ENGINE REPAIR
AND
ADJUSTMENT PARAMETERS

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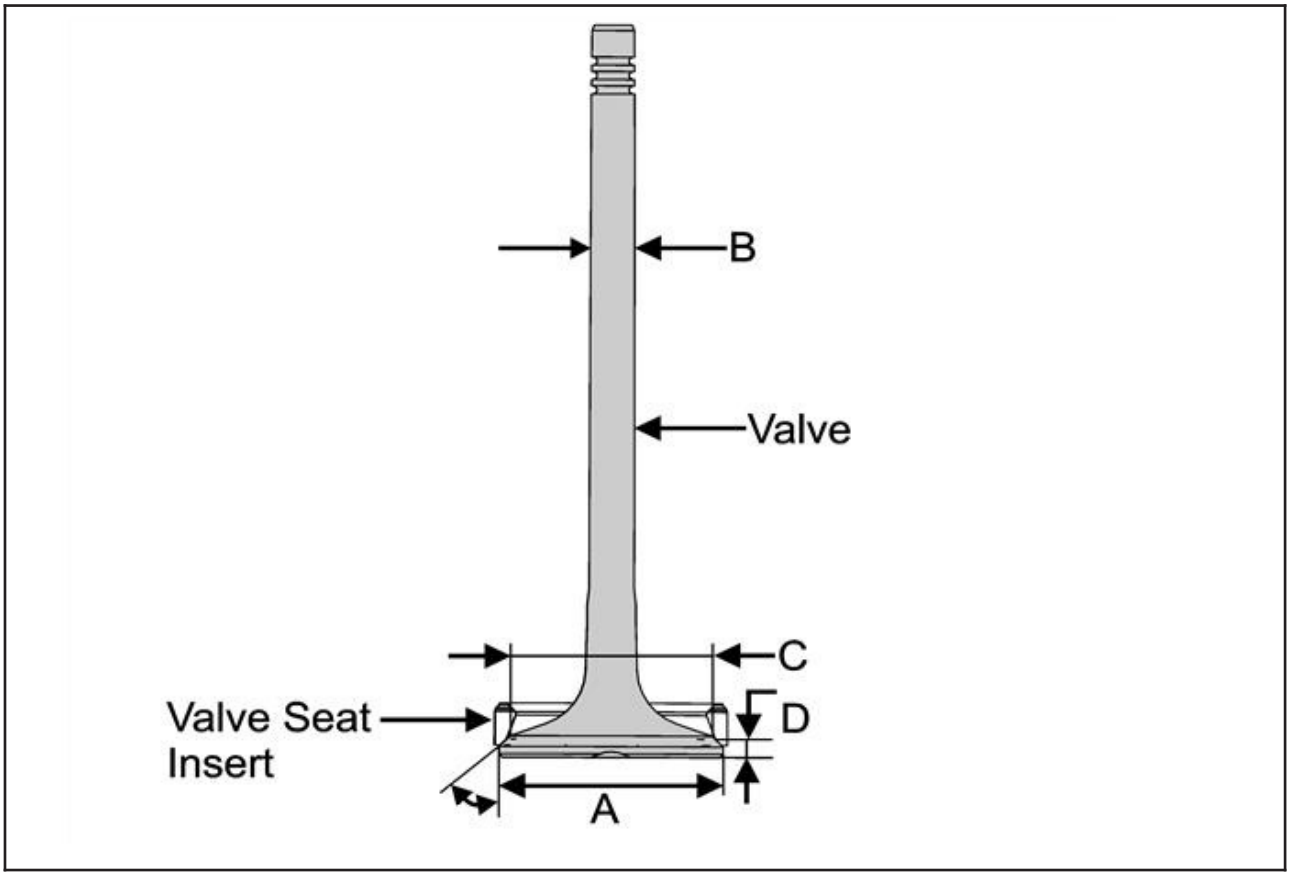
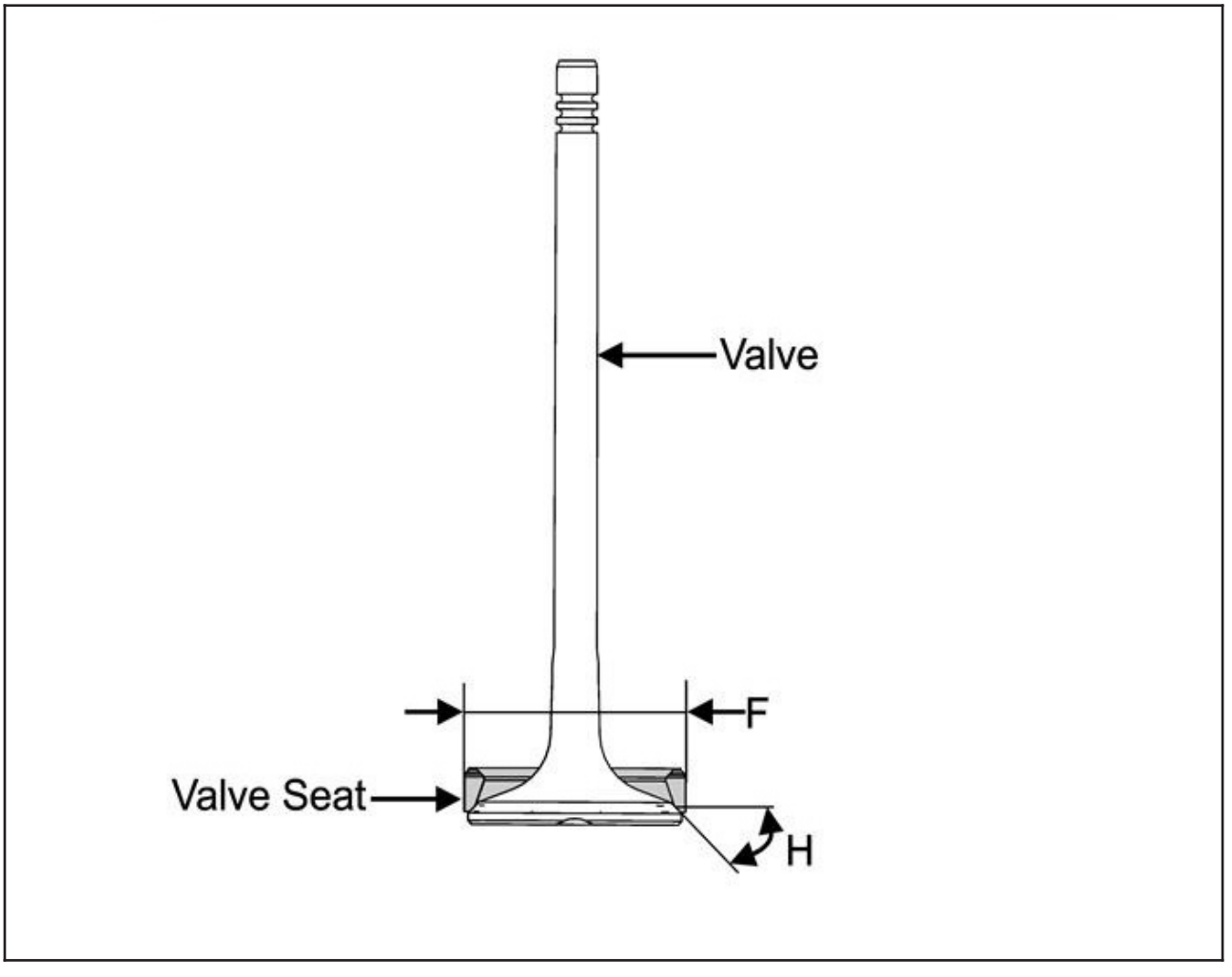
ENGINE REPAIR AND ADJUSTMENT PARAMETERS

A. VALVE AND VALVE SEAT DIMENSIONS

VALVE DIMENSIONS (mm)		INLET	EXHAUST
Valve head diameter 'A'		33.0 $^{+0.1}$	29.7 $^{+0.1}$
Valve seat angle		60^0 + 15'	45^0 + 15'
Valve stem diameter 'B'	Standard Size	6.963$^{+0.007/-0.008}$	6.953$^{+0.007/-0.008}$
	Ist Oversize	7.039$^{+0.007/-0.008}$	7.029$^{+0.007/-0.008}$
	IInd Oversize	7.090$^{+0.007/-0.008}$	7.080$^{+0.007/-0.008}$
	IIIrd Oversize	7.217$^{+0.007/-0.008}$	7.207$^{+0.007/-0.008}$
Maximum run out of valve face with respect to valve stem		0.1	0.1
Valve seat diameter. 'C'		27.4±0.10	23.9±0.10
Valve seat distance from valve face 'D'		1.98 $^{+0.08}$	2.05 $^{+0.08}$
Maximum run out of valve seat with respect to valve stem		0.03	0.03
Distance of valve head from cylinder head mating surface with crankcase 'E'		0.524±0.080/0.085	0.5±0.13/0.08



VALVE DIMENSIONS (mm)	INLET	EXHAUST
Valve seat angle ‘H’	60°	45°
Valve seat Insert diameter “F” in cylinder head	(Normal)	(Normal)
	34.000 +0.080/+0.065	31.1+0.080/+0.065
	(Normal 1)	(Normal 1)
	34.3 +0.080/+0.065	31.3 +0.080/+0.065
Maximum run out of valve seat in cylinder head with respect to valve guide axis (mm)	0.035	0.035



B. VALVE SEAT INSERT AND BORE DIAMETER IN CYLINDER HEAD

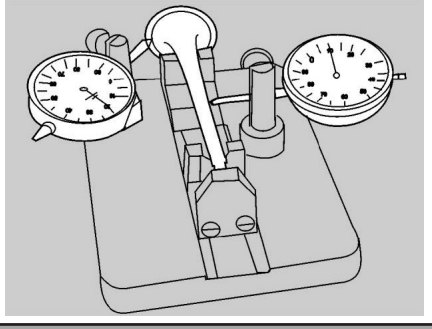
SIZE	VALVE SEAT INSERT BORE DIAMETER IN CYLINDER HEAD	VALVE SEAT INSERT OUTSIDE DIAMETER (mm)
INLET		
NORMAL	34 +0.021	34.0 +0.080/+0.065
NORMAL 1	34.3 +0.021	34.3 +0.080/+0.065
OUTLET		
NORMAL	31.1 +0.021	31.1 +0.080/+0.065
NORMAL 1	31.3 +0.021	31.3 +0.080/+0.065

C. VALVE GUIDE BORE DIAMETER IN CYLINDER HEAD

VALVE STEM RECEIVING BORE SIZE	INLET VALVE GUIDE BORE DIAMETER IN CYLINDER HEAD (mm)	EXHAUST VALVE GUIDE BORE DIAMETER IN CYLINDER HEAD (mm)
STANDARD SIZE	6.991 +0.0015	6.991 +0.0015
IST OVERSIZE	7.067 +0.015	7.067 +0.015
IIND OVERSIZE	7.118 +0.015	7.118 +0.015
IIIRD OVERSIZE	7.245 +0.015	7.245 +0.015

D. VALVE INESPECTION

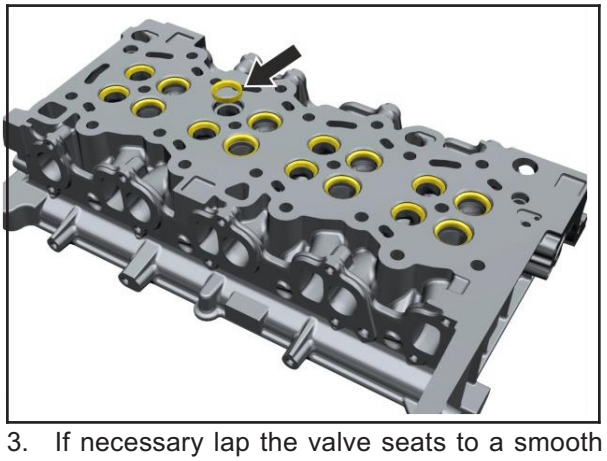
1. Check valve leakages by pouring gasoline on valve head. Gasoline must not seep past valve seat.
2. Valves with burnt heads, excessive scoring and wear on stem should be replaced.
3. Check valve seat run out with respect to valve stem. If it exceeds specified limit replace valve. No attempt should be made to straighten bent valves.



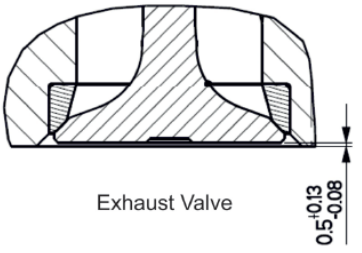
NOTE

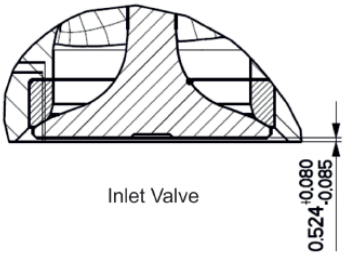
- Valve seat must be absolutely faultless and without any chatter marks

1. Check valve seat height with respect to cylinder head mating surface. Replace valve seat inserts if they are worn out beyond specified limit.
2. Cut exhaust valve seat insert with 45° and Intake valve seat insert with 60° cutter.



3. If necessary lap the valve seats to a smooth and even finish by using suitable hand pump grinder or a lapping paste and valve itself.
4. Smear valve seat with carbon blue. Install valve in guide and turn it slowly under axial pressure.
5. Contact line on valve seat must be around entire circumference at equal width.
6. Distance between narrow diameters of valve face to contact line should be minimum 0.5 mm.





7. Check for leakages through valve seat by pouring gasoline on valve head. Gasoline must not seep past valve seat.

F. VALVE SEAT INSERTS REMOVAL

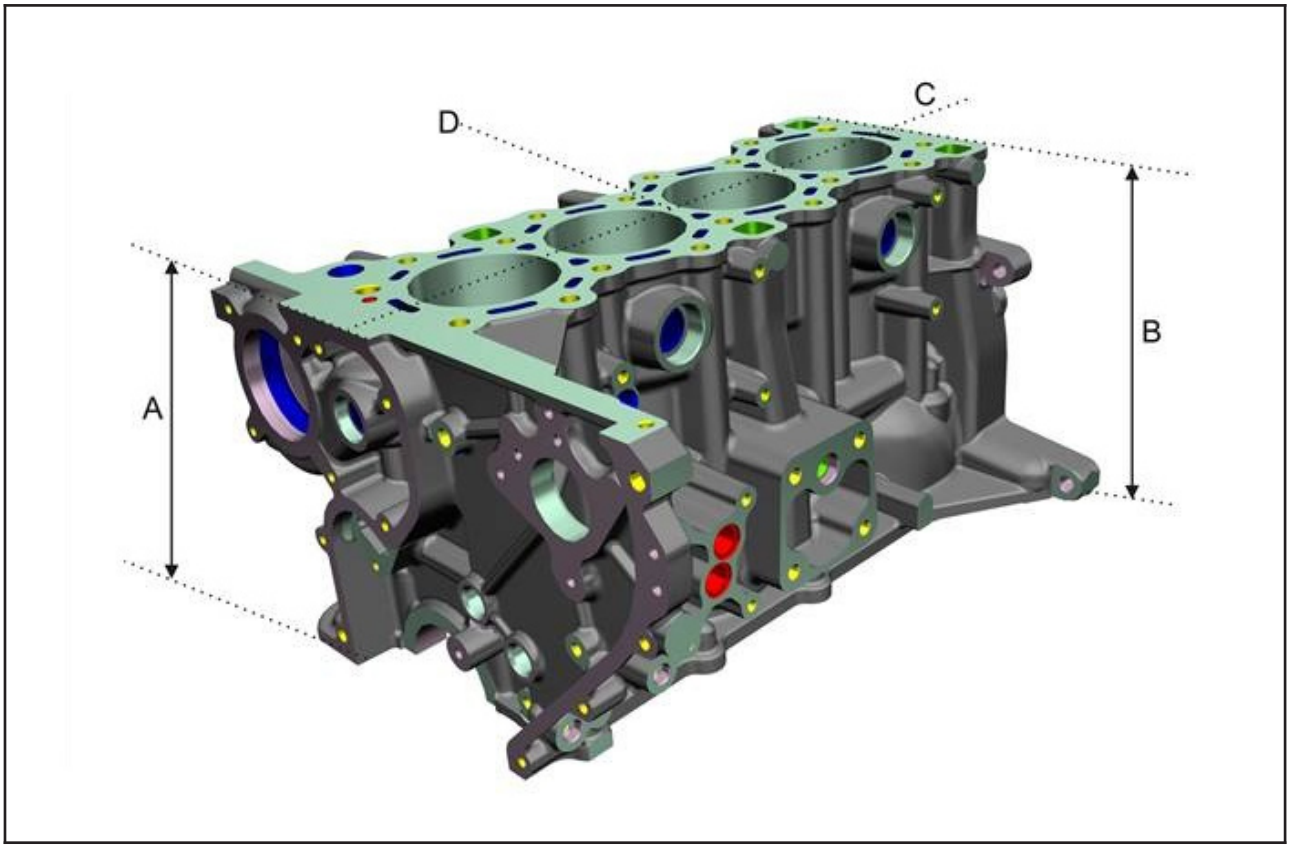
1. For removing valve seat inserts from cylinder head use suitable boring machine. Bore old insert thin (About 0.5 mm thickness) and then pry it out.
2. Alternatively use a suitable turning tool to cut an annular groove into valve seat insert and then pull it out with a suitable puller. In order to avoid damaging machined cylinder head mating surface with crank case, place any soft protective sheet metal under supports of puller.
3. Measure valve seat insert bore diameter in cylinder head.
4. If boring and prying is done carefully without damaging valve seat insert bore in cylinder head, fitment of an oversize valve seat insert will not be necessary.
5. Re-machined valve seat insert bore in cylinder head must be exactly at right angle to cylinder head mating surface with crank case.
6. All specified dimensions should be strictly maintained to ensure proper interference of valve seat insert in its bore.
7. Clean valve seat insert and its bore in cylinder head thoroughly.

VALVE SEAT INSERTS FITMENT

1. Place valve seat insert in the mixture of Methanol and dry ice for about 20-30 minutes to bring temperature down to -150ºC.
2. Heat cylinder head to approximately 80ºC in hot water bath.
3. Install valve seat insert in the cylinder head bore quickly by light hammering
4. Machine valve seat in cylinder head.

G. CRANKCASE

Height of crankcase (Dimensions A and B)		276.8 ± 0.05 mm
Maximum permissible unevenness of cylinder block	Lengthwise ‘c’	0.05
mating surface with cylinder head 100 x 100 mm	Crosswise ‘D’	0.025
Maximum permissible out off parallelism between cylinder block top and bottom machined surface		0.1
Maximum permissible shift in perpendicularity of cylinder bore from Crank shaft axis when checked at 200mm from crank shaft centre line.		0.04
Maximum permissible circularity		0.01
Ovality of cylinder bore (Cylindricity)		0.01
Straightness		0.01
Cylinder offset		5± 0.05 mm



H. PISTON AND PISTON BORE SIZES

Stage	Grade	Cylinder bore diameter mm	Piston stamped diameter mm (Gallery Cooled Piston)
Standard (Ø 100)	A	100.000 - 100.010	99.89
	B	100.011 - 100.020	99.901
	C	100.021 - 100.030	99.911
Repair I (Ø 100.2)	A	100.200 - 100.210	100.09
	B	100.211 - 100.220	100.101
	C	100.221 - 100.230	100.111
Repair II (Ø 100.4)	A	100.400 - 100.410	100.29
	B	100.411 - 100.420	100.301
	C	100.421 - 100.430	100.311
Repair III (Ø 100.6)	A	100.600 - 100.610	100.49
	B	100.611 - 100.620	100.501
	C	100.621 - 100.630	100.511
Piston to bore clearance(mm)			0.103 - 0.127
Weight variation in each set of 4 piston to be within 5 gms			

I. PISTON RINGS

Type of ring	Rings	Axial clearance	Butt clearance in cylinder bore (mm)
1st Compression Ring	3	-	0.25 - 0.4
2nd Compression Ring	2.5 -0.005/-0.030	0.065/0.11	0.6 - 0.8
3rd Oil Control Ring	2.5 -0.005/-0.030	0.025/0.070	0.3 - 0.6

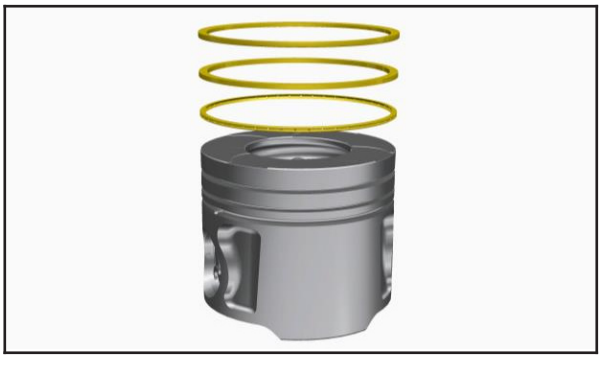
J. REPAIR SIZES FOR PISTON RING

Piston Ring Type	Piston Ring Sizes	Piston Rings Color	Cylinder Bore Diameter (D1)	Piston Ring Inner Diameter (D2)
Top Ring	STD Size	Clay Brown	100	92.6
	0.2 Over size	Flame Red	100.2	92.8
	0.4 Over size	Pastel Blue	100.4	93
	0.6 Over size	Emerald Green	100.6	93.2
Taper Faced 2nd Ring	STD Size	Yellow	100	91.7
	0.2 Over size	Flame Red	100.2	91.9
	0.4 Over size	Pastel Blue	100.4	92.1
	0.6 Over size	Emerald Green	100.6	92.3
Coil Spring Loaded Bevel Edged Oil Ring	STD Size	Yellow	100	93.7
	0.2 Over size	Flame Red	100.2	93.9
	0.4 Over size	Pastel Blue	100.4	94.1
	0.6 Over size	Emerald Green	100.6	94.3

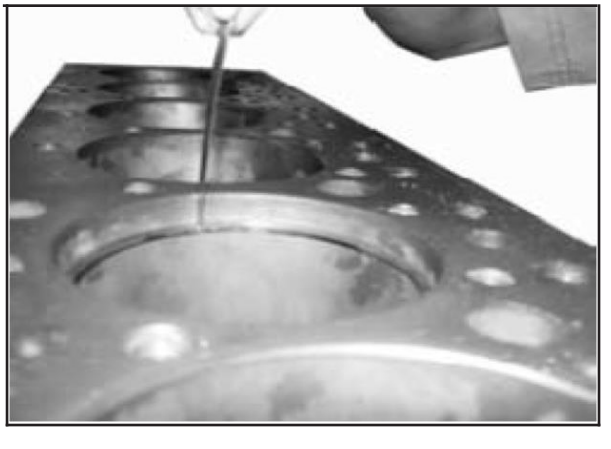
K. PISTON AND PISTON RINGS INSPECTION

1. Remove piston rings from piston using ring expander.

2. Remove carbon deposits from piston.
3. Clean piston and piston rings thoroughly.
4. In case cylinder bore taper and ovality is within specified limit, then same piston and piston rings may be reused.
5. Examine pistons for cracks, scoring, other damages, like Ring groove wear, piston pin bore wear, spring clip groove wear/ damage etc.



6. In case any one of the piston has any defect, all the piston set should be replaced.
7. Examine piston rings for scoring, lateral clearance in piston ring groove and butt clearance in cylinder bore.



8. Butt clearance of piston ring should be measured in unworn portion of cylinder bore
9. In case of any piston ring with any one of this defect, complete ring set should be replaced.
10. When cylinder bores are re-bored or honed, pistons and rings of appropriate size should be used. Piston size grade is stamped on piston crown.
11. Install piston rings in their respective position on piston using ring expander.

12. Stagger piston rings gaps such that they are 120°apart (with butt gap not in line with piston pin)

L. CONNECTING ROD

Stage	Connecting Rod small end	
	Parent bore diameter (mm)	Bush Outside diameter
Standard	39 H6	39 H6
Standard 1	39.2 H6	39.2 H6
Max. permissible Cylindricity of connecting rod small end parent bore		0.008 mm
Connecting rod small end bush inside diameter. (to be finished after installation) (Piston pin oiled has thumb push fit in small end bush)		$36^{+0.03/+0.02}$
Max. Permissible out of parallelism (bend) between connecting rod small end and big end parent bores measured from centre line of connecting rod big end.		0.02 mm
Centre to centre distance between connecting rod small end and big end parent bores.		165+0.05 mm
Maximum permissible twist of connecting rod		0.035 mm
Connecting rod big end parent bore diameter		66 H6
Max. permissible perpendicularity of connecting rod big end parent bore Cylindricity		0.05 mm

Stage	Connecting Rod with bearing shell big end parent bore diameter	Crank pin journal diameter (mm)
Normal (STD)	62.016 – 62.051	61.965 – 61.985
Normal 1	61.916 – 61.951	61.865 – 61.885
Repair 1	61.766 – 61.801	61.715 – 61.735
Repair 2	61.516 – 61.551	61.465 – 61.485
Repair 3	61.266 – 61.301	61.215 – 61.235
Repair 4	61.016 – 61.051	60.965 – 60.985
Bearing shells to be selected such that clearance is maintained as		0.031 – 0.086
Pre tension of connecting rod big end bearing shells		0.090 – 0.120
Maximum permissible difference in weight of connecting rods in one engine		10 gms
Connecting rod big end axial play		0.3 to 0.56

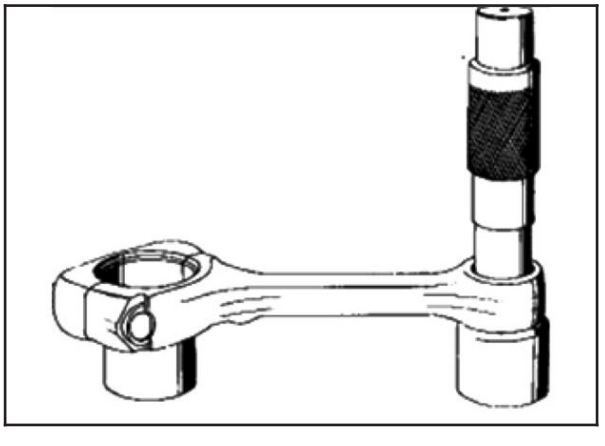
M. CONNECTING ROD INSPECTION

1. Install connecting rod bearing caps without bearing shells on connecting rod.
2. Tighten connecting rod bearing cap mounting bolts to specified torque.

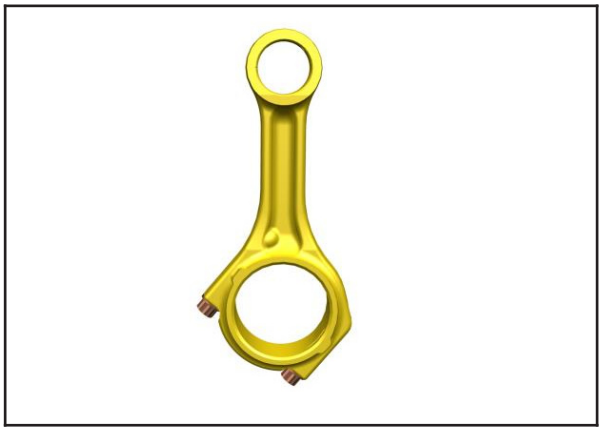
NOTE

- Ensure that identification numbers for connecting rod and connecting rod bearing cap are matched and notches for bearing shells are on the same side.

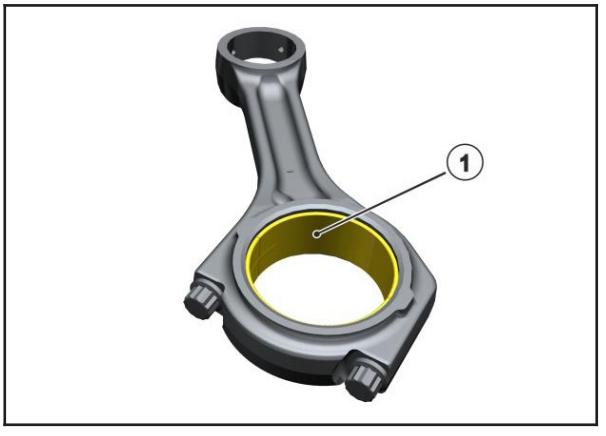
3. Check twist and bend of connecting rod by using new piston pin in connecting rod small end bush.



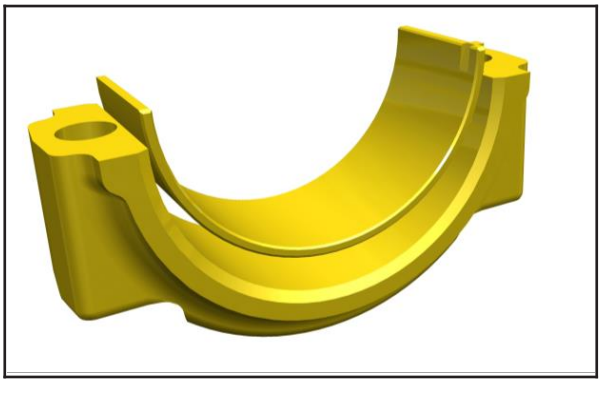
4. Measure twist and bend of connecting rod with feeler gauge with respect to vertical face of the connecting rod alignment gauge in vertical and horizontal plane at a distance of 50 mm from line joining centers of connecting rod small end and big end bosses.



5. Check connecting rod big end parent bore dimension (1).



6. If connecting rod big end parent bore is slightly more than maximum permissible limits, it is possible to reclaim the connecting rod provided the wear is confined only to connecting rod bearing cap. In such cases the connecting rod bearing cap mating surface can be slightly faced. The parent bore should then be finished on a connecting rod boring machine.
7. Ensure that the connecting rod big end and small end axis are parallel to each other within the specified limits. Centre to centre distance between connecting rod small end and big end is maintained within specified limits.
8. If one or more connecting rods are to be replaced, ensure that difference in weight of connecting rod in one engine is within permissible limits.
9. Install new pair of connecting rod bearing shell according to size of crank pin journal diameter, making sure that securing lugs of bearing shells are properly seated in grooves of connecting rod and its bearing cap.



NOTE

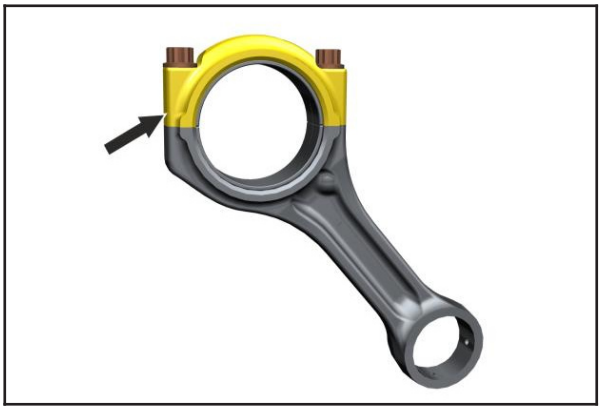
- Lower and upper bearing halves are not interchangeable.

10. Install connecting rod bearing cap with bearing shell on connecting rod. Tighten connecting rod bearing cap MTG. screws to specified torque.

11. Measure connecting rod bearing bore. Record the readings in the format given in this manual.

12. If connecting rod big end parent bore dimension is maintained within specified limits, proper bearing bore dimension is automatically achieved.

13. However, it must be physically measured and confirmed. Measure pretension of connecting rod bearing shell with a feeler gauge after loosening connecting rod bearing cap mounting screws on opposite side of bearing shell lug.



NOTE

- Connecting rod bearing shells are precision finished and should not be bored or scraped.

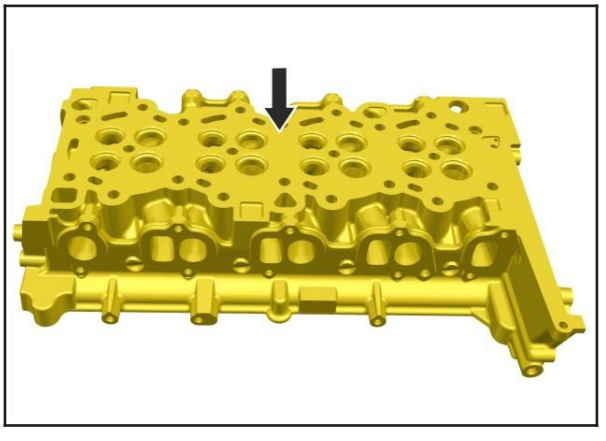
N. CYLINDER HEAD

INSPECTION OF CYLINDER HEAD

CHECKING CYLINDER HEAD MATING SURFACE

Using a straight edge and feeler gauge, check evenness of cylinder head parting surface with crankcase. If unevenness exceeds specified values, replace cylinder head.

1. Permissible unevenness of cylinder head mating surface:- 0.1 (Length wise)
2. Permissible unevenness of cylinder head mating surface:- 0.025 (100X100 mm) (Cross wise)



NOTE

- Re-machining of cylinder head top and bottom surfaces are not permitted during service

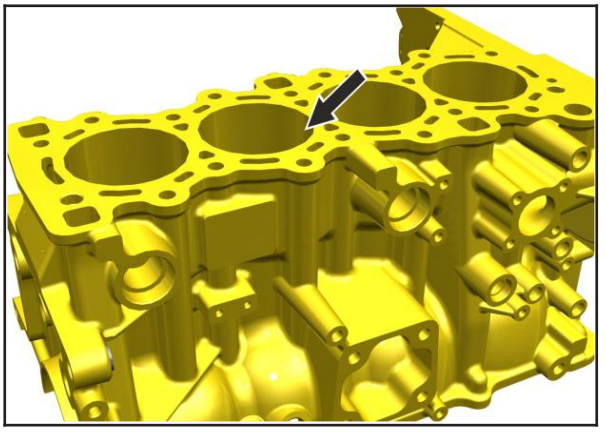
O. CYLINDER BLOCK INSPECTION

1. Check cylinder block for cracks by pressure testing method. Clean cylinder bores, bearing surfaces, oil passages in crank case thoroughly. Check water jackets for leakages by blowing air at a pressure of 5 bar & then dipping the cylinder block in the hot water (Temp of water 70° to 80°C)

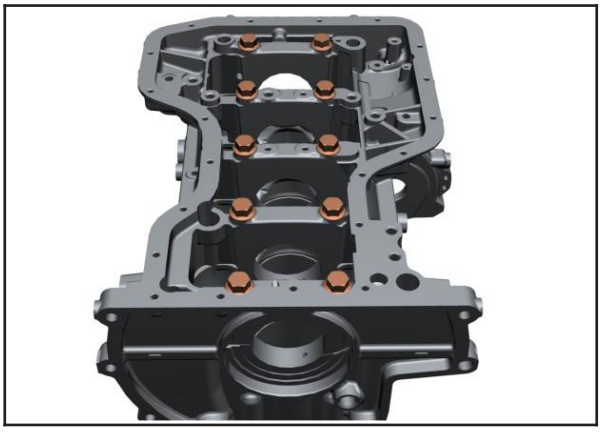
NOTE

- The block with any leakages / cracks should be discarded

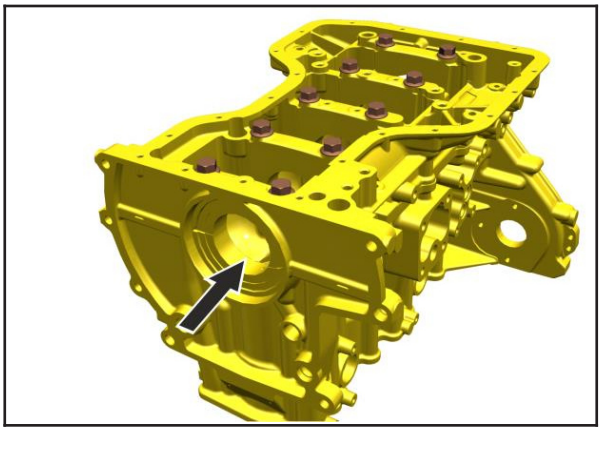
2. Check crankcase mating surface with cylinder head for unevenness with the help of straight edge and feeler gauge. If necessary grind this surface just too clear unevenness. Measure across the length and also across the breath.

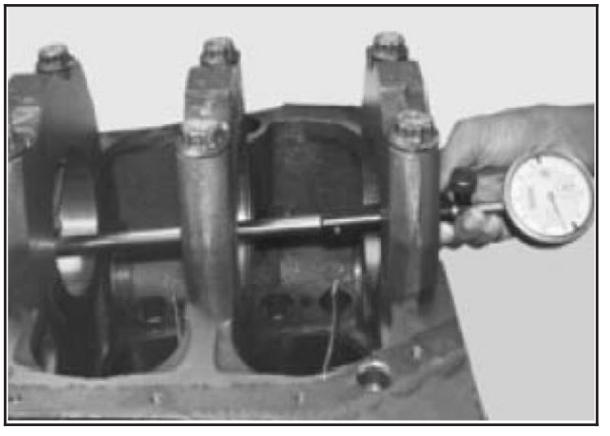


3. Ensure that the minimum height of crank case is not less than the specified minimum height.
4. Tighten main bearing & other M-8 (bedplate to block bolts) bolts to specified torque

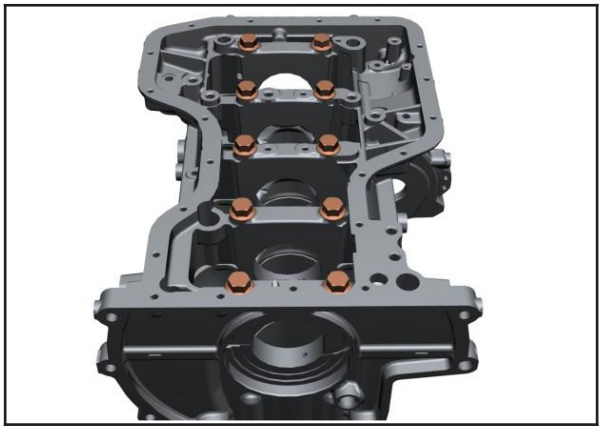


5. Check crank case main bearing parent bore dimensions and then dismantle the bedplate.



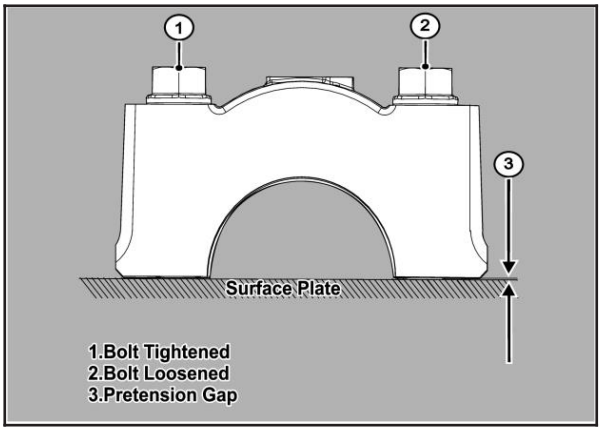


6. Install new pairs of main bearing shells according to size of crank shaft main bearing journal diameter, making sure that securing lugs of bearing shells are properly seated in grooves of crank case and main bearing caps.
7. Install bed plate with bearing shells in their respective position on crank case. Tighten main bearing cap mounting bolts in specified sequence to specified torque. Measure main bearing bore.



8. If main bearing parent bore dimensions are within specified limits, proper main bearing bore dimension is automatically achieved.

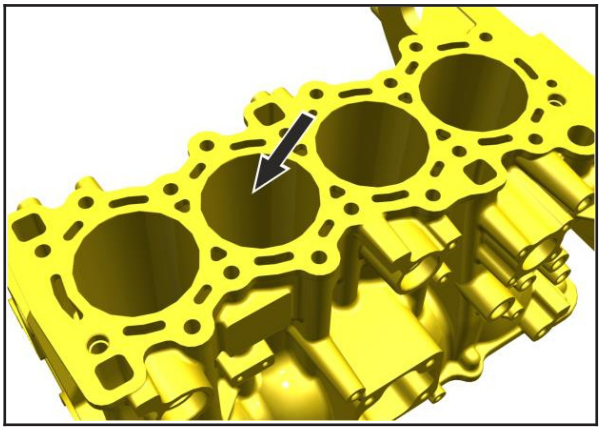
9. Loosen bed plate main bearing cap mounting bolt. Now using a feeler gauge measure the pretension of main bearing shell. As the main bearing caps are guided, the measurement has to be done on a flat surface and not on cylinder block.



10. Main bearing shells are precision finished and should not be bored or scrapped.
11. Select new pair of thrust washer according to crank shaft 4th main journal width.
12. Crush height for main bearing and connecting rod bearing: 0.085 to 0.09mm.

P. CYLINDER BORES

1. Clean cylinder bores thoroughly.
2. Check cylinder bore dimension, taper and ovality.



3. If taper and ovality is found to exceed specified limit or bore is excessively worn out then replace the block.

Q. CYLINDER HEAD GASKET SELECTION

Piston Projection (mm)	Gasket Thickness (mm)	Identification
0.40 ± 0.05	**1.3**	**1** HOLES
0.50 ± 0.05	**1.4**	**2** HOLES
0.60 ± 0.05	**1.5**	**3** HOLES
0.70 ± 0.05	**1.6**	**4** HOLES

R. CRANK SHAFT

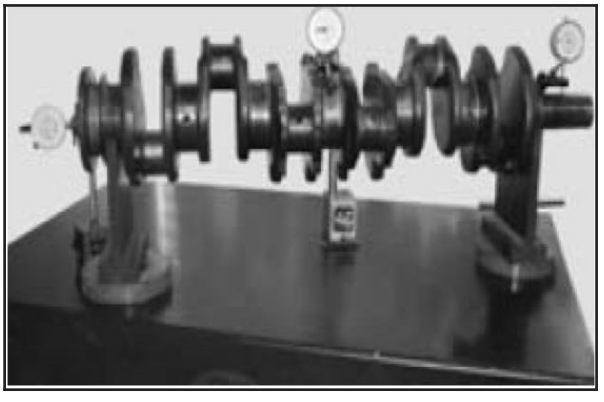
Stage	Crank case main bearing bore diameter with bearing shell (mm)	Crank case main bearing journal diameter (mm)
Normal (STD)	78.02 – 78.052	77.96 – 77.98
Normal1	77.92 – 77.952	77.86 – 77.88
Repair 1	77.77 –77.802	77.71 – 77.73
Repair 2	77.52 –77.552	77.46 – 77.48

Thickness of 4th bearing thrust washers ———— Standard – (33.5+0.06 mm) Repair size 0.300 (33.8+0.06 mm) Repair size 0.500 (34+0.06 mm)	2.450 – 2.500 mm 2.600 – 2.650 mm 2.700- 2.750 mm
End play of crankshaft	0.15 – 0.36 mm
Fillet radius of main bearing journals	2.75 – 3.25 mm
Fillet radius of crank pin journal	2.5 – 3 mm
Width 1st, 2nd, 3rd, and 4th main bearing journals	33.5 + 0.16 mm
Width crank pin journal	33.5 + 0.16mm
Maximum permissible circularity of main journal	0.008 mm
Cylindricity of main bearing journal	0.008 mm
Maximum permissible Cylindricity of crank pin	0.05 mm
Maximum permissible run out of 2nd,3rd and4th 5th main bearing journals	0.02 mm
Maximum permissible out of parallelism between crank pin and main journal axis	0.01 mm
Pre tension of main bearing shells	0.085 – 0.120 mm
Hardness of crank shaft main bearing and crank pin journals	56 ±3 HRC
Main bearing parent bore diameter. In crankcase	83 +0.02
Maximum permissible concentricity of main bearing parent bore	0.03 mm
Maximum permissible Cylindricity of main bearing parent bore	0.01 mm
Crankshaft journal to main bearing clearance	0.040 – 0.092 mm
Crankpin Journal Circularity	0.005

S. CRANKSHAFT INSPECTION

Clean and carry out visual inspection of crank shaft for the following:

1. Overheating of journals, this is indicated by bluish brown colour.
2. Scoring marks on journals
3. Cracks, which should be checked on magnetic crack detector
4. Check crank shaft run out by supporting it on V-block at 1st and 5th main bearing journals.



5. If run out exceeds permissible limits, discard the crank shaft.
6. Similarly check lateral and radial run outs of flywheel mounting flange.
7. Check crank shaft main bearing and crank pin journal dimension.
8. Thoroughly clean crank shaft with kerosene. Use wire brush for cleaning oil holes
9. Apply grease to all machined surfaces, if crank shaft is to be stored. Crank shaft must always be stored in vertical position.
10. Thoroughly clean main bearing caps and corresponding machined surfaces of crankcase.
11. Install main bearing caps without bearing shells in their respective positions on crankcase.

NOTE

- Ensure that the serial numbers on crank case and main bearing caps are matching. Also caps are in order and notches forbearing shells are on same side.

T. ASSEMBLY CLEARANCES

Connecting rod clearance (Big End)	0.031 mm / 0.086 mm
Connecting rod Axial play (Big End)	0.3 mm / 0.56 mm
Connecting rod small end bush clearance	0.020 mm / 0.036 mm
Camshaft Bearing Clearance	0.030 mm to 0.072 mm
Camshaft bearing axial play	0.065 mm to 0.198 mm
Valve Stem Clearance (Inlet)	0.021 mm to 0.051 mm
Valve stem Clearance (Exhaust)	0.031 mm to 0.061 mm
Piston Clearance on skirt (Bore to piston thrust side)	0.098 mm / 0.122 mm
Main bearing clearance	0.040 mm / 0.092 mm
Gap between cam sensor and cam sensor wheel in assembled condition	0.5 mm to 1.5 mm
Injector tip from bottom surface of cylinder head (NTP)	2.63 ± 0.35 mm
Crankshaft axial play	0.15 mm / 0.36 mm
Minimum clearance between crankweb with R5 radius and block	1.1 mm
Rocker shaft bearing clearance	0.020 mm to 0.062 mm
Tappet valve clearance inlet	0.30 ± 0.05 mm
Tappet valve clearance exhaust	0.30 ± 0.05 mm
Rocker arm clearance	0.020 mm to 0.059 mm
Rocker arm axial play	0.2 mm to 0.6 mm