mm {in})	Minimum	IN	1.62 {0.0637}		
			EX	1.82 {0.0716}		
Valve seat						
Valve seat contact width	(mm {in})	Standard	IN	1.2—1.6 {0.048—0.062}		
			EX	1.2—1.6 {0.048—0.062}		
Valve seat angle		(°)	IN	45		
			EX	45		
Valve seat sinking (Valve protrusion height)	(mm {in})	Standard	IN	40.64—42.24 {1.600—1.662}		
			EX	40.50—42.10{1.595—1.657}		
Valve spring						
Out-of-square	(mm {in})	Maximum		1% (2.10 {0.082})		
Pressing force at valve spring height H	(N {kgf, lbf})	H: 27.8 mm {1.094 in}		494.9 {50.47, 111.2}		
OCV (Oil control valve)						
Coil resistance [20° C{68°F}]	(ohm)	Standard		—		6.9—7.9 *

TECHNICAL DATA

Item			Engine		
			L8	LF	L3, L3 (with variable valve timing mechanism)
Connecting rod and connecting rod bearing					
Connecting rod side clearance	(mm {in})	Standard	0.14—0.36 {0.0056—0.0141}		
		Maximum	0.435 {0.0172}		
Connecting rod bearing size	(mm {in})	Standard	1.496—1.502 {0.0589—0.0591}		
		0.25 {0.01} Oversize	1.623—1.629 {0.0639—0.0641}		
		0.50 {0.02} Oversize	1.748—1.754 {0.0688—0.0690}		
Connecting rod bearing oil clearance	(mm {in})	Standard	0.026—0.052{0.0011—0.0020}		
		Maximum	0.10{0.0039}		
Crankshaft					
Crankshaft runout	(mm {in})	Maximum	0.05 {0.0019}		
Main journal diameter	(mm {in})	Standard	51.980—52.000 {2.0464—2.0472}		
		0.25 {0.01} undersize	51.730—51.750 {2.0366—2.0373}		
Main journal oil clearance	(mm {in})	Standard	0.019—0.035{0.0007—0.0013}		
		Maximum	0.10 {0.0039}		
Main journal out of round	(mm {in})	Maximum	0.05 {0.0019}		
Main bearing size	(mm {in})	Standard	2.506—2.509 {0.0987—0.0988}		
		0.25 {0.01} Oversize	2.628—2.634 {0.1034—0.1037}		
		0.50 {0.02} Oversize	2.753—2.759 {0.1084—0.1086}		
Crank pin journal diameter	(mm {in})	Standard	49.980—50.000 {1.9677—1.9685}		
		0.25 {0.01} undersize	49.730—49.750 {1.9579—1.9586}		
Crank pin out of round	(mm {in})	Maximum	0.05 {0.022}		
Crankshaft end play	(mm {in})	Standard	0.22—0.45{0.0087—0.0177}		
		Maximum	0.55 {0.0216}		
Front oil seal					
Pushing distance of the front oil seal [from the edge of the engine front cover]		(mm {in})	0—0.5 {0—0.019}		
Bolt					
Cylinder head bolt length		Standard	149.0—150.0 {5.86—5.90}		
		Maximum	150.5 {5.92}		
Connecting rod bolt length		Standard	44.7—45.3 {1.75—1.78}		
		Maximum	46.0 {1.81}		
Main bearing cap bolt length		Standard	110.0—110.6 {4.33—4.35}		
		Maximum	111.3 {4.38}		
Balance shaft					
Gear backlash	(mm {in})	Maximum	—		0.005-0.101 {0.00019— 0.0039}

*: With variable valve timing mechanism

SPECIAL TOOLS

SPECIAL TOOLSST-2
ENGINE SSTST-2

ST

SPECIAL TOOLS

SPECIAL TOOLS

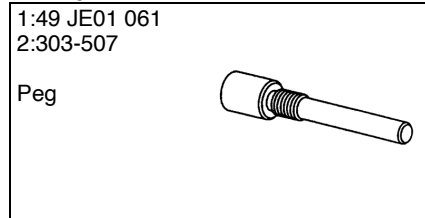
ENGINE SST

A6E941001001E01

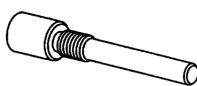
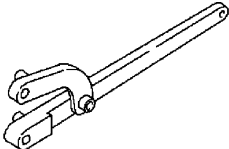
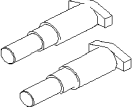
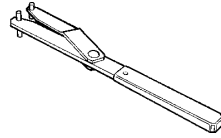
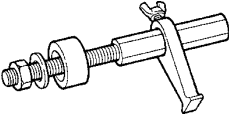
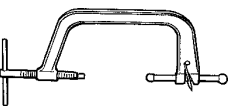
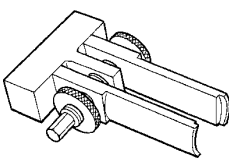

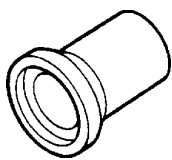
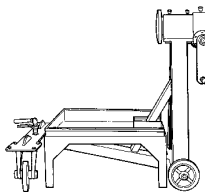
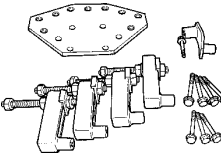
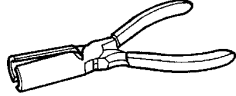
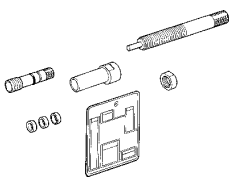

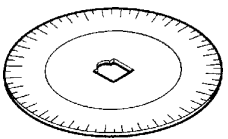
Ford SST numbers are collated with Mazda SST numbers in the example below.

Ford SSTs are marked with Ford SST number.

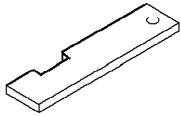
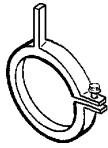
Example



1: Mazda SST number
2: Ford SST number

<p>1:49 JE01 061 2:303-507</p> <p>Peg</p> 	<p>1:49 UN20 5072 2:205-072</p> <p>Holder</p> 	<p>1:49 UN20 507202 2:205-072-02</p> <p>Adapter</p> 
<p>1:49 G032 354 2: -</p> <p>Adjusting wrench</p> 	<p>1:49 E011 1A0 2: -</p> <p>Ring gear brake set</p> 	<p>1:49 0636 100B 2: -</p> <p>Valve spring lifter arm</p> 
<p>1:49 B012 0A2 2: -</p> <p>Pivot</p> 	<p>1:49 B012 015 2: -</p> <p>Valve guide installer</p> 	<p>1:49 H010 401 2: -</p> <p>Oil seal installer</p> 
<p>1:49 0107 680A 2: -</p> <p>Engine stand</p> 	<p>1:49 L010 1A0 2: -</p> <p>Engine hanger set</p> 	<p>1:49 S120 170 2: -</p> <p>Valve seal remover</p> 
<p>1:49 L012 0A0B 2: -</p> <p>Valve seal and valve guide installer set</p> 	<p>1:49 T032 302 2: -</p> <p>Bearing installer</p> 	<p>1:49 D032 316 2: -</p> <p>Protractor</p> 

SPECIAL TOOLS

1:49 JE01 054 (Europe) 49 UN30 3376 (Except Europe) 2: 303–376 Plate		1:49 G011 201 2: – Attachment		–
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ST