

ENGINE

Engine Mechanical - [1AR-FE] (Preparation) - Sienna

1AR-FE ENGINE MECHANICAL

SST

SST

	09201-01055	Valve Guide Bushing Remover & Replacer 5.5	
	09201-10000	Valve Guide Bushing Remover & Replacer Set	
	(09201-01050)	Valve Guide Bushing Remover & Replacer 5	
	09201-41020	Valve Stem Oil Seal Replacer	
	09202-70020	Valve Spring Compressor	
	(09202-00010)	Attachment	
	09213-54015	Crankshaft Pulley Holding Tool	
	09223-15030	Oil Seal & Bearing Replacer	
	09223-22010	Crankshaft Front Oil Seal Replacer	
	09276-75010	Valve Lifter Tool	
	09330-00021	Companion Flange Holding Tool	
	09843-18030	Tacho-pulse Pickup Wire No. 2	
	09843-18040	Diagnosis Check Wire No. 2	
	09950-50013	Puller C Set	
	(09951-05010)	Hanger 150	
	(09952-05010)	Slide Arm	
	(09953-05020)	Center Bolt 150	
	(09954-05011)	Claw No. 1	
	09950-70010	Handle Set	
	(09951-07100)	Handle 100	
	(09951-07150)	Handle 150	
	91551-80650	Bolt	

RECOMMENDED TOOLS

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	09010-3C110	Set, Hexagon Socket Wrench	
	(09013-6C100)	Socket Hexagon	

		5mm	
	(09013-6C130)	Socket Hexagon 10mm	
	09013-1C500	"TORX" Socket Wrench E-type E5	
	09013-1C520	"TORX" Socket Wrench E-type E7	
	09013-1C530	"TORX" Socket Wrench E-type E8	
	09013-1C540	"TORX" Socket Wrench E-type E10	
	09013-7C120	Straight Hexagon 14mm	
	09013-7C310	Bi-hexagon Wrench 10mm	
	09051-1C110	Plastic Hammer	
	09072-1C200	Vernier Calipers 150mm	
	09090-04020	Engine Sling Device	
	09091-1C100	Oil Pan Seal Cutter	

EQUIPMENT

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Brush	
Broken ring	
Compression gauge	
Compound	
Connecting rod aligner	
Container	
CO/HC meter	
Caliper gauge	
Chain block	
Cylinder gauge	
Day penetrant	
Dial indicator	
Engine lifter	
Feeler gauge	
Groove cleaning tool	
Hand-lap	
Heater	
Knife	

Magnet base	
Magnet hand	
Micrometer	
MP grease	
Non-residue solvent	
Paint	
Pin	
Piston ring expander	
Plastigage	
Precision straightedge	
Prussian blue	
Ridge reamer	
Rubber piece	
Sharp reamer (5.5 mm)	
Spring scale	
Solvent	
String	
Steel square	
Tachometer	
Timing light	
V-block	
Valve seat cutter (30°, 45°, 60°, 75°)	
Vinyl tape	
Vise	
Wooden block	

SSM

SSM

Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent	
Toyota Genuine Adhesive 1324, Three Bond 1324 or equivalent	
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent	

ENGINE

Engine Mechanical - [1AR-FE] (Service Specifications) - Sienna

1AR-FE ENGINE MECHANICAL

SERVICE DATA

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ENGINE

Ignition timing	with Terminals TC and CG connected of DLC3	8 to 12° BTDC at idle
	without Terminals TC and CG connected of DLC3	5 to 15° BTDC at idle
Idle speed		600 to 700 RPM (Transmission neutral position)
Compression	Standard	1450 kPa (14.7 kgf/cm ² , 210 psi) or higher
	Minimum	980 kPa (9.9 kgf/cm ² , 142 psi)
	Difference	200 kPa (2.0 kgf/cm ² , 29 psi) or less

CYLINDER HEAD

Warpage	Cylinder head lower side		0.05 mm (0.00197 in.)
	Intake manifold side		0.10 mm (0.00394 in.)
	Exhaust manifold side		0.10 mm (0.00394 in.)
Compression spring	Free length		50.0 mm (1.97 in.)
	Maximum deviation		1.0 mm (0.0394 in.)
	Maximum angle		2°
Intake valve	Valve stem diameter		5.470 to 5.485 mm (0.2154 to 0.2159 in.)
	Margin thickness	Standard	1.0 mm (0.0394 in.)
		Minimum	0.50 mm (0.0197 in.)
	Overall length	Standard	103.92 mm (4.09 in.)
		Minimum	103.42 mm (4.07 in.)
Exhaust valve	Valve stem diameter		5.465 to 5.480 mm (0.2152 to 0.2157 in.)
	Margin thickness	Standard	1.0 mm (0.0394 in.)
		Minimum	0.50 mm (0.0197 in.)
	Overall length	Standard	112.91 mm (4.44 in.)
		Minimum	112.41 mm (4.43 in.)
	Bush inside diameter		5.510 to 5.530 mm (0.2169 to 0.2177 in.)

Valve guide bush	Standard oil clearance	Intake	0.025 to 0.060 mm (0.000984 to 0.00236 in.)
		Exhaust	0.030 to 0.065 mm (0.00118 to 0.00256 in.)
	Maximum oil clearance	Intake	0.08 mm (0.00315 in.)
		Exhaust	0.10 mm (0.00394 in.)
	Bush bore diameter (Cylinder head side)		10.285 to 10.306 mm (0.405 to 0.406 in.)
	Bush bore diameter (Valve guide bush)	Standard	10.333 to 10.344 mm (0.4068 to 0.4072 in.)
		O/S 0.05	10.383 to 10.394 mm (0.4088 to 0.4092 in.)
	Bush length	Intake	41.3 to 41.7 mm (1.626 to 1.642 in.)
		Exhaust	46.8 to 47.2 mm (1.843 to 1.858 in.)
	Protrusion height	Intake	14.8 to 15.2 mm (0.582 to 0.598 in.)
		Exhaust	14.2 to 14.6 mm (0.559 to 0.575 in.)
Camshaft oil clearance	Standard oil clearance	Intake No. 1 journal	0.035 to 0.072 mm (0.00137 to 0.00283 in.)
		Exhaust No. 1 journal	0.049 to 0.086 mm (0.00193 to 0.00339 in.)
		Other journal	0.025 to 0.062 mm (0.000984 to 0.00244 in.)
	Maximum oil clearance	Intake No. 1 journal	0.085 mm (0.00335 in.)
		Exhaust No. 1 journal	0.095 mm (0.00374 in.)
		Other journal	0.085 mm (0.00335 in.)
Camshaft thrust clearance	Standard		0.060 to 0.155 mm (0.00236 to 0.00610 in.)
	Maximum		0.170 mm (0.00669 in.)
Spark plug tube	Standard protrusion height		112 mm (4.41 in.)
Cylinder head ring pin	Standard protrusion height		6.5 to 7.5 mm (0.256 to 0.295 in.)
Intake valve seat	Standard width	Inspection	1.1 and 1.5 mm (0.0433 and 0.0591 in.)
		Repair	1.0 to 1.4 mm (0.0394

			to 0.0551 in.)
Exhaust valve seat	Standard width	Inspection	1.1 and 1.5 mm (0.0433 and 0.0591 in.)
		Repair	1.2 to 1.6 mm (0.0472 to 0.0630 in.)

CYLINDER BLOCK

Connecting rod thrust clearance	Standard		0.160 to 0.512 mm (0.00630 to 0.0202 in.)
	Maximum		0.512 mm (0.0202 in.)
Connecting rod oil clearance	Standard		0.030 to 0.063 mm (0.00118 to 0.00248 in.)
	Maximum		0.07 mm (0.00276 in.)
Crank pin	Standard diameter		51.492 to 51.500 mm (2.0272 to 2.0276 in.)
Connecting rod big end inside diameter	Mark 1		54.500 to 54.508 mm (2.1457 to 2.1460 in.)
	Mark 2		54.509 to 54.516 mm (2.1460 to 2.1463 in.)
	Mark 3		54.517 to 54.524 mm (2.1463 to 2.1466 in.)
Bearing center wall thickness	Mark 1		1.483 to 1.487 mm (0.0584 to 0.0585 in.)
	Mark 2		1.488 to 1.491 mm (0.0586 to 0.0587 in.)
	Mark 3		1.492 to 1.495 mm (0.0587 to 0.0589 in.)
Crankshaft thrust clearance	Standard		0.04 to 0.24 mm (0.00157 to 0.00945 in.)
	Maximum		0.30 mm (0.0118 in.)
Thrust washer	Standard thickness		1.93 to 1.98 mm (0.0760 to 0.0780 in.)
Cylinder block	Maximum warpage		0.05 mm (0.00197 in.)
	Cylinder bore	Standard	90.000 to 90.013 mm (3.543 to 3.544 in.)
		Maximum	90.133 mm (3.549 in.)
Piston	Standard diameter		89.970 to 89.980 mm (3.5421 to 3.5425 in.)
	Oil clearance	Standard	0.020 to 0.043 mm (0.00079 to 0.00169 in.)
		Maximum	0.10 mm (0.00394 in.)
		No. 1 ring	0.020 to 0.070 mm (0.000787 to 0.00276 in.)
			0.020 to 0.060 mm

Piston ring	Ring groove clearance	No. 2 ring	(0.000787 to 0.00236 in.)
		Oil ring	0.020 to 0.070 mm (0.000787 to 0.00276 in.)
	Standard end gap	No. 1 ring	0.22 to 0.27 mm (0.00866 to 0.0106 in.)
		No. 2 ring	0.37 to 0.42 mm (0.0146 to 0.0165 in.)
		Oil ring	0.10 to 0.20 mm (0.00394 to 0.00787 in.)
	Maximum end gap	No. 1 ring	0.87 mm (0.0342 in.)
		No. 2 ring	1.02 mm (0.0402 in.)
		Oil ring	0.80 mm (0.0315 in.)
Piston pin	Piston pin hole inside diameter	Mark A	22.001 to 22.004 mm (0.86618 to 0.86630 in.)
		Mark B	22.005 to 22.007 mm (0.86634 to 0.86642 in.)
		Mark C	22.008 to 22.010 mm (0.86645 to 0.86653 in.)
	Piston pin diameter	Mark A	21.997 to 22.000 mm (0.86602 to 0.86614 in.)
		Mark B	22.001 to 22.003 mm (0.86617 to 0.86626 in.)
		Mark C	22.004 to 22.006 mm (0.86630 to 0.86638 in.)
	Connecting rod small end bush inside diameter	Mark A	22.005 to 22.008 mm (0.86634 to 0.86645 in.)
		Mark B	22.009 to 22.011 mm (0.86649 to 0.86657 in.)
		Mark C	22.012 to 22.014 mm (0.86661 to 0.86669 in.)
	Oil clearance (Piston side)	Standard	0.001 to 0.007 mm (0.0000394 to 0.000276 in.)
		Maximum	0.013 mm (0.000512 in.)
	Oil clearance (Connecting rod side)	Standard	0.005 to 0.011 mm (0.000197 to 0.000433 in.)
		Maximum	0.017 mm (0.000669 in.)
Connecting rod	Maximum bend		0.05 mm (0.00197 in.) per 100 mm (3.94 in.)
	Maximum twist		0.15 mm (0.00591 in.) per 100 mm (3.94 in.)
	Maximum circle runout		0.003 mm (0.000118 in.)
			54.988 to 55.000 mm

Crankshaft	Standard main journal diameter		(2.1649 to 2.1654 in.)
	Maximum main journal taper and out-of-round		0.003 mm (0.000118 in.)
	Standard crank pin diameter		51.492 to 51.500 mm (2.027 to 2.028 in.)
	Maximum crank pin taper and out-of-round		0.003 mm (0.000118 in.)
	Oil clearance	Standard	0.016 to 0.039 mm (0.000630 to 0.00154 in.)
		Maximum	0.05 mm (0.00197 in.)
Cylinder block journal inside diameter (A)	Mark 0		59.000 to 59.002 mm (2.32283 to 2.32291 in.)
	Mark 1		59.003 to 59.004 mm (2.32295 to 2.32299 in.)
	Mark 2		59.005 to 59.006 mm (2.32303 to 2.32307 in.)
	Mark 3		59.007 to 59.009 mm (2.32311 to 2.32318 in.)
	Mark 4		59.010 to 59.011 mm (2.32322 to 2.32326 in.)
	Mark 5		59.012 to 59.013 mm (2.32330 to 2.32334 in.)
	Mark 6		59.014 to 59.016 mm (2.32338 to 2.32346 in.)
Crankshaft main journal diameter (B)	Mark 0		54.999 to 55.000 mm (2.16531 to 2.16535 in.)
	Mark 1		54.997 to 54.998 mm (2.16523 to 2.16527 in.)
	Mark 2		54.995 to 54.996 mm (2.16515 to 2.16519 in.)
	Mark 3		54.993 to 54.994 mm (2.16507 to 2.16511 in.)
	Mark 4		54.991 to 54.992 mm (2.16500 to 2.16504 in.)
	Mark 5		54.988 to 54.990 mm (2.16488 to 2.16496 in.)
Bearing center wall thickness	Mark 1		1.991 to 1.994 mm (0.07839 to 0.07850 in.)
	Mark 2		1.995 to 1.997 mm (0.07854 to 0.07862 in.)
	Mark 3		1.998 to 2.000 mm (0.07866 to 0.07874 in.)
	Mark 4		2.001 to 2.003 mm (0.07878 to 0.07886 in.)
Crankshaft bearing cap	Measuring point		58.5 mm (2.30 in.)
			9.77 to 9.96 mm (0.385 to

bolt	Standard diameter		0.392 in.)
	Minimum diameter		9.1 mm (0.358 in.)
Connecting rod bolt	Standard		8.5 to 8.6 mm (0.335 to 0.339 in.)
	Minimum		8.3 mm (0.327 in.)
Cylinder block ring pin	Protrusion height	Ring pin A	5.0 to 7.0 mm (0.197 to 0.276 in.)
		Ring pin B	4.0 to 7.0 mm (0.157 to 0.276 in.)
Cylinder block straight pin	Protrusion height	Straight pin A	11.0 to 13.0 mm (0.433 to 0.512 in.)
		Straight pin B	5.0 to 7.0 mm (0.197 to 0.276 in.)
Crankshaft bearing	Dimension A - B or B - A: 0 to 0.7 mm (0 to 0.0276 in.)		
Connecting rod bearing	Dimension A - B or B - A: 0 to 0.7 mm (0 to 0.0276 in.)		

ENGINE UNIT

Crankshaft backlash	Standard		0.005 to 0.020 mm (0.000197 to 0.000787 in.)
	Maximum		0.020 mm (0.000787 in.)
Camshaft	Maximum circle runout		0.03 mm (0.00118 in.)
	Journal diameter	No. 1 journal	34.449 to 34.465 mm (1.35626 to 1.35689 in.)
		Other journals	22.959 to 22.975 mm (0.90390 to 0.90453 in.)
Cam lobe height	Standard	Intake	44.163 to 44.305 mm (1.73870 to 1.74429 in.)
		Exhaust	44.144 to 44.286 mm (1.73795 to 1.74354 in.)
	Minimum	Intake	44.013 mm (1.73279 in.)
		Exhaust	43.996 mm (1.73212 in.)
Timing chain	Maximum chain elongation		137.7 mm (5.42 in.)
Crankshaft timing sprocket	Minimum sprocket diameter (with chain)		59.94 mm (2.36 in.)
Chain tensioner slipper	Maximum depth		1.0 mm (0.0394 in.)
No. 1 chain vibration damper	Maximum depth		1.0 mm (0.0394 in.)
Timing chain guide	Maximum depth		1.0 mm (0.0394 in.)
No. 1 balance shaft	Thrust clearance	Standard	0.05 to 0.09 mm (0.00197 to 0.00354 in.)
		Maximum	0.09 mm (0.00354 in.)
No. 2 balance shaft	Thrust clearance	Standard	0.05 to 0.09 mm (0.00197 to 0.00354 in.)

	Maximum	0.09 mm (0.00354 in.)
Balance shaft backlash	Standard	0.04 to 0.17 mm (0.00157 to 0.00669 in.)
	Maximum	0.17 mm (0.00669 in.)
Cylinder head bolt	Measuring point	106 mm (4.17 in.)
	Standard diameter	10.85 to 11.00 mm (0.427 to 0.433 in.)
	Minimum diameter	10.6 mm (0.417 in.)
Exhaust manifold converter	Maximum warpage	0.7 mm (0.0276 in.)
Stiffening crankcase ring pin	Protrusion height	4.3 to 5.3 mm (0.169 to 0.209 in.)
Camshaft bearing cap setting ring pin	Protrusion height	2.7 to 3.3 mm (0.106 to 0.130 in.)
Camshaft housing straight pin	Protrusion height	5.0 to 7.0 mm (0.197 to 0.276 in.)
No. 1 camshaft bearing	Dimension A - B or B - A: 0 to 0.7 mm (0 to 0.0276 in.)	
No. 2 camshaft bearing	Standard distance	1.15 to 1.85 mm (0.0453 to 0.0728 in.)

TORQUE SPECIFICATIONS

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ENGINE

Part Tightened	N*m	kgf*cm	ft.*lbf
Spark plug x Cylinder head	25	254	18
Ignition coil x Cylinder head cover	10	102	7

CAMSHAFT

Part Tightened	N*m	kgf*cm	ft.*lbf
Camshaft bearing cap x Camshaft housing	16	163	12
Camshaft bearing cap x Cylinder head	27	275	20
Camshaft timing gear x No. 1 camshaft	85	867	63
Camshaft timing exhaust gear x No. 2 camshaft	85	867	63
No. 1 chain tensioner x Cylinder block	10	102	7
Timing chain cover plate x Timing chain cover	10	102	7
Engine wire x Generator assembly	9.8	100	87 in.*lbf
Engine wire x Cylinder head cover sub-assembly	8.4	86	74 in.*lbf
Engine wire x Cylinder head	8.4	86	74 in.*lbf

Engine wire x Wire harness bracket	8.4	86	74 in.*lbf
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CYLINDER HEAD GASKET

Part Tightened		N*m	kgf*cm	ft.*lbf
Cylinder head x Cylinder block	1st	36	367	27
	2nd	36	367	27
	3rd	Turn 90°	Turn 90°	Turn 90°
	4th	Turn 90°	Turn 90°	Turn 90°
Camshaft bearing cap x Camshaft housing		16	163	12
Camshaft housing x Cylinder head		27	275	20
Camshaft timing gear x No. 1 camshaft		85	867	63
Camshaft timing exhaust gear x No. 2 camshaft		85	867	63
No. 1 chain vibration damper x Cylinder head, Cylinder block		21	214	15
Chain tensioner slipper x Cylinder head		21	214	15
No. 1 chain tensioner x Cylinder block		10	102	7
Timing chain guide x Camshaft housing		21	214	15

CYLINDER HEAD

Part Tightened	N*m	kgf*cm	ft.*lbf
Stud bolt x Cylinder head	9.5	97	84 in.*lbf
No. 1 straight screw plug x Cylinder head	44	449	32
No. 2 straight screw plug x Cylinder head	78	795	58

CYLINDER BLOCK

Part Tightened		N*m	kgf*cm	ft.*lbf
Stud bolt x Cylinder block	Stud bolt A	9.5	97	84 in.*lbf
	Stud bolt B	15	153	11
No. 2 oil nozzle x Cylinder block		10	102	7
No. 1 oil nozzle x Cylinder block		10	102	7
Crankshaft bearing cap x Cylinder block	1st	20	204	15
	2nd	40	408	30
	3rd	Turn 90°	Turn 90°	Turn 90°
Connecting rod cap x Connecting rod	1st	40	408	30
	2nd	Turn 90°	Turn 90°	Turn 90°

ENGINE REAR OIL SEAL

Part Tightened	N*m	kgf*cm	ft.*lbf

ENGINE ASSEMBLY

Part Tightened		N*m	kgf*cm	ft.*lbf
No. 1 and No. 2 engine hanger x Cylinder head		43	438	32
Engine mounting insulator LH x Automatic transaxle assembly		95	969	70
Engine mounting insulator RH x Engine mounting bracket RH		95	969	70
Front engine mounting insulator x Front engine mounting bracket		87	887	64
Drive shaft bearing bracket x Cylinder block		64	649	47
Frame side rail plate x Body	Nut	32	327	24
	Bolt A	32	327	24
	Bolt B	85	867	63
Front suspension member rear braces RH and LH x Body	Nut	32	327	24
	Bolt A	32	327	24
	Bolt B	85	867	63
Torque converter setting bolt x Torque convertor		41	418	30
No. 3 engine mounting stay RH x Engine moving control rod x Engine moving control bracket	Bolt B	52	530	38
	Bolt C	45	459	33
Engine moving control rod x Engine mounting bracket RH, Body		38	387	28
Ground cable x Engine moving control rod		5.5	56	49 in.*lbf
No. 2 engine mounting stay RH x Engine mounting bracket RH, Body		38	387	28
Positive (+) cable x Wire harness		13	130	9 in.*lbf
Ground wire x Body		8.4	86	74 in.*lbf
Engine wire x Engine room junction block		8.4	86	74 in.*lbf
Engine moving control rod x Body		38	387	28
Transmission control cable x Control shaft lever		12	122	9
Air cleaner x Air cleaner bracket		5.0	51	44 in.*lbf
Air cleaner inlet x Body		6.0	61	53 in.*lbf
Battery clamp x Body	Bolt	5.5	56	49 in.*lbf
	Nut	5.5	56	49 in.*lbf
Positive (+) cable x Positive (+) battery terminal		5.4	55	48 in.*lbf

ENGINE UNIT

Part Tightened		N*m	kgf*cm	ft.*lbf
Stud bolt x Stiffening crankcase	for stud bolt A	5.0	51	44 in.*lbf
	for stud bolt B	9.5	97	84 in.*lbf
Engine balancer x Stiffening crankcase		24	245	18
Stiffening crankcase x Cylinder block	for bolt A	24	245	18
	except bolt A	43	438	32
No. 1 oil pan baffle plate x Stiffening crankcase		10	102	7
Oil strainer x Stiffening crankcase		10	102	7
Oil pan x Stiffening crankcase		10	102	7
Stud bolt x Camshaft housing		9.5	97	84 in.*lbf
Timing chain cover plate x Timing chain cover		10	102	7
Timing chain cover tight plug x Timing Chain cover		30	306	22
Cylinder head cover sub-assembly x Camshaft housing		12	122	9
Crankshaft pulley x Crankshaft		260	2651	192
Inlet water housing x Cylinder4 block		43	438	32
V-ribbed belt tensioner x Inlet water housing		21	214	15
No. 1 water by-pass pipe x Inlet water housing, Cylinder block		10	102	7
Separator case x Ventilation case		10	102	7
Ventilation case x Cylinder block		21	214	15
Engine cover joint x Cylinder head cover, Camshaft housing		10	102	7
Sensor wire x Cylinder block		21	214	15
Intake manifold x Cylinder head		21	214	15
No. 1 compressor mounting bracket x Cylinder block, Stiffening crankcase		21	214	15
Engine oil level dipstick guide x Inlet water housing		10	102	7