



ENGINE SERVICE AND REPAIR

Course 151 Technician Handbook



University
of Toyota



Toyota Motor Sales, U.S.A., Inc.

© 2011 Toyota Motor Sales, U.S.A., Inc.

TOYOTA Technical Training

All rights reserved. This book may not be reproduced or copied, in whole or in part by any means, without the written permission of Toyota Motor Sales, U.S.A., Inc.

Revision Date: May 31, 2011

151 Engine Service and Repair

Engine Service & Repair	Course Menu	3
Section 1:	Section 1 Topics	5
Internal Combustion Engine Operation	Primary Engine Components	7
	Other Engine Systems	7
	Cylinder Head Components	8
	Cylinder Block Components	9
	The 4-Stroke Cycle	10
	Intake Stroke	11
	Compression Stroke	12
	<i>Displacement</i>	13
	<i>Compression Ratio</i>	14
	<i>Ignition Timing</i>	15
	Combustion (Power) Stroke	16
	Exhaust Stroke	17
	Engine and Block Designs	18
	Inline	18
	V-type	18
	Horizontally Opposed	18
	Engine Position	19
	Cylinder Identification	19
	Engine Serial Number	20
	Engine Decoder	21
Section 2:	Section 2 Topics	23
Basic Engine Components	Main Components	24
	Short Block vs. Long Block	24
	Cylinder Block Major Components	25
	Cylinder Block Designs	26
	Pistons and Connecting Rods	27
	Piston Rings	28
	High vs. Low Tension Rings	28
	Piston Ring Grooves	29
	Piston Ring Function	30
	Crankshaft	31
	Oil Passages	31
	Counterweights	31
	Flywheel	31
	Crank Pin Position	32
	Crankshaft Main Bearings	33
	Balance Shafts	34
	Balance Shaft Timing	35
	Cylinder Head	36
	Valve Train	37

151 Engine Service and Repair

	Camshaft	38
	Camshaft Operation	39
	Valve Assemblies	40
	Mechanical Lifters and Valve Lash	40
	Hydraulic Valve Lash Adjuster	40
	Timing Chain	41
	Interference Engines	41
	VVT-i	42
	Timing Belt	43
Section 3:	Section 3 Topics	45
Tools, Materials	Shop Safety	46
and Equipment	Engine Lift	47
	Parts Washers	48
	Cylinder Head Cleaning	48
	Cylinder Block Cleaning	48
	Engine Sealing	49
	Seal Installation	50
	FIPG	51
	Sealing Packing Application	52
	Dye Penetrant	53
	Plastigage	54
	Thread Cleaning	55
	Vernier Caliper	56
	Reading a Vernier Caliper	57
	Micrometer	59
	Reading a Micrometer	60
	Micrometer with Vernier Scale	62
	Digital Micrometer	63
	Inside Diameter Gauges	64
	Dial Indicator	65
Section 4:	Section 4 Topics	67
Engine	Engine Removal Precautions	68
Removal and	Parts Organization and Labeling	69
Disassembly	Fuel Pressure Discharge	70
	Fluid Drain	71
	Hood Removal	72
	Engine Hangers	73
	Engine Lifting	74
	Engine Stand Mounting	75
	Disassembly	76

151 Engine Service and Repair

Section 5:	Section 5 Topics	79
Cylinder Head	Camshaft Oil Clearance	80
Diagnosis and	Camshaft Thrust Clearance	81
Repair	Removing Valve Assemblies	82
	Valve, Guide, and Spring Inspection	83
	Valve Seat Inspection	84
	Warpage Inspection	85
	Crack Inspection	86
	Head Bolt Inspection	87
	Timing Chain Inspection	88
	Priming Hydraulic Valve Lash Adjusters	89
	Lash Adjuster Inspection	90
	Oil Seals	91
	Installing Valves	92
	Mechanical Valve Lash Inspection	94
	Valve Lash Adjustment	94
	Calculation Example	95
	Selection Chart Example	96
	Valve Lifter Selection Chart (Intake)	97
	Mechanical Valve Lash Adjusters	98
Section 6:	Section 6 Topics	101
Cylinder Block	Warpage Inspection	102
Diagnosis and	Cylinder Bore Wear	103
Repair	Ridge Reamer	104
	Cylinder Bore Visual Inspection	105
	Cylinder Bore Measurement	106
	Piston Inspection	108
	Piston Oil Clearance	109
	Crankshaft Journal Visual Inspection	110
	Journal Taper and Out-of-round	111
	Crankshaft Oil Clearance	112
	Bearing Selection and Replacement	113
	Using the Bearing Selection Table	115
	Piston Ring Installation	116
	Piston Tools	117
	Piston Installation	118
Section 7:	Section 7 Topics	121
Lubrication	Lubrication System	122
System	Oil Circuit	123
	Oil Pump	124
	Oil Jets	125
	Oil Filter	126
	Oil Cooler	127
	Oil Properties and Grades	128
	Viscosity and Temperature	128

151 Engine Service and Repair

	Oil Inspection	129
	Oil Pressure Test	130
	Causes of High or Low Oil Pressure	131
	Oil Pump Inspection – Tip Clearance	132
	Oil Pump Inspection – Side Clearance	133
	Oil Pump Inspection – Body Clearance	134
Section 8:	Section 8 Topics	135
Cooling System	Cooling System Routing and Flow	136
	Coolant Passages	137
	Water Jacket	138
	Water Jacket Spacer	138
	Water Pump	139
	Electric Water Pump	140
	Thermostat	141
	Radiator	142
	Cooling Fan	143
	Engine Coolant	144
	Coolant Dilution	145
	Effect of Pressure on Boiling Point	145
	Cooling System Safety	145
	Cooling System Problems	146
	Coolant Leak Test	147
	Cooling Fan Inspection	148
	Cooling System Service	149
Section 9:	Section 9 Topics	151
Engine	Engine Reassembly Precautions	152
Reassembly	Cylinder Block Reassembly – Overview	153
	Crankshaft and Bearing Installation	154
	Upper Bearing Alignment	155
	Lower Bearing Alignment	156
	Bearing Cap Bolt Torque	157
	Engine Sealing	158
	Cylinder Head Installation – Overview	159
	Cylinder Head Gasket	160
	Cylinder Head Installation	161
	Torquing the Head Bolt	162
	Installing Valvetrain Components	163
	Installing Camshafts	164
	Camshaft Housing Subassembly Sealing	165
	Camshaft Housing Subassembly Bolts	166
	Engine Timing & Chain Installation	167
	Installing No. 2 Timing Chain	168
	Installing No. 1 Timing Chain	169

151 Engine Service and Repair

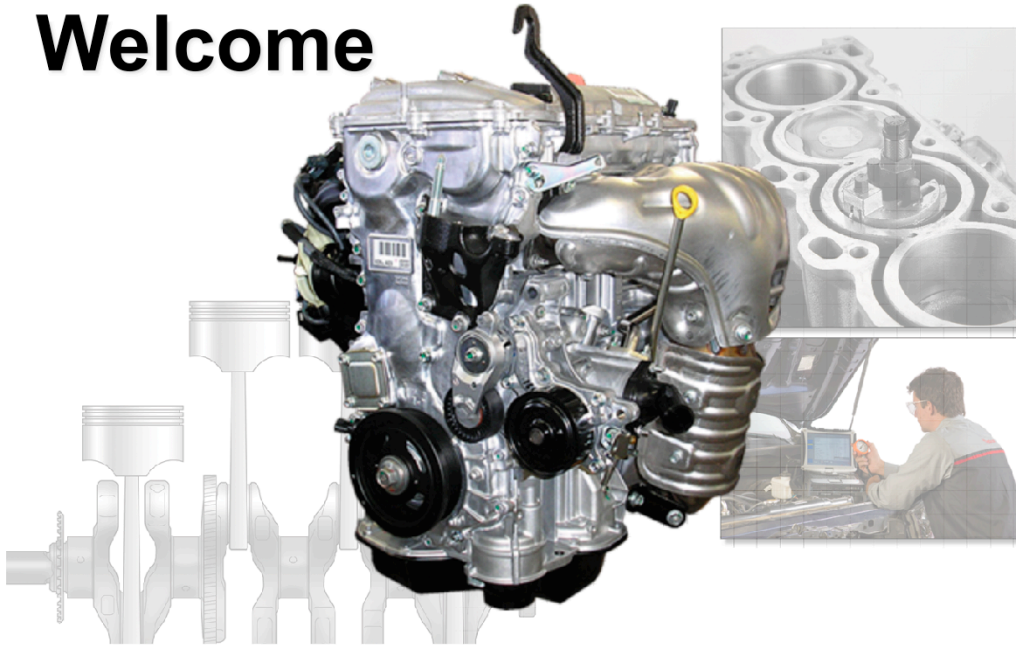
	Install Crankshaft Gear	170
	Installing Timing Gears	171
	Timing Cover Installation	173
	Bolt Chart	174
Section 10:	Section 10 Topics	177
General Engine	Consumption Issues	178
Mechanical	Leak Inspection	179
Diagnosis	Exhaust Discoloration	180
	Noise and Vibration	181
	Compression Loss	182
	Cylinder Balance Test	183
	Techstream Compression Test	184
	Standard Compression Test	185
	Wet Compression Test	186
	Cylinder Leakage Test	187
Appendix	Appendix Topics	189
	2AZ-FE Timing Marks	190
	IGR-FE Timing Marks	191
	1UR-FE Timing Marks	192
	2GR-FE Timing Marks	193
	How to Determine Nut Strength (1 of 2)	195
	How to Determine Nut Strength (2 of 2)	196
	How to Determine Bolt Strength (1 of 2)	197
	How to Determine Bolt Strength (2 of 2)	198
	Specified Torque for Standard Bolts (1 of 2)	199
	Specified Torque for Standard Bolts (2 of 2)	200
	Required Tools and Equipment	201

151 Engine Service and Repair

This page intentionally left blank.

Course 151: Engine Service and Repair

Welcome



This page is intentionally blank.

Course Menu

Engine Service and Repair

- ▶ 1. Internal Combustion Engine Operation
- ▶ 2. Basic Engine Components
- ▶ 3. Tools, Materials, and Equipment
- ▶ 4. Engine Removal and Disassembly
- ▶ 5. Cylinder Head Diagnosis and Repair
- ▶ 6. Cylinder Block Diagnosis and Repair
- ▶ 7. Lubrication System
- ▶ 8. Cooling System
- ▶ 9. Engine Reassembly
- ▶ 10. General Engine Mechanical Diagnosis
- ▶ Appendix

This page is intentionally blank.