# GROUP 11D

## ENGINE OVERHAUL

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**Removal and Installation**

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### GENERAL INFORMATION

#### VEHICLE AND ENGINE MODELS

<table>
<thead>
<tr>
<th>Vehicle name</th>
<th>Vehicle model</th>
<th>Engine model</th>
<th>Displacement cc</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Colt</td>
<td>Z27A</td>
<td>4G15-7</td>
<td>1,468</td>
<td>Double overhead camshaft (DOHC), 16-valve, V.V.T.</td>
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</tbody>
</table>

### GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total displacement mL</td>
<td>1,468</td>
</tr>
<tr>
<td>Bore × Stroke mm</td>
<td>75.5 × 82.0</td>
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<tr>
<td>Compression ratio</td>
<td>9.0</td>
</tr>
<tr>
<td>Compression chamber</td>
<td>Pentroof</td>
</tr>
<tr>
<td>Camshaft arrangement</td>
<td>DOHC</td>
</tr>
<tr>
<td>Number of valve</td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>2</td>
</tr>
<tr>
<td>Exhaust</td>
<td>2</td>
</tr>
<tr>
<td>Valve timing</td>
<td></td>
</tr>
<tr>
<td>Intake opening</td>
<td>BTDC 34° – ATDC 6°</td>
</tr>
<tr>
<td>Intake closing</td>
<td>ABDC 30° – ABDC 70°</td>
</tr>
<tr>
<td>Exhaust opening</td>
<td>BBDC 50°</td>
</tr>
<tr>
<td>Exhaust closing</td>
<td>ATDC 10°</td>
</tr>
<tr>
<td>Fuel system</td>
<td>Electronically controlled multipoint fuel injection</td>
</tr>
<tr>
<td>Rocker arm</td>
<td>Roller type</td>
</tr>
<tr>
<td>Auto-lash adjuster</td>
<td>Equipped</td>
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### SERVICE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard value</th>
<th>Limit</th>
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<tbody>
<tr>
<td><strong>TIMING BELT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-tensioner rod extension length</td>
<td>4.8 – 5.5</td>
<td>–</td>
</tr>
<tr>
<td>(with timing belt installed) mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-tensioner rod extension length</td>
<td>12.0</td>
<td>–</td>
</tr>
<tr>
<td>(when free) mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-tensioner rod retraction length</td>
<td>Less than 1</td>
<td>–</td>
</tr>
<tr>
<td>(when pressed with force of 98 – 196 N·m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ROCKER ARMS AND CAMSHAFTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cam height mm</td>
<td>Intake valves</td>
<td>35.08</td>
</tr>
<tr>
<td></td>
<td>Exhaust valves</td>
<td>34.26</td>
</tr>
<tr>
<td>Item</td>
<td>Standard value</td>
<td>Limit</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>CYLINDER HEAD AND VALVES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder head gasket surface warp mm</td>
<td>0.03</td>
<td>0.2</td>
</tr>
<tr>
<td>Cylinder head gasket surface grinding limit</td>
<td>–</td>
<td>0.2</td>
</tr>
<tr>
<td>(including cylinder block grinding amount) mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder head overall height mm</td>
<td>131.9 – 132.1</td>
<td></td>
</tr>
<tr>
<td>Valve margin mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake valves</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Exhaust valves</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Valve length mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake valves</td>
<td>106.35</td>
<td>105.85</td>
</tr>
<tr>
<td>Exhaust valves</td>
<td>106.85</td>
<td>106.35</td>
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<tr>
<td>Valve spring free height mm</td>
<td>54.8</td>
<td>55.8</td>
</tr>
<tr>
<td>Valve spring squareness</td>
<td>2° or less</td>
<td>4°</td>
</tr>
<tr>
<td>Valve stem-to-guide clearance mm</td>
<td></td>
<td></td>
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<tr>
<td>Intake valves</td>
<td>0.02 – 0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Exhaust valves</td>
<td>0.03 – 0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>Valve guide length mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake valves</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Exhaust valves</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Valve guide projection mm</td>
<td>22.7 – 23.3</td>
<td></td>
</tr>
<tr>
<td>Valve face-to-seat contact width mm</td>
<td>0.9 – 1.3</td>
<td></td>
</tr>
<tr>
<td>Valve projection from valve spring seat mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake valves</td>
<td>48.8</td>
<td>49.3</td>
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<tr>
<td>Exhaust valves</td>
<td>48.7</td>
<td>49.2</td>
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<tr>
<td><strong>OIL PUMP AND OIL PAN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil pump tip clearance mm</td>
<td>0.06 – 0.18</td>
<td></td>
</tr>
<tr>
<td>Oil pump side clearance mm</td>
<td>0.10 – 0.18</td>
<td></td>
</tr>
<tr>
<td>Oil pump body clearance mm</td>
<td>0.040 – 0.095</td>
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</tr>
<tr>
<td><strong>PISTONS AND CONNECTING RODS</strong></td>
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<td></td>
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<tr>
<td>Piston pin press-in load (at ambient temperature) N</td>
<td>4,900 – 14,700</td>
<td></td>
</tr>
<tr>
<td>Piston ring side clearance in ring groove mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 1</td>
<td>0.03 – 0.07</td>
<td>0.1</td>
</tr>
<tr>
<td>No. 2</td>
<td>0.02 – 0.06</td>
<td>0.1</td>
</tr>
<tr>
<td>Piston ring end gap mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 1</td>
<td>0.15 – 0.30</td>
<td>0.8</td>
</tr>
<tr>
<td>No. 2</td>
<td>0.30 – 0.45</td>
<td>0.8</td>
</tr>
<tr>
<td>Oil ring</td>
<td>0.20 – 0.50</td>
<td>1.0</td>
</tr>
<tr>
<td>Connecting rod big end thrust clearance mm</td>
<td>0.10 – 0.25</td>
<td>0.4</td>
</tr>
<tr>
<td>Oil clearance at crankshaft pins mm</td>
<td>0.025 – 0.040</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>CRANKSHAFT AND CYLINDER BLOCK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crankshaft end play mm</td>
<td>0.05 – 0.18</td>
<td>0.25</td>
</tr>
<tr>
<td>Oil clearance at crankshaft journals mm</td>
<td>0.02 – 0.04</td>
<td>0.1</td>
</tr>
<tr>
<td>Cylinder block gasket surface warp mm</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>Cylinder block gasket surface grinding limit</td>
<td>–</td>
<td>0.2</td>
</tr>
<tr>
<td>(including cylinder head grinding amount) mm</td>
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## REWORK DIMENSIONS

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<tr>
<th>Item</th>
<th>Standard value</th>
<th>Limit</th>
</tr>
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<tbody>
<tr>
<td>Cylinder bore diameter mm</td>
<td>75.50 – 75.53</td>
<td>–</td>
</tr>
<tr>
<td>Taper of cylinder mm</td>
<td>0.01 or less</td>
<td>–</td>
</tr>
<tr>
<td>Cylinder-to-piston clearance mm</td>
<td>0.02 – 0.04</td>
<td>–</td>
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### CYLINDER HEAD AND VALVES

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard value</th>
<th>Standard value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder head oversize valve guide hole diameter mm</td>
<td>0.05 O.S.</td>
<td>10.55 – 10.57</td>
</tr>
<tr>
<td></td>
<td>0.25 O.S.</td>
<td>10.75 – 10.77</td>
</tr>
<tr>
<td></td>
<td>0.50 O.S.</td>
<td>11.00 – 11.02</td>
</tr>
<tr>
<td>Cylinder head oversize valve seat hole diameter, intake mm</td>
<td>0.30 O.S.</td>
<td>31.30 – 31.33</td>
</tr>
<tr>
<td></td>
<td>0.60 O.S.</td>
<td>31.60 – 31.63</td>
</tr>
<tr>
<td>Cylinder head oversize valve seat hole diameter, exhaust mm</td>
<td>0.30 O.S.</td>
<td>27.80 – 27.82</td>
</tr>
<tr>
<td></td>
<td>0.60 O.S.</td>
<td>28.10 – 28.12</td>
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## TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
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<th>N·m</th>
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<tbody>
<tr>
<td><strong>ALTERNATOR AND IGNITION SYSTEM</strong></td>
<td></td>
</tr>
<tr>
<td>Oil level gauge guide bolt</td>
<td>24 ± 4</td>
</tr>
<tr>
<td>Water pump pulley bolts</td>
<td>9.0 ± 2.0</td>
</tr>
<tr>
<td>Crankshaft bolts</td>
<td>181</td>
</tr>
<tr>
<td>Alternator brace bolt (alternator side)</td>
<td>22.5 ± 2.5</td>
</tr>
<tr>
<td>Alternator brace bolt (tightened with water pump)</td>
<td>24 ± 3</td>
</tr>
<tr>
<td>Alternator nut</td>
<td>44 ± 10</td>
</tr>
<tr>
<td>Adjusting bolt</td>
<td>5.0 ± 1.0</td>
</tr>
<tr>
<td>Ignition coil bolts</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Spark plug</td>
<td>25 ± 5</td>
</tr>
<tr>
<td>Cam position sensor bolt</td>
<td>8.8 ± 1.0</td>
</tr>
<tr>
<td>Cam position sensor support bolts</td>
<td>14 ± 1</td>
</tr>
<tr>
<td><strong>TIMING BELT</strong></td>
<td></td>
</tr>
<tr>
<td>Timing belt cover bolts</td>
<td>11 ± 1</td>
</tr>
<tr>
<td>Rocker cover bolts</td>
<td>5.0 ± 1.0 → 7.0 ± 1.0</td>
</tr>
<tr>
<td>Plug cap</td>
<td>21 ± 3</td>
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<tr>
<td>Tensioner pulley bolt</td>
<td>48 ± 6</td>
</tr>
<tr>
<td>Item</td>
<td>N·m</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Tensioner arm bolt</td>
<td>48 ± 6</td>
</tr>
<tr>
<td>Auto-tensioner bolts</td>
<td>23 ± 3</td>
</tr>
<tr>
<td>Idler pulley bolt</td>
<td>44 ± 10</td>
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<tr>
<td>Crank angle sensor bolts</td>
<td>9.8 ± 2.0</td>
</tr>
<tr>
<td>V.V.T. sprocket bolt</td>
<td>55 ± 5</td>
</tr>
<tr>
<td>Camshaft sprocket bolt</td>
<td>88 ± 10</td>
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<tr>
<td>Engine support bracket bolts, nut</td>
<td>36 ± 6</td>
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<tr>
<td><strong>FUEL AND EMISSION PARTS</strong></td>
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<tr>
<td>Throttle body bolts</td>
<td>13 ± 2</td>
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<tr>
<td>Solenoid valve bolts</td>
<td>9.0 ± 1.0</td>
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<tr>
<td>Purge valve bolts</td>
<td>5.0 ± 1.0</td>
</tr>
<tr>
<td>Delivery pipe and injector bolts</td>
<td>12 ± 1</td>
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<td>Fuel pressure regulator bolts</td>
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<tr>
<td>Vacuum pipe bolts</td>
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<tr>
<td>Solenoid valve nut</td>
<td>5.0 ± 1.0</td>
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<tr>
<td><strong>WATER PUMP AND WATER HOSE</strong></td>
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</tr>
<tr>
<td>Engine coolant temperature sensor</td>
<td>29 ± 10</td>
</tr>
<tr>
<td>Water inlet fitting bolts</td>
<td>22 ± 4</td>
</tr>
<tr>
<td>Water pipe bolts (M6)</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Water pipe bolt s(M8)</td>
<td>13 ± 2</td>
</tr>
<tr>
<td>Water inlet pipe bolts</td>
<td>13 ± 2</td>
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<td>Water pump bolts</td>
<td>14 ± 1</td>
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<tr>
<td><strong>INLET MANIFOLD</strong></td>
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<tr>
<td>Inlet manifold stay bolts (M8)</td>
<td>18 ± 2</td>
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<tr>
<td>Inlet manifold stay bolts (M10)</td>
<td>31 ± 3</td>
</tr>
<tr>
<td>Inlet manifold bolts and nuts</td>
<td>18 ± 2</td>
</tr>
<tr>
<td>Engine hanger bolt</td>
<td>19 ± 3</td>
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<tr>
<td><strong>EXHAUST MANIFOLD</strong></td>
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<tr>
<td>Oxygen sensor</td>
<td>50 ± 10</td>
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<tr>
<td>Turbocharger cover bolts</td>
<td>10 ± 2</td>
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<tr>
<td>Oil return pipe bolts</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Exhaust fitting bracket bolts</td>
<td>35 ± 6</td>
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<tr>
<td>Exhaust fitting bolts</td>
<td>59 ± 5</td>
</tr>
<tr>
<td>Turbocharger bracket bolts (turbocharger side)</td>
<td>59 ± 5</td>
</tr>
<tr>
<td>Turbocharger bracket bolts (cylinder block side)</td>
<td>35 ± 6</td>
</tr>
<tr>
<td>Oil pipe bolt (flange bolt)</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Oil pipe bolt (eye bolt)</td>
<td>17 ± 2</td>
</tr>
<tr>
<td>Turbocharger bolts, nuts</td>
<td>59 ± 5</td>
</tr>
<tr>
<td>Water pipe bolt (eye bolt)</td>
<td>31 ± 2</td>
</tr>
<tr>
<td>Water pipe bolt (flange bolt)</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Item</td>
<td>N·m</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
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</tr>
<tr>
<td>Exhaust manifold nuts (M8)</td>
<td>29 ± 3</td>
</tr>
<tr>
<td>Exhaust manifold nuts (M10)</td>
<td>49 ± 5</td>
</tr>
<tr>
<td>Thermostat housing hanger bolt</td>
<td>24 ± 4</td>
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<tr>
<td>Engine hanger bolt</td>
<td>19 ± 3</td>
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<tr>
<td><strong>ROCKER ARMS AND CAMSHAFT</strong></td>
<td></td>
</tr>
<tr>
<td>Oil feeder control valve bolt</td>
<td>11 ± 1</td>
</tr>
<tr>
<td>Oil pipe eye-bolt (cylinder block side)</td>
<td>30 ± 3</td>
</tr>
<tr>
<td>Oil pipe eye-bolt (cylinder head side)</td>
<td>42 ± 2</td>
</tr>
<tr>
<td>Cam position sensing cylinder bolt</td>
<td>22 ± 4</td>
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<td>Front bearing cap bolt</td>
<td>21 ± 2</td>
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<tr>
<td>Rear bearing cap bolts</td>
<td>21 ± 2</td>
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<tr>
<td>Bearing cap bolts</td>
<td>11 ± 1</td>
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<tr>
<td><strong>CYLINDER HEAD AND VALVES</strong></td>
<td></td>
</tr>
<tr>
<td>Cylinder head bolts</td>
<td>49 → 0 → 20 → +90° +90°</td>
</tr>
<tr>
<td><strong>OIL PUMP AND OIL PAN</strong></td>
<td></td>
</tr>
<tr>
<td>Oil cooler bolt</td>
<td>27 ± 2</td>
</tr>
<tr>
<td>Oil pressure switch</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Drain plug</td>
<td>39 ± 5</td>
</tr>
<tr>
<td>Oil pan bolts</td>
<td>7.0 ± 1.0</td>
</tr>
<tr>
<td>Transmission stay bolts</td>
<td>23 ± 4</td>
</tr>
<tr>
<td>Oil screen bolts</td>
<td>19 ± 3</td>
</tr>
<tr>
<td>Baffle plate bolts</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Relief plug</td>
<td>44 ± 5</td>
</tr>
<tr>
<td>Oil pump case bolts</td>
<td>14 ± 1</td>
</tr>
<tr>
<td>Oil pump cover bolts</td>
<td>10 ± 2</td>
</tr>
<tr>
<td><strong>PISTONS AND CONNECTING RODS</strong></td>
<td></td>
</tr>
<tr>
<td>Connecting rod cap nuts</td>
<td>17 ± 2 → +90° to 94°</td>
</tr>
<tr>
<td><strong>CRANKSHAFT AND CYLINDER BLOCK</strong></td>
<td></td>
</tr>
<tr>
<td>Flywheel bolts</td>
<td>132 ± 5</td>
</tr>
<tr>
<td>Rear plate bolts</td>
<td>10 ± 2</td>
</tr>
<tr>
<td>Oil seal case bolts</td>
<td>11 ± 1</td>
</tr>
<tr>
<td>Bearing cap bolts</td>
<td>34 ± 2 → +30° to 34°</td>
</tr>
<tr>
<td>Detonation sensor bolts</td>
<td>20 ± 1</td>
</tr>
</tbody>
</table>
### SEALANTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Specified sealant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camshaft position sensor support*</td>
<td>Mitsubishi Genuine Part No. 970389 or equivalent</td>
</tr>
<tr>
<td>Rocker cover*</td>
<td>Mitsubishi Genuine Part No. 970389 or equivalent</td>
</tr>
<tr>
<td>Engine coolant temperature sensor</td>
<td>3M Nut Locking Part No.4171 or equivalent</td>
</tr>
<tr>
<td>Cylinder head (camshaft bearing cap fitting section)</td>
<td>3M ATD No.8660 or equivalent</td>
</tr>
<tr>
<td>Oil pan*</td>
<td>Mitsubishi Genuine Part No. 970389 or equivalent</td>
</tr>
<tr>
<td>Oil pump case*</td>
<td>Mitsubishi Genuine Part No. 970389 or equivalent</td>
</tr>
<tr>
<td>Oil pressure switch</td>
<td>3M ATD No.8660 or equivalent</td>
</tr>
<tr>
<td>Rear oil seal case*</td>
<td>Mitsubishi Genuine Part No. 970389 or equivalent</td>
</tr>
</tbody>
</table>

**NOTE:** *: Part to be sealed with a form-in-place gasket (FIPG)

### FORM-IN-PLACE GASKET (FIPG)

This engine has several areas where the form-in-place gasket (FIPG) is used for sealing. To ensure that the FIPG fully serves its purpose, it is necessary to observe some precautions when applying it.

Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of fluid passages. To prevent leaks or blocking of passages, therefore, it is absolutely necessary to apply the FIPG evenly without a break, while observing the correct bead size.

FIPG hardens as it reacts with the moisture in the atmospheric air, and it is usually used for sealing metallic flange areas.

### Disassembly

Parts sealed with a FIPG can be easily removed without need for the use of a special method. In some cases, however, the FIPG in joints may have to be broken by tapping parts with a mallet or similar tool.

### Surface Preparation

Thoroughly remove all substances deposited on the FIPG application surface, using a gasket scraper. Make sure that the FIPG application surface is flat and smooth. Also make sure that the surface is free from oils, greases and foreign substances. Do not fail to remove old FIPG that may remain in the fastener fitting holes.

### FIPG Application

Applied FIPG bead should be of the specified size and free of any break. FIPG can be wiped away unless it has completely hardened. Install the mating parts in position while the FIPG is still wet (in less than 15 minutes after application). Do not allow FIPG to spread beyond the sealing areas during installation. Avoid operating the engine or letting oils or water come in contact with the sealed area before a time sufficient for FIPG to harden (approximately one hour) has passed. FIPG application method may vary from location to location. Follow the instruction for each particular case described later in this manual.
## SPECIAL TOOLS

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<th>Name</th>
<th>Use</th>
</tr>
</thead>
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<td><img src="image.jpg" alt="MB991883" /></td>
<td>MB991883</td>
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<td>Retention of flywheel</td>
</tr>
<tr>
<td><img src="image.jpg" alt="MD998762" /></td>
<td>MD998762</td>
<td>Circular packing installer</td>
<td>Installing of circular packing</td>
</tr>
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<td><img src="image.jpg" alt="D998713" /></td>
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<td>Camshaft oil seal installer</td>
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<tr>
<td><img src="image.jpg" alt="MD998442" /></td>
<td>MD998442</td>
<td>Air bleed wire</td>
<td>Air bleeding of lash adjuster</td>
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<td>MB991653</td>
<td>Cylinder head bolt wrench</td>
<td>Removal and installation of cylinder head bolts</td>
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<tr>
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<td>Valve spring compressor</td>
<td>Compression of valve spring</td>
</tr>
<tr>
<td><img src="image.jpg" alt="MB991671" /></td>
<td>MB991671</td>
<td>Valve stem seal installer</td>
<td>Installation of valve stem seal</td>
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<tr>
<td>Tool</td>
<td>Number</td>
<td>Name</td>
<td>Use</td>
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<td>Oil pan remover</td>
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<tr>
<td>Crankshaft front oil seal guide</td>
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<td>Installation of crankshaft front oil seal (used with MD998306)</td>
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<tr>
<td>Camshaft oil seal installer</td>
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<td>Installation of crankshaft front oil seal (used with MB991962)</td>
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<tr>
<td>Piston pin setting tool</td>
<td>MD998780</td>
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<td>Removal and press-fitting of piston pin (used with MB991659)</td>
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<td>Guide D</td>
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<td>Guide for removal of piston pins (used with MD998780)</td>
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<td>Angle gauge</td>
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<td>Installation of crankshaft bearing caps</td>
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<tr>
<td>Crankshaft rear oil seal installer</td>
<td>MD998011</td>
<td></td>
<td>Installation of crankshaft rear oil seal</td>
</tr>
</tbody>
</table>
Removal steps
1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. Drive belt
5. Water pump pulley
6. Crankshaft bolt
7. Crankshaft pulley
8. Alternator
9. Adjust nut

Removal steps (Continued)
10. Alternator brace
11. Ignition coil
12. Spark plug
13. Cam position sensor
14. O-ring
15. Cam position sensor support
16. Air intake pipe bracket
REMOVAL SERVICE POINT
<<A>> CRANKSHAFT BOLT REMOVAL

1. Lock the flywheel using the special tool Flywheel stopper (MB991883).
2. Then loosen the crankshaft bolts.

INSTALLATION SERVICE POINTS
>>A<< CAM POSITION SENSOR SUPPORT INSTALLATION

1. Completely remove existing form-in-place gasket from the cam position sensor support and cylinder head (surface to which cam position sensor support is fitted).
2. Apply a 3 ± 1 mm bead of form-in-place gasket (FIPG) to the area shown.
   
   Specified sealant:
   Mitsubishi Genuine Part No.970389 or equivalent
3. With the tightening bolt, tighten the cam position sensor support and the air intake pipe bracket assembly together with the cylinder head to the specified torque of 14 ± 1 N·m.

>>B<< CRANKSHAFT BOLT INSTALLATION

1. Lock the flywheel using the special tool Flywheel stopper (MB991883).
2. Clean the bolt hole in crankshaft.
3. Clean and degrease the crankshaft pulley.
   
   NOTE: Degreasing is necessary to prevent decrease in friction between of the mating surfaces due to the presence of oil.
4. Install the crankshaft pulley.
5. Apply a proper minimum quantity of engine oil to the threads of crankshaft and the lower part of flange.
6. Install the washer, whose grooved surface is toward the bolt flange.
7. Tighten the crankshaft bolt to the specified torque of 181 N·m.
Removal steps

1. Timing belt front upper cover
2. Timing belt front lower cover
3. Breather hose
4. PCV hose
5. PCV valve
6. PCV valve gasket
7. Oil filler cap
8. Rocker cover
9. Rocker cover gasket A
10. Rocker cover gasket B

Removal steps (Continued)

11. Rocker cover gasket C
12. Plug cap
13. Timing belt
14. Tensioner pulley
15. Tensioner arm
16. Shaft
17. Auto-tensioner
18. Idler pulley
19. Bracket
20. Crank angle sensor
Removal steps (Continued)

**<<C>> 21. Crankshaft sprocket**

**<<C>> 22. Spacer**

**<<C>> 23. Sensing blade**

**<<C>> 24. V.V.T. sprocket bolt**

**<<B>> 25. V.V.T. sprocket**

**<<D>> 26. Camshaft sprocket bolt**

**27. Camshaft sprocket**

**28. Engine support bracket**

**29. Timing belt rear cover, right**

**30. Timing belt rear cover, left**

⚠️ **CAUTION**

Never disassemble the V.V.T. sprocket.

---

**REMOVAL SERVICE POINTS**

**<<A>> PLUG CAP REMOVAL**

Remove the plug cap using a wrench fitted on the hexagonal portion of the camshaft.

**<<B>> TIMING BELT REMOVAL**

1. By turning the crankshaft, position the No.1 cylinder at the Top Dead Center of the compression stroke.

2. If the timing belt is to be reused, it is necessary to install it in the same direction as it was before. Mark an arrow that shows the direction of rotation on the back surface of the timing belt with chalk, etc.

**<<C>> V.V.T. SPROCKET BOLT REMOVAL**

Remove the V.V.T. sprocket bolt using a wrench fitted on the hexagonal portion of the camshaft.

**<<D>> CAMSHAFT SPROCKET BOLT REMOVAL**

Remove the camshaft sprocket bolt using a wrench fitted on the hexagonal portion of the camshaft.
INSTALLATION SERVICE POINTS

>>A<< CAMSHAFT SPROCKET BOLT INSTALLATION

Tighten the camshaft sprocket bolt to 88 ± 10 N·m while preventing the camshaft from rotation using a wrench fitted on the hexagonal portion of the camshaft.

>>B<< V.V.T. SPROCKET BOLT/V.V.T. SPROCKET INSTALLATION

1. Apply a proper minimum quantity of engine oil to the following points.
   - Camshaft end
   - Insertion hole in V.V.T. sprocket (all over inside and outside surfaces)
   - Threads and head of V.V.T. sprocket bolt
   - Bearing surface of V.V.T. sprocket bolt
2. Install the V.V.T. sprocket onto the camshaft.
3. Make sure that the V.V.T. sprocket is installed all the way onto the camshaft. Holding the hexagonal portion of the camshaft with a wrench, check that the V.V.T. sprocket does not turn.
4. Holding the hexagonal portion of the camshaft with a wrench, tighten the V.V.T. sprocket bolt to a specified torque of 55 ± 5 N·m.
5. Holding the hexagonal portion of the camshaft with a wrench, check that the V.V.T. sprocket is not loose to turn.

   NOTE: This check is to ascertain that the V.V.T. sprocket is locked at the most retarding position by means of internal pin.

>>C<< CRANKSHAFT SPROCKET/SPACER/SENSING BLADE INSTALLATION

1. Clean the hole in the crankshaft sprocket.
2. Clean and degrease the mating surfaces of the crankshaft sprocket and spacer; sensing blade; crankshaft sprocket; and oil pump case.

   NOTE: Degreasing is necessary to prevent decrease in friction between the mating surfaces due to presence of oil.
3. Assemble the crankshaft sprocket and sensing blade, projection to slot, as shown.

4. Align the pins to the pin holes and apply even pressure in the arrow direction.

**CAUTION**
When installing the sprocket, do not bend the sensing blade.

5. Install the crankshaft sprocket onto the crankshaft.

---

1. If the auto-tensioner rod remains in its fully extended position, reset it to the retracted position as follows:
   (1) Clamp the auto-tensioner in a vise at right angles to the jaws.

   **CAUTION**
   Because the leak down of the auto-tensioner takes a long time, slowly insert the rod. If the rod is suddenly inserted, the auto-tensioner could be damaged.
   (2) Push in the rod little by little with the vise until the set hole A in the rod is aligned with the set hole B in the cylinder.

   (3) Insert a piece of wire (1.4 mm diameter) into the set holes.
   (4) Remove the auto-tensioner from the vise.

2. Install the auto-tensioner in position. Leave the wire installed until the auto-tensioner is completely installed.
**>>E<< TENSIONER PULLEY INSTALLATION**

Install the tensioner pulley onto the tensioner arm, with the machined holes facing in front as shown.

**>>F<< TIMING BELT INSTALLATION**

1. For aligning the timing marks on the camshaft sprocket and V.V.T. sprocket, install the rocker cover temporarily.

2. Align the timing mark on the camshaft sprocket.

3. Align the timing mark on the V.V.T. sprocket.

4. Align the timing mark on the crankshaft sprocket.

5. First fit the timing belt onto the crankshaft sprocket.

6. Fit the timing belt onto the idler pulley.

7. Fit the timing belt onto the camshaft sprocket, and bind it with paper clip in the illustrated shown in the illustration.

8. Fit the timing belt onto the V.V.T. sprocket, and bind it with paper clip in the position shown in the illustration.
9. Fit the timing belt onto the tensioner pulley.
   
   **NOTE**: To make belt installation easier, turn the V.V.T. sprocket a little counter-clockwise.

10. Using the special tool of tensioner pulley socket (MD998767), apply the tension to the timing belt by turning the tensioner pulley counterclockwise, then temporarily tighten the fixing bolt of the tensioner pulley and fix the tensioner pulley firmly.

11. Turn the crankshaft a quarter turn counter-clockwise, then turn it clockwise to align the timing marks.

12. Install the special tool Set screw (MD998738) in position and drive it in to such an extent that the wire inserted when the auto tensioner was installed lightly moves.

---

**CAUTION**

The timing belt is loosened with the rotation of the intake and exhaust camshafts. Take care that the timing belt does not slip out of place.

13. Loosen the lock bolt holding the tensioner pulley.

14. Turn the torque wrench attached to the special tool Tensioner pulley socket (MD998767) counterclockwise until the slack in the timing belt is taken up.

15. Torque to 0.8 N-m with the torque wrench.

16. Check that all the timing marks are in alignment.

17. Remove the special tool Set screw (MD998738) installed at step 12.

18. Give the crankshaft two turns clockwise, and leave it in that state for approximately 15 minutes.

19. Check to see if the wire inserted when the auto tensioner was installed can be easily pulled out. If so, the belt tension is optimal and the wire may be removed. Alternatively, if the protrusion of the auto tensioner rod is within the specified range of standard values, the belt tension is optimal.

   **Standard value**: 4.8 – 5.5 mm

**CAUTION**

When the crankshaft bolt was turned counter-clockwise, be sure to check its tightening torque. If the bolt is loose, retighten it.

20. If the wire cannot be easily removed, repeat the steps from 12 to 18 above for proper tension of the belt.

21. Finally, remove the temporarily installed rocker cover.
**>>G<< PLUG CAP INSTALLATION**

**CAUTION**

Do not reuse washer.

1. Replace washer on the plug cap.

2. Holding the hexagonal portion of the camshaft with a wrench, tighten the plug cap to a specified torque of 21 ± 3 N·m.

**>>H<< ROCKER COVER INSTALLATION**

1. Completely remove existing form-in-place gasket from the rocker cover and cylinder head.

2. Apply beads of FIPG on the surfaces of the rocker cover indicated in the illustration.

   **Specified sealant:**
   Mitsubishi Genuine Part No. 970389 or equivalent

3. Install the rocker cover to the cylinder head before the FIPG hardens, and tighten the tightening bolt to the specified torque of 3.5 ± 0.5 N·m.

**INSPECTION**

**TIMING BELT**

Check closely the entire timing belt. Replace it if any of the following conditions is found.

1. Hardened back side rubber.

   Back side surface is glossy, lacking in elasticity, and so hard that no impression is left when pressed with fingernail.

2. Cracks in back rubber surface.

3. Cracks in canvas.


5. Cracks in belt sides.
6. Abnormally worn belt sides.
   NOTE: belt sides are normal if they have "knife-cut" surfaces.

7. Badly worn teeth.
   Initial stage: Canvas is worn (canvas fiber is fluffy; teeth look whitish due to worn-out rubber; canvas texture is unclear)
   Second stage: Canvas is lost and rubber is exposed (tooth width narrows down)

8. Missing tooth.

AUTO-TENSIONER

1. Check the auto-tensioner for leaks from the sealed sections.
   Replace it if leaky.

2. Check the rod end for wear and other damage.
   Replace the auto-tensioner if the rod is badly worn or damaged.

3. Measure the extension length of the rod.
   If it is not within the standard value range, replace the auto-tensioner.
   **Standard value: 12 mm**

4. Press the rod with a force of 98 – 196 N and measure the amount of retraction. If the measurement exceeds the standard value, replace the auto-tensioner.
   **Standard value: 1 mm maximum**
Removal steps
1. Water hose
2. Water hose
3. Throttle body
   >>B<< 4. Throttle body gasket
5. Vacuum hose
6. Vacuum hose
7. Solenoid valve
8. Purge valve
9. Delivery pipe and injector
10. Insulator

Removal steps (Continued)
11. Insulator
12. O-ring
   >>A<< 13. Injector
14. Fuel hose
15. Fuel pressure regulator
   >>A<< 16. Delivery pipe
17. Vacuum pipe and hose
18. Solenoid valve
INSTALLATION SERVICE POINTS

>>A<< INJECTOR/DELIVERY PIPE INSTALLATION

1. Fit the insulator onto the injector.

   **CAUTION**
   Take care that no engine oil enters the delivery pipe.

2. Apply a little fresh engine oil to the injector O-ring.

   Then, insert the injector, center to center, into the injector mounting hole on the delivery pipe.

3. Make sure that the injector connector projection is properly engaged with the delivery pipe.

   Turn the injector to ensure engagement if necessary.

4. Check that the injector rotates smoothly. If it does not, remove it and check the injector O-ring for damage. If damage is evident, replace the O-ring, reinstall the injector to the delivery pipe and check it again for smooth rotation.

5. Install the delivery pipe to the cylinder head.

   **CAUTION**
   Connect the injector securely, having no air leakage from the insulator.

6. Install the insulator, connecting securely to the injector without the clearance.

>>B<< THROTTLE BODY GASKET INSTALLATION

Install the throttle body gasket, facing the gasket’s protruded portion in the illustrated position.
Removal steps

1. Engine coolant temperature sensor
2. Water inlet fitting
3. Thermostat
4. Water hose
5. Water hose
6. Water hose
7. Water hose
8. Water hose

Removal steps (Continued)

9. Water hose
10. Water pipe
11. Water inlet pipe
12. O-ring
13. O-ring
14. Water pump
INSTALLATION SERVICE POINTS

>>A<< O-RING/WATER INLET PIPE INSTALLATION

⚠️ CAUTION
• Do not apply engine oil or any other oily substance to the O-rings.
• Secure the water pipe after the thermostat case has been installed.
Replace the water inlet pipe O-rings with new ones, then apply water to the O-rings so that they can be inserted easily into the water pump and thermostat case.

>>B<< THERMOSTAT INSTALLATION

Install the thermostat to the thermostat housing so that its jiggle valve can locate around the center.

>>C<< ENGINE COOLANT TEMPERATURE SENSOR INSTALLATION

⚠️ CAUTION
Take care not to damage the connector (plastic) with tool.

1. Completely remove existing sealant from the engine coolant temperature sensor and mating hole in the thermostat housing.
2. Apply the specified sealant to the threads of the sensor.
   Specified sealant: 3M Nut Locking Part No.4171 or equivalent
3. Tighten the water temperature sensor together with the thermostat housing to the specified torque of 29 ± 10 N·m.
INLET MANIFOLD

REMOVAL AND INSTALLATION

Removal steps
1. Inlet manifold stay
2. Inlet manifold
3. Inlet manifold gasket
4. Engine hanger

INSTALLATION SERVICE POINTS

>>A<< INLET MANIFOLD STAY INSTALLATION

Make sure that the inlet manifold stay tightly fits the inlet manifold and the mating boss of the cylinder block, then tighten bolts the specified torques.

Tightening torque:
M8 18 ± 2 N·m
M10 31 ± 3 N·m
**Removal steps**

1. Oxygen sensor
2. Turbocharge cover
3. Oil return pipe
4. Oil return pipe gasket
5. Oil return pipe gasket
6. Exhaust fitting bracket
7. Exhaust fitting
8. Exhaust fitting gasket
9. Turbocharger bracket
10. Oil pipe
11. Water pipe "B"

**Removal steps (Continued)**

12. Turbocharger
13. Turbocharger gasket
14. Water pipe "A"
15. Exhaust manifold
16. Exhaust manifold gasket
17. Thermostat housing
18. Thermostat housing gasket
19. Engine hanger
**>>A<< WATER PIPE INSTALLATION**

Put the bracket of the water pipe "B" over the bracket of the water pipe "A" as shown in the illustration. Tighten them together with the turbocharger to the tightening torque of 10 ± 2 N·m.

**>>B<< EXHAUST FITTING BRACKET INSTALLATION**

Make sure that the exhaust fitting bracket fits exactly the exhaust fitting and the turbocharger bracket. Tighten the exhaust fitting bracket to the specified torque of 35 ± 6 N·m.

**>>C<< OIL RETURN PIPE GASKET INSTALLATION**

Install the projection of the oil return pipe gasket to the turbocharger and the oil pan as shown in the illustration.
Apply engine oil to all moving parts before installation.

Removal steps

- Oil feeder control valve
- Oil pipe
- Oil feeder control valve filter
- Oil seal
- Circular packing
- Cam position sensing cylinder
- Front bearing cap
- Bearing cap
- Rear right bearing cap
- Rear left bearing cap
- Intake camshaft
- Exhaust camshaft
- Roller rocker arm
- Lash adjuster
REMOVAL SERVICE POINTS

<<A>> CAM POSITION SENSING CYLINDER REMOVAL

Holding the hexagonal portion of the camshaft with a wrench, remove the cam position sensing cylinder.

<<B>> LASH ADJUSTER REMOVAL

⚠️ CAUTION

If the lash adjuster is to be reused, be sure to clean and inspect it before installation. (Refer to P.11D-30.)

INSTALLATION SERVICE POINTS

>>A<< LASH ADJUSTER INSTALLATION

⚠️ CAUTION

If the lash adjuster is to be reused, be sure to clean and inspect it before installation. (Refer to P.11D-30.)
While using care not to spill diesel fuel in the lash adjuster, install the lash adjuster on the rocker arm.

>>B<< CAMSHAFT INSTALLATION

⚠️ CAUTION

- Do not confuse intake and exhaust camshafts.
- A 4 mm slit is on the rear end of the intake camshaft.

Apply engine oil to the camshaft journal and cams before installation.

>>C<< FRONT BEARING CAP/BEARING CAP/REAR RIGHT BERING CAP/REAR LEFT BEARING CAP INSTALLATION

1. Place the dowel pins of the camshafts in the positions shown in the illustration.

NOTE: By getting the dowel pins into position shown in the illustration, the camshaft slots of tightening the cylinder head bolt are put in position.

2. The bearing caps No. 2 to 5 are identical in shape. Before installation, be sure to check the cap numbers and identification marks so that right bearing caps are installed in right places.

Identification marks (Die-stamped on front and No. 2 to 5 bearing caps)

I: Intake side
E: Exhaust side

3. Completely remove existing sealant from the bearing caps and cylinder head.
4. Apply specified sealant to the cylinder head at the points shown in the illustration.

   **Specified sealant:**
   3M ATD No.8660 or equivalent

5. Install the bearing caps in position and tighten bolts increasingly by giving turns 2 to 3 times each.

   **NOTE:** Completely wipe off excess of applied sealant that comes out.

6. Finally, tighten the bearing cap bolts to a specified torque.

   **Specified torque**
   Front bearing cap: $21 \pm 2$ N·m
   Bearing cap: $11 \pm 1$ N·m
   Rear right bearing cap: $21 \pm 2$ N·m
   Rear left bearing cap: $21 \pm 2$ N·m

7. Check that the rocker arms are installed in position.

   **>>D<< CAM POSITION SENSING CYLINDER INSTALLATION**

   Holding the hexagonal portion of the camshaft, tighten the cam position sensing cylinder to a specified torque of $22 \pm 4$ N·m.

   **>>E<< CIRCULAR PACKING INSTALLATION**

   Using the special tool Circular packing installer (MD998762), install the circular packing into the cylinder head.

   **>>F<< OIL SEAL INSTALLATION**

   Using the special tool Oil seal installer (MD998713), install the oil seal into the cylinder head.

   **>>G<< OIL FEEDER CONTROL VALVE FILTER INSTALLATION**

   **CAUTION**
   Check the filter for foreign matters, damage and deformation before installation.

   **>>H<< OIL FEEDER CONTROL VALVE INSTALLATION**

   1. Apply a small amount of engine oil to the o-ring of the oil feeder control valve.
   2. Install the oil feeder control valve to the cylinder head.
   3. Tighten the oil feeder control valve bolt to the specified torque of $11 \pm 1$ N·m.
Measure the cam height (nose-to-heel diameter). If any cam is worn beyond the limit, replace the camshaft.

**Standard values:**
- Intake 35.08 mm
- Exhaust 34.26 mm

**Limit:**
- Intake 34.58 mm
- Exhaust 33.76 mm

**LASH ADJUSTERS**

**CAUTION**
- The lash adjuster is a precision-engineered component. Do not allow dust or other foreign matter to enter it.
- Do not disassemble lash adjusters.
- Use only non-contaminated diesel fuel to clean the lash adjuster.

1. Prepare three containers and approximately five liters of diesel fuel. Pour into each container the diesel fuel in an amount enough for a lash adjuster placed in the container in its upright position to completely submerge.

2. Place the lash adjuster in container A and wash its outside surface.
   
   **NOTE:** Use a nylon brush if there are hard-to-remove deposits.

3. While gently pushing the internal steel ball using the special tool Air bleed wire (MD998442), move the plunger in and out 5–10 times to eliminate stiffness in the plunger and expel contaminated oil.
   
   **NOTE:** The plunger must be free from jamming and any other abnormalities. If a defect is found in plunger operation, replace the lash adjuster.
**CAUTION**
The hole in the side of the lash adjuster must be directed toward the inside of container A. Never direct it against any person.

4. Take the lash adjuster out of the container, then move the plunger by pushing the steel ball gently to discharge the diesel fuel from the pressure chamber.

**CAUTION**
The steel ball spring of the lash adjuster is extremely weak. The lash adjuster’s functionality may be badly affected if the special tool is inserted too strongly.

5. Soak the lash adjuster in the diesel fuel in container B. Move the plunger in and out 5 – 10 times by gently pushing the internal steel ball using the special tool Air bleed wire (MD998442) until the plunger moves smoothly to wash the lash adjuster’s pressure chamber.

**CAUTION**
The hole in the side of the lash adjuster must be directed toward the inside of container B. Never direct it against any person.

6. Take the lash adjuster out of the container, then move the plunger by pushing the steel ball gently to discharge the diesel fuel from the pressure chamber.

**CAUTION**
Do not use container C for cleaning. If cleaning is performed in container C, foreign matter could enter the pressure chamber when the chamber is filled with diesel fuel.

7. Soak the lash adjuster in the diesel fuel in container C. Gently push the internal steel ball using the special tool Air bleed wire (MD998442).

8. Place the lash adjuster upright with the plunger at the top. Push the plunger firmly until it makes a full stroke, then return the plunger slowly and release the hold of the steel ball to allow the pressure chamber to be filled with diesel fuel.

9. Take the lash adjuster out of the container, place it upright with the plunger at the top, and push the plunger firmly. The plunger must not move at all.
NOTE: If the lash adjuster contracts, perform the operations 7 through 9 again. Replace the lash adjuster if it still contracts even after the pressure chamber has completely been filled with diesel fuel (air has been bled).

10. Keep the serviced lash adjusters in their upright positions to prevent diesel fuel from spilling out. Protect them from dust or other foreign matter. Install the lash adjusters onto the engine as soon as possible.
Apply engine oil to all moving parts before installation.

**Removal steps**

<<A>><>D<<
1. Cylinder head bolt
2. Cylinder head assembly
3. Cylinder head gasket

<<B>><>C<<
4. Retainer lock
5. Valve spring retainer
6. Valve spring
7. Intake valve
8. Retainer lock
9. Valve spring retainer
10. Valve spring
11. Exhaust valve

**Removal steps (Continued)**

<<A>><>D<<
12. Valve stem seal
13. Valve spring seat
14. Valve stem seal
15. Valve spring seat
16. Intake valve guide
17. Exhaust valve guide
18. Intake valve seat
19. Exhaust valve seat
20. Cylinder head

49 ± 2 N·m → 0 N·m → 20 ± 2 N·m → 90° + 90°
REMOVAL SERVICE POINTS

<<A>> CYLINDER HEAD BOLT REMOVAL

Use the special tool Cylinder head bolt wrench (MB991653) to loosen the cylinder head bolts.

<<B>> RETAINER LOCK REMOVAL

Compress the valve spring using the special tool Valve spring compressor (MD998772), then remove the retainer lock.

NOTE: Store removed valves, springs and other parts, after putting to each of them a tag that identifies its cylinder No. or installation location.

INSTALLATION SERVICE POINTS

>>A<< VALVE STEM SEAL INSTALLATION

1. Install the valve spring seat.
2. Install the valve.
3. Apply a thin coat of engine oil to a new valve stem seal.

NOTE: Do not confuse the stem seals for intake valves with those for exhaust valves.

![Intake valve stem seal](Colour: Gray) ![Exhaust valve stem seal](Colour: Grayish green)

![CAUTION](AK201791AC)

- Do not reuse the valve stem seal.
- The special tool must always be used when installing the valve stem seal. Improper installation could result in oil leaks past the valve guide.

4. Use the special tool Valve seal installer (MB991671) to install the stem seal on the valve guide. Use the stem of the valve to guide the stem seal.
>>B<< VALVE SPRING INSTALLATION

Install each valve spring with the painted end toward the rocker arm.

>>C<< RETAINER LOCK INSTALLATION

Compress the valve spring using the special tool Valve spring compressor (MD998772), then install the retainer lock.

>>D<< CYLINDER HEAD BOLT INSTALLATION

1. When reusing a cylinder head bolt, check that its nominal length (shank length) is not greater than the limit. If the limit is exceeded, replace the bolt.

   Limit: 103.2 mm

2. Apply engine oil to the threads and washer of the bolt.

   CAUTION
   - If the tightening angle is smaller than 90°, proper fastening performance could not be assured. Be sure to respect that angle.
   - If the bolt is tightened to an angle greater than the specified angle, loosen the bolt completely and then retighten it beginning with the first step.

3. Tighten the bolts to 49 ± 2 N·m in the indicated sequence.
4. Loosen all the bolts completely.
5. Tighten the bolts again to a torque of 20 ± 2 N·m in the indicated sequence.

6. Make paint marks on each bolt’s head and on the cylinder head.
7. Turn the bolts 90° in the tightening direction and in the indicated sequence.
8. Give another 90° turn in the tightening direction to each bolt, making sure that the paint mark on the bolt head and that on the cylinder head are on the same line.

INSPECTION

CYLINDER HEAD

1. Before cleaning the cylinder head, check it for traces of water and gas leakage and for cracks and any other damage.
2. Thoroughly remove oils, scale, sealants, carbon and other contamination. Clean the oil passages, then check using compressed air that they are not blocked.

3. Check the cylinder head gasket surface for warp using a straightedge and thickness gauge. If the surface is warped beyond the limit, grind the surface for rectification.

**CAUTION**

The thickness of the metal that can be removed by grinding from both the cylinder head and the mating cylinder block is limited to 0.2 mm in total.

- Gasket surface warp
  - Standard value: 0.03 mm or less
  - Limit: 0.2 mm
  - Grinding limit: 0.2 mm
- Cylinder head height (standard value for new part):
  131.9 – 132.1 mm

VALVES

1. Check the valve face for correct contact with the seat. Reface the valve if the contact is partial or one sided.

2. Measure the margin.

   Replace the valve if its margin is smaller than the limit.
   - **Standard values:**
     - Intake 1.0 mm
     - Exhaust 1.5 mm
   - **Limits:**
     - Intake 0.5 mm
     - Exhaust 1.0 mm

3. Measure the total length of the valve.

   Replace the valve if the length is less than the limit.
   - **Standard values:**
     - Intake 106.35 mm
     - Exhaust 106.85 mm
   - **Limits:**
     - Intake 105.85 mm
     - Exhaust 106.35 mm
VALVE SPRINGS

1. Measure the free height of the spring.
   Replace the spring if its height is smaller than the limit.
   
   **Standard value:** 54.8 mm
   **Limit:** 53.8 mm

2. Measure the squareness of the spring.
   Replace the spring if it is out of square beyond the limit.
   
   **Standard value:** 2° or less
   **Limit:** 4°

VALVE GUIDE

Measure the valve guide inside diameter and valve stem diameter to calculate the clearance between the valve guide and valve stem.
If the limit is exceeded, replace the valve guide or valve, or both.

**Standard values:**
- Intake 0.02 – 0.05 mm
- Exhaust 0.03 – 0.06 mm

**Limits:**
- Intake 0.10 mm
- Exhaust 0.15 mm

VALVE SEATS

With the valve installed in position and its face pressed against the valve seat, measure the valve stem projection (distance between the valve stem end and spring seating surface). If the measurement exceeds the limit, replace the valve seat.

**Standard values:**
- Intake 48.8 mm
- Exhaust 48.7 mm

**Limits:**
- Intake 49.3 mm
- Exhaust 49.2 mm

VALVE SEAT RECONDITIONING

1. Before reconditioning the valve seat, check the clearance between the valve guide and valve stem and, if necessary, replace the valve guide.

2. Resurface the valve seat to the indicated width and angles.

3. After resurfacing, lap the valve and valve seat using lapping compound.
**VALVE SEAT REPLACEMENT**

1. Cut inside of the valve seat to be replaced until its wall becomes thin enough for removal, then remove the valve seat.

2. Re bore the valve seat hole in the cylinder head to a diameter matched to the diameter of the selected oversize valve seat.
   - **Intake valve seat hole diameters:**
     - 0.3 oversize: 31.30 – 31.33 mm
     - 0.6 oversize: 31.60 – 31.63 mm
   - **Exhaust valve seat hole diameters:**
     - 0.3 oversize: 27.80 – 27.82 mm
     - 0.6 oversize: 28.10 – 28.12 mm

3. Before fitting the valve seat, cool it in liquid nitrogen to prevent damage to its hole in the cylinder head due to interference.

4. Resurface the valve seat. See the VALVE SEAT RECONDITIONING section.

**VALVE GUIDE REPLACEMENT**

1. Force out the valve guide toward the cylinder block using a press.

   **CAUTION**
   Do not use a replacement valve guide of the same size as the removed one.

2. Machine the valve guide hole in the cylinder head to the size matched to the selected oversize valve guide.
   - **Valve guide hole diameters**
     - 0.05 oversize: 10.55 – 10.57 mm
     - 0.25 oversize: 10.75 – 10.77 mm
     - 0.50 oversize: 11.00 – 11.02 mm

3. Press-fit the valve guide until it remains protruded above the cylinder head by the amount indicated in the illustration.
   - **Standard value:** 22.7 – 23.3 mm

   **NOTE:** Press the valve guide from above the cylinder head.

   **NOTE:** The valve guides for the intake valves are different in length from those for the exhaust valves (48 mm for intake valves; 55 mm for exhaust valves)

4. After installing the valve guide, insert a new valve in it to check for smooth movement.
Apply engine oil to all moving parts before installation.

Removal steps:

**>>F<<**
1. Oil filter
2. Oil cooler bolt
3. Oil cooler

**>>E<<**
4. Oil pressure switch

**>>D<<**
5. Drain plug
6. Drain plug gasket
7. Transmission stay

**<<A>>**
8. Oil pan
9. Oil screen
10. Oil screen gasket
11. Baffle plate

Removal steps (Continued):
12. Relief plug
13. Relief spring
14. Relief plunger

**>>B<<**
15. Front oil seal

**>>A<<**
16. Oil pump case
17. O-ring
18. Oil pump cover
19. Oil pump outer rotor
20. Oil pump inner rotor
1. Remove the oil pan mounting bolts.
2. Knock the special tool Oil pan remover (MD998727) between the oil pan and cylinder block as shown in the illustration.
3. Tapping the side of the special tool, slide the tool along the oil pan/cylinder block seal and thus remove the oil pan.

**CAUTION**
The mounting bolts are different in length. Take care not to use wrong bolts in wrong places.

3. Install the oil pump case to the cylinder head, and tighten mounting bolts to a specified torque of 14 ± 1 N·m.

**>>B<< FRONT OIL SEAL INSTALLATION**

1. Place the special tool Crankshaft front oil seal guide (MB991962) on the crankshaft's front end and apply engine oil to the its outer circumference.

2. Apply engine oil to the oil seal lip, then push the oil seal along the guide by hand until it touches the front case. Tap the oil seal into place using the special tool Camshaft oil seal installer (MD998306).
**>>C<< OIL PAN INSTALLATION**

1. Completely remove existing form-in-place gasket from the cylinder block (oil pan mounting surface) and oil pan.

2. Apply a 4 ± 1mm bead of form-in-place gasket to the oil pan at the positions shown in the illustration.

   **Specified sealant:**
   Mitsubishi Genuine Part No. 970389 or equivalent

3. Install the oil pan to the cylinder block and tighten the tightening bolt to the specified torque of 7.0 ± 1.0 N·m.

**>>D<< DRAIN PLUG GASKET INSTALLATION**

**CAUTION**
Installing the gasket with the wrong side facing the oil pan will result in oil leakage.
Replace the drain plug gasket with a new one. Install it with the side indicated in the illustration toward the oil pan.

**>>E<< OIL PRESSURE SWITCH INSTALLATION**

**CAUTION**
The threaded part tip of the switch must be clear of the sealant.

1. Completely remove existing sealant from the oil pressure switch and the switch mounting hole on the oil pump case.
2. Apply specified sealant to the threaded part of the oil pressure switch as shown.

Specified sealant: LOCTITE 565 or equivalent

3. Install the oil pressure switch to the oil pump case by tightening to a specified torque of 10 ± 2 N·m.

>>F<< OIL FILTER INSTALLATION

1. Clean the filter mounting surface on the front case.

2. Apply engine oil to the O-ring of the oil filter.

3. Screw the oil filter in and tighten the oil filter to the specified torque using a commercially available filter wrench from where the O-ring has come into contact with the oil filter mounting surface.

Specified torque:
MD348631, MD365876 16 ± 4 N·m (approx. 3/4 of a turn)
MD360935 14 ± 2 N·m (approx. 1 turn)

CAUTION If the filter is tightened by hand only, it will be insufficiently torqued, resulting in oil leaks.

INSPECTION

OIL PUMP

1. Fit the inner rotor and the outer rotor into the oil pump case.

2. Check the tip clearance using a thickness gauge.

   Standard value: 0.06 – 0.18 mm

3. Check the side clearance using a straight edge and thickness gauge.

   Standard value: 0.10 – 0.18 mm

4. Check the body clearance using a thickness gauge.

   Standard value: 0.040 – 0.095 mm
Apply engine oil to all moving parts before installation.

Removal steps

1. Connecting rod nut
2. Connecting rod cap
3. Connecting rod bearing
4. Piston and connecting rod assembly
5. Connecting rod bearing
6. Piston ring No. 1
7. Piston ring No. 2

17 ± 2 N·m + 90° to 94°

Removal steps (Continued)

8. Oil ring
9. Piston pin
10. Piston
11. Connecting rod
12. Bolt
REMOVAL SERVICE POINTS

<<A>> CONNECTING ROD CAP REMOVAL

Mark the cylinder number on the side of the connecting rod big end as a guide for reassembly.

<<B>> PISTON PIN REMOVAL

1. The special tool Piston pin setting tool (MD998780) consists of the elements shown in the illustration.
2. When removing the piston pin, the special tool Guide D (MB991659) is also used.
3. Insert Push rod, into the piston from the front mark side, then attach Guide D, to the push rod.
4. Place the piston and connecting rod assembly on Base, with the front mark facing up.
5. Use a press to remove the piston pin.

NOTE: Keep the disassembled pistons, piston pins and connecting rods per cylinder.

INSTALLATION SERVICE POINTS

>>A<< PISTON PIN INSTALLATION

1. When replacing a piston, check the cylinder bore size mark stamped at the indicated location on the cylinder block and select an appropriate replacement piston using the following table.
Cylinder bore size mark | Piston size mark
---|---
A | A
B | None
C | C

NOTE: The piston size mark is located on the piston top surface.

2. Insert the push rod into the piston pin and install the guide "A."
3. Align the front mark of the piston with that of the connecting rod. Align the piston with the connecting rod.
4. Apply engine oil to the outer circumference of the piston pin.
5. Insert the piston pin guide "A" installed at Step 2 into the pin hole from the front mark of the piston.
6. Screw the guide "B" into "A" until the clearance "L" reaches 2.25 mm between "A" and "B."
7. Place the piston and connecting rod assembly onto Base, with the front marks facing up.
8. Install the piston pin using a press. If the required press force is less than the standard value, replace the piston and piston pin assembly or the connecting rod, or both.

Standard value: 4,900 – 14,700 N

>>B<< OIL RING INSTALLATION

1. Fit the oil ring spacer into the piston ring groove.
2. Install the upper side rail, then the lower side rail.

NOTE: New spacers and side rails are identified by color marks as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Color mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>No mark</td>
</tr>
<tr>
<td>0.50 mm oversize</td>
<td>Blue</td>
</tr>
<tr>
<td>1.00 mm oversize</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

CAUTION

Use of ring expander to expand the side rail end gap can break the side rail, unlike other piston rings.

2. To install each side rail, first fit one end of the rail into the piston groove, then press the remaining portion progressively into position by finger as shown in the illustration.
3. Make sure that the installed side rails move smoothly in either direction.

4. Locate the side rail and spacer end gaps as shown in the illustration.
Using a piston ring expander, install the piston rings with their identification marks facing up (toward the piston crown).

Identification marks:
No. 1 ring 1R
No. 2 ring 2R

NOTE: Each of the available piston rings has a size mark as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Size mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>No mark</td>
</tr>
<tr>
<td>0.50 mm oversize</td>
<td>50</td>
</tr>
<tr>
<td>1.00 mm oversize</td>
<td>100</td>
</tr>
</tbody>
</table>

1. Apply engine oil generously to the piston's outside surface, piston rings, and oil ring.

2. Align the end gaps of the piston rings and oil ring (side rails and spacer) as shown in the illustration.

3. Insert the piston and connecting rod assembly from the top of cylinder with the front mark on the crown toward the timing belt side.

4. Use a piston ring band to hold the piston rings compressed when inserting the piston and connecting rod assembly into the cylinder.
>>E<< CONNECTING ROD BEARING INSTALLATION

1. When replacing the connecting rod bearing, select a bearing of the size appropriate for the crankshaft pin diameter in accordance with the crankshaft pin and connecting rod bearing matching table shown below.

<table>
<thead>
<tr>
<th>Crankshaft Identification mark</th>
<th>Pin diameter mm</th>
<th>Connecting rod Identification mark</th>
<th>Bearing identification mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>A or I</td>
<td>41.994 – 42.000</td>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>B or II</td>
<td>41.988 – 41.994</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>C or III</td>
<td>41.982 – 41.988</td>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>4</td>
</tr>
</tbody>
</table>

2. The identification mark of the connecting rod is found in the position shown in the illustration.

3. Select bearings from the bearing selection table in accordance with the identification marks and color codes checked at steps 1 and 2 above.

<Bearing selection example>

(1) If the measured outside diameter of crankshaft pin is 42.000 mm, the identification mark are "A" and I, respectively.

(2) Based on the above, if the identification of the connecting rod is "A," select the bearing marked in I.
1. Install the bearing cap on the connecting rod while aligning the marks made during disassembly. If the connecting rod is new and has no alignment mark, assemble it with the cap such that the both bearing locating notches are on the same side as shown in the illustration.

2. Make sure that the thrust clearance of the connecting rod big end is proper.

   **Standard value:** 0.10 – 0.25 mm
   **Limit:** 0.4 mm

3. Apply engine oil to the threads and bearing surface of each nut before installation.

4. Finger-tighten the nuts on the bolts, then tighten the nuts alternately and repeatedly to install the cap properly.

5. Tighten the nuts to a torque of 17 ± 2 N·m.

6. Make a paint mark on the head of each nut.

7. Make a paint mark on the bolt at a point 90° to 94° away from the paint mark made on the nut in the tightening direction.

   **CAUTION**
   - If the tightening angle is less than 90°, adequate tightness could not be assured.
   - If the tightening angle exceeds 94°, loosen the nut completely and then perform the tightening procedure again beginning with the first step.

8. Turn the nut 90° to 94° to bring the mark on the nut into alignment with that on the bolt.
INSPECTION

PISTON RING

1. Measure the clearance between each piston ring and its groove. If the limit is exceeded, replace the ring or piston, or both.

   **Standard values:**
   - No. 1 ring 0.03 – 0.07 mm
   - No. 2 ring 0.02 – 0.06 mm

2. Install the piston ring into the cylinder bore and force it down with the head of the piston until the ring becomes right-angled to the cylinder wall. Then, measure the end gap of the ring with a thickness gauge. If the end gap is excessive, replace the piston ring.

   **Standard values:**
   - No. 1 ring 0.15 – 0.30 mm
   - No. 2 ring 0.30 – 0.45 mm
   - Oil ring 0.20 – 0.50 mm

   **Limits:**
   - No. 1 ring 0.8 mm
   - No. 2 ring 0.8 mm
   - Oil ring 1.0 mm

CRANKSHAFT PIN OIL CLEARANCE
(PLASTIC GAUGE METHOD)

1. Wipe off oil from the crankshaft pin and connecting rod bearing.
2. Cut a piece of plastic gauge whose length is equivalent to the width of the bearing and place it on the crankshaft pin in parallel with its axis.
3. Install the connecting rod cap carefully and tighten the nuts according to INSTALLATION SERVICE POINTS >>G<<P.11D-43.
4. Remove the nuts, then remove the connecting rod cap carefully.

5. Measure the largest width of the crushed plastic gauge using the ruler printed on the bag of the plastic gauge.

   **Standard value:** 0.025 – 0.040 mm
   **Limit:** 0.1 mm
Apply engine oil to all moving parts before installation.

**Removal steps**

<<A>> 1. Flywheel bolt
        2. Flywheel
        3. Rear plate
        >>E<< 4. Rear oil seal case
        >>D<< 5. Rear oil seal
        >>C<< 6. Bearing cap bolt
        >>C<< 7. Bearing cap
        >>C<< 8. Bearing cap center
        >>C<< 9. Bearing cap No.4
        >>B<< 10. Crankshaft bearing, lower

**Removal steps (Continued)**

>>B<< 11. Crankshaft bearing, center
        12. Crankshaft
        >>B<< 13. Crankshaft bearing, upper
        >>B<< 14. Crankshaft bearing, center
        15. Detonation sensor
        <<B>> 16. Oil jet
        >>A<< 17. Cylinder block
1. Using the special tool Flywheel stopper (MB991883), hold the flywheel in place.
2. Remove the flywheel bolts.

**CAUTION**
Pay full attention not to damage the cylinder wall. Using the metallic bar of the appropriate length, strike to the oil jet.

Until reaching the bottom, strike the oil jet from the crankshaft journal using the pin punch whose diameter is 4.5mm.
**>>B<< CRANKSHAFT BEARING INSTALLATION**

1. Measure the crankshaft journal diameter and select bearings according to identification marks or color codes given in the table below. The journal diameter can be identified if the crankshaft is provided with identification markings in the illustrated positions.

<table>
<thead>
<tr>
<th>Crankshaft</th>
<th>Cylinder block identification mark</th>
<th>Bearing identification mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification color or mark</td>
<td>Journal diameter mm</td>
<td>No color or 2</td>
</tr>
<tr>
<td>Yellow or 1</td>
<td>47.994 – 48.000</td>
<td>0</td>
</tr>
<tr>
<td>No color or 2</td>
<td>47.988 – 47.994</td>
<td>1</td>
</tr>
<tr>
<td>White or 3</td>
<td>47.982 – 47.988</td>
<td>0</td>
</tr>
</tbody>
</table>

2. Cylinder block bearing bore diameter identification marks are stamped in the positions shown, starting with No. 1 from the timing belt side.

3. Based on the identifiers verified in steps 1 and 2, select bearings from the table above.

   **<Bearing selection example>**

   (1) If measured crankshaft journal diameter is 48.000mm, it means yellow in crankshaft color code or 1 in crankshaft identification mark.

   (2) Based on the above, if the cylinder block bearing bore diameter identification mark is 1, select a bearing with an identification mark of 2.
4. Install grooved bearings to the cylinder block.
   NOTE: Center bearings (with thrust flanges) are grooveless.

5. Install grooveless bearings to the bearing caps.

**>>C<< BEARING CAP/BEARING CAP CENTER/BEARING CAP NO.4 INSTALLATION**

1. On the bottom surface of each bearing cap is the cap's number and an arrow. Starting at the timing belt side, fit the bearing caps in numerical order. Ensure that the arrows point toward the timing belt side.

2. Apply engine oil to the threaded portion and bearing surface of the bolt.

3. Tighten the bolts to the specified torque of 34 ± 2 N.m.

4. Using the special tool Angle sensor (MB991614), tighten the bolts to a further 30° to 34°.

5. After fitting the bearing caps, measure the end play in the crankshaft. If the measurement exceeds the specified limit, replace the crankshaft bearings.

   **Standard value: 0.05 – 0.18 mm**
   **Limit: 0.25 mm**

**>>D<< REAR OIL SEAL INSTALLATION**

Press-fit the rear oil seal using the special tool Crankshaft rear oil seal installer plate (MD998011).
**REAR OIL SEAL CASE INSTALLATION**

1. Remove completely old FIPG remaining on the rear oil seal case and cylinder block (oil seal case mounting surface).

2. Apply a bead of FIPG to the surface of the rear oil seal case as shown in the illustration.

   **Specified sealant:**
   Mitsubishi Genuine Part No. 970389 or equivalent

3. Install the oil seal into the cylinder block after applying an appropriate amount of engine oil to the entire circumference of its lip portion.

4. Install the rear oil seal case by tightening its bolts to $11 \pm 1$ N·m.

**DRIVE PLATE BOLT INSTALLATION**

1. Using the special tool Flywheel stopper (MD998781) secure the flywheel.

2. Tighten the flywheel bolt to the specified torque of $132 \pm 5$ N·m.

**INSPECTION**

**CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)**

This plastic gauge method is recommended as the simplest way of measuring the crankshaft oil clearance.

Measure the crankshaft oil clearance using a plastic gauge as follows:

1. Wipe off oil from the crankshaft journal surface and the crankshaft bearing inner surface.

2. Install the crankshaft.

3. Cut a piece of plastic gauge whose length is equivalent to the width of the bearing and place it on the crankshaft journal in parallel with its axis.

4. Install the crankshaft bearing cap carefully and tighten the bolts to the specified torque according to INSTALLATION SERVICE POINTS >>B<<P.11D-50.

5. Remove the bolts, then remove the crankshaft bearing cap carefully.

6. Measure the largest width of the crushed plastic gauge using the ruler printed on the bag of the plastic gauge.

   **Standard value:** $0.02 – 0.04$ mm
   **Limit:** $0.1$ mm

   **NOTE:** The crankshaft pins and journals are fillet-rolled and must not be machined to undersize dimensions.
CYLINDER BLOCK

1. Visually check the cylinder block for scratches, rust, and any other corrosion. Also check it for cracks using a flaw detecting penetrant.
   
   If any defect is evident, replace the cylinder block.

2. Use a straightedge and thickness gauge to check the cylinder block top surface for warp.
   
   If the warp exceeds the specified limit, correct by grinding.

   Make sure that the surface is free from remaining gasket material and other foreign matter.

   Standard value: 0.05 mm
   Limit: 0.1 mm
   Grinding limit: 0.2 mm

3. Check cylinder walls for scratches and seizure.

   If defects are evident, re bore to oversize or replace the cylinder block.

4. Use a cylinder gauge to measure the cylinder bore diameter and taper.

   If the cylinder is worn badly, re bore it to an oversize and replace the piston and piston rings with ones matched with the new bore size.

   The points at which the measurements should be made are indicated in the illustration.

   Standard value: 75.50 – 75.53 mm
   Taper: 0.01 mm or less

BORING CYLINDERS

1. Select an oversize of the pistons to be used based on the largest of the cylinder bores.

2. Oversize pistons are available in two oversizes: 0.50 mm and 1.00 mm. Bore each cylinder to a size that provides the standard clearance when combined with the selected piston. The reference position for piston diameter measurement is as shown in the illustration.

   Based on the piston diameter measurement, calculate the boring finish dimension.
   • Boring finish dimension = [Piston diameter] + [0.02 – 0.04 mm (clearance between piston and cylinder)] – [0.02 mm (honing margin)]

   CAUTION
   To prevent deformation of cylinder block that would result from the heat generated by boring, bore the cylinders in the following sequence: No. 2 → No. 4 → No. 1 → No. 3.

4. Bore all the cylinders to the calculated boring finish dimension.

5. Hone the bored cylinders to the final finish dimension (piston diameter + clearance between piston and cylinder).

6. Check the clearance between the piston and cylinder.

   Standard value: 0.02 – 0.04 mm