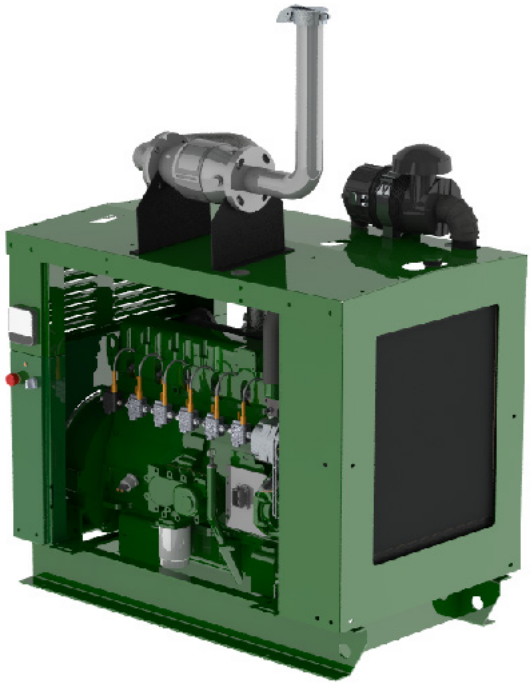
ARROW ENGINE
ENGINES & COMPRESSION

Original Equipment.

Engineered Solutions.

A54E

PARTS AND OPERATIONS MANUAL



ARROW ENGINE
ENGINES & COMPRESSION

ARROW ENGINE COMPANY
2301 E. Independence St., Tulsa, OK 74110
www.arrowengine.com

A54E-POM-JAN2024

A54E

PARTS AND OPERATIONS MANUAL

A54E-POM-JAN2024

2301 E. Independence St.

Tulsa, OK 74110

1. Maintenance Providers

Maintenance and repair services may be performed by you or any qualified engine service provider that you choose. However, your engine warranty does not cover damage or failure caused by improper maintenance or repairs.

2. Operations Manual and Maintenance Log Storage and Use

Store this Operations Manual and Maintenance Log in a safe, visible place by your engine. The maintenance log must be updated whenever your engine is serviced.

Table of Contents

THIS PAGE INTENTIONALLY LEFT BLANK

U.S. EPA Legal Requirements

This engine has been certified by the U.S. Environmental Protection Agency (EPA) as a stationary and constant-speed mobile engine. It is illegal to operate this engine in a variable-speed (foot-pedal speed-control) application.

To ensure emissions compliance, the U.S. EPA requires you to perform one of the following two options:

1. Operate and maintain your engine as specified in this Operations Manual. In addition, you are required by law to keep detailed maintenance records.
2. If you do not operate and maintain your engine as specified in this Operations Manual, your engine will be considered a noncertified engine.

In this case, you must:

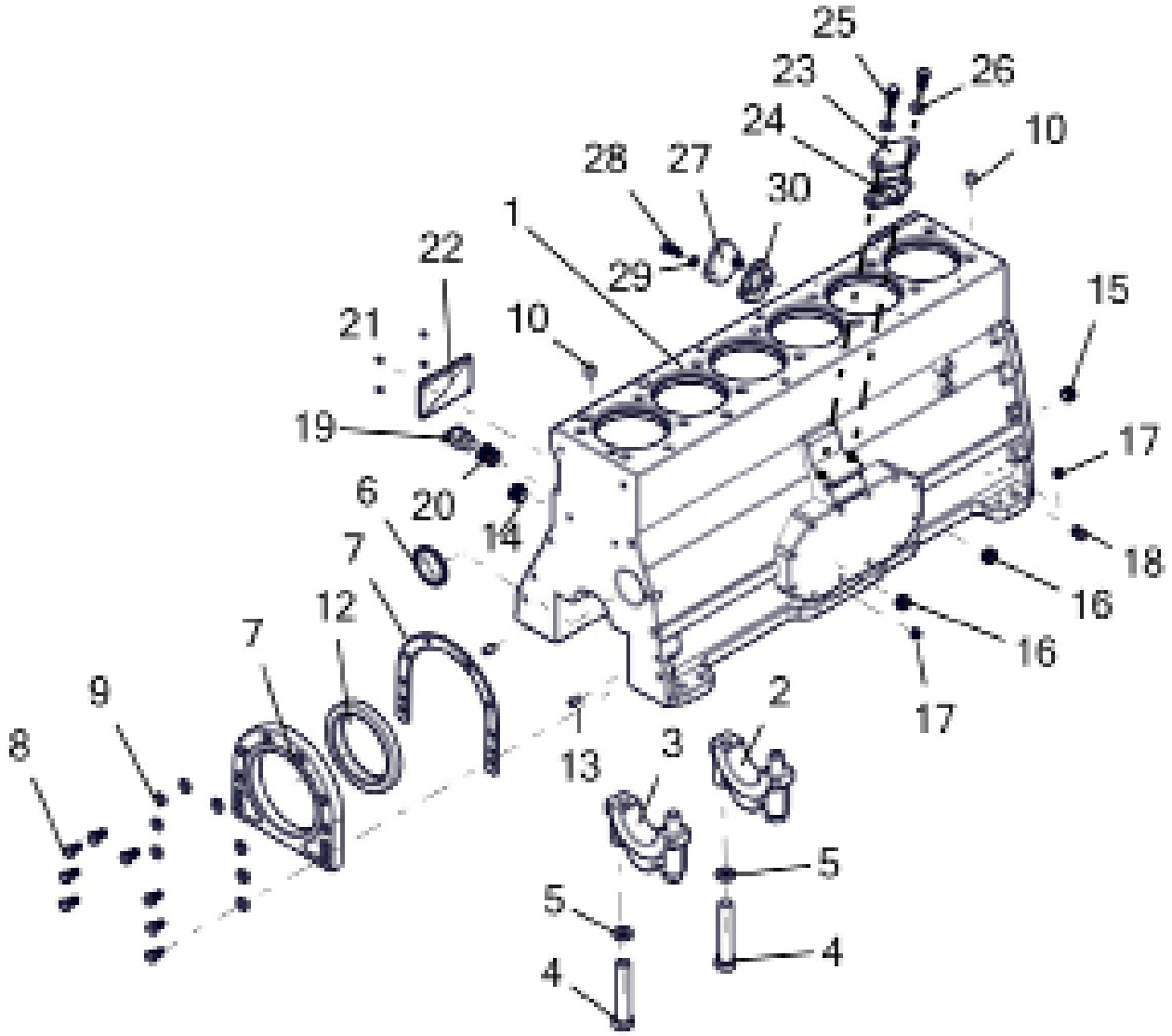
- Keep a maintenance plan and records of conducted maintenance.
- To the extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practices for minimizing emissions.
- For engines rated over 100 HP (not the Arrow A54), conduct an initial performance test within one year of engine startup to demonstrate compliance. Contact your regional EPA office for instructions on how to conduct an initial performance test.

Per section 113 of the U.S. Clean Air Act, failure to abide by these legal requirements can result in fines of the following amounts: up to $49,342 per engine for manufacturers and $49,342 per day for owner-operators.

A maintenance plan and log are provided at the back of this manual for you to record your engine maintenance. Update the log each time you service your engine.

THIS PAGE INTENTIONALLY LEFT BLANK

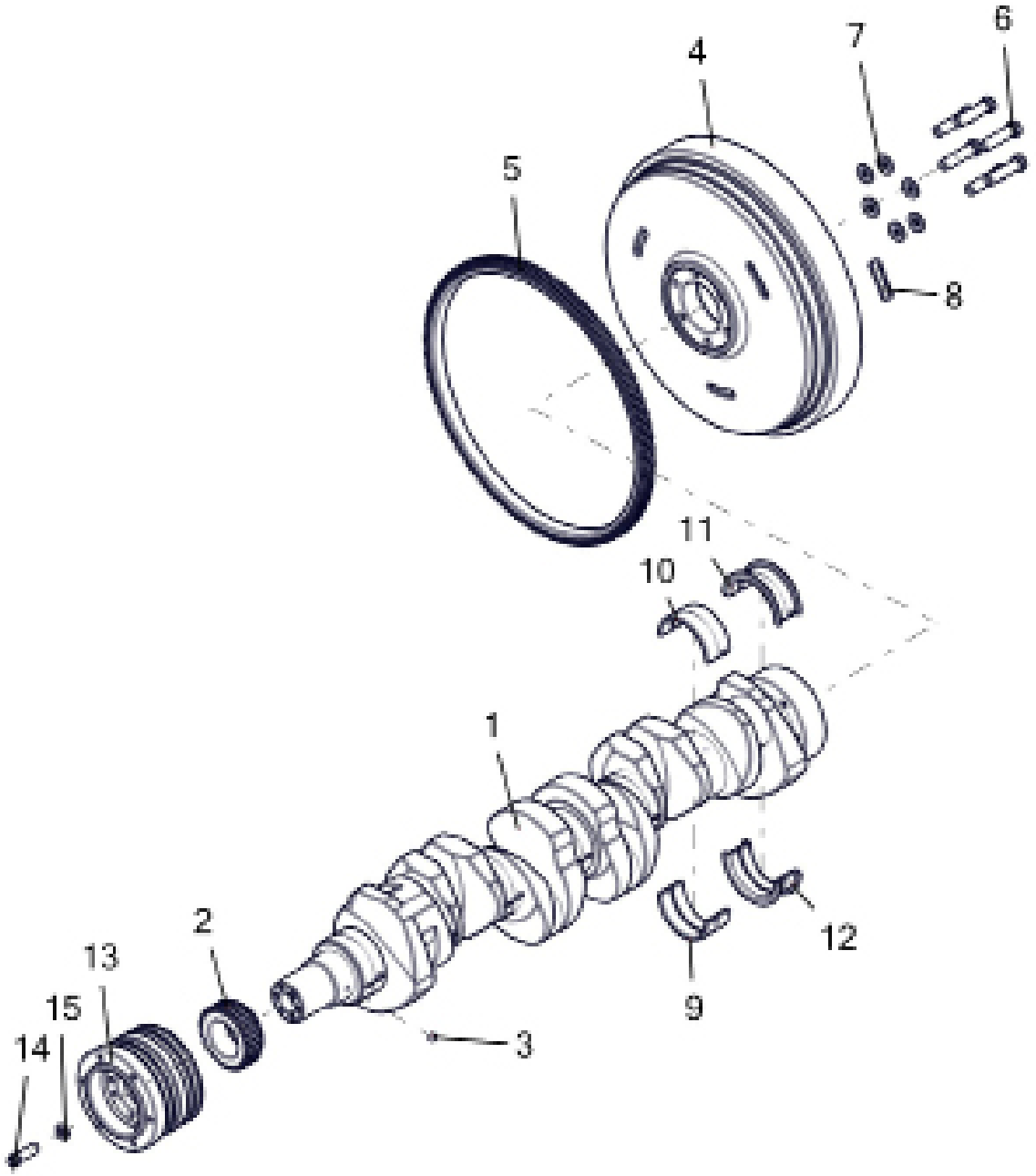
PARTS


25
23
26
24
10
28
27
30
1
29
22
21
10
15
19
17
6
20
14
18
7
16
12
16
7
17
9
2
8
13
3
5
5
4
4

CRANKCASE

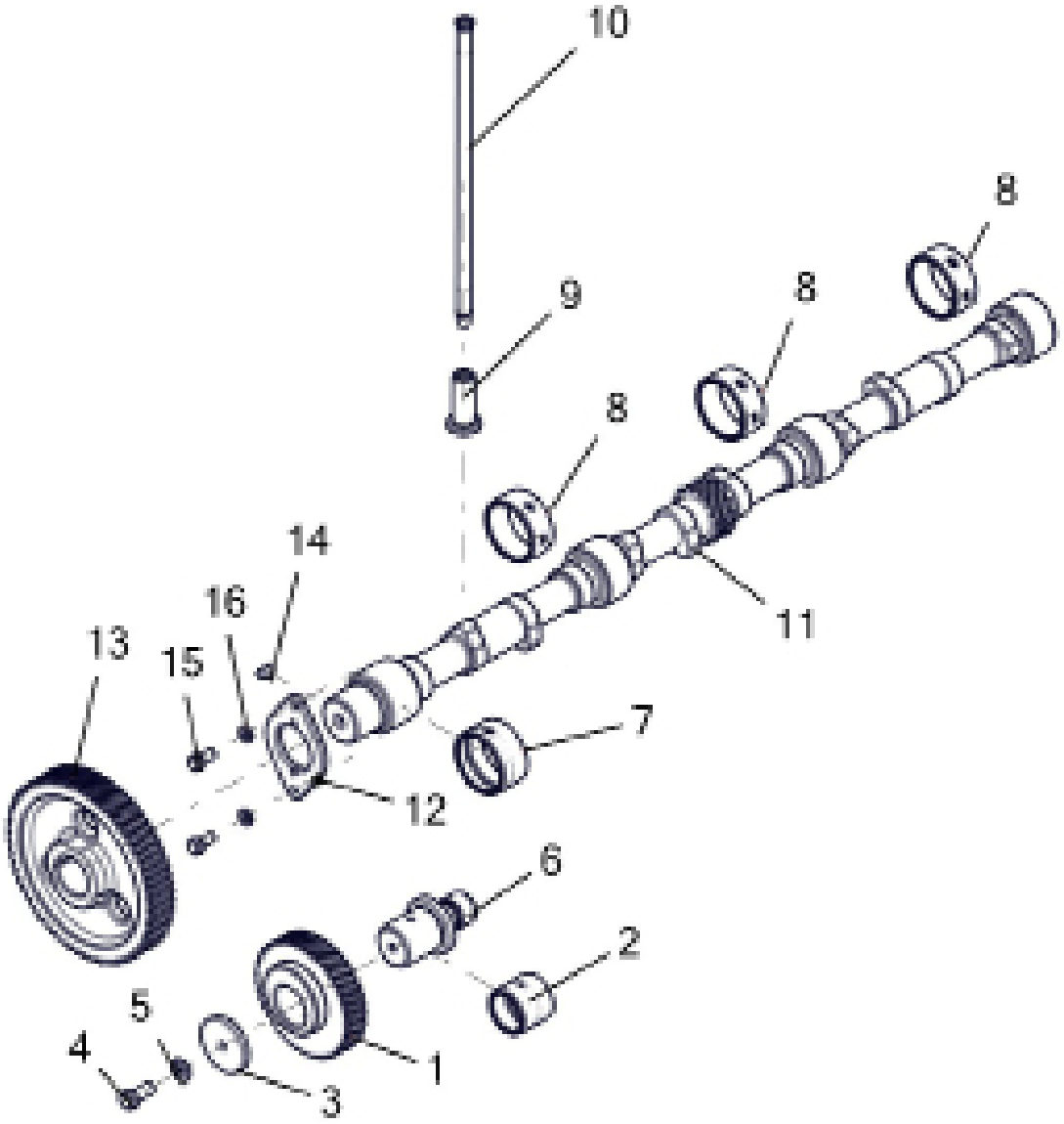
Crankcase

Item No.	Part No.	Qty.	Description
1	C217020	1	Crankcase Assembly (Includes Camshaft Bushings)
2	216049A	1	Cap, Main Bearing–Thrust (Serviced Only as Semi-finished)
3	216046A	6	Cap, Main Bearing (Serviced Only as Semi-Finished)
4	151796A	14	Screw, Main Bearing Cap
5	152879	14	Washer, Plain, 5/8-inch
6	80609	1	Plug, Expansion
7	208448	1	Gasket, Rear Oil Seal Retainer
8	7A-5/1618X3/4	8	Screw, Cap, Hex Head, 5/16-inch–18 X 3/4-inch
9	1A-5/16	8	Washer, Lock, 5/16-inch
10	B3568	2	Pin, Dowel
11	A216090	1	Retainer, Rear Oil Seal–Assembly
12	208458T	1	Seal, Oil–Rear
NS	208458TI	1	Tool, Rear Seal Installation
13	B565	2	Pin, Dowel
14	78283J	2	Plug, Pipe, Countersunk Headless–Plated, 1/2-inch
15	26411	4	Plug, Pipe, Allen Head–Plated, 3/8-inch (without Oil Cooler)
16	26411	1	Plug, Pipe, Allen Head–Plated, 3/8-inch (with Oil Cooler)
17	Y18802	3	Plug, Pipe, Allen Head, 1/8-inch
18	26743	5	Plug, Pipe, Hex Head, 1/8-inch
19	76400	1	Block, Drain
20	78212C	1	Bushing, Reducing, 1/2-inch to 1/4-inch
NS	HT-100	1	Heat Tab, 235°
21	B557A	4	Pin, Nameplate
22	207658	1	Plate, Name
23	208763	1	Plate, Cover (Less Distributor)
24	208762	1	Gasket, Cover Plate (Less Distributor)
25	7A-3/816X7/8	2	Screw, Cap, Hex Head, 3/8-inch–16 X 7/8-inch (Less Distributor)
26	1A-3/8	2	Washer, Lock, 3/8-inch Less Distributor
27	73954C	1	Cover, Fuel Pump
28	7A-5/1618X7/8	2	Screw, Cap, Hex Head, 5/16-inch–18 X 7/8-inch
29	B2135	2	Washer, Plain–Copper, 5/16-inch
30	73842C	1	Gasket, Fuel Pump
KITS			
NS	G975-277		Short Block, Compression Ratio 8:1



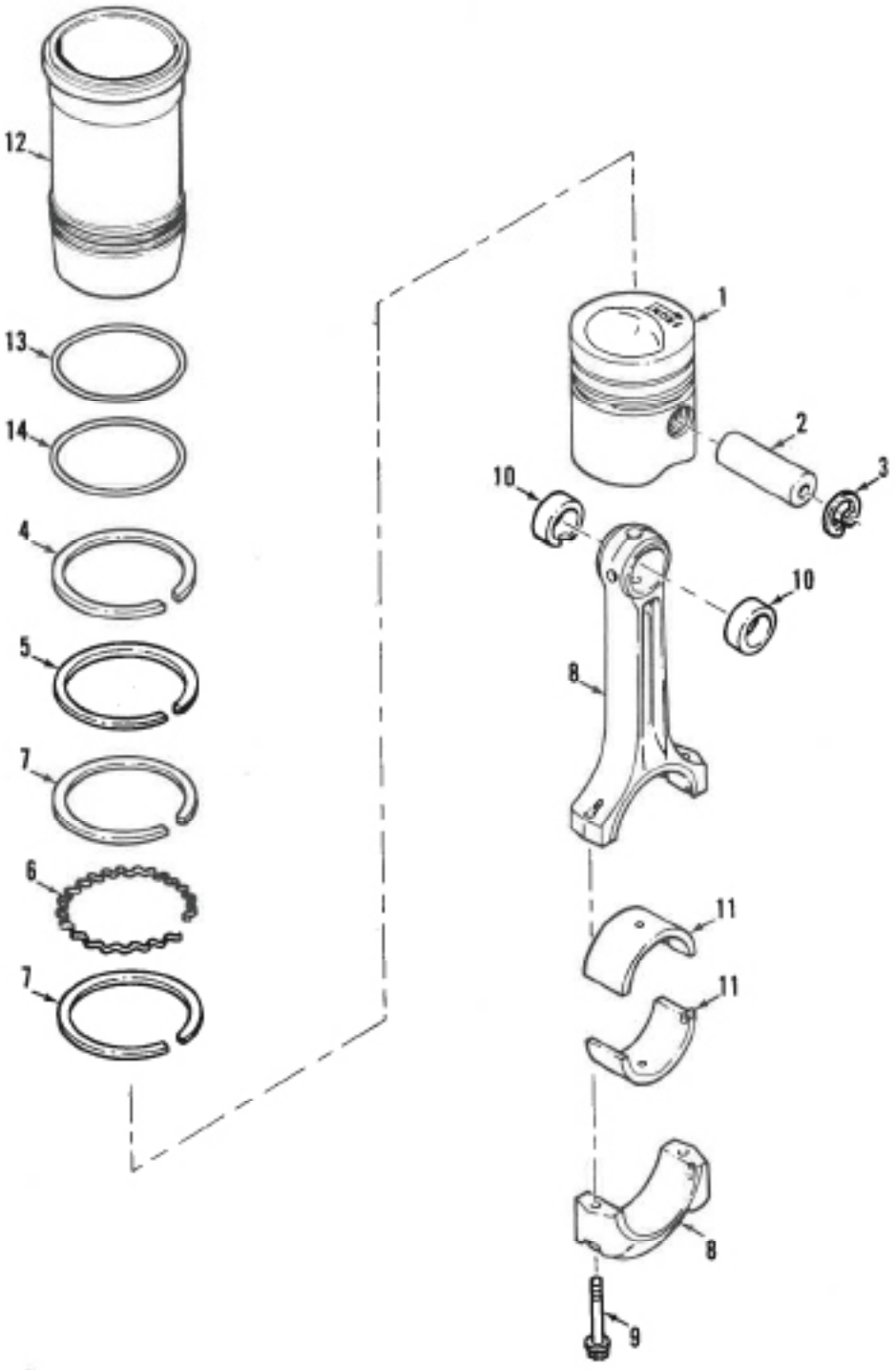
CRANKSHAFT, PULLEY, FLYWHEEL

Item No.	Part No.	Qty.	Crankshaft, Pulley, Flywheel Description
	A217011	1	Crankshaft Assembly (Not Sold Separately)
1A	217011	1	Crankshaft, Less Gear
2	216012	1	Gear, Crankshaft
3	207988	1	Ball, Crankshaft Gear Retaining
4	A216013	1	Flywheel Assembly, 4 and 5
4A	216013	1	Flywheel
5	190066	1	Gear, Ring–Flywheel, 121 Teeth
6	28642	6	Screw, Cap, Hex Head–Grade 8, 7/16-inch–20 X 2-inch
7	810245	6	Washer, Plain, 7/16-inch
8	208623H	1	Tape, Timing
NS	74013A	1	Stub Shaft, not shown
9	216022A	6	Bearing, Main, Lower Only
10	216022	6	Bearing, Main, Upper Only
11	216018	1	Bearing, Main–Thrust–Upper Only
11A	2160182	1	Bearing, Main–Thrust–Upper Only, .020
12	216018A	1	Bearing, Main–Thrust–Lower Only
12A	216018A2	1	Bearing, Main–Thrust–Lower Only, .020
13	216295A-4	1	Pulley with Holes Drilled, 12+1
14	28643	6	Screw, Cap, Ferry Head, 3/8-inch–24 X 1-3/8-inch
15	1A-3/8	6	Washer, Lock, 3/8-inch
KITS			
20	911-209		Crankshaft and Crankshaft Bearing Kit (Includes Item Nos. 1–2, 7–9, and Connecting Rod Bearings)
	911-216	1	
21	G-918-307		Main Bearing Kit–Standard (Includes Item Nos. 7–9)
	G-918-308	1	
22	HW918309		Main Bearing Kit–.010-inch Undersize (Includes Item Nos. 7–9)
	HW918310	1	
23	G-918-311		Main Bearing Kit–.020-inch Undersize (Includes Item Nos. 7–9)
	G-918-312	1	
24	992111	1	Sleeve Front
25	994511	1	Sleeve Rear



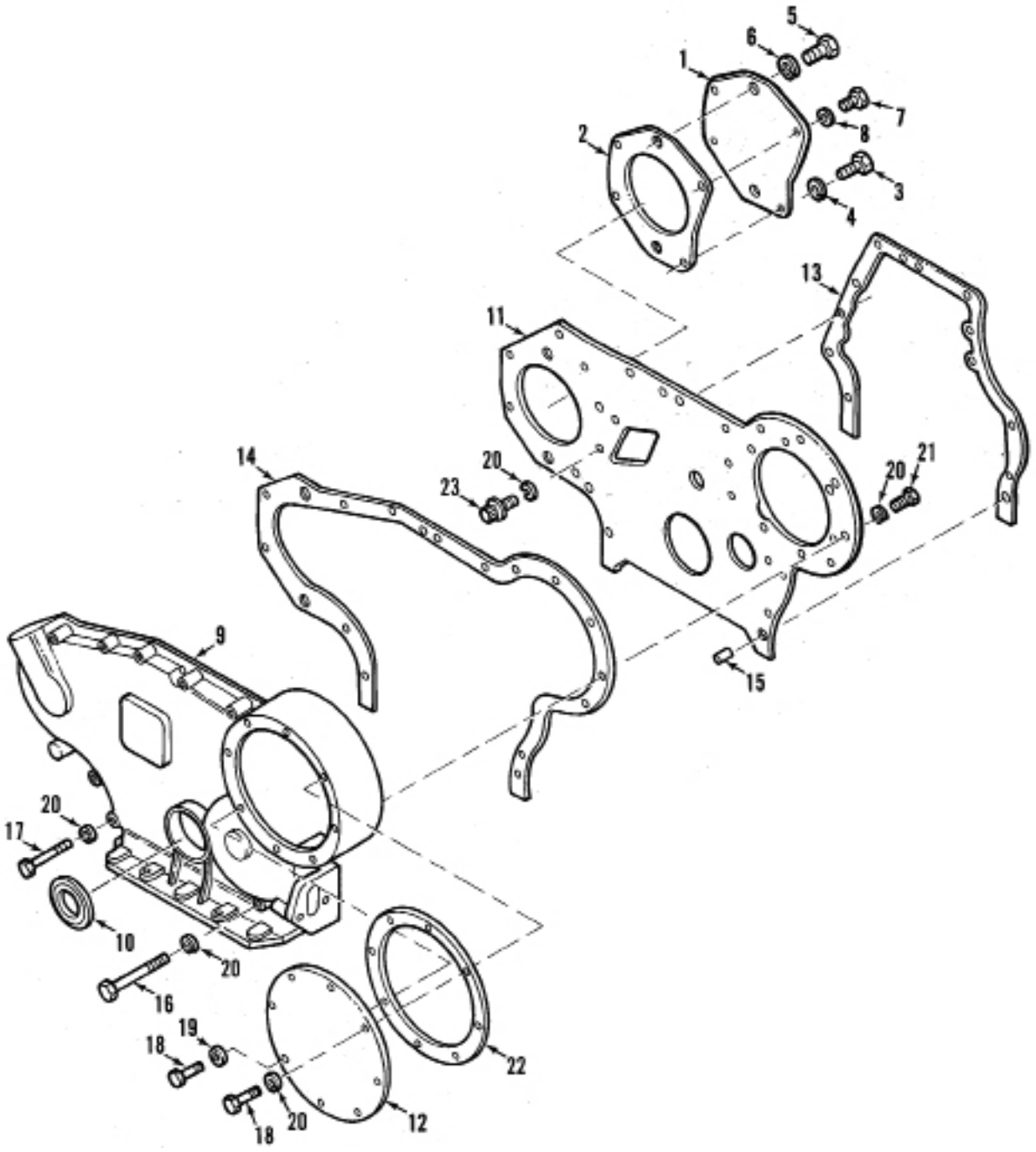
CAMSHAFT, VALVE LIFTER, PUSH ROD, IDLER GEAR

Item No.	Part No.	Qty.	Camshaft, Valve Lifter Push Rod, Idler Gear Description
1	A216015A	1	Gear, Idler–Assembly
2	216029A	1	Bushing, Idler Gear
3	169420D	1	Washer, Thrust
4	28152	1	Screw, Cap, Hex Head, 5/16-inch–24 X 7/8-inch
5	1A-5/16	1	Washer, Lock, 5/16-inch
6	208514	1	Spindle, Idler Gear
7	216050	1	Bushing, Camshaft–Front (Undersize for Align-boring)
7A	216050S	1	Bushing, Camshaft–Front (Pre-reamed to Size)
8	216053	3	Bushing, Camshaft–Center and Rear (Undersize for Align-boring)
8A	216053S	3	Bushing, Camshaft (Pre-reamed to Size)
9	180037C	12	Lifter
10	216038	12	Rod, Push
11	A217123G	1	Camshaft Assembly
11A	217123G	1	Camshaft
12	208509	1	Plate, Thrust
13	216026	1	Gear, Camshaft
14	104A-#6	1	Key, Woodruff, No. 6
15	7A-1/420X5/8	2	Screw, Cap, Hex Head, 1/4-inch–20 X 5/8-inch
16	1A-1/4	2	Washer. Lock, 1/4-inch
KITS			
19	927-46		Camshaft Bushing Kit (Includes Item Nos. 6, 7, and Undersize Bushings)
	927-48	1	
	927-50	1	Camshaft Bushing Kit (Includes Item Nos. 6, 7, and Pre-reamed Bushings)
	927-52	1	



PISTONS, CONNECTING RODS, CYLINDER SLEEVES

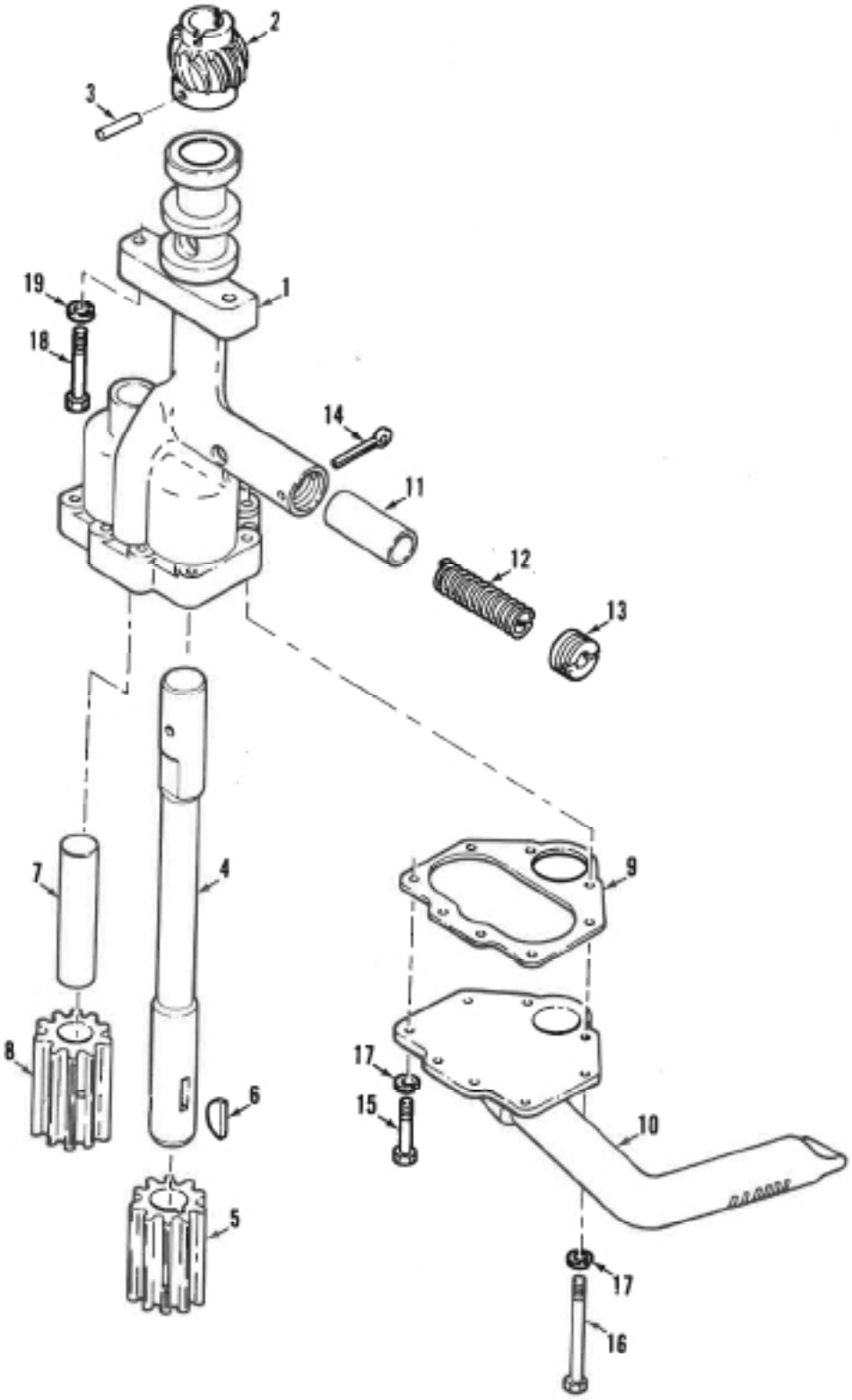
Item No.	Part No.	Qty.	Pistons, Connecting Rods, Cylinder Sleeves Description
1	216104A	6	Piston (8:1)
2	221006A	6	Pin, Piston
3	44999	12	Retainer, Piston Pin
4	223305B	6	Ring, Piston–Compression (Top Groove)
	223305C	6	Ring, Piston–Compression (Top Groove) Hastings
5	223605M	6	Ring, Piston–Compression
	223605N	6	Ring, Piston–Compression, Hastings
6	221705	6	Spacer, Oil Ring Rails
7	221805	12	Rail, Oil Ring
8	A216007	6	Rod, Connecting–Assembly
9	208447A	12	Bolt, Connecting Rod
10	216008	12	Bushing, Piston Pin
	216008A	12	Bushing, Piston Pin, Aluminum
11	216010A	6	Bearing, Connecting Rod Pair
	HW216010A3	6	Bearing, Connecting Rod Pair, .030
	216010A2	6	Bearing, Connecting Rod Pair, .020
	HW216010A1	6	Bearing, Connecting Rod Pair, .010
12	216030C	6	Sleeve, Cylinder
13	208464B	12	Ring, Packing–Cylinder Sleeve (Upper Groove–Black)
14	208465A	6	Ring, Packing–Cylinder Sleeve (Lower Groove–Red)
KITS			
15	907-185	6	Single Piston Ring Kit (8:1) (Includes Item Nos. 4–7)
16	932-262	6	Single Cylinder Sleeve Kit (8:1) (Includes Item Nos. 1–7, 12–14)



GEAR COVER

Gear Cover

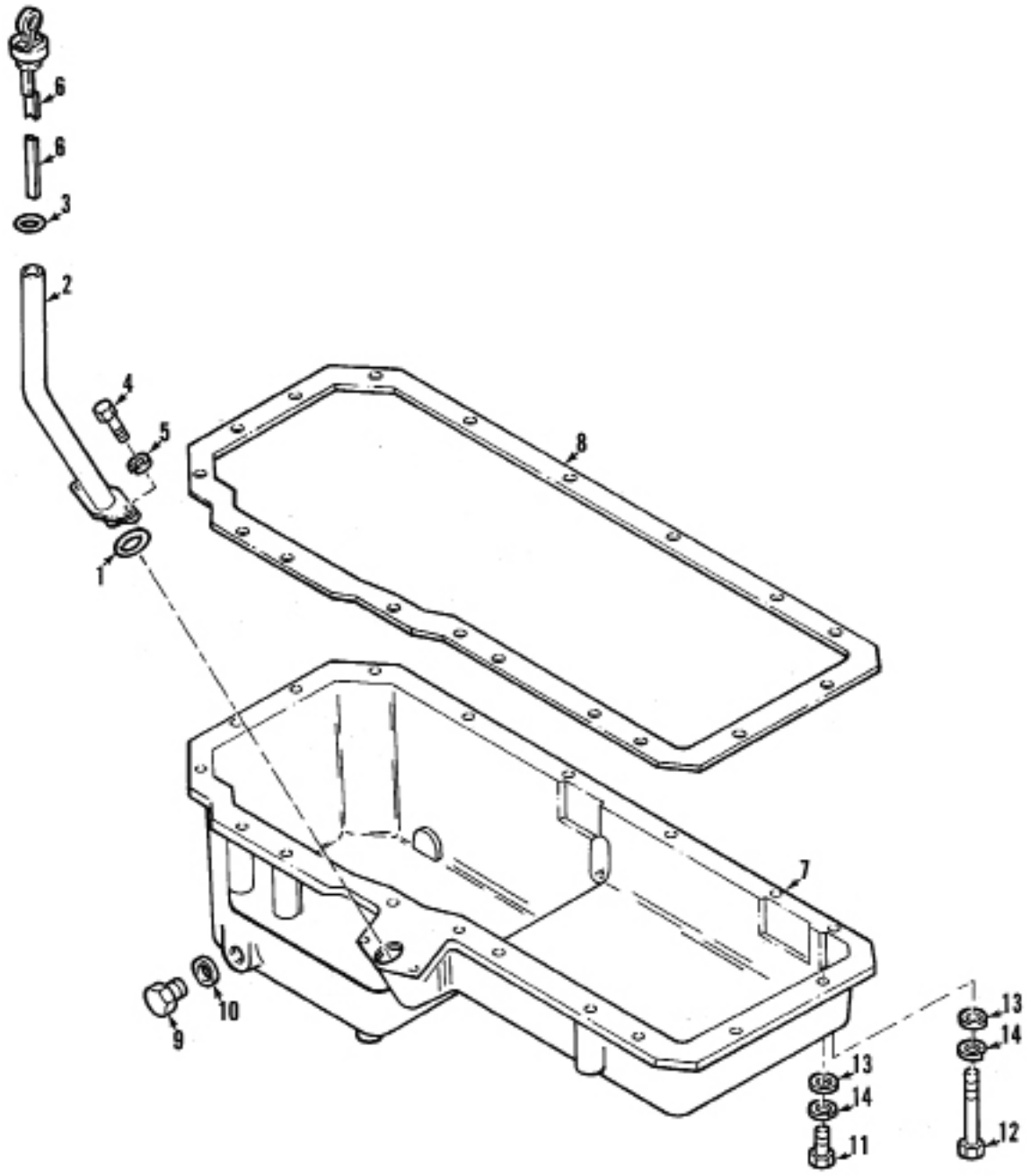
Item No.	Part No.	Qty.	Description
1	208647	1	Plate, Access Cover
2	208643	1	Gasket, Access Cover
3	7A-5/1618X7/8	3	Screw, Cap, Hex Head, 5/16-inch–18 X 7/8-inch
4	1A-5/16	3	Washer, Lock, 5/16-inch
5	7A-1/213X1	2	Screw, Cap, Hex Head, 1/2-inch–13 X 1-inch
6	1A-1/2	2	Washer, Lock, 1/2-inch
7	7A-5/1618X1/2	1	Screw, Cap, Hex Head, 5/16-inch–8 X 1/2-inch
8	B2135	1	Washer, Copper
9	216045C	1	Cover, Gear
10	208526	1	Seal, Oil–Front
11	216054	1	Plate, Front
12	208512	1	Plate, Cover
13	208616	1	Gasket, Front Plate
14	208543	1	Gasket, Gear Cover
15	Y18678	2	Pin, Dowel
16	26348	1	Screw, Cap, Hex Head, 5/16-inch–18 X 3-inch
17	21323	5	Screw, Cap, Hex Head, 5/16-inch–18 X 2-1/2-inch
18	7A-5/1618X3/4	8	Screw, Cap, Hex Head, 5/16-inch–18 X 3/4-inch
19	21950	2	Washer, Brass
20	1A-5/16	26	Washer, Lock, 5/16-inch
21	7A-5/1618X7/8	7	Screw, Cap, Hex Head, 5/16-inch–18 X 7/8-inch
22	208513	1	Gasket, Cover Plate
23	28644	5	Screw, Cap, Ferry Head, 5/16-inch–18 X 7/8-inch
24	B4296	1	Gasket, Cap
25	176412	1	Gasket, Cap



OIL PUMP

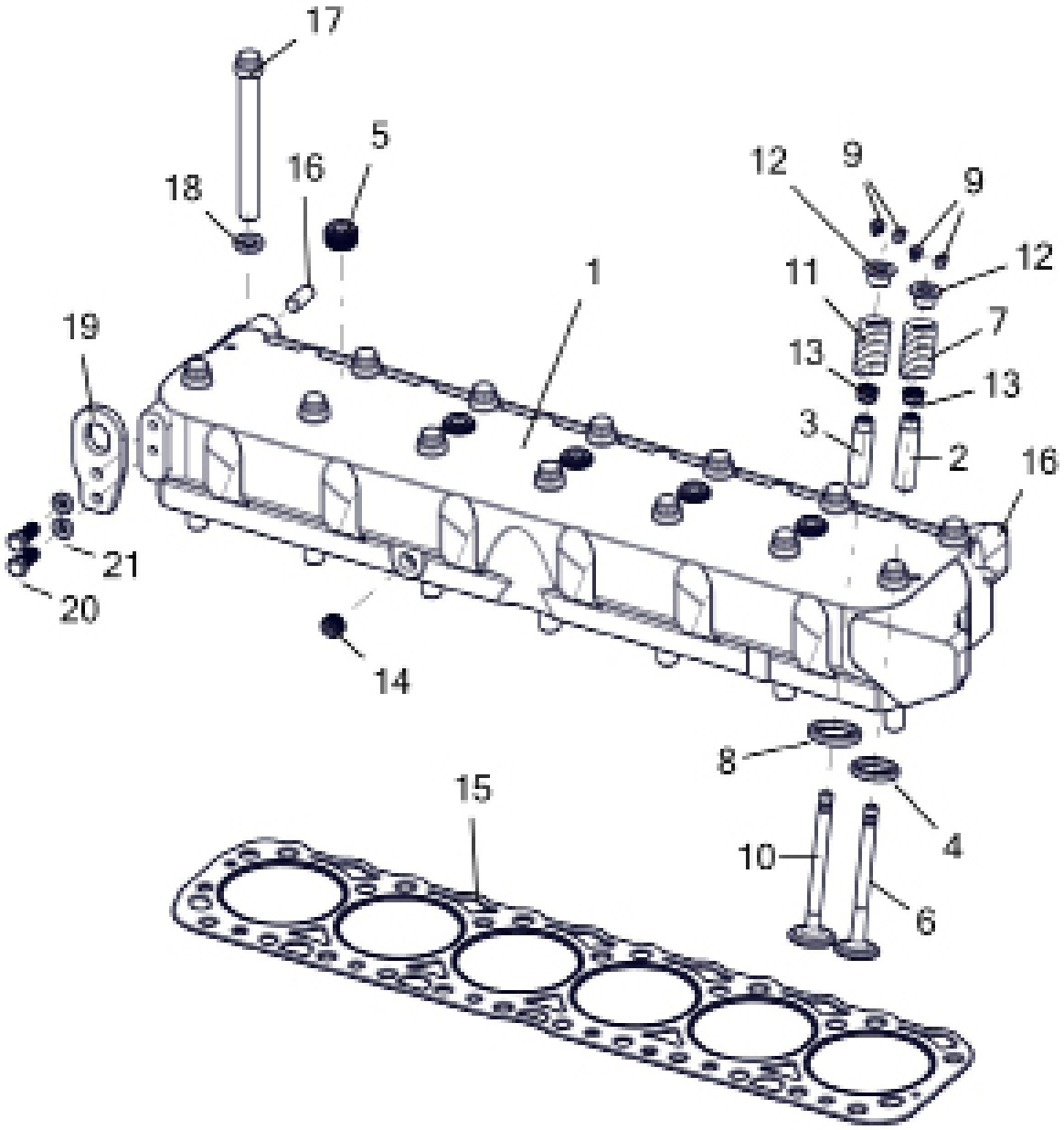
Oil Pump

Item No.	Part No.	Qty.	Description
	J216080C		Oil Pump Assembly
1	216080C	1	Body, Oil Pump
2	216051A	1	Gear, Oil Pump Drive
3	26583	1	Pin, Roll, 3/16-inch X 1 1/4-inch
4	216084A	1	Shaft, Oil Pump Drive
5	216081A	1	Gear, Oil Pump Drive
6	104A-#5	1	Key, Woodruff, No. 5
7	216083	1	Shaft, Oil Pump Idler Gear
8	216085	1	Gear, Oil Pump–Idler
9	208562	1	Gasket, Oil Pump Cover
10	C216182A	1	Cover, Oil Pump
NS	28641		Plug, Pipe, Allen Head, 3/4-inch
11	208580A	1	Plunger, Relief Valve
12	208565	1	Spring, Relief Valve
13	208588	1	Screw, Relief Valve Adjusting
14	2A-1/8X13/4	1	Pin, Cotter, 1/8-inch X 1 3/4-inch
15	7A-1/420X1	6	Screw, Cap, Hex Head, 1/4-inch–20 X 1-inch
16	21291	2	Screw, Cap, Hex Head, 1/4-inch–20 X 2-inch
17	1A-1/4	8	Washer, Lock, 1/4-inch
18	21354	2	Screw, Cap, Hex Head, 3/8-inch–16 X 1 3/8-inch
19	1A-3/8	2	Washer, Lock, 3/8-inch
KITS			
NS	980-153	1	Oil Pump Repair Kit (Oil Pump Assembly 216080C) Includes Item Nos. 1–7, 9–10



OIL PAN

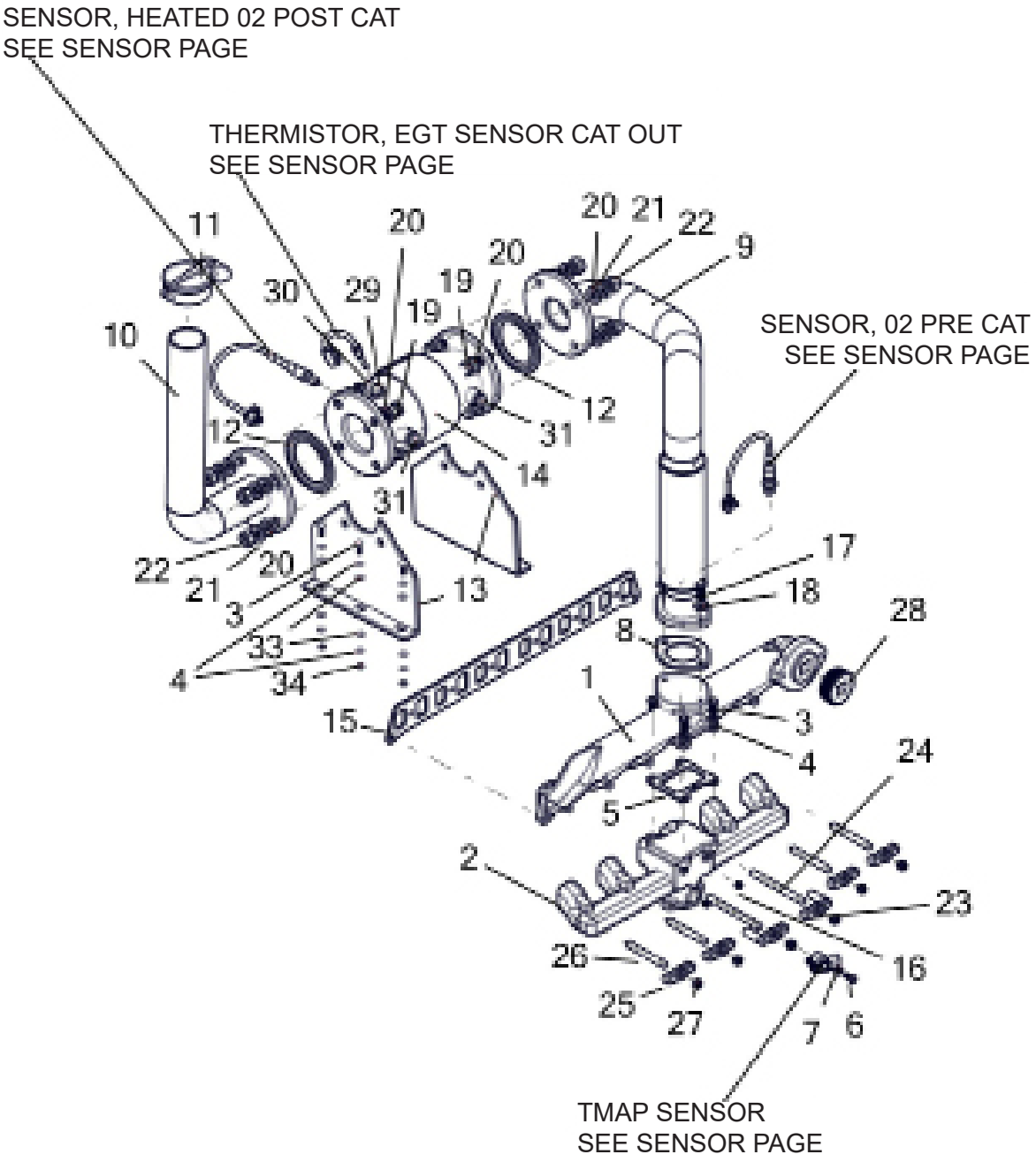
Item No.	Part No.	Qty.	Description — Oil Pan
1	118013M	1	O-ring
2	A208481A	1	Tube, Oil Level Dipstick (with 199178 Series Dipstick)
3	157497X	1	O-ring
4	7A-5/1618X7/8	2	Screw, Cap, Hex Head, 5/16-inch-18x7/8-inch
5	1A-5/16	2	Washer, Lock, 5/16-inch
6	199178F	1	Dipstick, Oil Level (with 217014 Oil Pan)
7	217014HC	1	Pan, Oil (High-capacity), 17.6 quarts
8	208626A	1	Gasket, Oil Pan
9	76909	1	Plug, Drain
10	B175	1	Gasket, Drain Plug
11	7A-8/1618X1	19	Screw, Cap, Hex Head, 5/16-inch–18 X 1-inch
12	26125	3	Screw, Cap, Hex Head, 5/16-inch–18 X 3-3/4-inch
13	B277	22	Washer, Plain, 5/16-inch
14	1A-5/16	22	Washer, Lock, 5/16-inch
KITS			
	5020-3E-KIT	1	Oil Level Kit (with Regulator)



CYLINDER HEAD, VALVES

Cylinder Head, Valves

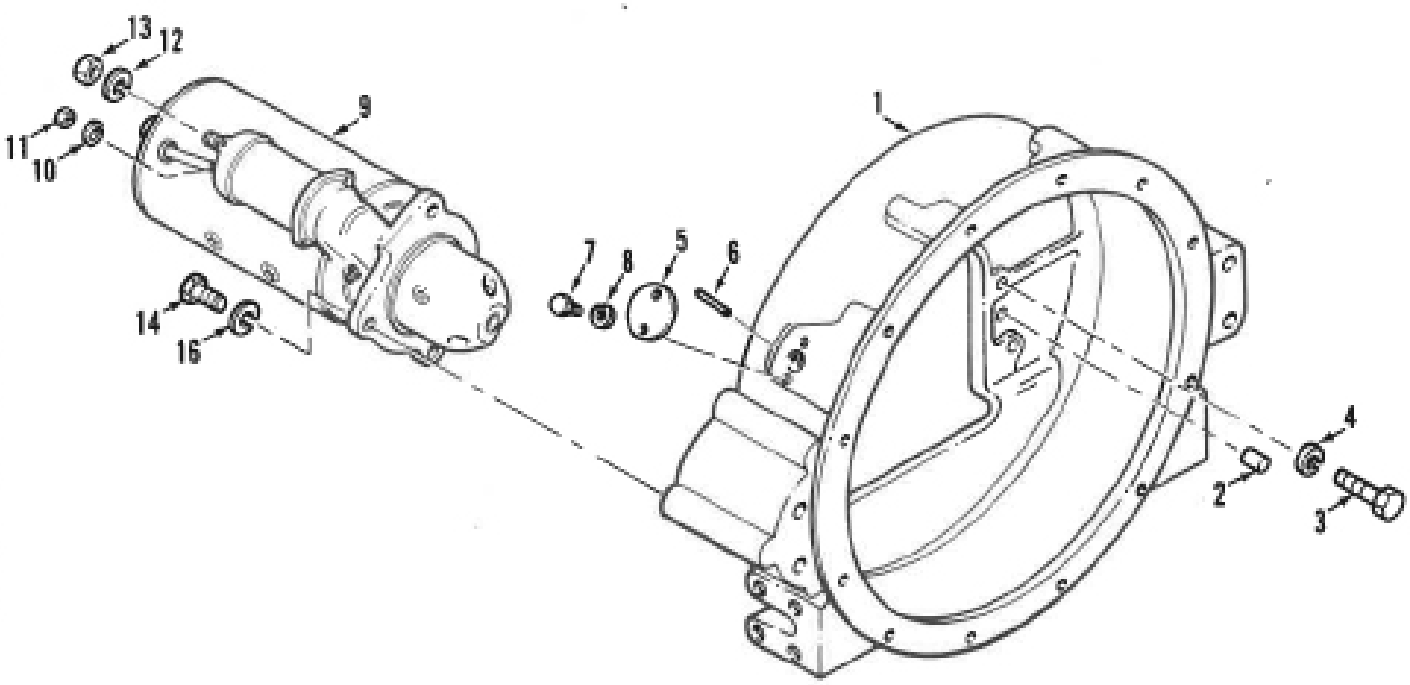
Item No.	Part No.	Qty.	Description
1	CA217102	1	Head, Cylinder Assembly
NS	A217102	1	Cylinder Head with Guides and Seats
2	224609A	6	Guide, Valve, Exhaust
3	224609D	6	Guide, Valve, Intake
4	166469AS	6	Insert, Valve Seat, Exhaust
5	78283B	5	Plug, Pipe, Countersunk Headless, 3/4-inch
6	222536C	6	Valve, Exhaust
7	224135	6	Spring, Valve, Exhaust
NS	HW166461	6	Insert, Valve Seat, Intake
8	163235	12	Taper, Valve Spring
9	163670	24	Retainer, Valve Spring
10	222436B	6	Valve, Intake
11	224135	6	Spring, Valve, Intake
13	208712N	12	Seal, Valve Stem
14	26411	1	Plug, Pipe, Allen Head–Plated, 3/8-inch
15	217000A	1	Gasket, Cylinder Head
16	B9824	2	Pin, Dowel
17	28716	14	Bolt, Cylinder Head
18	152879	14	Washer, Cylinder Head Screw
19	208579	1	Plate, Lifting Eye
20	29605	2	Screw, Cap, Hex Head, 3/8-inch–16 X 1-inch
21	1A-3/8	2	Washer, Lock, 3/8-inch
NS	HT-100	1	Heat Tab, 235°F
NS	G-936-1	1	Valve Overhaul Kit (Item Nos. 2,3,4,11)



INTAKE AND EXHAUST MANIFOLD

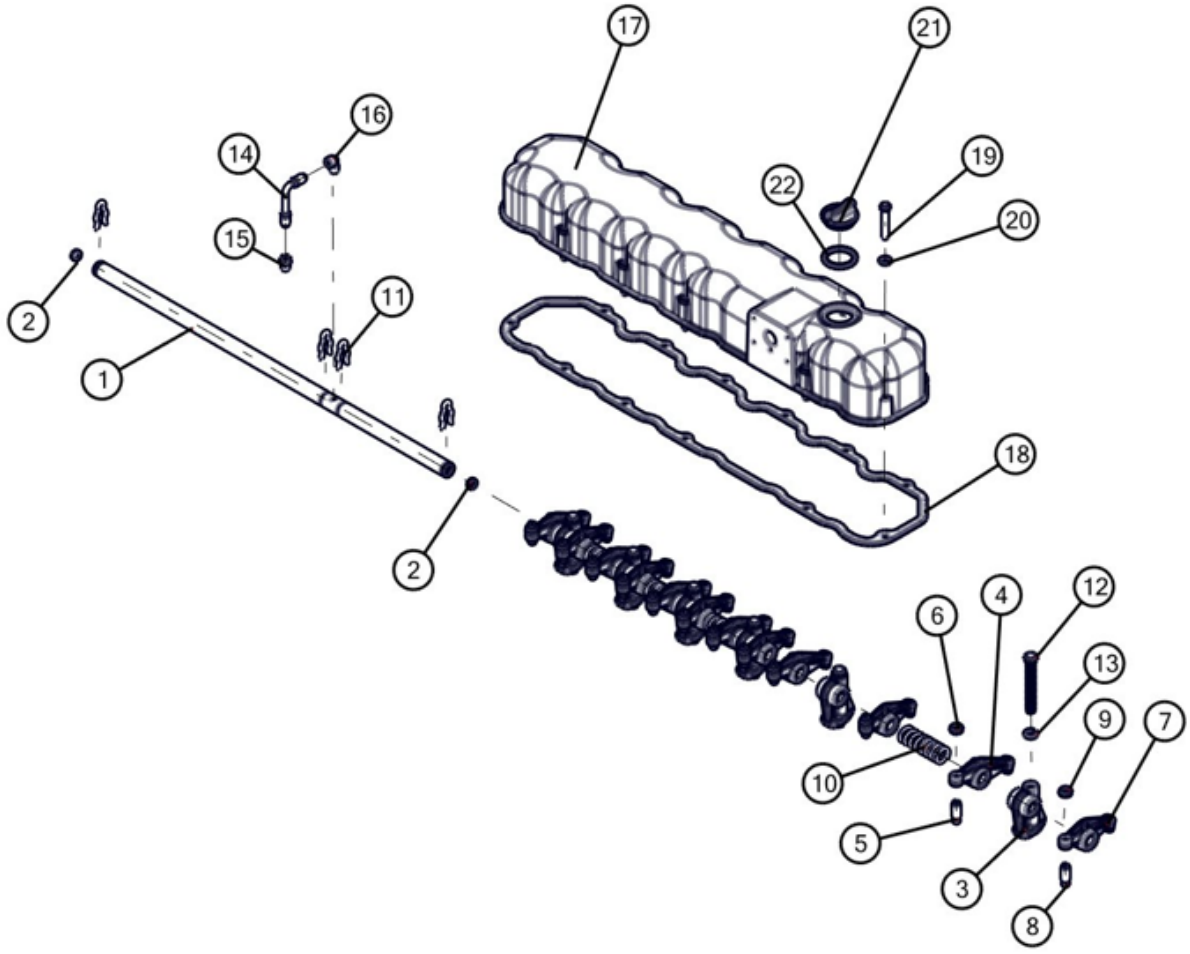
Intake and Exhaust Manifold

Item No.	Part No.	Qty.	Description
1	A217142	1	Manifold Assembly
	217142	1	Exhaust Manifold
2	217141	1	Manifold, Intake
3	7A-3/816X1	10	Screw, Cap, Hex Head, 3/8-inch–16 X 1-inch
4	1A-3/8	13	Washer, Lock, 3/8-inch
5	159884	1	Gasket, Intake to Exhaust Manifold
6	7A-1/420X3/4	1	Cap screw Hex Head
7	1N-1/4	1	Washer Flat SAE-plated
8	WR03001	1	Gasket, Exhaust Outlet
9	CAT FLEX INLET-A54	1	Flex Inlet Pipe for AFR/Catalyst
10	CAT OUTLET	1	Outlet Tail Pipe for Catalyst
11	155938T	1	Rain Cap
12	AFR-GASKET	2	Flange Gasket for AFR/Catalyst
13	152802A	2	Bracket, Mount, Integral CAT
14	DDC70031	1	Catalyst, Integral, 7.0-inch Single
15	208597	1	Gasket Manifold Graphoil
16	PF18-1/8	2	Plug Socket Head Pipe
17	7A-1/213X1-1/4	2	Cap Screw Hex Head
18	1N-1/2	2	Washer Flat SAE-plated
19	7A-5/811X21/2	8	Cap Screw Hex Head
20	1N-5/8	16	Washer Flat SAE-plated
21	1A-5/8	8	Lock washer-plated
22	25A-5/811	8	Nut Hex Heavy
23	158978	12	Clamp, Manifold
24	107120	2	Stud GR5 .375X6.06LG
25	158978A	4	Clamp, Manifold
26	74358	4	Stud GR5 .375X4.44LG
27	29A-3/824	6	Nut Hopper Stud
28	Y9097	1	Plug Pipe
29	KA17007	1	Plug M12X1.25 Hex
30	KA17001	1	Plug 18MX1.5
31	HP-3000-1/2	2	Hex Plug, 1/2-inch, SA105, 3-6M
32	KB50027		Optional Muffler (not shown)
33	1N-3/8	12	Washer Flat SAE-plated
34	29A-3/816	6	Nut Hex



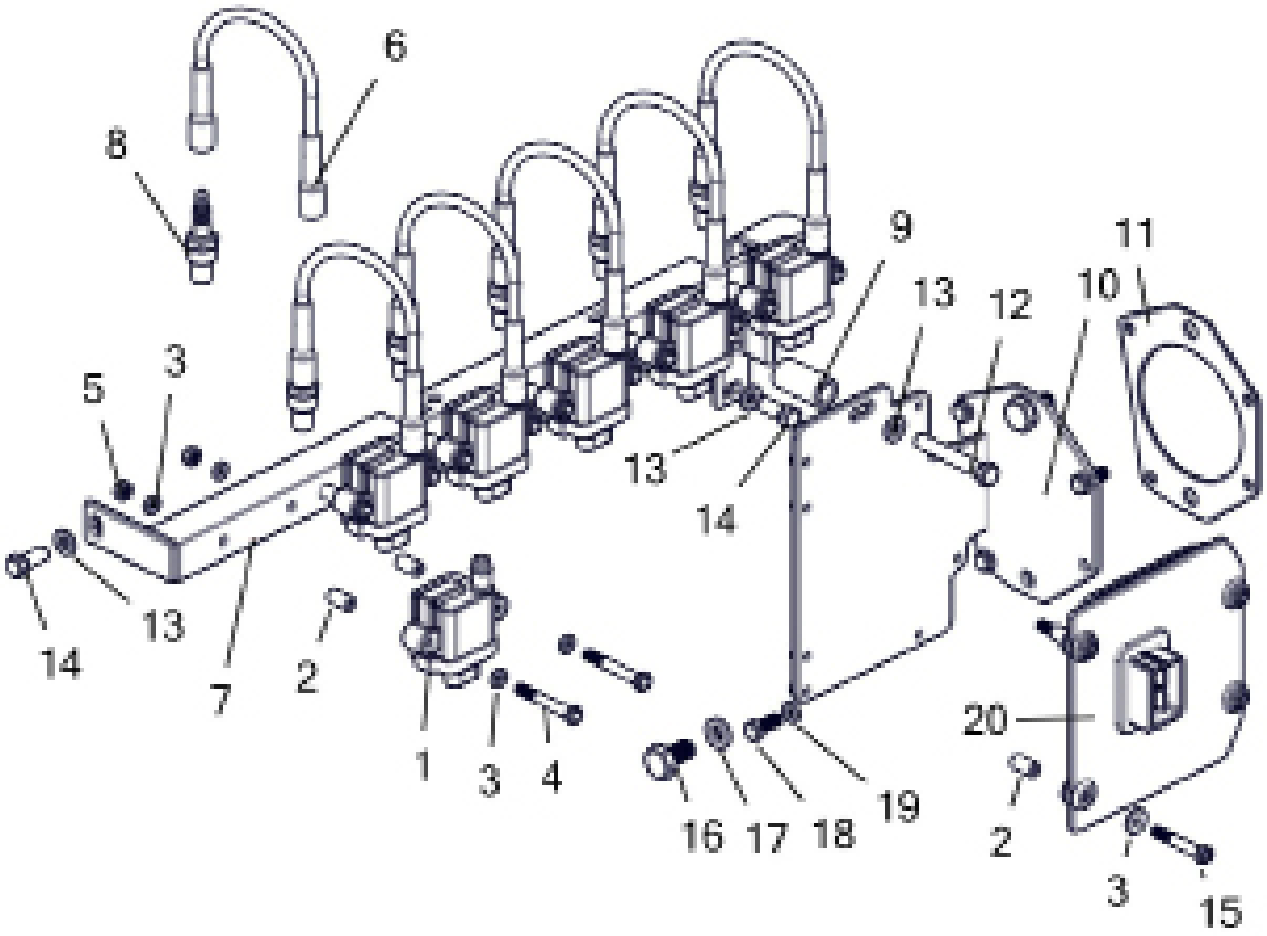
FLYWHEEL HOUSING, STARTER

Item No.	Part No.	Qty.	Flywheel Housing, Starter Description
1	216057F	1	Housing, Flywheel
NS	MSP-675	1	Speed Sensor
2	B9132	2	Pin, Dowel
3	21354	8	Screw, Cap, Hex Head, 3/8-inch–16 X 1 3/8-inch
4	1A-3/8	8	Washer, Lock, 3/8-inch
5	B7042	1	Cover, Timing
6	28650	1	Pin, Roll, 5/64-inch X 1 1/2-inch
7	7A-1/420X5/8	2	Screw, Cap, Hex Head, 1/4-inch–20 X 5/8-inch
9	69754A	1	Starter (Standard)
9A	60963D	1	Heavy-duty Starter (Optional)
9B	69754B	1	24 Volt Starter (Optional)
10	7A-3/816X1	3	Screw, Cap, Hex Head, 3/8-inch–16 X 1-inch
10A	21350	1	Screw, Cap, Hex Head, 3/8-inch–1 1/8-inch (Unit)
12	1A-3/8	3	Washer, Lock, 3/8-inch
NS	X-7441-A	1	Handle, Clutch, for use with CO_3 Actuator
NS	6625-A	1	Single Disc Drive Ring, 11-inch
NS	SP-111-HP-3	1	Single Disc Clutch, 11-inch, 2 1/4-inch Shaft
NS	X6931	1	Two Disc Drive Ring, 11-inch, 2 1/2-inch Shaft
NS	102540F	1	Two Disc Clutch, 11-inch
NS	9101	1	Starter Cable Set



ROCKER ARMS AND COVER

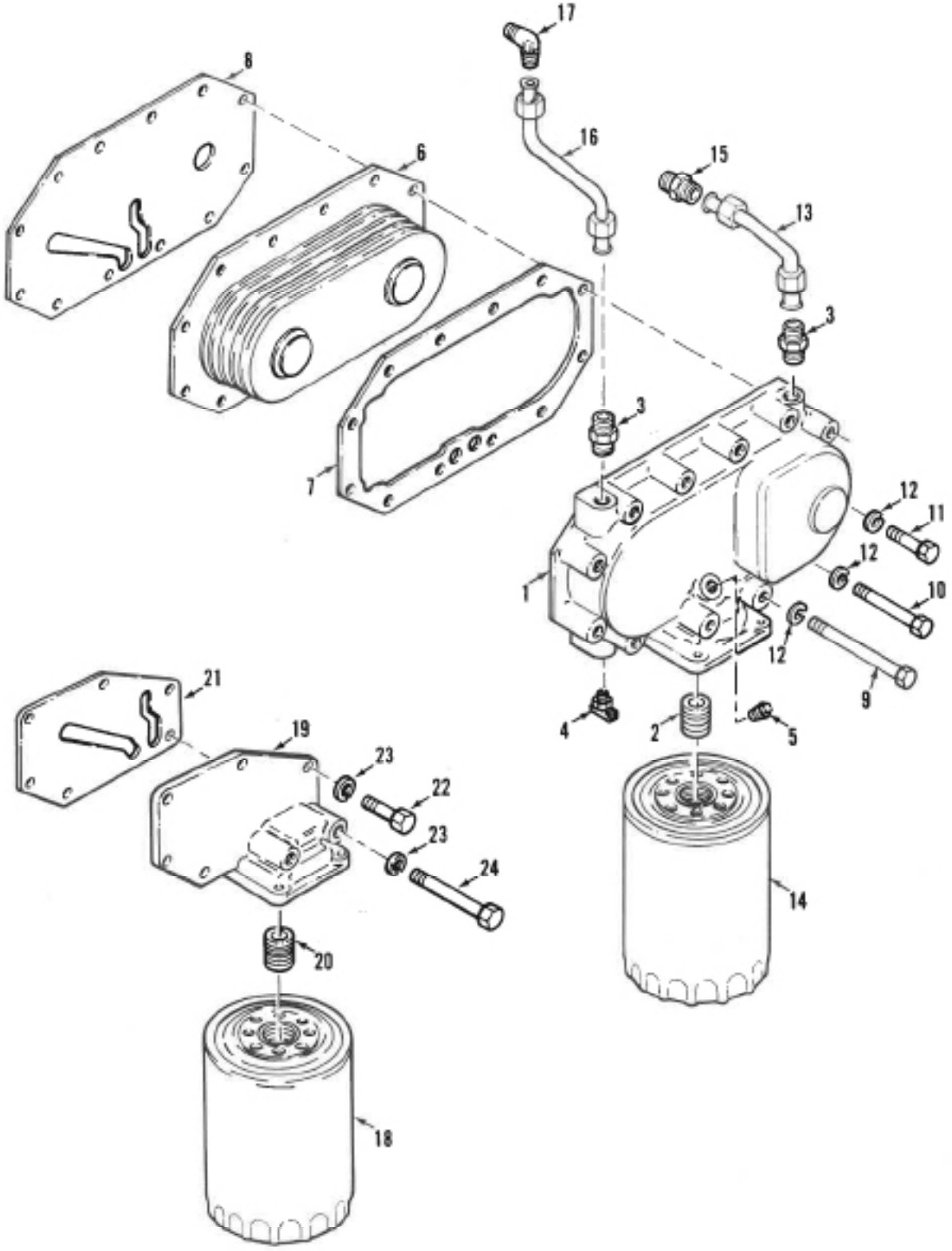
Item No.	Part No.	Qty.	Rocker Arms, Rocker Arm Cover Description
	DA217069	1	Shaft, Rocker Arm Assembly
1	217069	1	Shaft, Rocker Arm
2	B2857	2	Plug, Cup
3	216068	6	Support, Rocker Arm
4	216066A	6	Arm, Rocker-right-hand (Intake # 1, 2, and 3, Exhaust # 4, 5, and 6)
5	120860	6	Screw, Adjusting
6	21195	6	Nut, Thin Hex, 3/8-inch–24
7	216065A	6	Arm, Rocker-left-hand (Exhaust # 1, 2, and 3, Intake # 4, 5, and 6)
8	120860	6	Screw, Adjusting
9	21195	6	Nut, Thin Hex, 3/8-inch–24
10	73888	4	Spring
11	76898	4	Cotter, Rocker Arm Shaft
12	7A-3/816X31/2	6	Screw, Cap, Hex Head, 3/8-inch–16 X 3-1/2-inch
13	1A-3/8	6	Washer, Lock, 3/8-inch
14	A166009F	1	Tube, Oil
15	73017A	1	Connector, Inverted
16	73018A	1	Elbow, Inverted
17	217139E	1	Cover, Rocker Arm (Less Oil Filler Provision)
18	208615	1	Gasket, Rocker Arm Cover
19	21291	12	Screw, Cap, Hex Head, 1/4-inch–20 X 2-inch
20	1N-1/4	12	Washer, Plain, 1/4-inch
21	B4296	1	Cap, Oil Filter
22	176412	1	Gasket, Oil Filler Cap



COIL BAR/ELECTRICAL

Coil Bar/Electrical

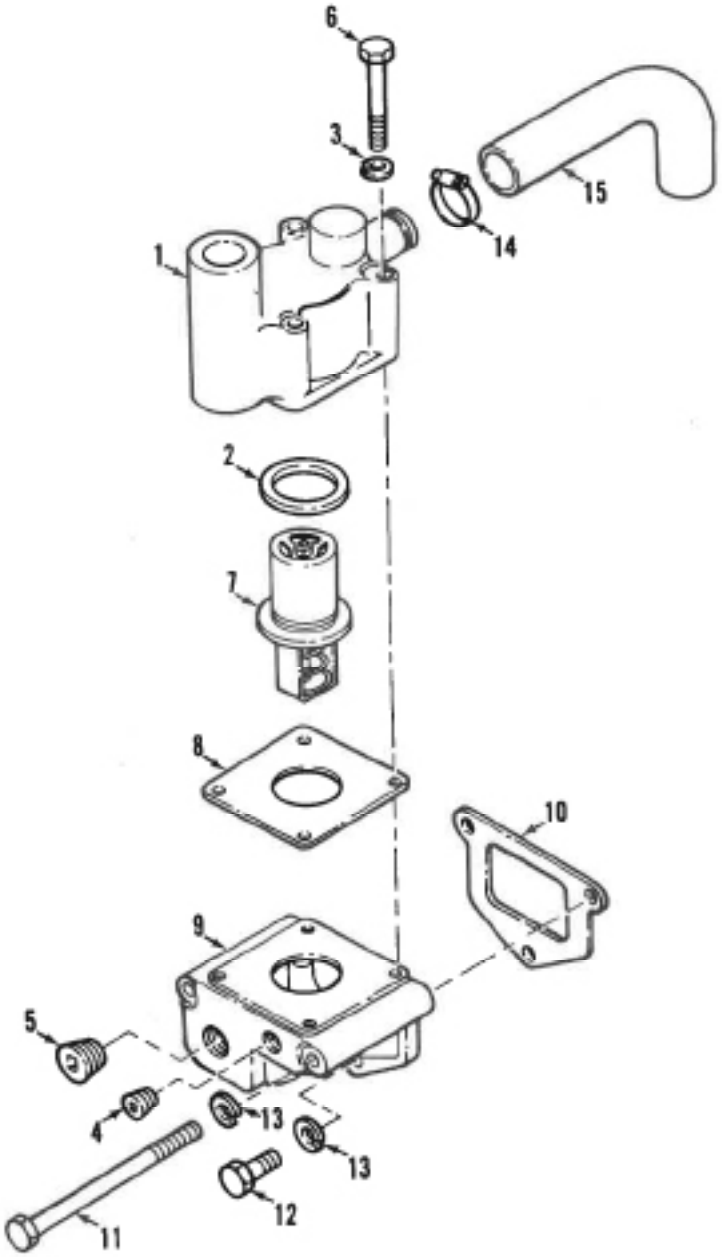
Item No.	Part No.	Qty.	Description
1	WD06000	6	Coil Ignition 12V Smart
2	SPACER-EMC-COIL	16	Spacer for ECS Unit
3	1N-1/4	28	Washer Flat SAE-plated
4	7A-1/420x21/4	12	Cap Screw Hex Head
5	29A-1/420	12	Nut Hex Finished Zinc-plated
6	WR06001	6	Wire Spark Plug
7	208391K	1	Bracket Coil Mounting (Zinc-plated)
8	69462	6	Spark Plug High Resistance
9	217067CD-S	1	Spacer Ignition Bracket
10	217067D	1	Bracket Ignition Integrated
11	208643	1	Gasket, Adapter Plate
12	21369	1	Cap Screw Hex Head
13	1N-3/8	3	Washer Flat SAE-plated
14	29605	2	Cap Screw Hex Head
15	21291	4	Cap Screw Hex Head, 7A-1/4 X 1-3/4
16	7A-1/213X1	2	Screw, Hex Head 1/2-13 X 1.00
17	1N-1/2	2	Washer Flat SAE-plated
18	7A-5/1618X7/8	4	Cap Screw Hex Head
19	1N-5/16	4	Washer Flat SAE-plated
20*	WD06002-A54E	1	ECM, SECM 70, program before shipping
21	69462	6	Spark Plug
* **NOTE:** Use Part No. WD06002-A54E, Programmed Unit.			



OIL FILTER AND COOLER

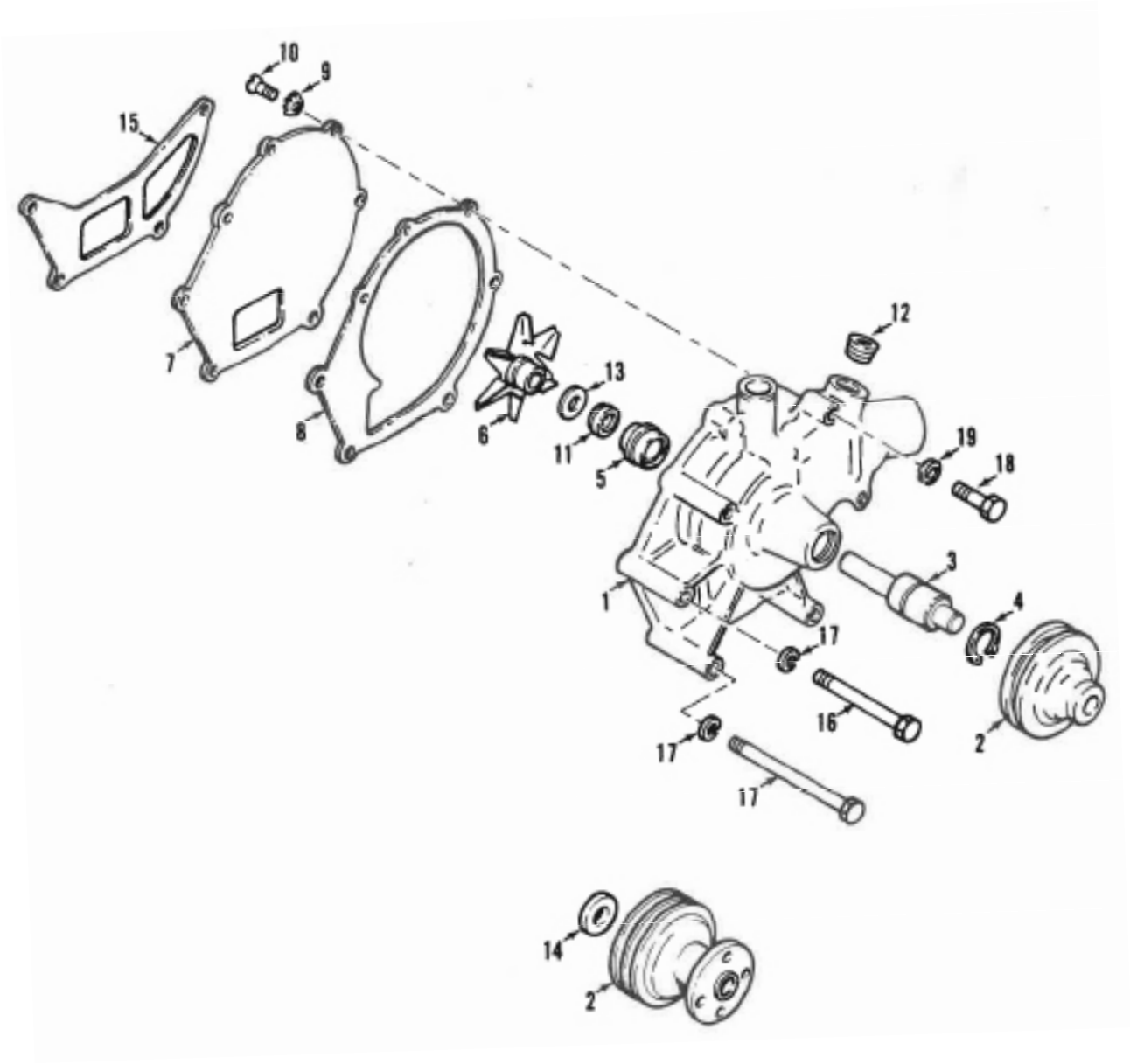
Oil Filter, Oil Cooler (Optional)

Item No.	Part No.	Qty.	Description
	A216055B	1	Cover, Oil Cooler–Assembly
1	216055B	1	Cover, Oil Cooler
2	199983B	1	Adaptor, Lube Oil Filter Element
3	164717E	2	Connector, Flex
4	73413A	1	Cock, Drain
5	78282C	1	Plug, Pipe, Square Head, 1/4-inch
5A	PF4-1/4		
6	208581	1	Element, Oil Cooler
7	208613	1	Gasket, Oil Cooler Cover
8	208614	1	Gasket, Oil Cooler
9	7A-3/816X31/2	2	Screw, Cap, Hex Head, 3/8-inch–16 X 3 1/2-inch
10	7A-3/816X21/2	9	Screw, Cap, Hex Head, 3/8-inch–16 X 2 1/2-inch
11	21350	1	Screw, Cap, Hex Head, 3/8-inch–16 X 1 1/8-inch
12	1A-3/8	12	Washer, Lock, 3/8-inch
13	AA208645A	1	Braided Hose, Water Inlet (New Style) Does Not Need Item Nos. 2,14
14	199982		Element, Oil Filter
15	164717E	1	Connector, Flex
16	AA208645	1	Braided Hose, Water Inlet (New Style) Does Not Need Item Nos. 2,16
17	16724F	1	Elbow, Flex–Brass
NS	199111D		Elbow, Flex–Brass
18	162709A	1	Element, Lube Oil Filter
19	C216155	1	Base, Lube Oil Filter–Assembly (Less Oil Cooler)
19A	216155	1	Base, Lube Oil Filter, Small
19B	5105HW	1	Base, Lube Oil Filter, Larger
20	199983B	1	Adaptor, Lube Oil Filter Element, Small
20A	199983T	1	Adaptor, Lube Oil Filter Element, Larger
20B	199983	1	Adaptor, Lube Oil Filter Element, Larger, Hex Head
20C	HW216255	1	Adaptor, Lube Oil Filter Element, Large
20D	208847	1	Adaptor, Lube Oil Filter Element, Remote Filter
21	208591	1	Gasket, Filter Base
21A	208848	1	Gasket, Filter Base, Remote Filter
NS	118013	1	O-ring, Remote Filler
22	21350	5	Screw, Cap, Hex Head, 3/8-inch–16 X 1 1/8-inch
22A	28651	4	Bolt, Remote Filter
23	1A-3/8	7	Washer, Lock, 3/8-inch
23A	1A-1/4	4	Washer, Lock
24	21369	2	Screw, Cap, Hex Head, 3/8-inch–16 X 3-inch



THERMOSTAT HOUSING

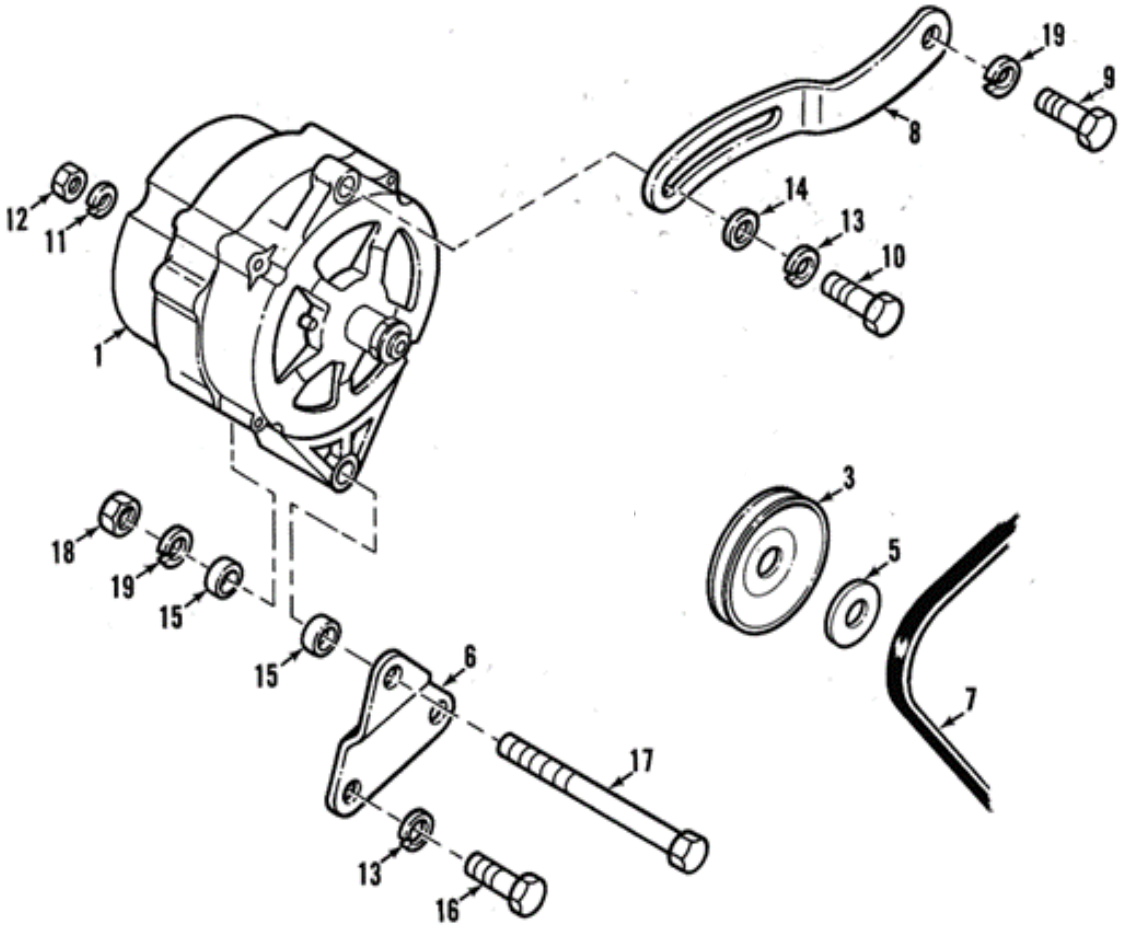
Item No.	Part No.	Qty.	Thermostat Housing Description
	AA216078	1	Housing, Thermostat–Assembly
1	216078	1	Housing, Thermostat
2	199175A	1	Seal, Thermostat
3	1A-5/16	4	Washer, Lock, 5/16-inch
4	21951	1	Plug, Pipe, Countersunk Headless, 3/8-inch
5	78283A	1	Plug, Pipe, Countersunk Headless, 1/2-inch
6	21324	4	Screw, Cap, Hex Head, 5/16-inch–18 X 2-3/4-inch
7	208622	1	Thermostat 175°F (79°C)
7A	208622A	1	Thermostat 190°F (88°C) (Optional)
8	208593	1	Gasket, Thermostat Housing
9	216077	1	Adaptor, Thermostat Housing
10	208592	1	Gasket, Water Outlet
11	21374	2	Screw, Cap, Hex Head, 3/8-inch–16 X 4-1/4-inch
12	7A-3/816X1	1	Screw, Cap, Hex Head, 3/8-inch 16 X 1-inch
13	1A-3/8	3	Washer, Lock, 3/8-inch
14	41236G	2	Clamp, Hose
15	208576A	1	Hose, Bypass
NS	26411	1	Socket, Plug, Pipe, HD 3/8-inch



WATER PUMP

Water Pump

Item No.	Part No.	Qty.	Description
	D216160C-A54	1	Pump, Water–Assembly (Water Pump-mounted Fan)
1	216160C	1	Body, Water Pump
2A	216194A	1	Pulley, Water Pump (Water Pump-mounted Fan)
3	208621C	1	Shaft/Bearing, Water Pump
4	44999R	1	Ring, Retaining
5	120320E	1	Seal, Water Pump
	120320MT	1	Tool for Unitized Mechanical Seal 120320M
6	220163	1	Impeller, Water Pump
7	216061	1	Cover, Water Pump
8	208625A	1	Gasket, Water Pump Cover
9	21842	3	Washer, External Shakeproof, 1/4-inch
10	28654	3	Screw, Flat Head, 1/4-inch–20 X 7/16-inch
11	161647B	1	Seat, Water Pump Seal
12	78283J	1	Plug, Pipe, Contersunk Headless–Plated, 1/2-inch
13	211345	1	Spacer, Impeller
14	153312A	1	Seal, Dust (Water Pump-mounted Fan)
15	208624	1	Gasket, Water Pump
17	21370	2	Screw, Cap, Hex Head, 3/8-inch–16 X 3 1/4-inch (Bracket-mounted Fan)
17A	7A-3/816X21/4	2	Screw, Cap, Hex Head, 3/8-inch–16 X 2 1/4-inch (Water Pump-mounted Fan)
18	7A-3/816X31/2	2	Screw, Cap, Hex Head, 3/8-inch–16 X 3 1/2-inch (Bracket-mounted Fan)
18A	21369	2	Screw, Cap, Hex Head, 3/8-inch–16 X 3-inch (Water Pump-mounted Fan)
19	7A-3/816X1	2	Screw, Cap, Hex Head, 3/8-inch–16 X 1-inch (Bracket-mounted Fan)
KITS			
23	960-254	1	Water Pump Repair Kit (Water Pump Assembly D216060A) Includes Item Nos. 2, 4, 5, 6–9, 11, 13
	960-255	1	Water Pump Repair Kit (Water Pump Assembly D216160B) Includes Item Nos. 2, 4, 5, 6–9, 11, 13

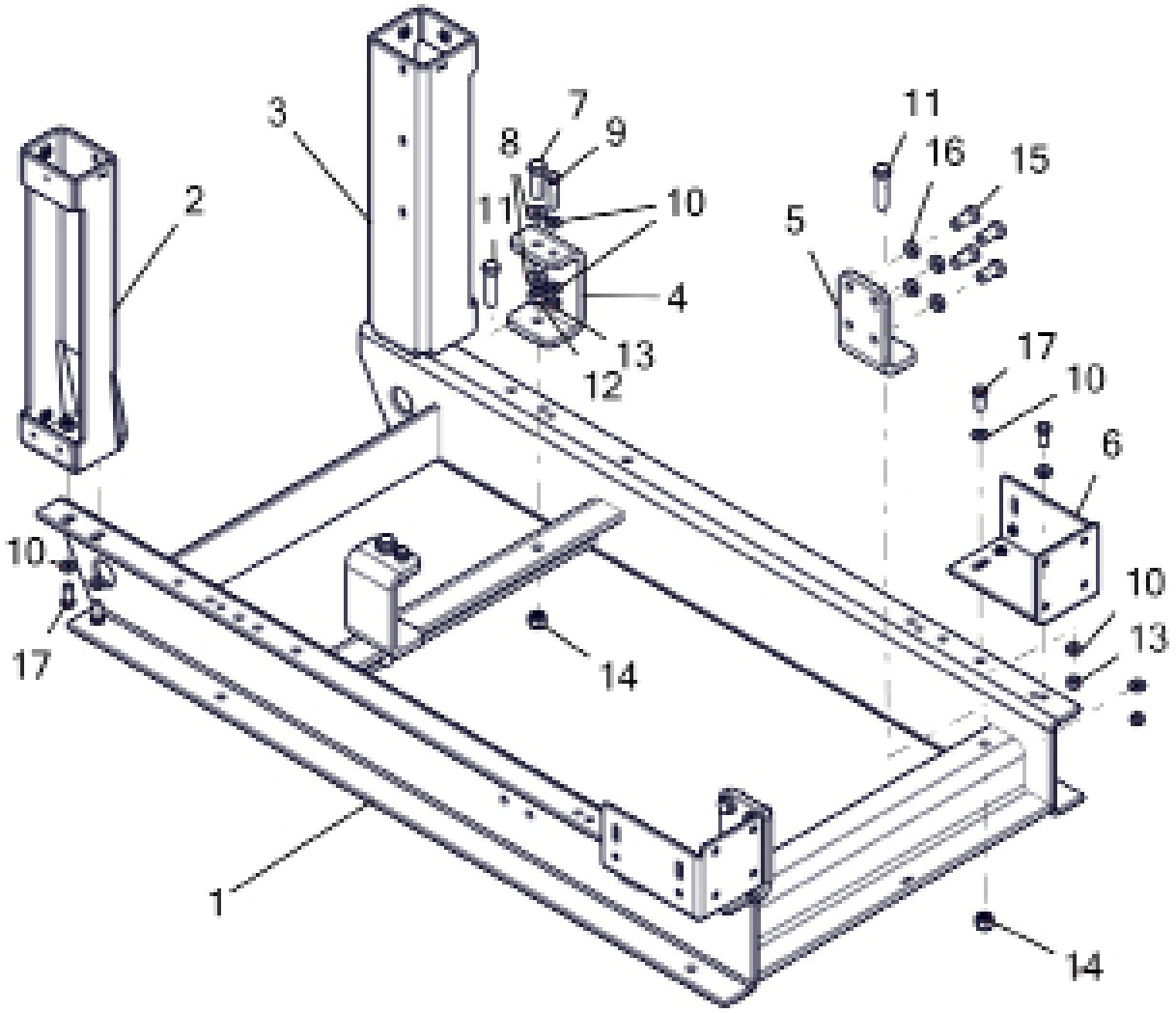


ALTERNATOR

Item No.	Part No.	Qty.	Alternator Description
1	69753LV	1	Alternator (Standard)
1A	24V ALT	1	Alternator, 24-volt (Optional)
3	216096E	1	Pulley, Alternator (Bracket-mounted Fan)
4	216096F	1	Collar, Alternator Pulley (Bracket-mounted Fan)
5	154084	1	Spacer (Bracket-mounted Fan)
6	216073	1	Bracket, Alternator Mounting
7	154337	1	Belt, Alternator (Bracket-mounted Fan)
7A	A154337	1	Belt, Alternator (Set of Two Belts, Water Pump-mounted Fan)
8	199094C	1	Strap, Adjusting (Bracket-mounted Fan)
8A	199094D	1	Strap, Adjusting (Water Pump-mounted Fan)
9	7A-3/816X1/2	1	Screw, Cap, Hex Head, 3/8-inch–16x5/8-inch (Bracket-mounted Fan)
9A	7A-3/816X1	1	Screw, Cap, Hex Head, 3/8-inch–16x1-inch (Water Pump-mounted Fan)
10	7A-5/1618X3/4	1	Screw, Cap, Hex Head–Plated M8x5/16-inch–18 X 3/4-inch
11	1A-3/8	1	Washer, Lock, 3/8-inch
12	29A-3/816	1	Nut, Hex, 3/8-inch–16
13	1A-5/16	3	Washer, Lock, 5/16-inch
14	1N-5/16	1	Washer, Plain, 5/16-inch
15	63809X	2	Spacer
16	7A-5/1618X3/4	2	Screw, Cap, Hex Head, 5/16-inch–18x3/4-inch
17	21370	1	Screw, Cap, Hex Head, 3/8-inch–16x3 1/4-inch
18	29A-3/816	1	Nut, Hex, 3/8-inch-16
19	1A-3/8	2	Washer, Lock, 3/8-inch

THIS PAGE INTENTIONALLY LEFT BLANK

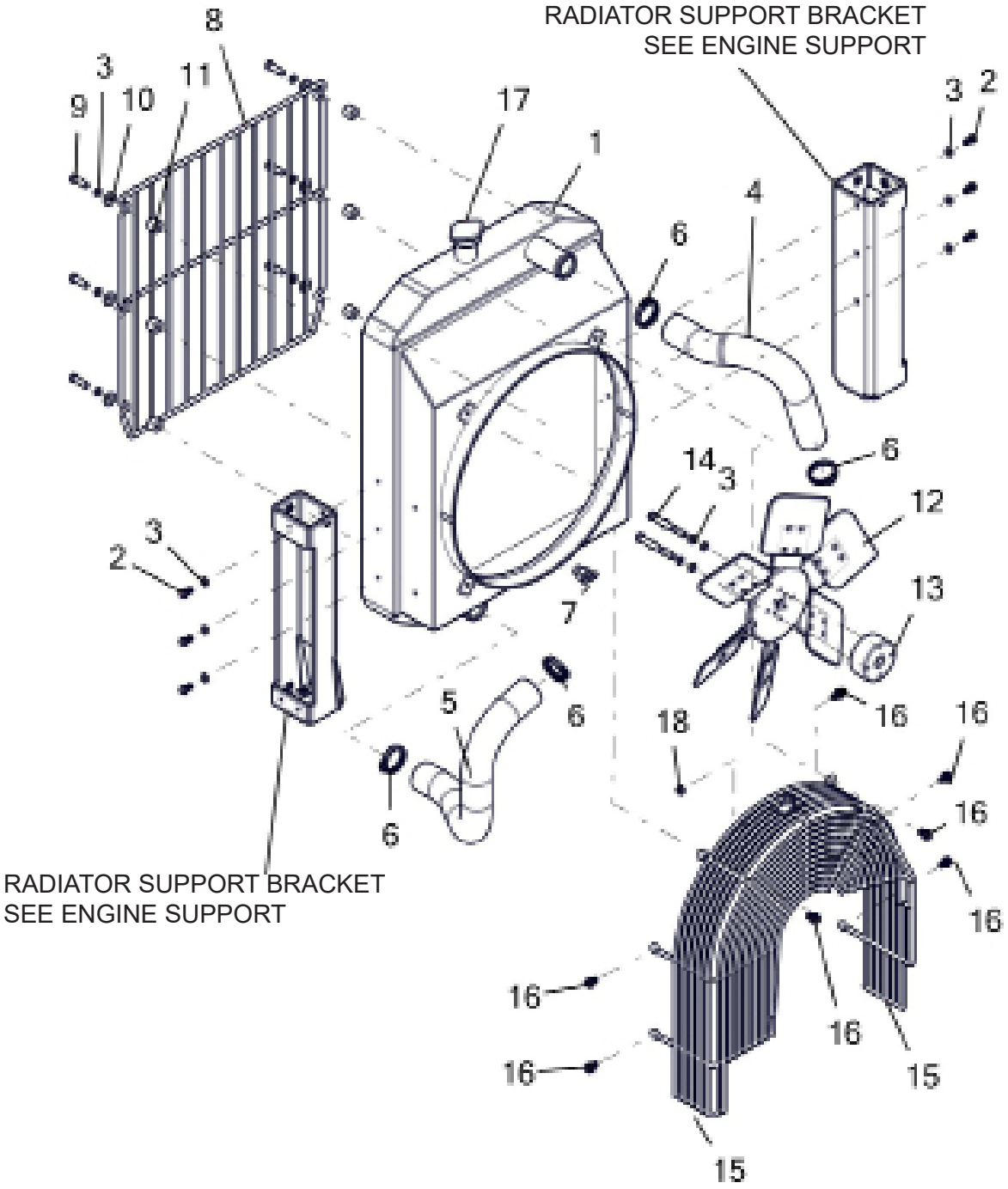
THIS PAGE INTENTIONALLY LEFT BLANK



ENGINE SUPPORT

Engine Support

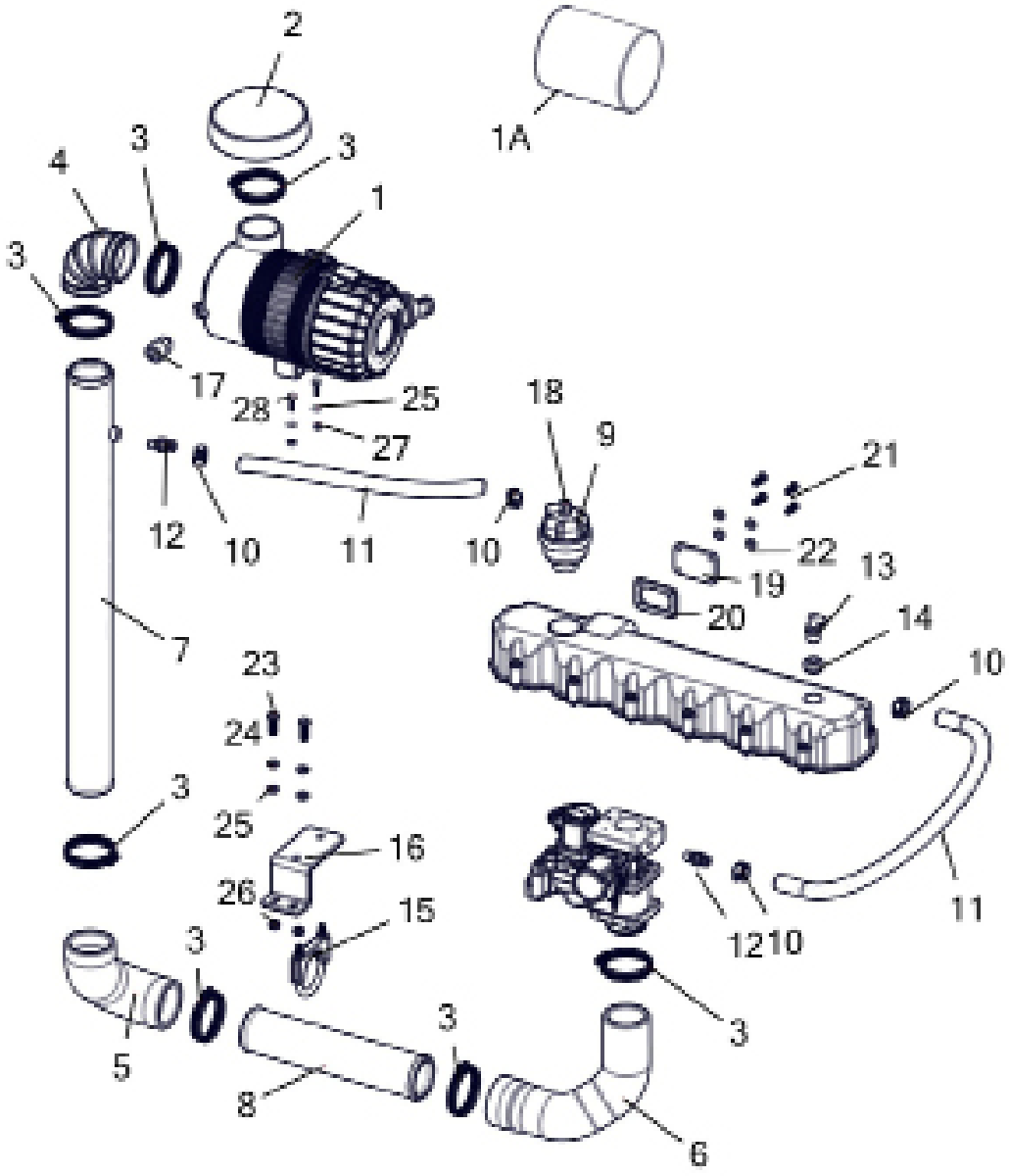
Item No.	Part No.	Qty.	Description
1	209015B	1	Sub-Base, Engine, Support
2	WR08006	1	Bracket Support Rad left-hand
3	WR08005	1	Bracket Support Rad right-hand
4	209018B	2	Support Engine Front right-hand and left-hand
5	209020A	2	Support Engine Rear
6	WR08002	2	Bracket Sheet Metal Rear
7	7A-1/2 13X13/4	2	Cap Screw Hex Head
8	1N-1/2	4	Washer Flat SAE-plated
9	7A-3/8 16X13/4	2	Cap Screw Hex Head
10	1B-3/8	16	Washer Flat standard
11	21437	4	Cap Screw, Hex Head 1/213X2-1/4 Plain
12	29A-1/213	2	Nut Hex Finished
13	29A-3/816	2	Nut Hex Finished
14	1199537	2	Nut, Stop 1/213X17/32-plated
15	26248	8	Cap Screw, Hex Head 1/213X1-1/8
16	1A-1/2	8	Lock washer-plated
17	7A-3/816X11/4	8	Cap Screw Hex Head



RADIATOR, SAFETY GUARDS

Radiator, Safety Guards

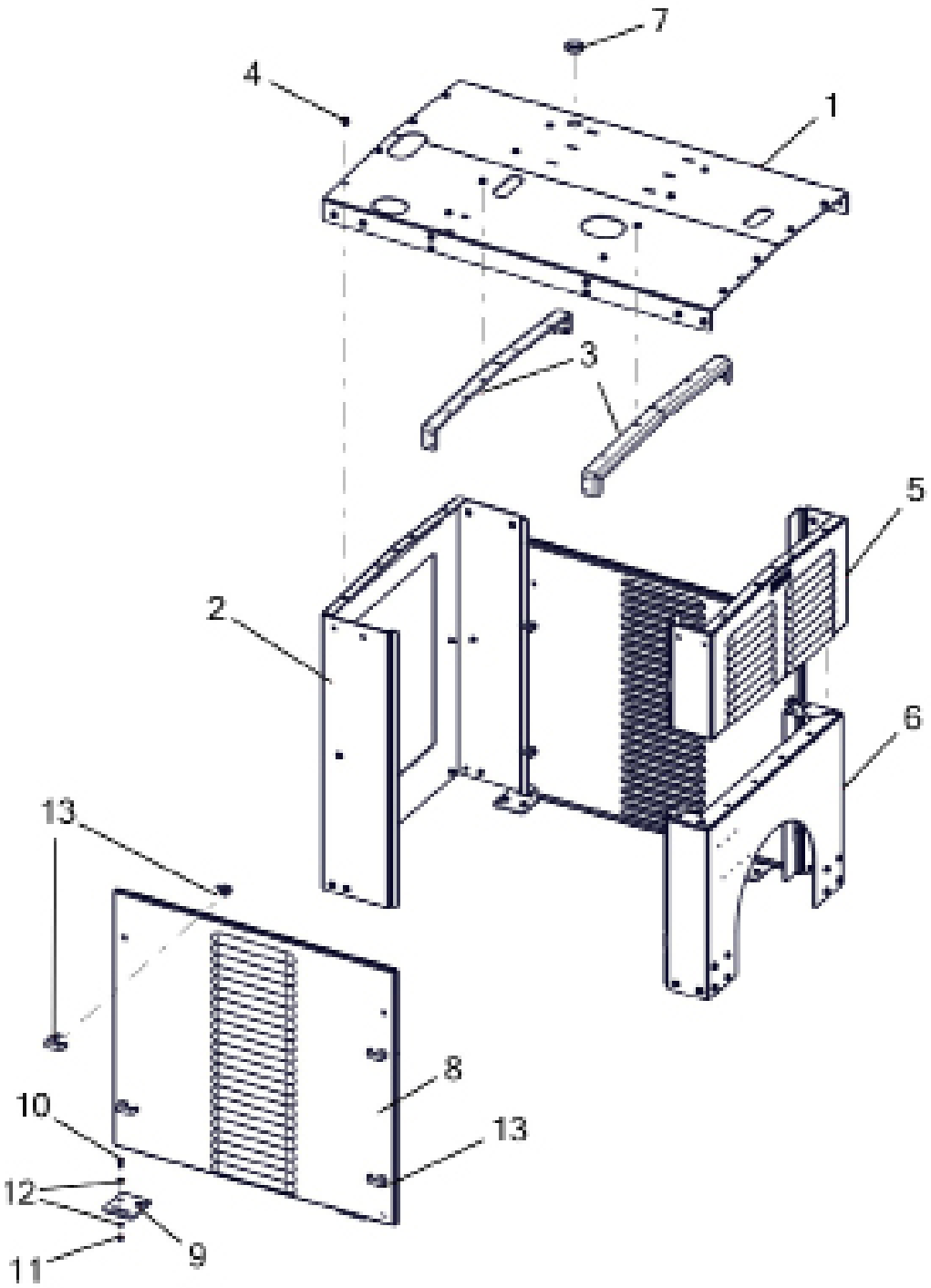
Item No.	Part No.	Qty.	Description
1	208771D	1	Radiator, Soldered, Aluminum Style
	208771C	1	Radiator, Bolted (optional)
	208771G	1	Gasket for Top Tank (optional for bolt tank)
2	7A-5/1618X1	6	Screw, Cap, Hex Head, 5/16-inch–18 X 1-inch
3	1A-5/16	16	Washer, Lock, 5/16-inch
4	208773	1	Hose, Upper Radiator
5	208774	1	Hose, Lower Radiator
6	41236C	4	Clamp, Hose
7	76400	1	Cock, Drain
8	208750	1	Guard, Radiator Core
9	26249	6	Screw, Cap, Hex Head, 5/16-inch–18 X 1-3/8-inch
10	159447C	6	Washer, Plain, 11/32-inch
11	80139B	6	Spacer
12	209027-NS	1	Blade, Fan (20-inch Suction)
	209026-NS	1	Blade, Fan (20-inch Pusher)
13	207973A	1	Spacer, Fan Blade, 1-17/32-inch
14	7A-5/1618X2	4	Screw, Cap, Hex Head, 5/16-inch–18 X 2-inch
15	A208926B	1	Guard, Fan Assembly, 2-piece
	A208926B-A54	1	Guard, Fan Assembly, for A54
16	28470	7	Screw, Cap, Hex Head, 5/16-inch–18 X 5/8-inch Whiz-lock
17	207945	1	Cap, Radiator, Heavy
18	29A-5/1618	1	Nut, Hex Heavy 5/16-18
19		1	Overflow Hose



PCV SYSTEM AND AIR CLEANER

PCV System and Air Cleaner

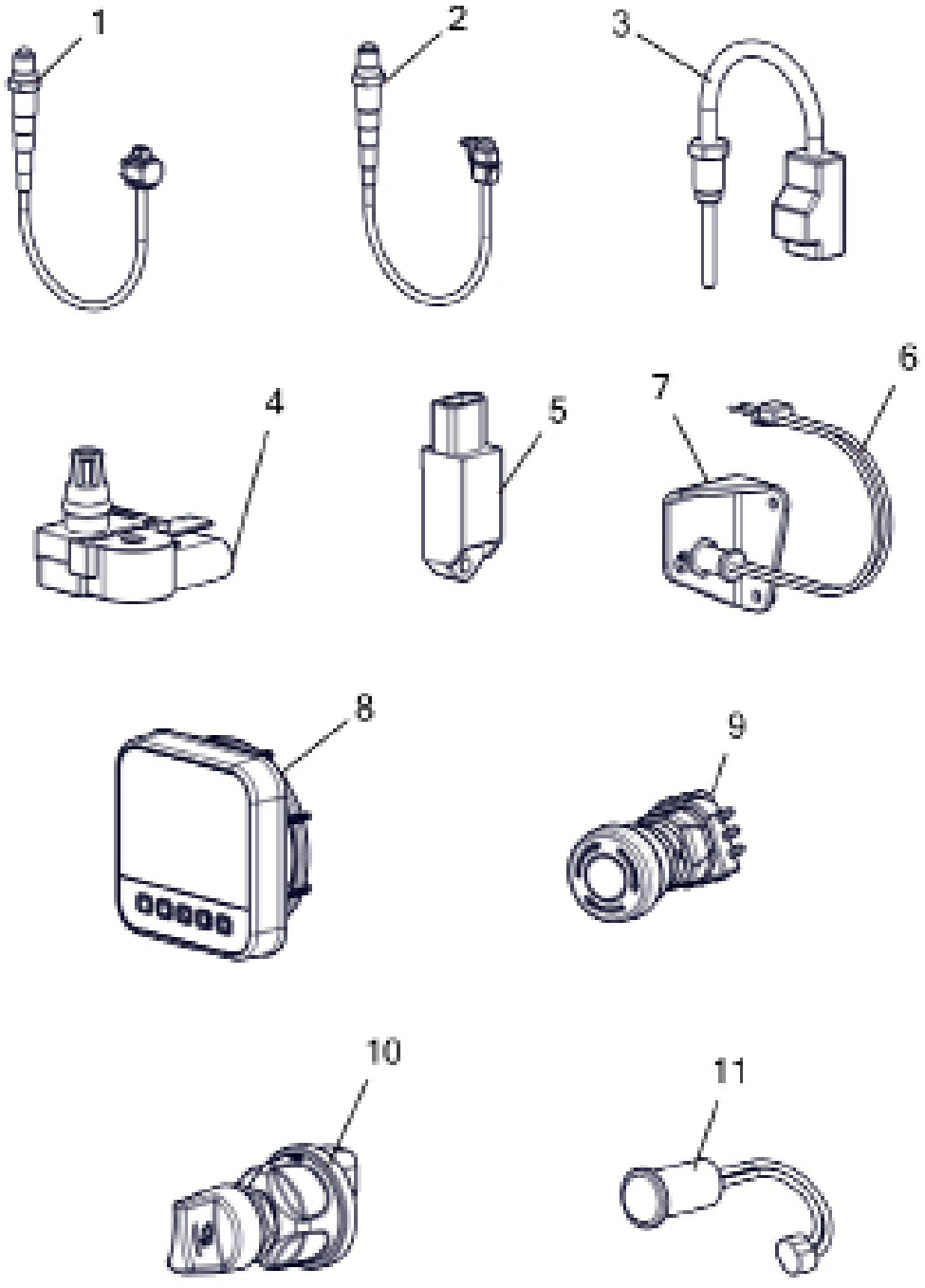
Item No.	Part No.	Qty.	Description
1	KB50019	1	Air Cleaner Assembly
1A	KB50021	1	Element, Replacement Air Filter, New 5-inch H20, Dirty 15-inch H20
2	KB17002	1	Rain Cap
3	41236A	7	Clamp, Hose 3.06-4.0 inch
4	WR05001	1	Hose, Air Cleaner Inlet to Upper Tube
5	WR05002	1	Hose, air Cleaner Inlet to Upper Tube
6	WR05003	1	Hose Mixer to Lower Air Intake Tube
7	WR05007	1	Tube, Upper, Intake Air with Weldment
8	WR05004	1	Tube Lower Intake Air
9	244-BCP	1	Breather Valve Cover Assembly
10	WR07000	4	Clamp, Hose 5/16-inch
11	WR05008	AR	Hose, 3/8-inch Rubber
12	KCN-1/4X3/8	2	1/4 NPT Barbed Brass Fitting
13	WR50011	1	Valve, PCV
14	244-GROM	1	Grommet for PCV Valve for Breather
15	4R07000	1	Clamp 3-inch Exhaust
16	WR08016	1	Bracket Intake Tube Clamp
17	153789	1	Indicator Restriction (optional)
18	WR18000	1	Fitting Brass 1/2-inch X 3/8-inch (90)
19	164822P	1	Block-off Plate
20	199412A	1	Gasket, Block-off Plate
21	7A-3/816X11/4	4	Cap Screw Hex Head, 1/4-20 x 7/8
22	1N-1/4	4	Bolt Hex Head
23	7A-3/816X11/4	2	Cap Screw Hex Head 3/8-16 x 1-1/4
24	1A-3/8	2	Lock Washer 3/8
25	1B-3/8	6	Flat Washer Standard
26	29A-3/816	2	Nut Hex Finished
27	28473	2	Nut for small flange Whiz-lock bolts
28	28470	2	Screw, Flange Whiz-lock



SHEET METAL

Sheet Metal

Item No.	Part No.	Qty.	Description
1	WR50004	1	Shell Hood Panel
2	WR5005	1	Shell Radiator Panel
3	WR08007	2	Brace Hood
4	28470	64	Screw, Flange Whiz-lock
5	WR50022	1	Shell, Clutch Panel, Rear Upper
6	WR50023	1	Shell, Clutch Panel, Rear Lower
7	WR16001	1	Grommet Hood
8	WR50007	2	Door Side Panel
9	WR08013	4	Bracket, Door Support
10	7A-5/16 18x7/8	8	Cap Screw Hex Head
11	29A-5/16 18	8	Nut Hex Finished Heavy Zinc-plated
12	1N-5/16	16	Washer Flat SAE-plated
13	208772	8	Latch Grip



SENSOR

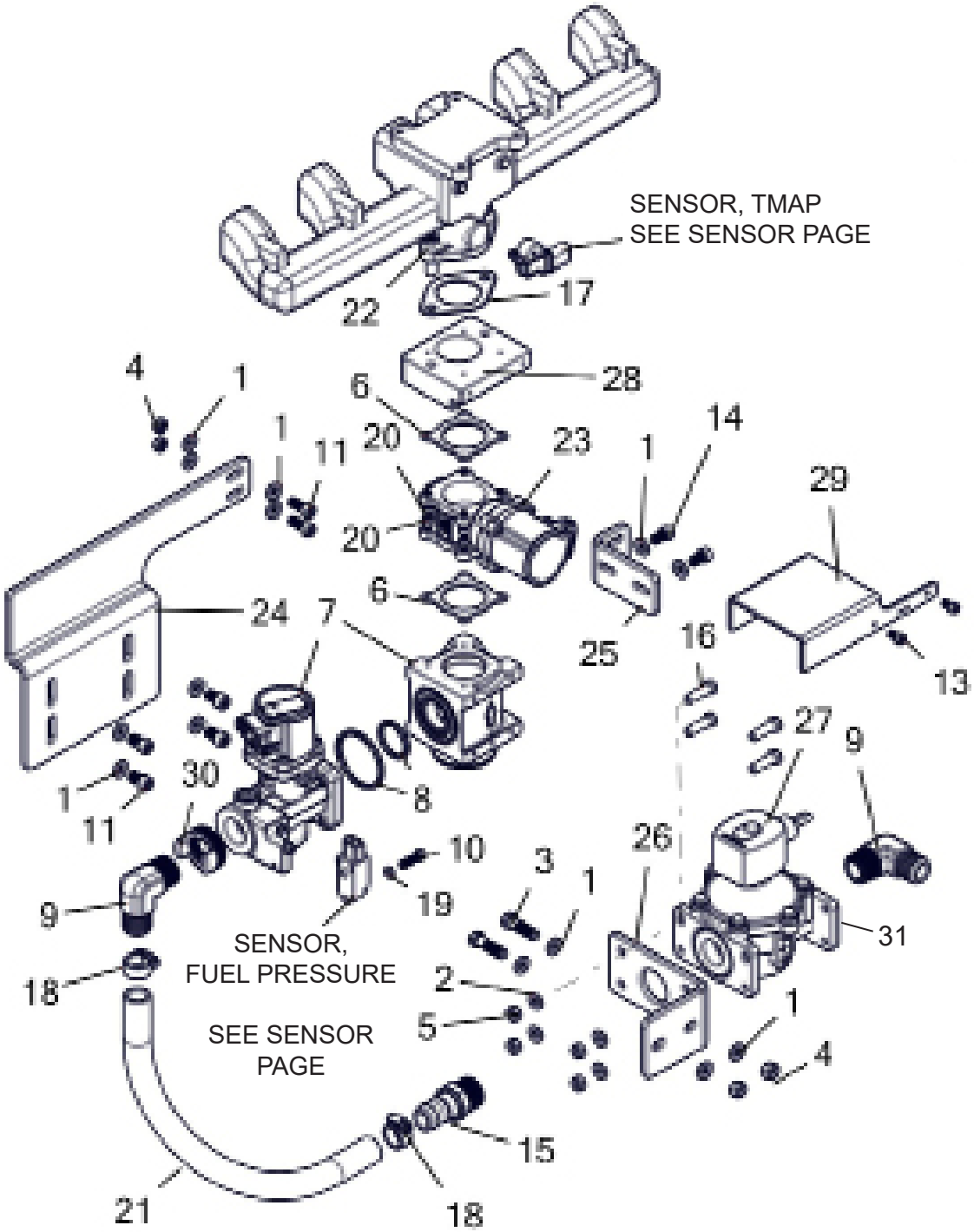
Sensor

Item No.	Part No.	Qty.	Description
1	WD06003	1	Sensor, O_2 Post CAT, torque to 37 ft.-lbs.
2	WD06004	1	Sensor, O_2 Pre CAT, torque to 37 ft.-lbs.
3	WR06000	1	Sensor, Exhaust Temperature
4	WD06005	1	Sensor, Manifold Pressure, TMAP
5	WD06007	1	Kit, Electronic Fuel Regulator, PG+ EFR Pressure Sensor
6	7910151	1	Sensor, RPM (E422F), Magnetic Pickup 3/4-16
7	208512MP	1	Bracket, RPM Sensor
8	WR50025	1	Panel, Control, WR08030 Gasket
9	WR06003	1	E-stop Switch
10	WR06004	1	Switch, Power
11	WR06007	1	Light, Malfunction Indicator Lamp (MIL)
12	TEMP-SENSOR	1	Sensor, Temperature, same as AECS
13	WR18002	1	Damper, Oil
14	WR15000	1	Engine / Wire Harness (not shown)
*	WD06002	1	ECM, SECM 70 Brain Box. Must be programmed before shipping. Use Part No. WD06002-A54E.

ENGINE / WIRE HARNESS

Printed version of schematic is available on foldout page at back of this manual.

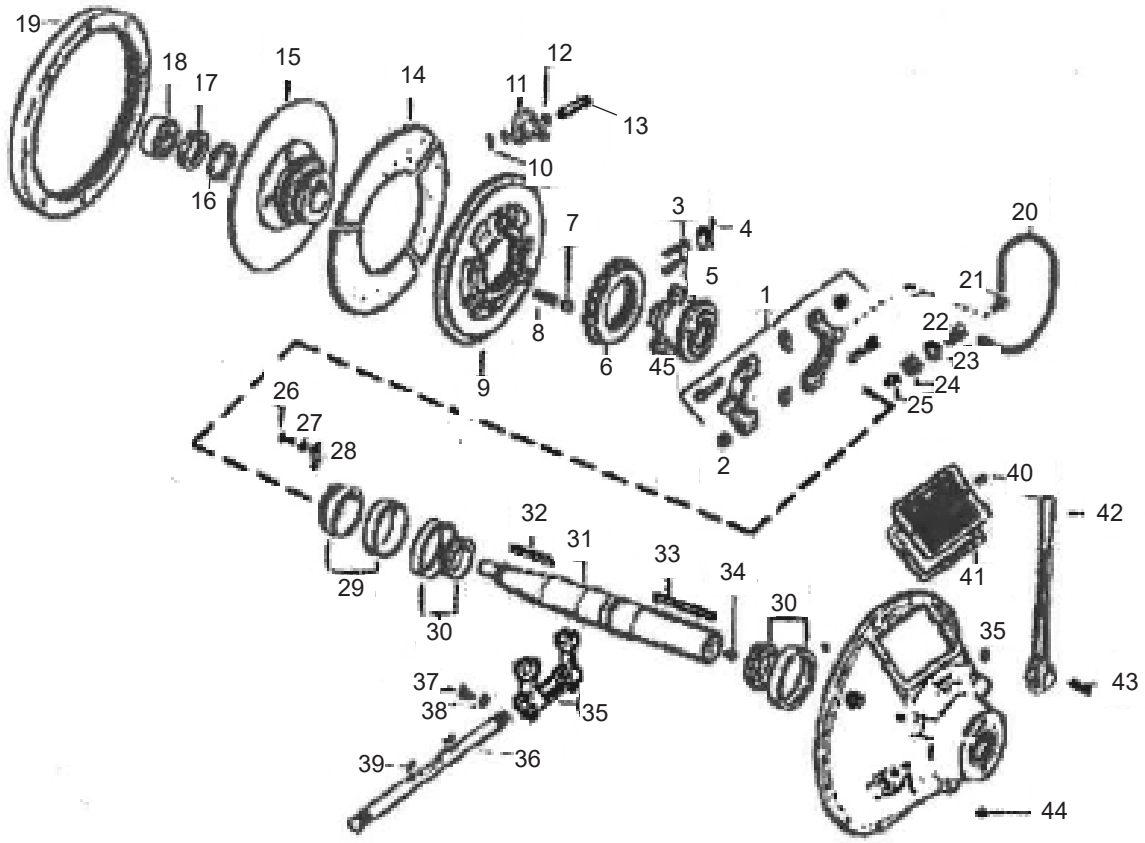
Digital version of schematic is available as a PDF file.


SENSOR, TMAP
SEE SENSOR PAGE
SENSOR,
FUEL PRESSURE
SEE SENSOR
PAGE

FUEL SYSTEM

Fuel System

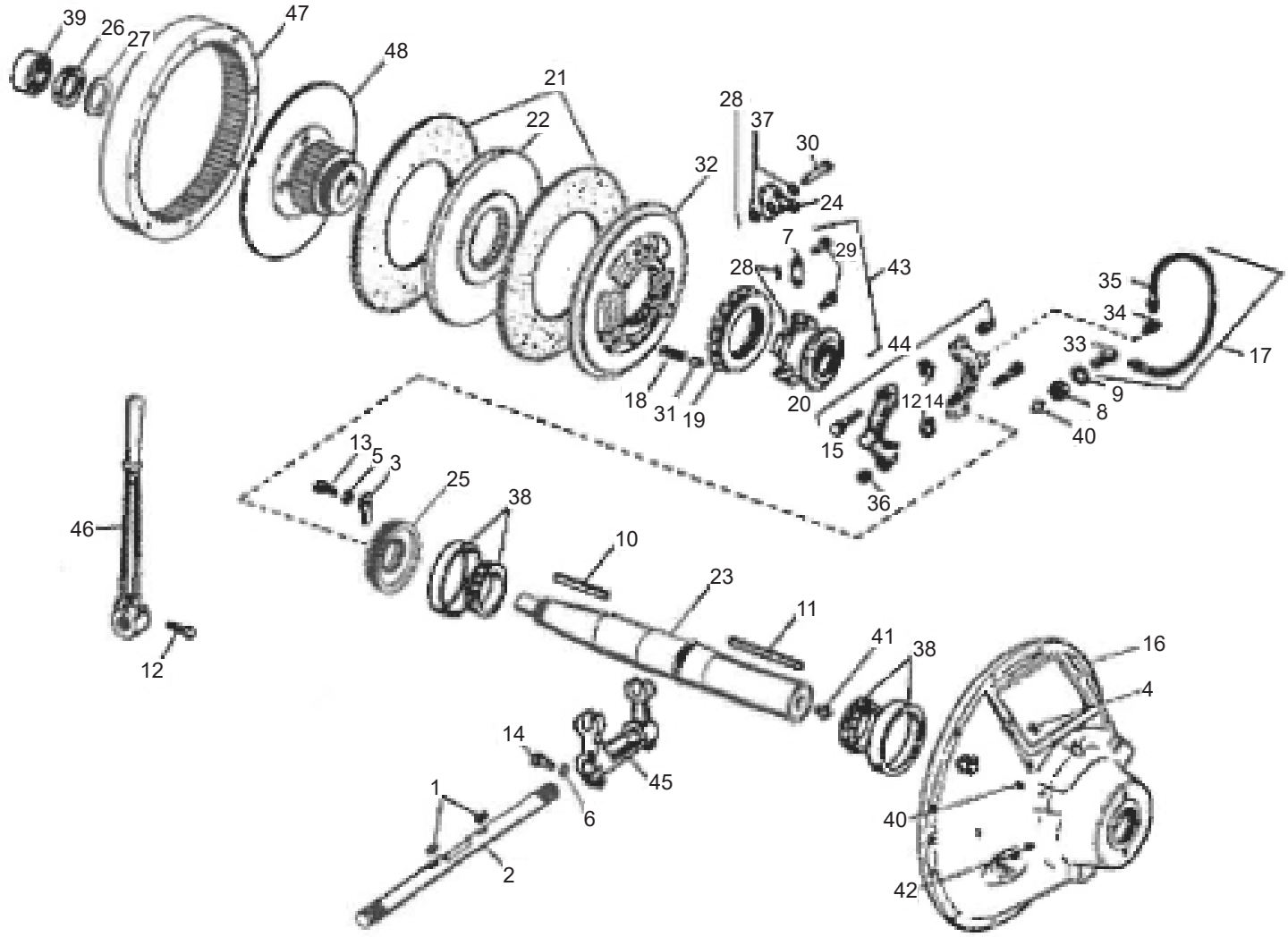
Item No.	Part No.	Qty.	Description
1	1B-3/8	14	Washer, Flat 3/8, Standard
2	1N-5/16	4	Washer, Flat 5/16
3	7A-3/816X11/4	2	Screw, Hex Head 5/16-18 X 1-1/4
4	29A-3/816	4	Nut, Hex 3/8-16
5	29A-5/1618	4	Nut, Hex 5/16-18
6	6343-G	2	Gasket for Woodward Gov.
7	WD06006	1	Valve, 24 mm-270 EFR/70 mm Open Mixer, 8407-732 WD#
8	WD06008	1 Kit	Kit, Mixer Insert O-rings for PG+EFR
9	WR18001	2	Fitting, 90-degree 1-inch Male X 1-inch Hose Barb
10	M6X25	1	Screw, Socket Head M6 X 25
11	9A-3/816X1	4	Cap Screw, Socket Head
12	M8X22	2	Screw, Socket Head 8 X 22
13	M6X16	2	Cap Screw, Hex Head
14	M8X20S	2	Screw, Socket Head M8 X 20S
15	KCN-1	1	Fitting, 1-inch NPT X 1-inch Hose Barb Straight
16	7A-5/1618X1	4	Cap Screw, Hex Head
17	G1-23	1	Gasket
18	41236G	2	Clamp, Hose .81-1.75
19	M05FW	1	Washer, Flat M5
20	M5X20S	8	Screw, Socket Head
21	WR05010	AR	Hose, Rubber, 1-inch X 24
22	VRCC5017	2	Screw 12 PT 3/8-16 X 1-3/4
23	WD06001	1	Throttle Body, 50 mm
24	WR080013	1	Bracket Support, Main Fuel System
25	WR08004	1	Bracket Support, Extension Fuel System
26	WR08018	1	Bracket Lock-off
27	WR14001	1	Valve, Propane, Lock-off 12V, with Filter (not shown)
28	WR16000	1	Adaptor, 50mm Throttle Body to Intake
29	WR50000	1	Heat Shield, Fuel System
30	PF9-11/4X1	1	Bushing Pipe
31	WR14000		Valve, Lock-off 12V, Natural Gas (NG), optional, ASCO
32	WR14006	1	NG Filter, 50-micron, 1-inch NPT, optional (not shown)
33	WR14007	1	Kit, Replacement, Natural Gas, optional (not shown)
34	WR14002	1	Vaporizer, Propane, optional (not shown)
35	WR14003	1	Valve, NG, Lock-off 24V, optional (not shown)
36	WR14004	1	Valve, Propane, Lock-off 24V, optional (not shown)
37	WR14005	1	Filter, Replacement, Propane, Lock-off, optional (not shown)



SINGLE PLATE CLUTCH

Single Plate Clutch

Item No.	Part No.	Qty.	Description
1	SP-111-HP-3	1	Clutch Assembly
2	X-117	1	Collar Assembly
3	32A-3/824	2	LockNut
4	2617	1	Lever Link
5	41A-3/32x5/8	8	Roll Pin
6	B-1537-D	8	Lever Link Pin
7	A-4238	1	Adjusting Ring
8	B-1272	1	Adjusting Lock Pin
9	115	1	10-inch Adjusting Lock Spring
10	XB-2343	1	Floating Plate
11	2B-5/32x1/2	4	Tee Head Cotter Pin
12	B-1304	3	Finger Lever
13	M-2115-D	8	Spring Washer
14	B-1538-A	3	Finger Lever Pin
15	A-5579-E	1	3-piece Drive Plate
16	ZA-6505-A	1	Hub, Back Plate Assembly
17	A-1588	1	Lock washer
18	1092	1	Hub Nut
19	M-167	1	10-inch Pilot Bearing
20	6625-A	1	Drive Ring
21	A-1663-A	1	11-inch Hose Assembly
22	M-1292-B	1	Flex Hose
23	M-1284	1	7, 8, 10-inch Fitting
24	M-1283	1	7, 8, 10-inch Fitting
25	2C-5/8	1	Internal Lock washer
26	29D-5/818	1	Jam Nut Finished Hex
27	M-268	2	Lube Fitting-Male
28	7A-5/1618x5/8	1	Cap Screw, Hex Head
29	2C-5/16	1	Internal Lock washer
30	1216-A	1	Bearing Retainer Shaft
31	B-2147	1	10-inch Bearing Spacer
32	M-207	1	10-inch Clutch Bearing
33	A-5188	1	11-inch Clutch Shaft
34	6A-3/8x3/8x21/2	1	Key, Square Ends
35	6A-5/8x5/8x53/8	1	Key, Square Ends
36	M-287	1	7, 8, 10-inch Shaft Fitting
37	X-125-A	1	Throwout Yoke
38	1144-E	1	Operating Shaft
39	7A-3/816x11/2	2	Cap Screw, Hex Head
40	2C-3/8	2	Internal Lock washer
41	104A-#15	2	Woodruff Key
42	12A-1/420x1/2	2	Machine Screw, Round Head
43	ANP-22-A	1	Spec. Plate
44	X-3799	1	7, 8, 10-inch Hand Lever
45	7A-1/213x13/4	1	Cap Screw, Hex Head
46	M-503	1	Grease Fitting Shaft
47	*S-601	1	Sleeve



DOUBLE PLATE CLUTCH

Double Plate Clutch

Item No.	Part No.	Qty.	Description
1	102540F	1	Double Plate Clutch
2	104A-#15	2	Woodruff Key
3	1144-F	1	10-inch Operating Shaft
4	1216	1	Bearing Retainer Lock
5	12A-1/420x1/2	2	Round Head Screw
6	1A-1/4	1	Lock Washer
7	1A-3/8	2	Lock Washer
8	2617	6	Lever Link
9	29D-5/818	1	Jam Nut
10	2C-5/8	1	Lock Washer
11	6A-3/8x7/8x21/2	1	Key
12	6A-5/8x5/8x53/8	1	Key
13	7A-1/213x13/4	1	Hex Headed Cap Screw 1/2–13 X 1-3/4
14	7A-1/420x5/8	1	Hex Headed Cap Screw 1/4–20 X 5/8
15	7A-3/816x11/2	2	Hex Headed Cap Screw 3/8–16 X 1-1/2
16	7A-3/824x21/4	2	Hex Headed Cap Screw 3/8–24 X 2-1/4
17	9682	1	Housing #2 SAE
18	9977-A	1	Housing #3 SAE NLA
19	A-1663-A	1	Hose Assembly
20	A-2702-BE	1	Spring (Obsolete)
21	A-4238	1	Adjusting Ring–C-106
22	A-4422	1	Sliding Sleeve (Obsolete)
23	A-5579-E	2	11-inch Driving Plate, 3-Piece
24	A-6690		Center Plate
25	A-6691-AC	1	Clutch Shaft with Keys
26	ANP-22-A	1	Instruction Cover Plate
27	B-1304	3	Finger Lever
28	B-1430	1	Bearing Retainer
29	B-1509-B	1	Hub Nut
30	B-1511-E	1	Lock Washer (Obsolete)
31	B-1537-B	3	Cotter Pin
32	B-1537-D	6	Lever Pin
33	B-1538-A	3	Lever Pin
34	B-2341	1	Adjusting Block Pin
35	HTA-6506-B	1	Floating Plate (Obsolete)
36	M-1283	1	Fitting
37	M-1284	1	Fitting
38	M-1292-B	1	14-inch Flexible Hose
39	M-1930-F	2	Hex Nut
40	M-2115-C	6	Spring Washer
41	M-2196	1	Roller Bearing
42	M-224-A	1	Pilot Bearing
43	M-268	2	Fitting
44	M-287	1	Shaft Fitting
45	M-503	1	Fitting
46	S-634	1	Sliding Sleeve Assembly
47	X-117-C-10	1	Collar Assembly
48	X-3507	1	Throwout Yoke
49	X-3799E	1	Hand Lever
50	X6931	1	Driving (or Spider) Ring
51	ZA-6684-A	1	Hub-and-Back Plate

Service Repair Kits

Part No.	Qty.	Description
BASIC GASKET SETS		
G-900-1000		Gasket Kit
G-900-1001	1	
SINGLE PISTON RING KIT		
G-907-185	1	Piston Ring Set
CRANKSHAFT AND CRANKSHAFT BEARING KITS		
G-911-209		Crankshaft A216011 Kit
G-911-216	1	Crankshaft A217011 Kit
MAIN BEARING KITS		
G-918-307		Standard
G-918-308	1	
G-918-311		.020-inch Undersize
G-918-312	1	
HEAD REPAIR KITS		
G-936-2		Head Repair Kit
G-936-1	1	
G-936-1S		
G-936-1CF		
CAMSHAFT BUSHING KITS		
G-927-50		Bushings Pre-Reamed
G-927-52	1	
G-927-48	1	Bushings Undersize for Align-Boring
SINGLE CYLINDER SLEEVE KITS		
G-932-262	1	Piston 216104 Kit
WATER PUMP REPAIR KITS		
G-960-254	1	Water Pump D216160C–Single Groove Pulley
G-960-255	1	Water Pump D216160C-A54–Double Groove Pulley
SHORT BLOCKS		
G-975-268		Compression Ratio 8:1
G-975-277	1	
VALVE OVERHAUL GASKET KITS		
G-979-231		Gasket Set
G-979-236	1	Gasket Set
G-979-262		
OIL PUMP REPAIR KIT		
G-980-153	1	Oil Pump 216080C Kit

OPERATION AND SERVICE

FEATURES

- EPA-certified stationary/nonroad mobile and emergency standby
- Woodward PG+ engine control system
- Standard canbus interface (SAE J1939)
- Telematics ready
- Pipeline NG, LPG/VPG, and wellhead NG (700–1,600 BTU/ft³) operating fuels different for prime and standby
- Fuel quality learn (no fueling adjustments required)
- Custom color display for engine control and diagnostics (power unit)
- Oil level regulator
- NG lock-off valve*
- LPG vaporizer and lock-off valve*
- Electric or standard clutch
- Coolant level shutdown
- Bi-fuel auto switching capable
- Open or closed power unit
- Open or closed genset
- Certified engine kit for OEM packagers
- Exhaust silencer
- Coalescent filter
- Fuel gas filter
- Electric or standard clutch
- Customer-specified control panel

* Lock-off valve required whether factory- or customer-supplied.

BRAKE HORSEPOWER DEDUCTIONS FOR ALTITUDE AND TEMPERATURE

Altitude: **A54E Engines**	Deduct 3% for each 1,000 ft. (305 m) above 1,500 ft. (475 m) (continuous duty), or above 500 ft. (152 m) (intermittent duty). EXAMPLE: Elevation = **5,500 ft.** (4,000 (x) .3 = .12) (68 BHP (x) .12 = 8.16) (68 BHP (-) 8.16 = 59.8) or **60 BHP**
Temperature	Deduct 1% for every 10°F (-12°C) above 100°F (38°C) (continuous duty), or above 85°F (29°C) (intermittent duty).
Intermittent Rating (I)	The highest load and speed that can be applied under specific conditions of varying lead and/or speed.
Continuous Rating (C)	The load and speed that can be applied without interruption except for normal maintenance.

All ratings corrected to 500 ft. (152 m) altitude, 29.38 inches (746 mm) Hg, and temperature of 85°F (29°C). Natural gas ratings are based on the use of 1,000 Btu LHV gas. Propane ratings are based on the use of 2,335 Btu HD-5 propane.

POWER RATINGS

I = INTERMITTENT C = CONTINUOUS

A54E MODEL Spark Ignited	PEAK INTERMITTENT TORQUE @ RPM FT.-LB. N-M		BRAKE HORSEPOWER AT SPEEDS INDICATED (SAE)											
			900		1,000		1,200		1,400		1,600		1,800	
			I	C	I	C	I	C	I	C	I	C	I	C
Natural Gas	233 @ 900	315 @ 900	40	36	44	40	52	47	60	54	68	61	75	68
HD-5 Propane	255 @ 1400	345 @ 1400	46	41	50	45	61	55	62	69	77	69	85	77

Power Ratings

50 Hz (1,500 RPM)				
Application	**Fuel**	**kWe**	**kWm**	**bHP**
Prime	NG	36	40	54
Prime	LPG/VPG	40	44	59
Standby	NG	40	45	60
Standby	LPG/VPG	44	49	66

60 Hz (1,800 RPM)				
Application	**Fuel**	**kWe**	**kWm**	**bHP**
Prime	NG	43	48	64
Prime	LPG/VPG	47	52	70
Standby	NG	48	53	71
Standby	LPG/VPG	52	58	78

Power ratings are for reference only. Final product data may differ slightly.

INTRODUCTION

Arrow A54E engines are EPA-certified and intended for portable and stationary applications such as gas compression, portable water pumps, pump jacks, irrigation, and generator sets. They are four-stroke, six-cylinder in-line, high-speed, overhead valve engines.

Overhaul instructions are not included, except where certain special procedures are required. Specifications information, discussed in the Repair and Replacement section of this manual, will allow a competent mechanic to determine when parts are no longer usable.

All data and recommendations contained in this manual represent the latest information available at the time of printing and are subject to change.

Symbols are incorporated throughout this manual to stress important information. These symbols and their meanings are as follows:

WARNING This symbol precedes information which, if disregarded, may result in injury or death of the user (or others) of the engine.

CAUTION This symbol precedes information which, if disregarded, may result in damage to the engine.

NOTE This symbol precedes information which is vital to the operation or maintenance of the engine.

SAFETY PRECAUTIONS

For details on safety rules and regulations in the United States of America, contact your local Occupational Safety and Health Administration (OSHA).

These safety precautions are published for your information. Arrow Engine Company, does not, by the publication of these precautions, imply or in any way represent that these published precautions are the sum of all dangers present near industrial engines. If you are operating industrial engines, it is your responsibility to ensure that such operation is in full accordance with all applicable safety requirements and codes. All requirements of the U.S. Federal Occupational Safety and Health Administration Act must be met when Arrow engines are operated in areas that are under the jurisdiction of that U.S. department. Engines operated in countries other than the United States of America must be installed, operated and serviced in accordance and compliance with any and all safety requirements of that country.

Bodily Protection

Wear OSHA-approved bodily, sight, hearing, and respiratory system protection. Never wear loose clothing, jewelry or long hair around an engine.

Exhaust Gases

Engine exhaust products are toxic and may cause injury or death if inhaled. All engine installations must have an exhaust discharge pipe so that exhaust gases are delivered into the outside air. A closed building or shelter must be adequately vented to provide a steady supply of fresh air.

Engine Fuels

Natural gas is highly combustible and may ignite or explode. Fuels must be connected to the engine with proper piping, free from leaks, and designed to resist breakage from vibration. When servicing engine, never smoke or use open flame in the immediate area. Fuel tanks should be grounded to prevent buildup of static electricity. If a gas engine has been cranked excessively without starting, shut off the gas fuel supply and ignition. Then crank the engine to purge the cylinders and exhaust system of accumulated, unburned gas. If you fail to do this, a spark plug could ignite the gas and cause an explosion. See the Fuels section of this manual for more information.

Positive Fuel Shut-off

Use of positive fuel shut-off shall be provided. Pressurized fuels (such as natural gas, liquefied petroleum gas, vapor petroleum gas) must have an automatic positive shut-off valve. Gas mixer does not provide gas shut-off protection. It is the final responsibility of the engine owner to ensure that an electric lock-off valve was installed and is free from fuel leakage, and the installation meets all applicable codes. See Fuels section for more information.

Safety Guards

Engines must be provided with guards to protect persons or structures from rotating or heated parts. It is the responsibility of the engine owner to specify or provide such protection.

Ignition Systems

Ignition systems can cause electrical shocks. Avoid contacting ignition components and wiring.

WARNING

If a gas engine has been cranked excessively without starting, shut off the gas fuel supply and ignition. Then crank the engine to purge the cylinders and exhaust system of accumulated, unburned gas. If you fail to do this, a spark plug could ignite the gas and cause an explosion.

Cooling System Pressure Caps and Connections

Do not remove the pressure caps while the engine is operating or while coolant is hot. The cooling system is under pressure, and severe burns could result from the hot coolant spewing out when the cap is removed. Wait until the engine and coolants have cooled down before removing the radiator or surge tank caps. Always replace worn hoses, lines, and fittings.

Generator Sets

The voltage produced by generator sets is dangerous. Severe, possibly fatal shock may result from contact. Make sure the generator set is grounded before operation. Be extremely careful when the unit or surrounding area is damp or wet.
When servicing any part of the electrical system or making any connections, make sure main power switch is OFF. Clean or service generator set only when engine is shut down.

In case of an accident from electrical shock, shut down the generator at once. If it cannot be shut down, free the victim from the live conductor. Avoid direct contact with the victim. Use a dry board, dry rope, or any nonconducting implement to free the victim. If the victim is unconscious, apply artificial respiration and get medical help.

Do not operate the generator with the ammeter circuit open. Voltage, dangerous to both equipment and personnel, can be generated in an open secondary circuit of a current transformer.

If the generator set is stopped by operation of safety devices, do not attempt to operate it until the cause has been eliminated.

When the generator set is shut down after operation, disconnect all line switches to all external power load and parallel circuits.

Repair and Service

Always stop the engine before cleaning, servicing, or repairing the engine or driven equipment. Place all controls in OFF position to prevent accidental restarting. If possible, lock all controls in the OFF position. Put a sign on the instrument panel warning that the engine is being serviced. Before restarting, make sure that all tools and other material are removed from the engine and equipment.

Proper service and repair is important to the safe, reliable operation of engines and related equipment. The procedures recommended by Arrow Engine Company in this manual are effective methods for performing service and repair operations. Some of these procedures require the use of specially designed tools. The special tools should be used as recommended. Anyone who uses a service, repair, or installation procedure not recommended by Arrow Engine must first satisfy themselves thoroughly that their safety will not be jeopardized by the service methods they select.

Housekeeping

Good housekeeping results in a clean, safe work area. An orderly work area with clean walkways and neatly arranged tools and equipment is a major factor in accident prevention.

Engine Fan Blades

1. Do not operate the engine with a fan which has been bent, mutilated, modified or in any way damaged.
2. Do not operate the engine if the fan contacts or strikes any engine accessory or the radiator shroud or core.
3. Do not rebalance the fan. Replace fan if damaged.
4. Ensure that all bolts attaching the fan are securely installed to the proper torque.
5. Perform all required maintenance on the subassembly to which the fan is attached (water pump, fan drive, etc.). See operator/service manual.
6. Do not modify or substitute any parts of the engine without the approval of Arrow Engine Company. Take special care not to make modifications, which will increase the operating speed of the fan.
7. Replace the fan if indications of excessive corrosion or erosion appear on the fan.
8. For reversible or adjustable pitch fans, make sure the blades are correctly locked in the proper position prior to operation. Also, inspect the fan prior to operation to ensure that ice and dirt have not accumulated on the fan to cause potential unbalance of the fan.
9. Be sure all fans, fan drives and belts are properly shielded.

Engine Storage Chemicals

Preservative oil contains a petroleum distillate which is harmful or fatal if swallowed. Avoid contact with skin. Vapor is harmful and causes irritation of eyes, nose, throat and skin. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin, eyes, and clothing. Do not take internally. Keep container closed and away from heat. Always read and observe the CAUTION labels on the containers. Do not destroy the labels on the containers.

Generally, heating of preservative compounds is limited to 200°F (93°C) or less. These temperatures are easily reached by placing the preservative container in heated water. If this is done, the container must be vented or opened to reduce the danger of explosion. Direct heating presents a dangerous and unnecessary fire hazard.

Fire Protection

Locate fire extinguishers so that they are easily accessible if a fire starts. Carefully maintain records of extinguisher inspection and recharging to ensure the fire extinguishing capabilities when required. Consult your fire extinguisher supplier or insurance engineer for recommendations on the type, size, and quantity of fire extinguishers required. Select and post alternate routes of escape from any engine installation. Design installation to meet all applicable fire codes.

Cleaning Solvents

Use approved cleaning solvents in a well-ventilated area. Avoid breathing fumes; some vapors can be fatal. Keep away from open flames or sparks. Do not use gasoline or paint thinners or other highly volatile fluids for cleaning. Always read and observe the CAUTION labels on containers. Do not destroy the labels on the containers. Cleaning solvents can cause various types of skin irritations.

Welding Equipment

Welding gas cylinders can explode if damaged. Cylinders must be stored in accordance with manufacturer's specifications and applicable safety requirements.

When using acetylene, install check valves between the regulators and hoses to prevent flashback into the regulators and supply tanks. Flashback could cause the regulators and supply tanks to explode.

Oily and greasy materials must be kept away from oxygen valves. Hoses, etc. Oxygen may combine with such materials and an explosive reaction could result.

Always wear protective eye shields when welding, cutting or watching a welding operation. Protective clothing and face shields must be worn. Do not weld or cut near combustible materials.

Grounding Precautions When Welding

When using an electric welder on an engine, clip the ground lead as close to the welding site as possible. Putting the ground lead too far from the welding site may result in arcing across the main bearings, and fusing them to the crankshaft.

Electric Power Tools

Be certain the electric tool is properly grounded. Wear proper eye protection. Do not work in wet or damp conditions. Be sure the tool is in good condition and safety guards are in position. An electric trouble light must also be grounded. Do not carry electric power tools by the cord. Do not yank the cord when removing from and outlet; instead grasp the plug to remove it from the outlet.

Lead Acid Batteries

Always disconnect the battery ground connection from batteries before performing any work on the engine or equipment. This will prevent sparks or burns from accidentally shorting an electrical connection.

Never expose batteries to open flame or electric spark. Battery action generates a flammable, explosive gas. Do not allow battery fluid to contact skin, eyes, fabrics, or painted surfaces. Battery fluid is a sulfuric acid solution, which could cause serious personal injury or property damage. Wear eye protection when working with batteries.

Precautions When Using Booster Batteries and Cables

Do not attempt to jump start an engine with a frozen battery. The battery may rupture or explode. Before starting, examine all fill vents on the battery. If ice can be seen, or if the electrolyte fluid cannot be seen, do not attempt to start with jumper cables.

Batteries should be treated carefully when using jumper cables. The following procedures assist in reducing sparks and explosion hazards always present in both batteries when connecting charged batteries to discharged batteries:

- Turn off all electrical loads. Remove vent caps and lay a damp cloth over open vent walls of each battery. The charged booster battery or batteries must have the same voltage capacity as the discharged battery or batteries.

- The positive post is identified by a "+", pos. and red color and is larger in diameter than the negative post.

- The negative post is identified by a "–", neg. and is gray.

Negative-grounded Battery

First, connect one jumper cable from the positive post on the charged battery or batteries to the positive post on the discharged battery or batteries. If more than one battery is connected in series or series parallel, connect the jumper cable to the positive post that has the cable leading to the starting motor.

Second, connect the other jumper cable from the negative post on the charged battery or batteries to a good ground on the engine.

When removing jumper cables, always disconnect the ground jumper cable from the engine before disconnecting the other jumper cable.

Compressed Air

Compressed air or gases should never be used to clean clothing or the body. Compressed air can pierce the skin and cause severe and painful injury. Never use your hand to check air, gas, or liquid flow rates. Do not engage in horseplay with air, gas, or liquid hoses. Observe all applicable regulations as related to compressed gases.

Sodium-filled Valves

When handling sodium-filled valves always wear approved safety goggles, a hat or cap, long sleeves, and gloves. If refacing of sodium-filled valves is required, do not exert undue force at the grinding wheel as this could crack the hollow valve stem and allow the sodium to escape.
Do not handle broken sodium-filled valves with bare hands. Sodium or sodium residue can cause severe burns. Sodium burns are of the same nature as caustic burns. Wash burns with large volumes of cold water, then neutralize with vinegar. The affected parts should then be treated as a burn and medical attention sought.

If a broken valve should ignite, smother the flames in dry soda ash or dry sand. Water, carbon dioxide in any form, or carbon tetrachloride should never be used on sodium fires because these materials react violently with hot sodium. The smoke and fumes are irritating. Provide adequate ventilation and inhalation and avoid contact with smoke and fumes.

Broken sodium-filled valves may be stored prior to disposal in moisture-free clean oil or kerosene. Unserviceable sodium-filled valves must be disposed of in accordance with local, state and/or federal regulations as applicable.

Intoxicants and Narcotics

Workers under the influence of intoxicants and/or narcotics are unsafe workers and are a hazard to themselves and other employees.

Safety Practices for Handling Acids

Throughout this manual, acid cleaning procedures are recommended for certain castings or pieces of equipment.

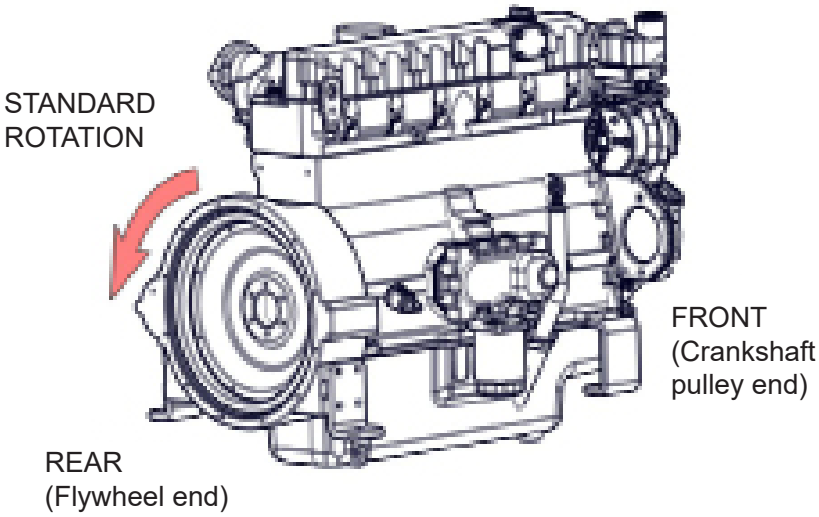
WARNING

Always add the acid to the water. Never add water to acid when mixing solution.

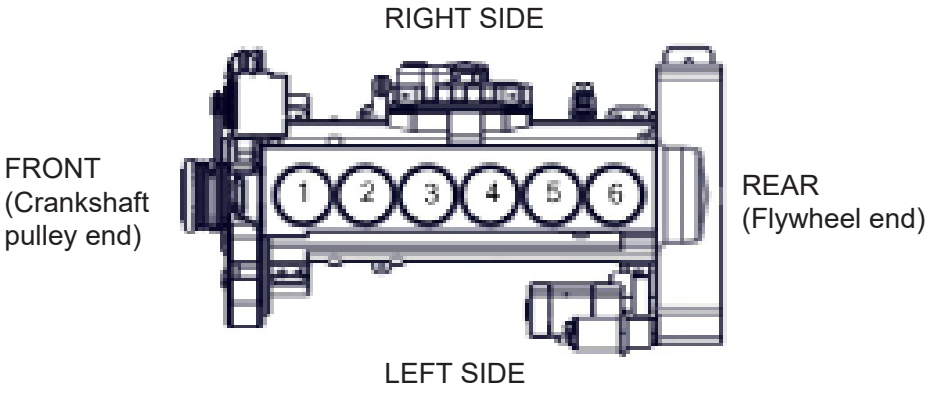
1. Keep acids off of concrete floors, as it attacks lime in the concrete. If solution does get on concrete surfaces, apply an alkaline solution to neutralize.
2. Acids can react with metals to form various gases. Generally, acid solutions on lime scale and rust form harmless carbon dioxide. However, when acids contact aluminum, zinc, cadmium, tin, sulfides, arsenic and cyanides, poisonous and explosive gases may be generated. When descaling is performed in closed equipment, install proper ventilation to carry the gases away. When using an open tank or crock, dilute gases by ensuring adequate airflow above the open tank.
3. Always fill closed vessels from bottom upward.
4. Be sure that there are no leaks in the vessel being descaled, which will permit solution to leak into opposite side or equipment. Good practice is to fill the opposite side of the equipment being descaled with water to a level higher than the acid solution.
5. Use an acid-proof pump, or an inexpensive, expendable one.
6. When mixing with water, pour acid into the water. Do not pour water in concentrated acid.

ENGINE SPECIFICATIONS		
Configuration	Vertical in-line 6-cylinder	
Induction system	Naturally aspirated	
Combustion system	Spark-ignited	
Cooling system	Water-cooled	
Displacement	5.4 L (330 cubic inches)	
Compression ratio	8:1	
Bore x stroke	3.9 x 4.7 inches (98 x 118 mm)	
Direction of rotation	Counterclockwise	
Approx. wet weight (power unit, G-drive)	1,764 lbs. (800 kg) power unit	1,324 lbs. (601 kg) G-drive
Length (power unit, G-drive)	68.9 inches, P.U.	58.0 inches, Gdrive
Width	31.9 inches, P.U.	29.8 inches, Gdrive
Height	74.9 inches, P.U.	45.5 inches, Gdrive
Valves per cylinder	2	
Fuel type	NG/ wellhead/ LPG/ VPG	

Weight and physical dimensions are for reference only.
Final product data may differ slightly.



IN-LINE ENGINE



A-SERIES NAMEPLATE

BEFORE STARTING ENGINE

1. Check coolant level.
2. Check clutch to be disengaged.
3. Check belts.
4. Check oil level.
5. Check gas connections.
6. Check malfunction indicator lamp (MIL) light, with key, engine OFF.

WARNING

Make certain all guards are secure on the engine and driven equipment.

Check the air restriction indicator. Clean the air filter element and dust cap if the indicator shows red.

Familiarize yourself with all engine controls before attempting to run the engine.

STARTING ENGINE

CAUTION

If adequate oil pressure is not present after fault bypass timer expires (15–30 seconds), then engine will shutdown. Never operate an engine without adequate oil pressure readings in hopes that a faulty sensor or cold oil is responsible. (The problem could be something else, and serious engine damage would result).

1. Turn key switch to ON position. MIL lamp should illuminate as part of a diagnostics check.
2. Ensure gas supply valve is open and correct fuel pressure is being delivered to the fuel inlet of the engine (8–16 INWC).
3. Ensure appropriate fuel type (natural gas or propane) is selected from the display menu. See the Fuels section of this manual for more information.
4. Ensure E-Stop switch is in the run position. E-stop switch is push to stop, pull to run.
5. Press Start button one time. Start button appears on screen and is the right-most button.

- Engine will begin Auto Crank sequence.
- Number of crank attempts is assigned in Engine Start Settings from the display.

Warm up engine until oil pressure stabilizes and coolant temperature reaches at least 100°F–120°F (38°C–49°C).

Check general engine components such as air intake and exhaust connections, belt, guard, bolts, etc.

Engine speed for applying load will vary depending upon engine application. Generally, load should be applied gradually with engine speed set high enough to carry the load.

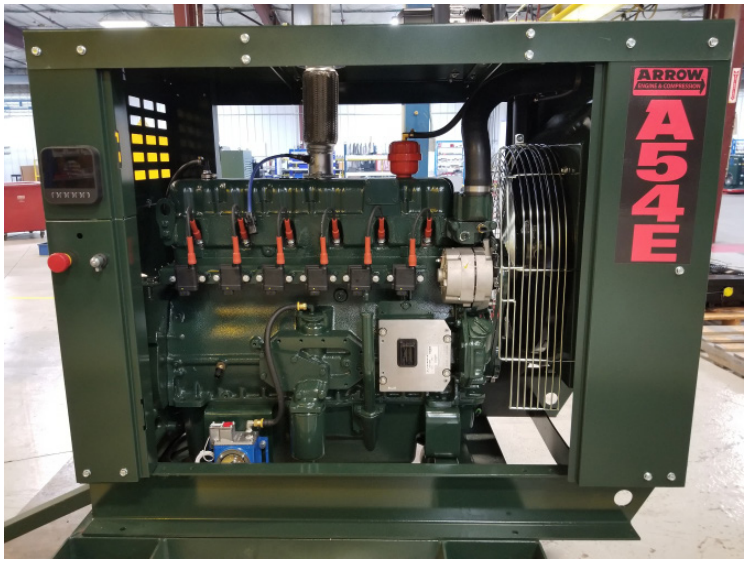
There are a number of important points to check while the engine is running.

Learn and record the normal operating readings for the engine. Normal oil pressures for the A54E series engines are 30–40 PSI at 1,800 RPM. The normal coolant temperature is 180°F–200°F (82°C–93°C).

Check the air intake restriction indicator.

Check for oil or coolant leaks.

Avoid prolonged idling, in excess of 20 to 30 minutes at a time, without bringing the engine up to normal operating temperatures near full-load. Excessive idling periods can cause cylinder problems by creating excessive coke and ash deposits.



BEFORE STOPPING ENGINE

Remove load by disengaging the clutch control lever, and allow the engine to idle for a few minutes to reduce and normalize engine temperatures.

CAUTION

It is advisable, if the engine has overheated due to either excessive load or through some malfunction of the cooling system, to operate the engine at idle speed for a few minutes to bring temperature back to normal. If temperature does not begin to recover to normal within one minute, shut the unit down hot.

Stop the engine when it has cooled sufficiently. Depending upon the engine installation, it can be stopped in a number of ways.

Gas engines should normally be stopped by shutting off the fuel supply. A54E engines require gas lock-offs to be used. Gas lock-off automatically closes when engine is stopped by display.

STOPPING ENGINE

1. The primary method to stop the engine is by pressing the Stop button located on the control panel.
2. Turn key switch to OFF position.
3. In an emergency, push the E-Stop switch located beneath the display or close the manual fuel shut-off valve feeding the engine.

NOTE: If manual fuel valve is closed while engine is running, a fault code will appear indicating low fuel pressure (SPN 632, FMI 7).

AFTER STOPPING ENGINE

Unless otherwise protected, the exhaust pipe should be capped upon shutting down the engine to prevent condensation, rain, or snow from getting into the engine. A pail or bucket inverted over the exhaust pipe will be sufficient.

Test the coolant solution for adequate antifreeze to protect the engine from freezing during shutdown periods. The immediate and anticipated air temperature will govern the amount of antifreeze needed.

Control Panel

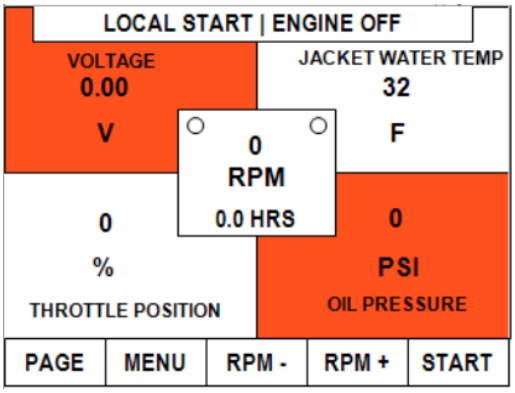
The A54E is equipped with a customized control panel designed with durability and ease-of-use. 14 digital gauges, 2 status indicator lights, and a dynamic banner present a variety of meaningful engine and application data. Multiple application modes and engine settings are easily adjusted from the intuitive menu structure. Four total digital inputs are available for customer integration: 2 External Shutdowns and for Autostart implementation, 1 Remote Start, and 1 Idle/Rated. The panel meets IP67 (with mating connectors), operates on 8-32 VDC, and has an operating temperature range of -40°F to +185°F (-40°C to +85°C).

Home Screen

The dynamic banner at the top of the screen displays important engine information including engine state, target RPM, fuel type, start mode, and if an external shutdown has occurred.

Gauges – Home screen gauges include Battery Voltage, Coolant Temperature, Throttle Position, Oil Pressure, Engine RPM, and Engine Hours.

Status Indicators – The upper left indicator light will turn red indicating an active fault. The upper right indicator light will turn green, indicating closed-loop control is active.



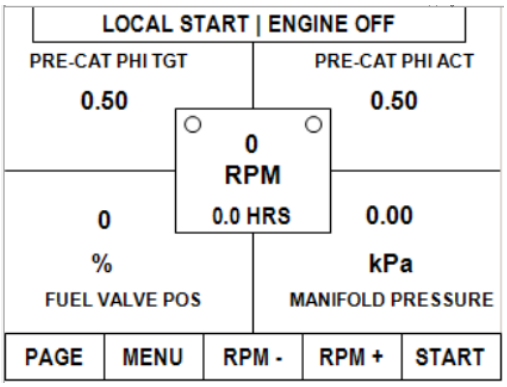
Page – Cycle through gauge screens and active faults page (DM1).

Menu – Access engine and control panel settings as well as historical faults page (DM2).

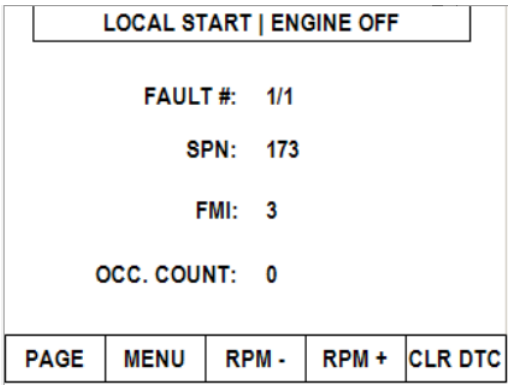
RPM-/RPM+, Idle/Rated – In Manual Speed Control mode use RPM-/RPM+ to adjust target speed (long press to ramp, short press for 1 RPM increments). In Idle/Rated speed control mode, press desired button once and engine will run at assigned Idle and Rated speed setpoints.

Start/Stop/X – Start initiates the ECM-controlled auto-crank sequence; Stop initiates the ECM-controlled engine stop sequence. If an external fault has occurred, the button will change to an X and a power cycle is required after correcting the issue causing shutdown.

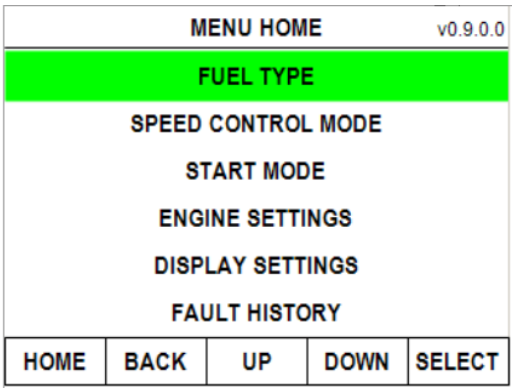
Additional Gauges – Pages 2 and 3 include digital gauges for Pre-cat Phi Target and Actual, Fuel Valve Position, Manifold Pressure, Ignition Timing, Post-cat Exhaust Temperature, Engine Load, and Fuel Pressure at EFR inlet.



Active Fault Screen (DM1) – The active fault screen will display any DM1 messages from the ECM, including SPN, FMI, and Occurred Count. Multiple DM1 messages are handled by automatic cycling of each message as indicated by Fault #: X/X. It is possible to send Active Fault messages to Fault History (DM2) by pressing the CLR DTC button. Fault history is accessible from Menu Home. **NOTE:** Consult the A54E Parts and Operations Manual for fault descriptions.



Menu Home – From the main menu, various engine settings can be configured for the application. See Settings and Defaults Table on the following page for the full menu layout as well as default settings. To enter a sub-menu or change a setting, use the Up/Down buttons to place the green banner and press Select. To confirm the setting has been changed, the banner will change to yellow. If adjusting a numerical setpoint within a range, use the +/- buttons and press Select once the desired setpoint is present. Again, the banner will change yellow to confirm the change. Press Back to return to the previous screen. Press Home to return to the home screen.



Settings and Defaults Table

See table on following page.

Settings Definitions

Fuel Type – Selecting Natural Gas or Propane will set the correct ECM calibration for the fuel type supplying the engine as well as operate the associated lock-off valve.

Speed Control Mode – Selecting manual mode will show RPM+/- buttons for manual speed control. Selecting Idle-Rated mode will show IDLE/RATED buttons. Idle and Rated setpoints are assigned in Run Settings. The behavior is like that of an idle/rated toggle switch.

Start Mode – Local Start mode means that the engine is started and stopped locally at the control panel. Remote Start mode should be selected when an Autostart device is connected to the engine. In this mode, the speed control and start/stop buttons are removed from the home screen. Starting the engine is accomplished by grounding the Remote Start wire. Stopping the engine is accomplished by ungrounding the Remote Start wire. Speed control while in the mode is accomplished by grounding or ungrounding the Idle/Rated wire. Rated speed is accomplished by grounding the wire. Idle speed is accomplished by ungrounding the wire. Warmup and cooldown timers should be set up prior to using Remote Start mode.

Start Buzzer Duration – Time interval for buzzer to sound prior to engine cranking. **NOTE:** The dynamic banner on the home screen will turn red prior to engine cranking.

Engine Crank Duration – Time interval for starter motor engagement. Additional time occurs on subsequent start attempts for fuel purging time prior to lock-off valve reopening.

Max Crank Attempts – Number of times the engine will attempt to start.

Time Between Restarts – Time interval between starts to allow starter motor to cool down.

Fault Bypass Timer – Time interval in which engine oil pressure sensor is ignored.

Idle RPM Target – Desired idle speed when in idle/rated or remote smart mode.

Rated RPM Target – Desired rated speed when in idle/rated or remote smart mode.

Warmup RPM Limit – Maximum allowed engine RPM until either time or temperature setpoint has been reached. **NOTE:** The dynamic banner on the home screen will turn orange if in warmup state.

Warmup Timer – Time interval before engine RPM can exceed Warmup RPM Limit setpoint. **NOTE:** The dynamic banner on the home screen will turn orange if in warmup state.

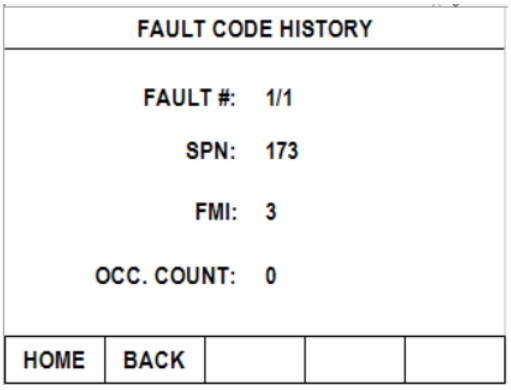
Warmup Temp Limit – Temperature limit that must be reached before engine RPM can exceed Warmup RPM Limit setpoint. **NOTE:** The dynamic banner on the home screen will turn orange if in warmup state.

Cooldown Timer – Time interval in which engine will idle after receiving stop command prior to shutdown. **NOTE:** The dynamic banner on the home screen will turn blue if in a cooldown state.

Overspeed RPM Setpoint – Speed setpoint in which engine will shut down if reached.

Fault Code History Screen (DM2) – The fault code history screen will display any DM2 messages stored in the ECM. These faults can be cleared only by the onboard logic of the ECM (i.e. engine has run 3 times without recurrence of fault condition).

NOTE: Consult the A54E Parts and Operations Manual for fault descriptions.



Settings and Defaults Table					
Menu Home	Fuel Type	Natural Gas		Setting Range	Default Setting
		Propane			
	Speed control mode	Manual mode			
		Idle-rated mode			
	Start mode	Local start			
		Remote start			
	Engine settings	Start settings	Start buzzer duration	0–10 seconds	5 seconds
			Engine crank duration	1–15 seconds	5 seconds
			Max crank attempts	1–5 attempts	1 attempt
			Time between restarts	10–20 seconds	10 seconds
			Fault bypass timer	10–30 seconds	30 seconds
		Run settings	Idle RPM target	900–1,000 RPM	900 RPM
			Rated RPM target	1,001–1,800 RPM	1,500 RPM
			Warmup RPM limit	900–1,000 RPM	1,000 RPM
			Warmup timer	0–100 seconds	0 seconds
			Warmup temp limit	0°F–150°F (-18°C–65°C)	0°F (-18°C)
		Stop settings	Cooldown timer	0–60 seconds	0 seconds
			Overspeed RPM setpoint	1,200–2,200 RPM	2,200 RPM
	Display settings	Set units	English		
			Metric		
		Display Brightness			
	Fault history				

QUICK TROUBLESHOOTING INFO FOR OPERATORS

CHECK CONTROLS	Follow starting steps. Reset safety controls. Remote or automatic operation engines have special procedures.
CHECK FUEL SYSTEM	Be sure fuel is getting to engine; check lock-off valve for proper operation. Check possibility of water, rust, and pipe scale. We recommend using one-inch fuel supply lines to avoid fuel volume starvation.
CHECK COOLING SYSTEM	Check coolant level. Make sure the system is not air locked. Radiator must not be blocked. Check shutter and fan operation. Raw water valves must be open to the heat exchanger.
CHECK AIR INTAKE AND EXHAUST SYSTEMS FOR BLOCKS	Check air filter and air restriction indicator. Air intake or exhaust outlet must be uncapped.
CHECK MECHANICAL ITEMS	Examine accessory drive belts for condition and tension. If cranking speed seems low, check battery condition.
CHECK IGNITION ON GAS ENGINE	Check for water on ignition parts and wires, signs of corrosion at wire terminals, broken wires, and spark plugs that are poorly gapped or worn out.

IF CHECKS ABOVE DO NOT SOLVE PROBLEM, REFER TO TROUBLESHOOTING SECTION.

START-UP

Cold-weather Starting

An engine jacket coolant heater, lubricating oil heater, and/or other approved starting aid should be utilized as required for cold-weather starting.

Engine Warm-up

Proper engine warm-up is important for long engine life. A warm-up period allows for an even thermal expansion of engine components. Also, the lubricant warms up and attains normal viscosity during warm-up. Oil pressure is also built up, assuring proper oil distribution and lubrication of vital engine parts.

Standby units that require immediately full load pick-up can be equipped to maintain a constant oil pressure and engine temperature. Consult your Arrow distributor for further information.

Break-in Procedure

New or overhauled engines should receive a break-in run.

NOTE: Standby generator engines should follow this procedure using a load bank.

EXERCISE OF STANDBY UNITS

It is recommended to exercise a generator set or other standby unit once each week. Keep a record of performance, servicing, and output of both the engine and driven equipment.
Always operate the engine long enough to stabilize oil and water temperatures at the normal operating level expected under load. Do not operate under no load conditions for other than brief periods. Loads of at least one-third up to the normal rated capacity are recommended.
Ordinarily, an exercise run of 1 to 1-1/2 hours is needed to stabilize temperatures. If the engine cannot be loaded, it should not be exercised for more than 10 minutes each exercise period.

It is recognized that some types of driven equipment cannot be operated without fairly extensive procedures to put them in line. Examples are hospital generators in some types of switching configurations: air-conditioning compressors which can be loaded only by changing over to chilled water from heating water circulation; and pumps which are not set up for waste discharge or recirculation.

In such cases, weekly exercise periods may need to be reduced, where possible, to operational periods long enough only to prove the engine's ability to crank and start; or, check starting circuitry and safety equipment with the starter disabled. In this event, special attention must be taken to prevent internal corrosion, sticking and gumming of fuel controls, and deterioration of starting batteries. In all cases, make arrangements to operate the engine and driven equipment under load at least every 90 days.

Light-load Operation Service Schedule

Arrow Engine Company recommends the following maintenance schedule for engines that are consistently run at 25% or less of the continuous-duty rating:

1. Maintain engine jacket coolant temperature between 180°F and 190°F (82°C–88°C).
2. Check air cleaner restriction indicator daily. Clean or replace element as required.
3. At intervals of 50 operating hours, run the engine at 50% load or better to clean carbon off the engine components.
4. Update the inspection and overhaul schedule of cylinder heads to allow for a 25% reduction in hours between servicings.
5. Change lube oil every 200 hours.

When applicable, it is recommended to run fewer engines per site to increase the load on each engine.

NOTE: When operating above 25% of the continuous-duty rating, follow the normal maintenance schedule.

Operational Inspection

Examine fuel, water, and lubricant lines for signs of leaks, damage, or corrosion.

Inspect the coolant level and condition. Rust, foaming, or oil in the coolant indicates need for cooling system servicing.

Check air cleaners and breathers daily for cleanliness and tightness.

Examine engine foundation for condition of grout, tightness of hold-down bolts, and general alignment of driven equipment.

Lubrication Recommendations

Observe the following precautions when lubricating the engine:

1. Keep all lubricants in closed containers and store them in a clean, dry place away from heat. Always protect the lubricants from dust, dirt, and moisture. Keep lubrication equipment clean and ready for use at all times.

2. Before adding oil, wipe surrounding areas clean to prevent dirt or other foreign matter from entering the lubrication system.

The performance of a lubricant, like that of any manufactured product, is the responsibility of the refiner and producer. A tabulation of lubricant producers and suppliers, together with performance grades for which the producers have indicated their products are qualified, is available in the EMA Lubricating Oils Data Book, complied by the Truck and Engine Manufacturers Association, (www.truckandenginemanufacturers.org). Arrow Engine Company has made it a practice not to recommend oil by brand name.

Arrow Engine Company's warranty is limited to the repair or replacement of parts that fail due to defective material or workmanship during the warranty period. The A54E Engine warranty does not include responsibility for satisfactory performance of the lubricating oil, this being the responsibility of the oil supplier.

Service Conditions

Oil performance will reflect engine load, temperature, fuel quality, atmospheric dirt, moisture and maintenance. If oil performance problems arise or are anticipated, consult the oil supplier.

Extended oil change intervals should be utilized with caution for any engine using highly dispersant oils. The dispersants function by absorption of particles of contaminants; however, when dispersant saturation is reached, these oils can dump out all of the suspended contaminants in a relatively short period of time. Laboratory analysis will not predict the dump-out point precisely; consequently, closer operator attention to engine conditions is required when establishing an extended oil change interval.

Hydrogen Sulfide

Engines operating with gaseous fuel containing more than 0.1% hydrogen sulfide should use oil compounded to a total base number (TBN) of 8 or higher, so that the oil can adequately counteract the acids formed in the combustion of such fuels.

When fuel is burned in an engine combustion chamber, any sulfur it contains is converted to sulfur oxides, which will combine with water vapor to form acids. These acids can cause serious corrosive damage to engine components. The engine oil should be compounded to neutralize these acids and inhibit corrosion. This is done by building alkalinity into the oil via the additive formulation. The commonly used measure of relative alkalinity is termed Total Base Number (TBN). The higher this number, the greater the reserve alkalinity or acid neutralizing capacity of an oil.

The following table gives guidelines for required TBN of new oil, and deterioration limit of used oil for a range of liquid fuel sulfur content. Perform the recommended oil drain intervals for each engine model unless the TBN drops below the minimum valve shown before that time. If this occurs, change the oil immediately.

SULFUR, WT% IN LIQUID FUEL	Up to 0.5	0.5 to 1.0*	1.0 to 1.5*
TBN — new oil	8	14	20
Minimum TBN (ASTM D664) in used oil	4	4	4
* Consult Arrow Engine Company for use of high-sulfur fuels.			

Lube oil suppliers will supply information about the TBN levels of their products. An oil analysis program will keep the user informed of the TBN level of the oil in service so that adequate corrosion protection is maintained.

Because low operating temperatures promote condensation of acid-bearing fumes in the crankcase, engine coolant temperatures should also be maintained at 185°F (85°C) minimum when using such fuels.

ENGINE LUBRICATION	
API, SAE, ASTM Letter Designation	CC, SD, SE
Military Designation	MIL-L-46152, MIL-L-2104B

OIL CHANGE INTERVALS			
Continuous Duty — At continuous-duty rating, clean environment with oil sump temperature 230ºF (110ºC) or below	Engines operated in **Excess of Continuous-duty** rating	**Light Load**	**Standby Service**
750 hours	200 hours	500 hours	300 hours and/or annually
NOTE: Lube oil and fuel filter elements should be changed when lube oil is changed.			

DEFINITIONS	
Continuous Duty	24 hours per day, 7 days per week
Continuous-duty Rating	BHP produced, see Power Rating Chart
Light Load Operation	25% or less of continuous-duty rating, see Power Rating Chart
Standby Service	Normally exercised 2 hours per month and operated during emergency conditions. If emergency conditions exist in excess of 2 continuous hours, load requirements should be adjusted to Continuous-duty Rating.

Convert Btu to Gallons for Propane Consumption

1. Propane has 101,050 Btu/Gal.
2. A54E engines consume 8,000 Btu/BHP-hours of propane.
3. 8,000 X 68 BHP = 544,000 Btu per hour.
4. 544,000 X 24 hours = 13,056,000 Btu per day.
5. 13,056,000/101,050 = 129 gallons of propane per day.

EXAMPLE: If 1,000 gallons of propane is used in 8 days = 1,000/8 = 125 gallons per day.

Oil Designation

Oil is designated in several ways, including the API, (usually stamped on the container), the military, and the engine manufacturer's designations. The preceding is satisfactory for A54E engines. The designations listed are not necessarily equivalent.

Sulfated Ash Content in Motor Oil

.04–.06	Low
.06 -.09	Medium
> 1.00	High

CAUTION

The type of oil, engine environment and installation, internal engine condition and/or the condition of the carburetion equipment may require more frequent oil changes. We suggest monitoring the lubricating oil with a quality oil analysis program. However, extended oil change intervals may cause varnish deposits, oil oxidation, or sludge, which an oil analysis cannot detect.

Low-temperature Operation

At low ambient temperatures, an oil must be used which will provide proper lubrication when the engine is hot and working. Lube oil and jacket water heaters are recommended for ambients below 50°F (10°C) to warm oil and water for fast starting and loading of engines. Arrow Engine Company will supply information on these devices upon request.

Multiviscosity oils should be used only in cold starting applications. However, the oil may deteriorate in continuous service, allowing the oil to revert to its original low viscosity base. In this state, the oil may not supply sufficient film strength and/or oil pressure. Therefore, an oil analysis program should be utilized to determine the oil change intervals.

Synthetic oils are not recommended by Arrow Engine Company due to insufficient experience with the product.

Oil Consumption

Oil consumption should range from 0.0005 to 0.004 pounds per horsepower hour as determined by the following formula:

LBS/HP-HR = 1.82 X quarts of oil used/operating HP X total hours of operation

Oil Viscosity Selection

The operating temperature of the oil in the sump is the best guide for selecting the proper SAE grade of oil. When the oil temperature on A54E Series engines is unknown, add 120°F (67°C) to the ambient temperature to obtain the estimated sump oil temperature.
For example: at an air temperature of 70°F (21°C), estimated oil pan operating temperature would be 190°F (88°C). Use SAE 30 as indicated in the table below.

NOTE: This is only an estimate, because the type of installation determines the amount of air circulation of cooling around the oil pan. Measure actual oil pan operating temperatures whenever possible.

Determine the correct lubricating oil viscosity (often referred to as weight) with the engine operating under its normal loaded speed and temperature, using SAE 30 oil.

Start and load the engine.

After oil and coolant temperatures stabilize, note the temperature of the oil in the oil pan. Use an accurate temperature gauge. Compare this temperature with the accompanying chart. The correct oil viscosity will be found in the right-hand column.

CLASS A ENGINES	
SUMP TEMPERATURE	**SAE No.**
210–250ºF (99–121ºC)	40
160–210ºF (71–99ºC)	30
130–160ºF (55–71ºC)	20

Engines operating with low oil temperatures [below 160°F (71°C)] can be expected to show excessive sludging and water. Engines operating with high oil temperatures [above 230°F (110°C)] may experience lacquering and ring sticking due to oil oxidation. If oil temperatures cannot be corrected to the normal operating range, more frequent oil changes may help in extending engine life.

Oil Changes

Check the crankcase level prior to each day's engine operation. The oil condition as revealed on the oil level dipstick should be carefully observed.

Replace oil if it is plainly diluted, broken down, thickened by sludge, or otherwise deteriorated. Remember that some modern oils cannot be judged on the basis of color alone because the additives are intended to hold carbon particles in suspension.

The standard filters supplied will not remove these particles. The dark appearance of the oil is not necessarily an indication that the oil should be changed. Whenever oil is changed, the filters must be serviced.

Oil Change Procedure

1. Remove the crankcase oil drain plug, drain oil and securely replace the plug.

2. Fill the element with oil (approximately one quart (.95 liter). Replace the filter element.

3. Fill the crankcase with oil.

4. Operate the engine for a few minutes to circulate the oil through the system.

CAUTION

If adequate oil pressure is not indicated within 25 to 30 seconds, shut the engine down at once and correct the cause. Never operate without an adequate oil pressure indication in the hope that a fully gauge or cold oil is responsible.

5. Stop the engine and check oil level. If necessary, add oil to bring the level to the full mark on the oil level dipstick.

OIL CAPACITY		
A54E with filter only	16.8 quarts	15.9 liters
A54E with filter and cooler	17.6 quarts	16.7 liters

Not all oils in every type of engine will give maximum service; therefore be careful to examine the oil after the first draining to determine whether it is standing up in service. Trial periods of ten hours are suggested; and at the end of such periods, make careful inspection of the oil level dipstick for sludging, frothing and emulsification. Such conditions call for more frequent oil changes or a different oil. In winter operation, low oil temperatures [below 160°F (71°C)] are particularly likely to cause sludge formation. Use temperature control devices (curtains, shutters, and so on) if needed to hold the oil temperature around 180°F (82°C).

Break-in

New or overhauled engines should receive a break-in run.

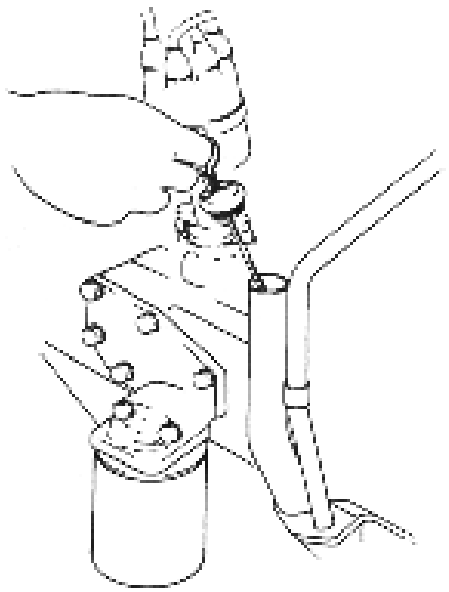
This operation can be performed with the lube oil as specified in this section. After warm-up of approximately 30 minutes, proceed with a load and unload cycle. Repeated loading (minimum of half load, maximum full load), with equal idle periods in 5-minute intervals for a period of two hours, results in rapid break-in and quick seating of piston rings. Never idle the engine for more than 15 minutes during the break-in or for the first 100 hours of operation.

NOTE: Standby generator engines should follow break-in procedures using a load bank.

Service Schedule and Procedures

Oil and Coolant Level

Check levels daily and fill as required. Change the oil and filter as recommended in the Maintenance Schedule section of this manual.



Air Filters

If equipped, check the restriction indicator daily and clean the filter if the indicator shows red.

Fan and Water Pump Belts

Check belts weekly for proper tension and material condition. Make sure guards are secure.

Valve Adjustment

Adjust valve clearance every 750 hours.

Spark Plugs

Inspect and replace spark plugs every 750 hours. Spark plug gap: .025-inch (.64 mm).

Spark Plug Size: 14 mm.

Crankcase Breather

Clean the breather every 750 hours.

Power Take-off

Lubricate the power take-off at intervals according to the instructions of the manufacturer.

Clean and inspect every 6 months.

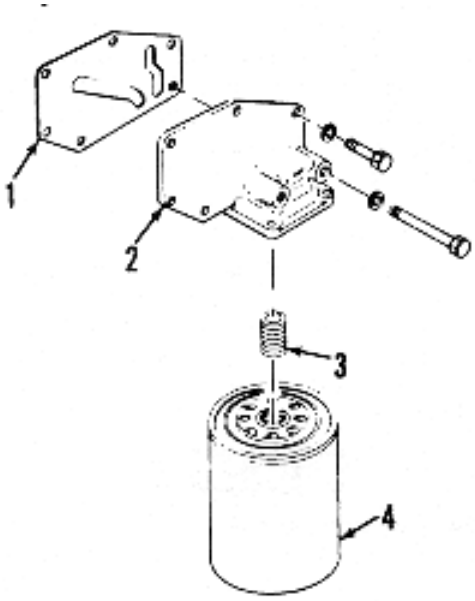
Oil Pump Inlet

The inlet of the oil pump is a slotted pickup tube designed to protect the pump and engine from the introduction of foreign material. If an indications of low or fluctuating oil pressure appear, wash the pickup tube thoroughly in a suitable solvent.

Oil Filters

A54E engines are equipped with full-flow oil filters. These are spin-on, disposable-type filters. When changing filters, carefully follow the manufacturer's directions.

Full-flow filters are an integral part of the lubrication system. Never run the engine with the filter blocked off. All oil going to the engine must pass through the filter. If the filter becomes clogged, the oil will bypass the filter. The engine will then be lubricated with dirty oil, which may reduce engine life. To avoid this possibility, change the oil filter at every engine oil change.



OIL FILTER ASSEMBLY

OIL FILTER

1. Gasket
2. Filter base
3. Filter adaptor
4. Filter element

Oil Cooler (When Equipped)

Oil cooler maintenance consists of largely of periodic cleaning and inspection for clogging or corrosion. Improper or fluctuating oil pressure, or an undesirable increase in oil temperature may indicate the need for servicing the cooler more frequently. In general, remove the cooler from the engine, disassemble, and clean annually or as required. Long service or expediency may make it more practical to replace the inner cooling core with a new unit. Remove all rust and lime deposits from the water passage area of the cooler. The sludge deposits within the cooler core may be cleaned out by several solvents and methods; but in all cases, it is recommended that cleaning take place as quickly as possible after removing the cooler from the engine. Ordinarily, a cleaning solvent or a commercial sludge and carbon remover will be effective if pumped vigorously through the cooler plates. Observe fire and safety precautions.

Air Cleaners

Follow the directions attached to the cleaner if any are present. Dry-type air cleaners are used on A54E engines.

An optional air restriction indicator is attached to the air cleaner. This indicator shows when air cleaner element service is necessary.

WARNING

The air cleaner condition indicator communicates directly with the intake manifold and is subject to occasional high pressure if gas engines backfire. A restrictor is normally installed in the air passage to dampen momentary high pressure which might damage the indicator and project broken pieces potentially harming nearby people. Check to ensure that this restrictor is actually in place.

As dirt trapped by the air cleaner gradually restricts the flow of air, the condition indicator signal, which is preset for a maximum restriction, rises within the gauge. When the maximum restriction is reached, the signal locks into full view indicating the need for servicing the air cleaner element.

CAUTION

Unless the signal is locked in view, indicating a clogged air cleaner element, the restriction indicator will return to a normal setting upon engine shutdown. Normally the air cleaner element is serviced long before the indicator shows a need, but the operator should check the indicator every day while the engine is running. After the air cleaner element has been serviced, depress the reset button on the restriction indictor to reset it.

Dry-type air cleaners are standard on A54E Series engines.

CAUTION

Do not rap, beat, or drop the element.

1. Do not use compressed air or water to clean air cleaners.

2. After cleaning, inspect the element by placing a light inside. Replace the element if it is ruptured or has pinholes or damaged gaskets. Refer to the Maintenance Schedule section of this manual for service intervals.

Cooling System Maintenance

When adding antifreeze compounds on a percentage basis, remember to include the coolant volume of the radiator and other external parts of the cooling system. The following table should be used as a guide:

COOLING SYSTEM CAPACITY			
Ethylene Glycol (Prestone)	Radiator Glycerine (G.P.A.)	Freezing Points	
		ºF	ºC
16%	37%	20	-7
25%	55%	10	-12
33%	70%	0	-18
39%	81%	-10	-23
44%	92%	-20	-29
48%	100%	-30	-34

To prevent rust when using water alone, add one ounce (29 cc) of soluble oil for every gallon (3.7 liters) of coolant in the cooling system.

Cooling Capacities, Engine Only

COOLING CAPACITIES — ENGINES ONLY		
A54E without oil cooler	16 quarts	15.1 liters
A54E with oil cooler	16.5 quarts	15.6 liters

Never fill the cooling system with only water if the engine is to be exposed to subfreezing temperatures. This applies even when warm water is used, because the water in the radiator and jacket passages cools rapidly and is likely to freeze during the next shutdown, Mix the proper proportion of antifreeze and water before filling the engine.

To drain the cooling system, drain the external components and remove the drain plug from the left rear side of the engine, and from the oil cooler (when so equipped).

Under normal conditions, the heat-sensitive thermostat in the water outlet will maintain temperatures within the desired limits of 190°F–200°F (88°C–93°C).

CAUTION

Do not remove thermostat. Proper operating temperature is required, or engine damage can occur.

Cleaning the Cooling System

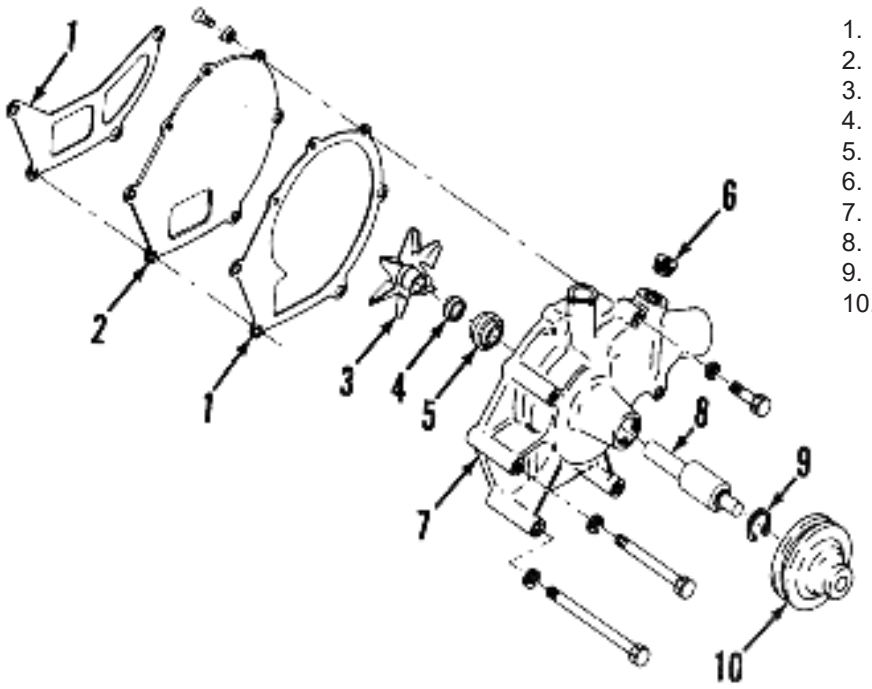
When clean, soft water is used as a coolant, and when the proper inhibitors or antifreeze solutions are used, radiator and cooling passage accumulations will not be excessive. Once a year, however, the engine will benefit if the cooling system is cleaned of sludge and sediment.

A number of excellent commercial cooling system cleaners are available. Arrow Engine Company suggests, however, that an operator considering the use of such a cleaner first investigate its possible reaction with the copper and bronze parts in the engine. If such a cleaner is used, follow the manufacturer's recommendations carefully.

The belt-driven water pump requires no special packaging or attention during its service life. The durable water pump has an internal seal, used in combination with a permanently lubricated integral ball bearing and pump shaft.

When servicing this water pump, the entire shaft, bearing, and seal must be disassembled from the pump body. Because an arbor press is required to remove the seal, field repairs are not recommended unless such equipment is readily available.

The sealing member of the pump consists of a smooth carbon washer riding against a polished surface.



1. Gasket
2. Cover plate
3. Impeller
4. Seal seat
5. Seal
6. Plug, zinc-plated
7. Pump body
8. Water pump shaft and bearing
9. Retaining ring
10. Pulley

WATER PUMP

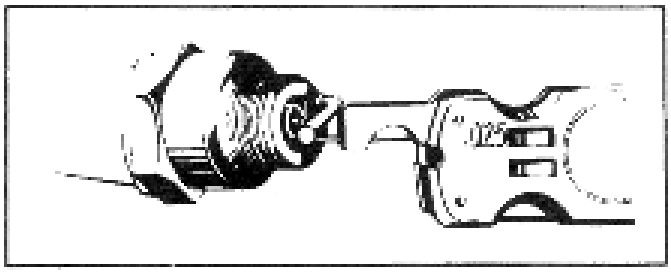
NOTE: Timing is nonadjustable.

Spark Plug Adjustments

Misfiring may be due to faulty spark plugs caused by carbon accumulations and burning of the electrodes. They should be cleaned, inspected, gaps checked, or replaced after 750 hours of operation or more often if the engine idles for prolonged periods.

Deposits on the electrodes and insulator can be removed by commercial abrasive cleaners. Scraping the insulator is not recommended, because the resulting scratches increase the tendency of forming carbon deposits.

After the spark plug has been cleaned, and the center electrode filed, adjust the gap with a round wire gauging tool to .025-inch (.64 mm) by bending the outer electrode. Because the spark plugs will have a tendency to burn the electrodes and widen the gap, it is important that the gap be checked whenever the plugs are removed from the engine. Engine misfiring at low speeds is often due to a wide spark plug gap.



Checking Spark Plug Gap

Examine plugs for cracked porcelain, leakage, burned electrodes, deposits on the center insulator, and incorrect gap. Check washer, thread, and seating surface conditions. Remember, a plug may appear satisfactory and not fire properly.

NOTE: When replacing spark plugs, use new gaskets. Proper seating of the gasket is necessary for sealing the combustion chamber and transfer ring heat from the plug. Use spark plug tap to clean threads. Clean threads allow for proper heat transfer.

Valve Clearances

Accurate valve clearance settings prolong engine life and aid performance. In addition to impairing performance, excessive clearances are detrimental to camshafts and valve lifters.

On the other hand, when the clearances are too tight, timing is disturbed and the possibility of burned valves increases.

Valve clearances specified in the Basic Engine Data section of this manual are for normal room temperatures, not for hot engines.

To adjust the valves:

1. Remove the rocker arm cover and bar the engine over until Number 6 cylinder is at the valve overlap point. (This is when the exhaust valve is nearly closed, and the intake valve is just beginning to open.) You can now adjust the valves on cylinder Number 1, because it is not the compression stroke with both valves closed (valve lifters on base circle).

2. Use a feeler gauge to check the clearance between the valve stem and the rocker arm. To adjust the clearance, loosen the locknut on the adjusting screw. Turn the adjusting screw until you feel a slight drag on the feeler gauge.

3. Tighten the locknut. Recheck the clearance to be sure you did not turn the adjusting screw when you tightened the locknut.

The remaining cylinders in the firing order are adjusted in the same way. The table below shows what cylinder valves to adjust at each valve overlap point.

Adjust the valves on this cylinder...	...when this cylinder's valves are at the overlap point
A54E ENGINE	
1	6
5	2
3	4
6	1
2	5
4	3

Compression Testing

To check the compression of gas engines, a standard automotive-type compression tester with a threaded adapter can be used.

Before checking compression, be sure the engine has been warmed up to operating temperature and the ignition switch is in the off position. Note the number of compression stokes needed to obtain the highest pressure reading. Repeat compression testing for each cylinder using the same number of compression strokes as used for the first cylinder tested.

Normal compression pressures at cranking speed are listed in the Repair and Replacement section of this manual under "Basic Engine Data." Uneven compression or pressures lower than normal call for further checking. Valve regrinding, piston ring replacement, or other overhaul procedures may be required to correct the problem.

GAUGE READINGS	ENGINE CONDITION
HIGH AND STEADY	Good
LOW AND STEADY	Loss of power in all cylinders caused possibly by late ignition or valve timing, or loss of compression due to leakage around the rings.
VERY LOW	Manifold or cylinder head gasket leak.
NEEDLE FLUCTUATES STEADILY AS SPEED INCREASES	A partial or complete loss of power in one or more cylinders caused by: • A leaking valve • Cylinder head or intake manifold gasket leak • A defect in the ignition system • A weak valve spring
GRADUAL DROP IN READING	Excessive back pressure in exhaust system.
INTERMITTENT FLUCTUATION	An occasional loss of power possibly caused by a defect in the ignition system or a sticking valve.

Engine Storage

Preservation of engines and generators in storage involves several basic requirements. New engines and generators include the following steps:

1. Protect machined metal surfaces, cylinders, valves, bearings, and so on, from the effects of both dampness and salt or other corrosive substances in the atmosphere.

2. Protect openings into the engine against entrance of dirt, abrasive material, and foreign matter of all types.

3. Protect accessory equipment, including fuel system, gas regulators, starters, generators, and fan belts against corrosion, dirt, moisture saturation and deterioration.

4. Protect the cooling system and LPG vaporizers against freezing, rusting, or seizure.

5. Protect against the elements: rain, snow, and extremes of temperature.

6. Protect batteries by disconnecting and removing them to a slow charging station where they can be kept fully charged. If this is neglected, the plates can be damaged and ruined by becoming sulfated.

7. Protect the generator or alternator by covering all openings to prevent the entry of dust, moisture, dirt, and rodents. A heavy craft paper will serve this purpose. Where these openings are in the form of screened or louvered guards or covered plates, the protective paper should be placed under these removable parts. If this is not possible, use a pressure-sensitive tape to hold the paper in position.

8. Do not use masking tape. It is not suitable for this type of service and will be difficult to remove after extended use. Apply protective paper on both the inside and outside of large, fixed, louvered surfaces. Large open areas should have a corrugated cardboard backing for paper.

NOTE: In the case of engines previously operated, additional items must be considered.

9. Protect interior engine parts, particularly bearings, cylinder walls, and valves, against corrosion by the products of combustion combined with atmospheric moisture and corrosion by lubricating oil contaminants.

The extent of the attention given to each of the preceding points of possible damage depends on the judgment of the person in charge of the equipment. Consider the following factors before deciding how much or how little preservation is required:

1. The period of time the equipment is likely to be inoperative.

2. The severity of the weather and atmospheric conditions at the point of storage. The problems of storing equipment in a tidewater warehouse, for example, differ greatly from storage problems in a location where the air is dry and dusty.

3. The accessibility of the equipment for periodic inspection and attention. An engine on a showroom floor that may be turned over occasionally and given periodic oiling requires less extensive treatment than engines crated and stocked in a warehouse.

CONVENTIONAL STORAGE

Storing New Engines

All A54E engines shipped by Arrow Engine Company will be shipped with oil. Engines stored outdoors or in a humid environment may require additional preservation methods. For recommendations, contact the factory.

NOTE: Remove emissions components such as catalyst and O_2 sensors before treatment and at restart. Start and burn out storage oils before reinstalling catalyst and O_2 sensors.

1. Engines in operable condition:

A. Mix an inhibitive-type preservative oil with the engine lubricating oil in the proportions recommended by the manufacturer of the preservative oil. (With some products no mixing may be necessary.) Operate the engine until the oil is hot. Cooling water used in this run should have an inhibitor, as explained in the cooling system maintenance.

B. Remove air cleaner from gas engines. With a manually operated sprayer, squirt can, or other means, inject preservative oil into the air intake while the engine is running.

Approximately one minute is ordinarily adequate. If possible, stop the engine by slugging enough oil through the air intake to make it stall. Continue injecting oil until the engine stops turning.

C. Drain oil and water while hot. If extra protection is desired, the rocker arm covers may be removed and a quantity of preservative oil poured over the rocker arm and valve mechanisms. Replace the rocker arm cover and tighten down to seal the vapor inside the cover.

D. For engines not stopped by slugging, remove spark plugs and squirt or spray several teaspoons of preservative oil into each combustion chamber. Coat spark plugs and reinstall.

E. Wipe the engine clean and dry. Apply wax tape or a like material to all openings such as intake openings in air cleaners, exhaust outlets, breathers, and open line fittings.

F. Relieve tension on belts. This is important because continual tension on belts without the working action that occurs in normal operation causes deterioration of the rubber.

G. Apply a coating of a heavy preservative compound with a brush to all exposed machined surfaces such as flywheels.

Engines treated in accordance with these instructions will normally be protected for one year or longer. Continual inspection, however, is the only way to determine if protection is adequate.

H. If possible, crank the engine by hand for one or two turns approximately once a month. This helps prevent seizure of water pump seals. If this is done, however, it is usually best to add more preservative oil to each cylinder.

Some types of preservative oil are not well-suited to periodic engine rotation because they are scraped from the cylinder walls which are then unprotected. Other oils are not scraped away, and for this reason the operator should carefully investigate the characteristics of the oil used.

2. When the engine is not operable:

A. Open drains as required to remove oil and water.

B. Remove the spark plugs and pour or squirt a teaspoon (5 cc) of preservative oil into each cylinder.

C. By hand or with mechanically operated atomizing spray (do not use ordinary compressed air), inject preservative oil into each cylinder.

Crank the engine in the normal direction approximately one-quarter turn and spray each cylinder again. Do this eight times, or until the engine has been turned through two complete revolutions. The purpose of this procedure is to bring each valve into an exposed position so the preservative oil will coat it.

D. The remaining steps are the same as steps E through H for an operable engine.

Storing Engines That Have Been In Service

In the course of normal engine operation, residues of various combustion products such as lead and sulfur accumulate in the combustion area and in the lubricating oil. Portions of these residues combine with atmospheric moisture to from corrosive compounds. The following treatment will help reduce damage from this source:

NOTE: Remove emissions components such as catalyst and O_2 sensors before treatment and at restart. Start and burn out storage oils before reinstalling catalyst and O_2 sensors.

1. Engines in operable condition:

A. Run the engine until the original oil is hot, then drain.

B. If practical, run the engine with a good flushing oil in the crankcase and drain the oil and water while still hot.

C. Refill the crankcase with preservative oil, or with the proper grade of lube oil to which an inhibitive-type preservative oil has been added in the proportion recommended.

D. Follow instructions D through H in the previous section “Storing New Engines” as circumstances warrant.

2. When the engine is not operable:

A. Follow the instructions for an inoperable new engine.

B. If the operator determines that storage conditions warrant, the engine should be disassembled, thoroughly cleaned, and reassembled for treatment as a new engine.

Ordinarily, this last procedure is unnecessary except in cases where fuels containing considerable sulfur have been used, or where extremely bad climactic conditions prevail.

PRESERVATION EQUIPMENT AND MATERIAL

Sprays and Atomizers

Many times it is necessary to apply protective compound under difficult field conditions. Several simple tools can be used to atomize preservative oil and force it into the manifolds and combustion chambers. One of these is a manually operated atomizing gun used ordinarily to lubricate inaccessible points on car and truck chassis. Another is a hand operated pump-type sprayer with a pointed discharge nozzle (commonly used with insecticides). If desired, small oil pumps can be rigged with a motor drive to make a convenient spray unit of the mechanical pressure type. In almost all cases, the air available from shop compressor lines carries too much moisture to be safe for this purpose. Do not use high-pressure air from this source.

Heating of Preservative Compounds

Many preservative compounds are most effective when heated before application. If possible, warm up the engine prior to applying preservatives. Heating the preservative oils reduces their viscosity so as to gain penetration into accessible areas. In addition, the hot compound reduces the moisture film at the metal surface and thus avoids trapping moisture under the preservative layer.

WARNING

Generally speaking, such heating is confined to 200°F (93°C) or less. These temperatures are easily reached by placing the preservative container in heated water. Direct heating presents a dangerous and unnecessary fire hazard.

PREPARING ENGINE FOR OPERATION AFTER STORAGE

The steps needed to bring an engine into active service after storage in accordance with these instructions are similar to the steps performed on any new engine. These include inspection, checking for free rotation, adequate cooling water or antifreeze, ample lubricating oil of the correct type and viscosity, and proper adjustments.

In addition, wipe down or wash away accumulated dust and dirt from the exterior before removing the covers over the engine openings.

Remove installed protection upon normal inspection of the engine, generator, and switchgear interiors prior to start-up. Partial removal may be necessary during installation, but this should be kept at a minimum. Engines that have not been rotated for some time should be oiled through the spark plug openings and cranked by hand or with the starting equipment before they are run. Investigate any resistance to free cranking; rust and corrosion can cause severe seizure that cannot be forced clear without engine damage.

CAUTION

Never attempt to start an engine that has been stored without first cranking it over with the spark plugs out. Spurting oil, water, or preservative compound from these openings could lead to a possible hydraulic lock if an attempt is made to operate the engine. Continue to crank the engine with the starter or by hand until liquid is no longer ejected from any openings. Inspect intake passages and manifolds for thickened preservative oil. Oil accumulated in this condition may melt when the engine warms up and cause a runaway.

TROUBLESHOOTING

A well-planned troubleshooting program can help determine the cause or causes of unsatisfactory engine operation and help point out the action needed to correct the problem. A working knowledge of how engine systems work, combined with the troubleshooting chart in this manual and current indications from the engine instrument panel, provide the best background for effective troubleshooting.

OPERATING CONTROLS

Please see the Control Panel section of this manual for discussion of the A54E operating controls and display screens.

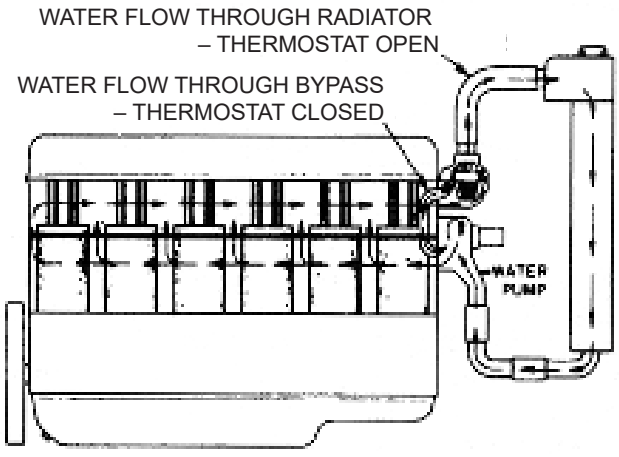
Electrical System

The engine electrical system consists of a main engine harness, engine control module, sensors, relays, fuses, heavy-duty starter, alternator, and other devices similar to automotive installations. The engine is started by closing a circuit from the battery to the starter. The starting motor solenoid provides positive engagement of the pinion before cranking. After cranking is completed and the engine starts, the solenoid disengages. The alternator recharges the battery. Regulators control the alternator's output and protect the system from reverse currents and excessive charging.

Arrow Engine Company supplies engines with negatively grounded electrical equipment only. This standardization of electrical system polarity is common for most equipment manufacturers, and this increases compatibility between supplied electrical equipment and that supplied by the equipment builder.

Cooling System

A pressure circulating cooling system is used on the A54E engines. The water enters the water pump inlet on the left side of the engine. The centrifugal pump pulls this supply of cool water through the pump body and forces it into a passage leading directly into the engine cylinder jacket. The water enters the engine just above the lower end of the cylinder sleeves. From here, the water flow is directed around the cylinder sleeves until it passes upward from the crankcase and into the passages in the cylinder heads. These passages are carefully designed to allow the cooling water to have access to the areas around the valve seats and valve guides. Water is collected from the cylinder head and enters the thermostat housing at the forward end.



The thermostat regulates the engine temperature by automatically controlling the amount of coolant passing through the cooler or radiator core. Back pressure at the water outlet must not exceed 5 PSI (.35 kg/cm^2).

Fuel System

A54E engine is equipped with Woodward PG+ fuel system comprised of an electronic flow regulator (EFR), fuel/air mixer, and electronic throttle body. The system is designed to operate with pipeline-quality natural gas, wellhead natural gas (700–1,600 Btu) or commercial-grade propane (VPG or LPG). Note that an electronic, automatic positive shut-off valve is required for proper and safe operation of the engine. The EFR does not provide any positive sealing of the fuel source. In bi-fuel applications in which both fuel sources are connected at the same time, two electronic lock-off valves are required (one for both fuel sources). The ECM controls the operation of each lock-off valve.

Air Intake System

With the exception of adequate supplies of clean oil and water, probably no other single service item contributes as much to engine life as a properly working air cleaner. This is particularly true under dusty and agricultural operating conditions, but surprising amounts of abrasive dirt are present in even the cleanest engine room. If carried into the engine through the air inlet, such abrasives would rapidly wear away cylinder walls, valve stems, bearings and other working parts.

Even though the dust particles are small, they can cause great damage. It is mandatory that air inlet connections be kept tight to avoid taking in unfiltered air beyond the air cleaner.

The purpose of all air cleaners is to trap dirt and grit. The element must be cleared or changed as dirt accumulates. Perform this several times daily if conditions are especially dirty.

Exhaust System

Efficient removal of engine exhaust is important. An engine consumes an incredible amount of air.

After combustion takes place, the products of combustion must be pushed out of the cylinders, manifolds and exhaust piping. Every possible provision must be made to minimize the restriction or back pressure in an exhaust system.

NOTE: A54E engines require exhaust back pressure below 20 in H_20.

Ignition System

Proper combustion requires fuel ignition within the cylinders at finely defined intervals. A54E engines are equipped with an advanced Woodward ignition system.

Lubrication System

The lubrication system on every A54E engine uses a gear-type oil pump and a full-flow filter. The oil cooler is optional on all engines.

The suction produced on the inlet side of the oil pump draws the oil through the slotted pickup tube (which screens the oil) and into the pump inlet. Oil is discharged under pressure at the top of the pump.

Oil gallery pressure is controlled by the adjustable pressure relief valve, located in the oil pump body. Correct oil pressure is 30–40 PSI (2.81–3.52 kg/cm^2) at 1,800 RPM. To adjust pressure, remove the oil pan to access the pump. Turn the relief valve adjusting screw inward to increase oil pressure; back it out to decrease pressure.

All the oil then passes through the full-flow filter (and cooler, if used) and into the main oil gallery. If the filter is clogged and excessive pressure builds up, a bypass valve in the filter allows oil to go directly to the gallery.

Drilled passages carry the oil from the gallery to the crankshaft main bearings, then to the camshaft bushings.

Oil from the crankshaft main journals travels through drilled passages and lubricates the crankshaft pin bearings. The piston pin bushings are lubricated by oil flowing from the crankpin bearing through a drilled passage in each connecting rod.

Oil flows through a notch in the bearing shell of the front main bearing and into a short passage that intersects with the left-mounting screw hole for the bearing cap. Oil travels around the counterbore relief of the screw threads and through a crankcase passage to the idler gear spindle. Both of the passages and the mounting screw hole must be clean; otherwise, the idler gear bushing will not get enough oil.

The idler gear spindle has an annulus cut into its base. Oil enters the annulus, travels through the shaft and lubricates the bushing. The end of the spindle must be closed off with a pipe plug; otherwise, the gear bushing will not get a pressurized supply of oil and engine oil pressure will drop.

Oil goes to the idler gear. Within the front gear case, oil splash and oil mist lubricate all the meshing gear teeth and transfer pump drive.

The rocker arm assembly is lubricated by oil that flows under metered pressure through a drilled crankcase passageway coming from the Number 2 camshaft bushing. This oil then drains back to the sump through cylinder head and crankcase drain holes, simultaneously lubricating the valve lifters and camshaft lobes.

The use of an oil cooler is optional. Oil goes from the filter, into the cooler and then into the gallery.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
CRANKSHAFT CANNOT BE BARRED OVER **CAUTION:** DO NOT attempt to rotate crankshaft with starter.	Seized piston.	Replace piston assembly and possibly sleeve. Determine cause of seizure-insufficient ring gap, insufficient lubrication, inadequate cooling, or overload.
	Coolant or obstruction in cylinder.	**CAUTION:** Remove spark plugs and crank engine to vent cylinders of accumulated coolant.
	Cracked head.	Replace head.
	Cracked sleeve.	Replace sleeve.
	Blown head gasket.	Replace head gasket.
	BEARINGS TOO TIGHT	
	High spots on bearings.	Replace bearings.
	Improper torque.	Loosen bearing cap and re-torque.
	Main bearing caps installed out of location.	Check each bearing cap. Place in proper location.
	Load not disengaged from engine.	Disengage load.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
ENGINE CRANKS BUT DOES NOT START	A. Fuse/harness connected. B. Mag pickup issue.	A. Repair or replace faulty component related to power supply. B. Replace/reset sensor.
	INSUFFICIENT CRANKING SPEED	
	A. Run-down battery or electric starter system malfunction. B. Lube oil viscosity too high.	A. Charge or replace battery; check starter system. B. Change to lower viscosity as recommended in PREVENTIVE MAINTENANCE.
	POOR COMPRESSION	
	A. Worn rings. B. Leaking valves. C. Leaking head gasket.	A. Replace rings. B. Recondition head and valves. C. Replace head gasket.
	FUEL SYSTEM INOPERATIVE	
	A. Water in fuel. B. Insufficient fuel supply. C. Bent gas pressure regulator control rod. D. Wrong type of fuel selected. E. Lock-off not working.	A. Drain water at strainers and tank. B. Check gas pressure. C. Replace control rod.
	Clogged air cleaner element.	Remove and replace element.
	Safety shutdown control not reset.	Key cycle.
	E-stop malfunctions.	Reset E-stop.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
ENGINE STOPS SUDDENLY	**FUEL**	
	A. Water in fuel. B. Insufficient fuel supply. C. Clogged fuel supply line. D. Check lock-off.	A. Drain water at tank. B. Check gas pressure. C. Replace line and fuel filter. D. Check power and operation.
	Obstructed exhaust manifold.	Determine and correct cause of obstruction.
	Faulty ignition system.	Repair or replace components as required.
	Clogged air cleaner element.	Remove and replace.
	Engine overspeed causes safety control to shut down engine.	Determine and correct cause of overspeed.
	Auxiliary shutdown device.	Determine and correct cause of shutdown.
	Excessive load causes engine to stall.	Determine and correct cause of overload.
	PISTON SEIZURE	
	A. Insufficient ring gap (applicable only immediately after overhaul). B. Insufficient lubrication. C. Insufficient cooling.	A. Replace scored piston, sleeve and rings. Adjust ring gap. B. Replace scored piston, sleeve and rings. Clean oil passages and/or determine cause of lack of lubrication. C. Replace scored piston, sleeve and rings. D. Clean and/or fill cooling system.
	Bearing seizure: Main, connecting rod, piston pin or camshaft bearings.	Replace bearings. Clean up or replace crankshaft, camshaft, or piston pin as required.
	Lack of lubrication.	Check lube oil system. Correct cause.
	Dirt in lube oil.	Check lube oil filter and replace if needed.
	Obstruction in cylinder.	Replace all parts that failed.
	Low oil pressure causes safety control to shut down.	Inspect lubricating oil system and components. Correct cause.
	High coolant temperature causes safety control to shut down engine.	Inspect cooling system and components. Correct cause.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
ENGINE POWER LOSS	**LOW COMPRESSION PRESSURE**	
	A. Leaking head gasket. B. Leaking exhaust, intake valves. C. Worn rings (excessive blow-by). D. Worn piston sleeves. E. Cracked piston. F. Cracked cylinder head. G. Misadjusted intake and exhaust valve (if recently overhauled). H. Dirty air cleaner element. I. Restriction in intake and/or exhaust system.	A. Replace head gasket; inspect for warped cylinder head and/or crankcase. Replace if necessary. B. Recondition head and valves. C. Replace rings. D. Replace if necessary. E. Replace. F. Replace. G. Adjust valves. H. Clean or replace. I. Check for obstruction.
	INSUFFICIENT FUEL	
	A. Cracked fuel lines/filters. B. Low gas pressure. C. Poor fuel quality (low Btus).	A. Replace cracked lines and damaged filters. B. Check gas fuel system. C. Perform fuel analysis; requires at least 45% methane.
	Excessive exhaust system back pressure.	Correct as required.
	Dirty air cleaner element.	Remove and clean or replace.
	Ignition timing incorrect.	Check pickup/bracket.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
LOW OR FLUCTUATING LUBRICATING OIL PRESSURE **CAUTION:** Shut down engine immediately!	Insufficient oil.	Add oil as required.
	Gauge inaccurate.	Compare to master gauge. Replace sensor.
	Engine operated at angles in excess of maximum safe tilt angles.	Operate within maximum safe tilt angles.
	Lube oil filter plugged.	Change oil filter.
	Worn lubricating oil pump.	Repair or replace pump.
	Worn bearings (connecting rod, main, and camshaft).	Replace worn bearings.
	Cracked or leaking lubricating oil piping.	Repair or replace piping.
	Lubricating oil of low viscosity.	Change to higher viscosity oil, as recommended in PREVENTIVE MAINTENANCE.
	Lubricating oil foaming.	Use oil grade recommended in PREVENTIVE MAINTENANCE. Check for water leaks into oil.
	Clogged oil pickup tube.	Remove and clean oil pickup tube.
	Clogged or corroded oil cooler.	Inspect and clean cooler.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
ENGINE WILL NOT REACH RATED SPEED	Ignition component issue.	Check ignition components.
	Engine overloaded.	Determine and correct cause of overload.
	Tachometer inaccurate.	Check pickup sensor.
	Insufficient fuel supply.	Check fuel supply system.
	Restricted air intake.	Correct cause.
	Low fuel supply.	Check pressures and regulators.
	Control panel not sending speed request over CAN bus.	Verify target speed changes when buttons are pressed. If it does not, contact factory.
	CAN bus issue.	Check CAN bus wiring.

SYMPTOM	PROBABLE CAUSE	REMEDY
ENGINE HUNTS OR SURGES	Fuel supply.	Adjust to correct pressure.
	Intake air restriction.	Replace filter.
	Erratic load on engine.	Check connected load. Observe manifold pressure readings.

SYMPTOM	PROBABLE CAUSE	REMEDY
HIGH PRESSURE – LUBRICATING OIL	Gauge inaccurate Compare to master gauge. Lubricating oil temperature too low.	Replace sensor, increase temperature.
	Oil pressure regulating valve stuck in closed position.	Replace pump.
	Lubricating oil of high viscosity.	Change to lower viscosity oil as recommended in PREVENTIVE MAINTENANCE.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
LOW TEMPERATURE – COOLING WATER	Sensor inaccurate.	Compare to master gauge. Replace sensor, check wires.
	Inoperative thermostat.	Replace thermostat.
	Thermostat seal missing or leaking.	Replace thermostat seal.

SYMPTOM	PROBABLE CAUSE	REMEDY
HIGH TEMPERATURE – COOLING WATER **CAUTION:** Cool engine slowly.	Gauge inaccurate.	Compare to master gauge. Check sensor and wires.
	Cooling system is air bound.	Purge air from cooling system.
	Low coolant level.	Fill cooling system.
	Worn water pump.	Replace or overhaul pump.
	Frozen coolant.	Completely thaw cooling system before restarting engine.
	Engine overloaded.	Determine and correct cause of overload.
	Poor coolant circulation.	Check entire cooling system.
	Blown head gasket.	Replace head gasket.
	Insufficient circulation of air (radiator cooling).	Correct as required.
	Cracked head.	Replace head.
	Loose water pump or fan drive belts.	Tighten or replace drive belts.
	Cracked sleeve.	Replace sleeve.
	Inoperative thermostat.	Replace thermostat.
	Late ignition.	Check ignition pickup/mounting bracket.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
HIGH CONSUMPTION – LUBRICATING OIL	Oil leaks in lubricating oil system.	Find and repair leaks.
	Lube oil of low viscosity.	Change to recommended viscosity for operating temperatures in PREVENTIVE MAINTENANCE
	Leaking oil seal(s): rear and/or front.	Change seal(s).
	Worn intake valve guides.	Change head; renew guides, or valve stem seals.
	Stuck/worn piston ring.	Replace rings.
	One or more pistons with rings upside down (if recently over-hauled).	Remove piston; correct position of rings.
	Excessive connecting rod bearing running clearance.	Replace bearings.
	Crankcase breather plugged.	Replace PCV valve/clean breather system.

SYMPTOM	PROBABLE CAUSE	REMEDY
LUBRICATING OIL CONTAMINATED **CAUTION:** Change oil.	**LUBRICATING OIL CONTAMINATED WITH WATER**	
	A. Sleeve seals leaking or sleeve cracked. B. Cracked crankcase.	A. Replace sleeve and/or O-rings. B. Replace crankcase.
	LUBRICATING OIL CONTAMINATED WITH DIRT	
	A. Lube oil filter bypass valve opening because filter is plugged. B. Lube oil filter punctured. C. Air cleaner punctured.	A. Replace filter. B. Replace filter. C. Replace air cleaner element.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
EXCESSIVE VIBRATION **CAUTION:** STOP engine immediately and investigate cause.	**FOUNDATION BOLTS**	
	A. Loose. B. Cracked.	A. Torque. B. Replace bolts. Torque all bolts.
	Vibration damper loose or failed.	Replace and re-torque bolts. Replace damper.
	Misfiring ignition system.	Repair or replace components as required.
	CRANKSHAFT	
	A. Cracked. B. Main bearing bolts loose.	A. Conduct a complete investigation of entire engine for any damage. B. Determine reason for loosening. Investigate the entire lower crankcase before torquing and subjecting engine to use. Replace main bearing bolts.
	Loose flywheel.	Replace cap screws and/or torque as required.

SYMPTOM	PROBABLE CAUSE	REMEDY
BLACK EXHAUST	**INSUFFICIENT INTAKE AIR**	
	A. Air cleaner element clogged. B. Engine overloaded.	A. Clean and repair. B. Determine and correct cause of overload.
	LOW COMPRESSION	
	A. Insufficient valve clearance. B. Burned valves. C. Worn/stuck rings and sleeves.	A. Reset valves. B. Replace or overhaul head. C. Overhaul.
	Over-rich fuel/air mixture.	Check fuel system/ supply.
	Excessive back pressure.	Reduce back pressure.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
HIGH TEMPERATURE – LUBRICATING OIL	Engine overload.	Determine and correct cause of overload.
	High cooling water temperature.	See “High Temperature – Cooling Water” chart for causes.
	Low lubricating oil pressure.	See “Low Lubricating Oil Pressure” table for causes.
	Clogged or corroded oil cooler.	Inspect and clean oil cooler.

SYMPTOM	PROBABLE CAUSE	REMEDY
KNOCKING OR UNUSUAL NOISES	Low octane fuel.	Change to higher octane fuel.
	Engine overloaded.	Determine and correct cause of overload.
	Insufficient oil to idler gear.	Clean oil passage by front main bearing cap (see description under “Lubrication System”). End of idler gear spindle must be plugged.
	Overly advanced ignition timing.	Check pickup sensor/bracket.
	Loose piston pins (failed).	Replace piston pins and/or pin bushings as required.
	Damaged or excessively worn accessory drives.	Repair or replace components as required.
	Excessive crankshaft end play.	Replace main thrust bearing.
	Excessive valve clearance.	Readjust valve clearance.
	Sticking valve or rocker arms.	Free up or replace.
	Misfitted or excessively worn timing gears.	Replace.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
EXCESSIVE FUEL CONSUMPTION	Leaks in fuel system.	Repair as required.
	Faulty ignition system.	Repair of replace components as required.
	Engine overload.	Determine and correct cause of overload.
	Poor compression.	Determine cause(s) and repair.
	Improper matching or torque converter to engine and load.	Replace torque converter.

SYMPTOM	PROBABLE CAUSE	REMEDY
LOW GAS PRESSURE	Incorrectly adjusted gas regulator.	Readjust.
	Insufficient line pressure.	Increase line pressure.
	Incorrect orifice and /or spring in gas regulator.	Replace orifice and/or spring.
	Undersize gas regulator.	Replace with gas regulator of adequate size.
	Undersized piping.	Replace with piping of adequate size.
	Gas regulator mounted too far from engine.	Remount gas regulator as close to the lock-off valve as possible.
	Lock-off valve failure.	Check lock-off valve for correct operation.

SYMPTOM	PROBABLE CAUSE	REMEDY
HIGH GAS PRESSURE	Incorrectly adjusted gas regulator.	Readjust.
	Incorrect spring or orifice in gas regulator.	Replace spring or orifice.
	Excessive line pressure.	Reduce line pressure.

CRANKCASE

The A54E crankcase is a single-piece iron casting. There are seven main bearing supports for the 6-cylinder engine. There are also locations for six wet-type cylinder sleeves. There are cooling water passages between the side walls of the crankcase casting and the cylinder sleeves. Thus, the sleeves are always in direct contact with the coolant. The cylinder sleeves are removable, so it is necessary to maintain a seal at the upper and lower sleeve-to-crankcase contact surfaces. This is done at the top of the sleeve by the head gasket which seals the mating surfaces of the sleeve flange and the crankcase deck. The bottom seal is made with three rubber seal rings at the lower end of the sleeve.

The crankcase has four support locations for the camshaft journals. These support the camshaft at the front and rear and at two intermediate points. All camshaft supports have pressed-in bushings.

At the rear end of the crankcase is a mounting surface for a flywheel housing and a retainer for the crankshaft lip-type oil seal. To ensure accurate mounting of the clutch or other drive unit in the flywheel housing, this rear mounting surface is held to close tolerances. Whenever the power take-off, flywheel, or flywheel housing is removed, the run-outs for the flywheel face, flywheel housing face, flywheel housing bore, and pilot bearing bore should be checked and adjusted as required. Install the rear oil seal between flush with and .060-inch (1.52 mm) below the back surface of the oil retainer. The oil seal lip faces toward the crankcase.

Faced mounting bosses and connections are provided on the crankcase exterior for mounting accessories, lines, and other equipment.

Cylinder Heads and Valves

The cast iron cylinder head is designed and fabricated especially for the temperatures and pressures of industrial use.
The poppet-type intake and exhaust valves on the A54E engines have hardened tips and recesses for split-taper locks.
All A54E engine intake and exhaust valves use a valve stem seal, consisting of a polyacrylic jacket and two steel retaining rings.

If the head has not been removed and the valve seals are to be replaced, care must be taken so the valves don't fall into the cylinder when the valve tapers are removed.

To secure the valves, remove spark plug. Fit an air hose adapter to the spark plug hole, and fill the cylinder with compressed air. The cylinder must be kept pressurized at all times. The air pressure will be enough to keep the valves in the closed position.

To install these seals, follow these steps:

1. Make sure the valve and guide assemblies are clean.
2. Gently slide the seal over the valve stem, and down until it comes into contract with the valve guide. The end of the seal with the widest opening must be over the guide.
3. Press the seal into place. All downward pressure should be exerted on the lower retaining ring, not on the polyacrylic part of the seal.

Never reuse valve stem seals. Always replace with new seals whenever a valve, valve guide, or valve stem seal is removed.

The exhaust valve of all A54E engines seat on a hardened valve seat insert in the cylinder head. This insert is shrunk and pressed into place. Intake and exhaust guides are pressed into place in the cylinder heads, but may be replaced.

Valves and springs are held in position by hardened retainers, which are stepped to center the springs. The retainers are seated on split-taper locks.

Valve actuation is obtained through chilled and polished mushroom-type valve lifters, riding directly on the camshaft lobes. This motion is transmitted to the rocker arms by tubular steel push rods, equipped with a hardened socket at the top end and a hardened tip at the bottom. There is a socket in the valve lifter to receive the lower end push rod tip.

The ductile iron rocker arms pivot on a hardened, hollow steel shaft. The rocker arms are curved to align with their respective intake or exhaust valve tips. To ensure long wear and accurate adjustment, the rocker arms are hardened in the valve-rocker arm contact area. Drilled openings along the shaft mate with passages in the rocker arms to permit lubrication of the entire overhead mechanism.

Cylinder Sleeves

The wet-type cylinder sleeves are iron centrifugal castings, designed for long wearing qualities and resistance to distortion. Each sleeve has a shoulder and flange at the upper end to locate the sleeve in crankcase and prevent shifting and leakage when the cylinder head and gasket are torqued into position. This flange, and the crankcase deck recess into which it fits, both have precision-finished mating surfaces to form a water seal. The cylinder sleeve projects above the deck to ensure a tight crush gasket joint. Whenever sleeves are installed, check the lower end of the sleeve projection. The lower end of the sleeve is tapered with grooves immediately above the taper for the rubber sealing rings. The top two grooves contain a black rubber sealing ring, and the bottom groove contains a red silicone sealing ring.

Cylinder Sleeve Projection

Use the following procedure to measure cylinder sleeve projection:

1. After removal of the head, clean carbon and other deposits from the face of the block and sleeve projections.
2. Place a metal bar across the center of the sleeve and bolt both ends into place using 150 ft.-lbs. (203.4 N-m) torque. This step will force the sleeve into the position it normally occupies when the head is in place.
3. Use a dial indicator to measure the height of the sleeve projection above the face of the block.

Pistons

The aluminum alloy pistons are heavy-duty castings. The piston pins are full floating, and are held in the piston by two spring-type clips. Two compression and one oil control ring are used on all pistons.

CAUTION

Pistons for all A54E Series engines are marked with the word FRONT and an arrow, and must be installed with the arrow pointing toward the gear cover (front) end of the engine.

Connecting Rods

I-section connecting rods are used in the A54E Engine. The rods and caps are forged. Hard bronze bushings are a press fit in the piston-pin end and are diamond bored for precise alignment. Piston pin bushings should be installed between flush with and .010-inch (.25 mm) below the side of the rod. Press each bushing in so that the relief notch on the side of the bushing surrounds, but does not cover, the oil hole in the connecting rod. Connecting rods are never bent for alignment purposes, neither at the factory nor in the field. Two heat-treated connecting rod screws hold the bearing caps in place. The upper and lower halves of connecting rod bearings are interchangeable.

CAUTION

The connecting rod cap must be aligned to the rod during rod installation. Improper rod alignment will decrease side play and lead to rapid rod and crankshaft wear.

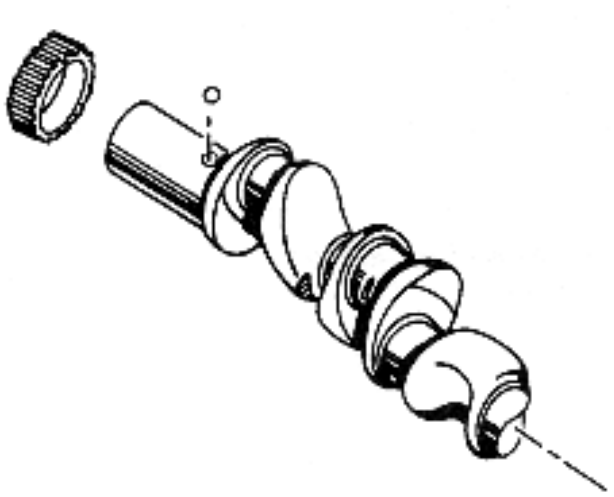
To align the rod and cap, hold the cap in position against the rod and snug the bolts into position. Do not tighten the bolts. Then, with a soft hammer, alternately tap the rod and then the rod cap to either side of the crank, against one of the crank thrust areas. When both the rod and cap are against the same thrust area, the cap and rod will be in alignment, and the connecting rod bolts can be torqued.

Crankshaft

The crankshaft is precision ground from a heat-treated steel forging. The crankshaft has flame-hardened main bearing journals which run in steel backed, alloy bearing shells. Connecting rod bearings are of similar construction for maximum serviceability.

CAUTION

The main bearing shells are stamped "upper" and "lower" and are not interchangeable. The main bearing upper shells are grooved while the lower are not.



The rear extremity of the shaft has an integral mounting flange for the flywheel. This flange is drilled and tapped for six flywheel-mounting bolts. One bolt hole is offset 1/16 inch (1.6 mm) to ensure proper flywheel installation. The front extension of the crankshaft provides the mounting surface to support the press fitted crankshaft drive gear. The crankshaft pulley is retained by six crank bolts. Two of the six bolt holes in the front of the crankshaft are slightly offset to allow for proper crankshaft pulley installation.

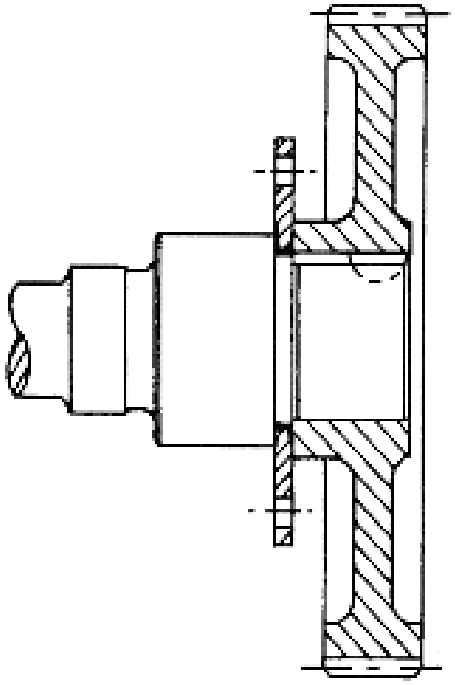
The A54E crankshafts use a chrome alloy steel ball to retain the gear. This ball protrudes from a hole drilled into the nose of the crankshaft. During servicing, take care not to lose the ball if removing the crankgear. The gear can be reinstalled by resting the ball in the drilled hole, and pressing the heated gear into place.

Flywheel

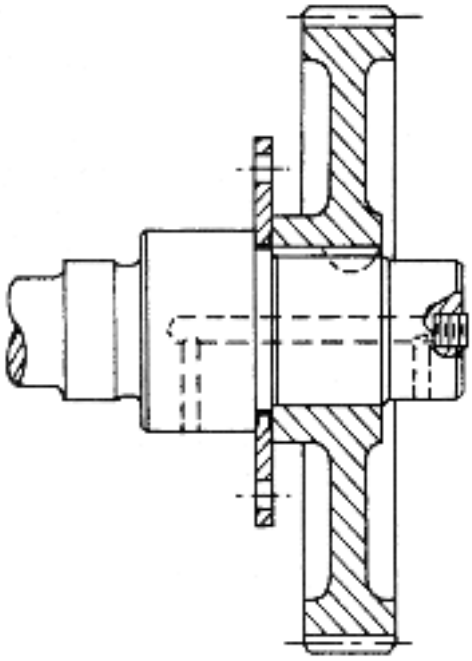
To prevent oil leaks from the flywheel-mounting flange always install the flywheel bolts using type C or CV Loctite. Torque to 65 ft.-lbs. (88 N-m).

Camshaft

The camshaft is a single casting, with ground cam lobes and journals. Individual hardened cam lobes actuate each of the valve lifters. An integral worm gear drive drives the internal oil pump. The forward end of the camshaft is keyed to hold the camshaft drive gear. Lubricating oil is supplied to each of the four journal areas. A steel-backed babbitt bushing, pressed in the main crankcase, supports the camshaft at all four journals.



STANDARD APPLICATION CAMSHAFT



SPECIAL APPLICATION CAMSHAFT

Installation of New Valve Lifters and New Camshaft

When a new camshaft is installed to replace a failed or worn camshaft, an entire set of new valve lifters must also be installed. The new camshaft will not be covered by warranty unless new lifters are also installed.

Wear patterns on the old lifters and/or damaged old lifters can result in early failure of the new camshaft when new lifters are not installed.

Protection of Engine and Parts

During repair and replacement procedures, use caution to prevent damaging parts in handling. Protect all machined surfaces and keep separate from other parts. Parts that are easily damaged require particular care to prevent bending, denting, or breakage. All parts should be covered to protect them from dirt. This will also speed reassembly by reducing cleanup time at assembly.

When parts are removed, the resulting openings into the engine should be covered to keep dirt or other foreign matter from entering the engine.

Cleaning and Inspection of Engine Parts

Parts and assemblies can frequently be inspected without removal or complete disassembly.
Use best practices to avoid disassembly beyond what is necessary to correct the fault and put the part or assembly in serviceable condition.

The following paragraphs describe cleaning procedures and, where applicable, name cleaning materials to be used if available. The different metals used in the engine components require different techniques and cleaning materials, so a generalization of cleaning methods cannot readily be supplied.

Carbon Removal

Carbon must be removed during maintenance operations from valves, pistons, and cylinder heads.

Carbon can be removed from hardened surfaces by first softening the carbon.

Soften the carbon by soaking the parts in a carbon removing compound. Rinse in kerosene or hot water and remove softened carbon with a rag or soft brush.

Never scrape parts with a metallic scraper.

Castings

Use a cleaning solvent to clean inner and outer surfaces of castings and all areas exposed to oil and grease.

Remove sludge and gum deposits with a stiff brush.

After cleaning, blow out all tapped holes and dry castings thoroughly with compressed air.

Oil Passages

Clean oil passages with wire brushes or probes to break up any sludge or gum deposits.

Wash passages by flushing with cleaning solvent and dry thoroughly with compressed air.

When cleaning lube oil passages, do not use any material that will leave lint or other foreign particles in the oil passages. Clogging or interference in passages may be caused by any foreign material. Such material could be worked into the bearings upon operating the engine, or could block oil flow to the engine components.

Oil Seals and Hoses

Clean seals and hoses with soap and water. Do not allow cleaning solvent to contact seals and hoses.

Ball and Roller Bearings

Do not spin bearings with air.

Antifriction bearings should receive special handling. As soon as a bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in kerosene and inspect races and balls or rollers. Discard bearings if they are pitted, scored, or burned. If a bearing is serviceable, coat it with light oil and

wrap it in clean paper. Do not unwrap bearings until just before installation.

Always use the proper tool or fixture for pulling or pressing out bearings. Normally, bearings should not be removed unless replacement is required.

When installing a bearing against the shoulder on a shaft, be sure the chamfered side is toward the shaft shoulder. When a bearing is to be pressed in, lubricate the mating surfaces prior to assembly. When a bearing is to be pressed into a bore, always exert the press forces onto the outer race of the bearing only. When pressing a bearing onto a shaft, exert the press force on the inner race. This will avoid bearing distortion.

Oil Seals

Oil seals should not be removed unless absolutely necessary for gaining access to another item, or unless they are being replaced due to damage or wear. If the seal must be cut through to remove it, care must be taken not to damage the seating area around it.

Lubricant leakage around the shaft or bearing is usually a sign of oil seal failure.

Oil seals that leak, or are worn to a point where they may begin to leak, must be replaced. An oil leak corrected in time will prevent overheated bearings resulting from a loss of lubricant. Never use oil seals a second time; once removed, they must be discarded and replaced.

A lubricant must be applied to the lip of all shaft-type rubber seals before installation. This will prevent seal damage during initial running, until oil has contacted the sealing face.

Attaching Parts

Use screws of a correct length. A screw which is too long may bottom before the head is tight against the part it is to hold. In addition, the threads may be damaged when the screw is tightened. If a screw is too short, there will not be enough thread contact to hold the part securely.

In addition to size variations, attaching parts may vary in material and heat treatment. Do not mix different types of attaching parts.

Use lock washers, cotter pins, or other locks to lock each nut and cap screw when specified.

Gears

Always use the tools recommended (or equivalent) for gear removal and installation. Gears must be carefully inspected for damaged or worn teeth. Always align the keyway in the gear with the keyway in the shaft before installation. Lubricate the mating surfaces of the gear and shaft when pressing the gear onto the shaft.

If crankshaft gear removal is necessary, use an appropriate heavy-duty puller. Never heat the gear for removal, because this may damage the crankshaft. Before installing new crankshaft gear, heat the gear in an oven or other even source of heat to a maximum of 400°F (205°C) to facilitate installation. Do not use a torch to heat the gear. The gear will not heat and expand evenly when torch heated.

WARNING

Use insulated gloves when handling a hot gear.

Quickly place the heated gear onto the crankshaft and hold it securely in place until it cools and contracts. The gear may be carefully tapped into place with a soft face hammer or driving tool if it sticks due to slight cocking or binding.

If the idler gear bushing is replaced, it should be installed approximately .125-inch (3.17 mm) below the front of the gear hub.

Gaskets

Install gaskets where required and use new ones whenever possible. Never use cork or felt gaskets a second time.

CAUTION

Be sure the holes in the gaskets correspond with lubricant passages in mating parts. If it is necessary to fabricate gaskets, select stock of a proper type and thickness, and be sure to cut the holes in the right places. Blank or incorrectly installed gaskets can cause serious damage by blocking lubricant passages.

Bushings

Do not remove bushings unless inspection reveals damage or wear that exceeds the specified clearance, or unless the bushing is loose in its mating bore. Bushings should be pressed out whenever possible. When pressing or driving (in or out), apply pressure directly in line with the bore. If the bushing must be driven, use a driver of the largest possible diameter or a bar with a smooth, flat end. Never drive bushings with a hammer. If the bushing has an oil hole, be sure to line up the oil hole in the bushing with the oil hole in the part in which it is assembled.

NOTE: Service cam bushings should be installed when cam bushings need replacing. Service cam bushings are manufactured with dimensions to allow for proper bearing clearance and alignment without line reaming.

Shafts

If a shaft offers unexpected resistance to removal, check carefully to see that all nuts, keys and cap screws have been removed before using force. Also check for interference with another part which must be removed first. Clean the rust preventive compound from all machined surfaces of all new parts before installing. Shafts fitted to other parts with tapers are always tight. If they are not tight when disassembled, inspect tapers and discard the part if the taper is worn. Before assembling shafts with tapers, be sure tapers are clean, dry and free from burrs. Press mating parts together tightly.

Flexible Hose Lines

Install fittings by threading the swivel nuts on by hand until they are finger tight. Hold the socket on the hose with one wrench and tighten the swivel nut securely with another wrench. This method prevents twisting the hose and does not exert any strain on the hose. Correct installation prevents hose damage that would not appear until there is pressure on the hose.

Repairing Damaged Threads

Damaged threads should be repaired by use of thread restorer or by chasing in a lathe. Internal threads should be repaired using a tap of a correct size.

If threads cannot be satisfactorily repaired, install a Heli-Coil or other standard insert or replace the part.

Repair of Damaged Machined and Polished Surfaces

Smooth rough spots, scores, burrs, galling, and gouges from damaged machined and polished surfaces so that the part will efficiently perform its normal function. The finish of the repaired part is to approximate that of the original finish. In performing any of these operations, critical dimensions must not be altered.

Removal of Rust or Corrosion

Remove corrosion from all parts of the material. To remove rust or corrosion, use a brass wire brush, abrasive cloth, bead blast, vapor blast equipment, or rust remover except on highly polished surfaces. On these surfaces, buffing or use of crocus cloth is recommended.

CAUTION

Do not expand rings more than is necessary to slip over the piston. Over-expansion of rings causes stress and may lead to early failure. Ring gaps should be staggered 180 degrees to prevent blowby during initial starting. Rings must be thoroughly lubricated with engine oil before being installed in the cylinder sleeve.

Two oil ring rails are separated by an oil ring rail spacer. The ends of the spacer are butted against each other with the upper and lower rail gaps staggered 120 degrees and 140 degrees respectively from the spacer gap.

Compression rings of A54E engines which are notched on the inner edge must be installed with the notch toward the top of the piston. Compression rings of A54E engines which are notched on the outer edge must be installed with the notch toward the bottom of the piston. The rings are stamped TOP or include a center punch mark which must be installed toward the top of the piston.

CAUTION

All A54E Series engine pistons are marked with an arrow and the word FRONT, and the piston must be installed with the arrow pointing toward the front of the engine.

Water Pump Seal Installation

When installing a new water pump seal, carefully wipe the carbon sealing surface and the mating ceramic surface with a soft cloth or absorbent paper to remove all traces of wax, grease, or oil. On a small part of the seal, apply either a 1% soluble oil and water solution or ethylene glycol-type anti-freeze to both sealing faces.

Water Pump or Fan Pulley Installation

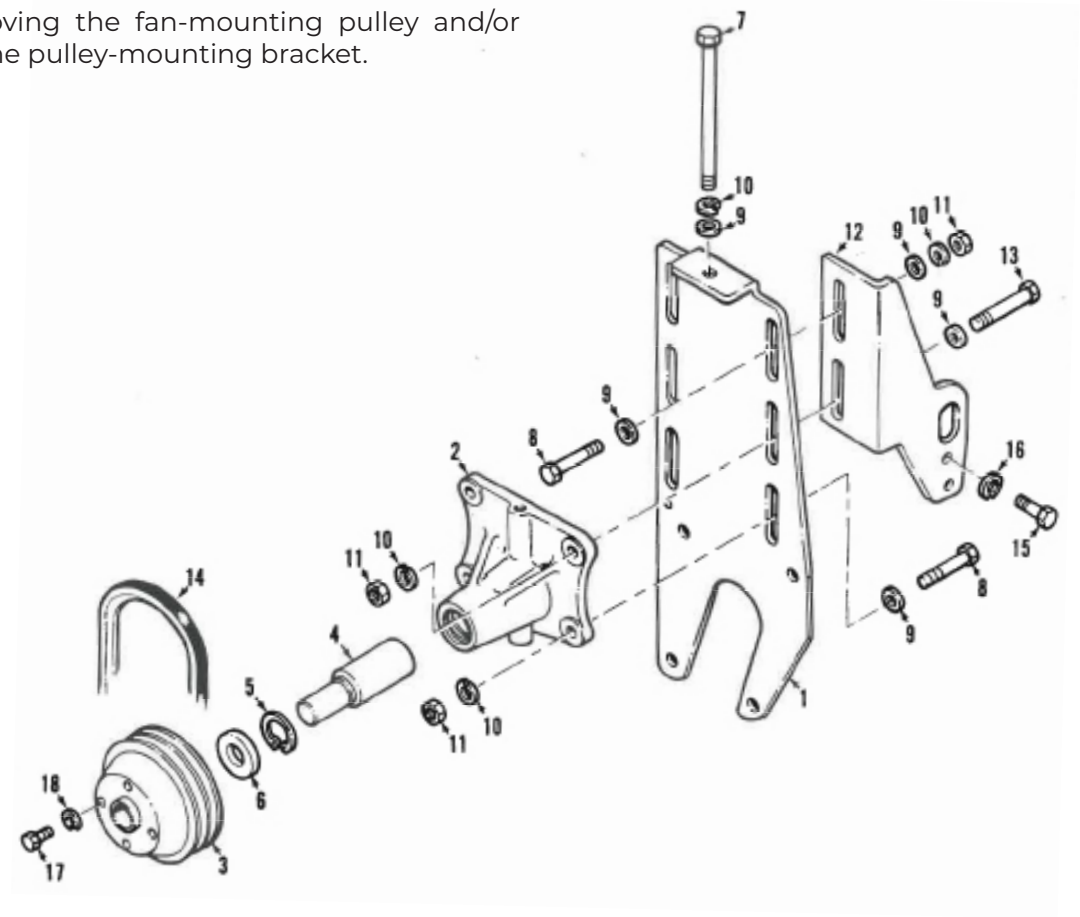
Before replacing the water pump or fan pulleys, carefully check all joining surfaces. These pulleys are held on by an interference fit. Loctite 601 bearing mount should always be used to secure the pulley.

Fan Height Adjustment and Fan Belt Tightening Procedures

The fan height on the A54E can be adjusted to 16, 18, 19, or 21 inches above the crankshaft center line by moving the fan-mounting pulley and/or inverting the pulley-mounting bracket.

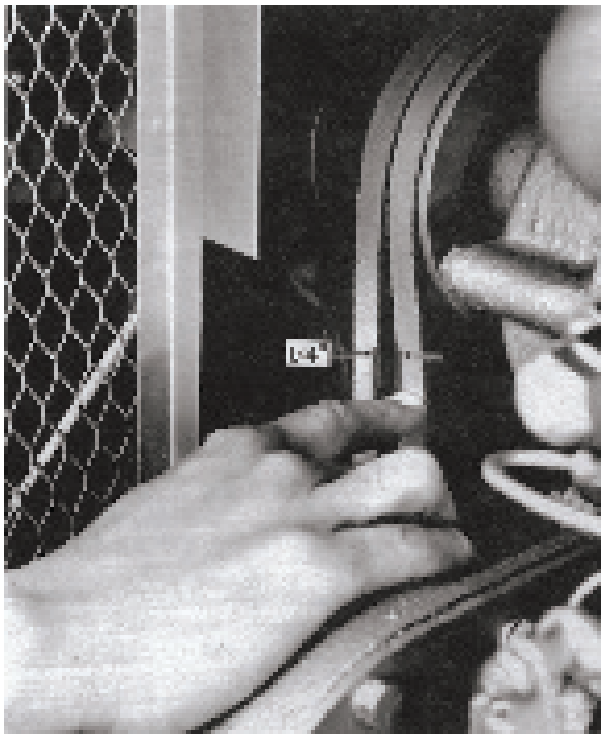
FAN BRACKET

1. Pulley
2. Fan belts
3. Shaft
4. Fan height adjusting screw
5. Bracket support
6. Reversible pulley mounting bracket



The following table lists the different belts and adjusting screws needed to change fan heights:

Nominal Fan Height	Fan Belts		Fan Adjusting Screw	
	Part Number	Length	Part Number	Screw Size
16" (41 cm)	A216003C	47" (119 cm)	26762	3/8"-16 x 5 1/4"
18" (46 cm)	A216003	51" (130 cm)	21374	3/8"-16 x 4 1/4"
19" (48 cm)	A216003A	53" (135 cm)	21362	3/8"-16 x 2"
21" (53 cm)	A216003B	57" (145 cm)	21354	3/8"-16 x 1-3/8"



Tighten all belts to 1/4-inch (6 mm) deflection.

The fan belts are tightened by loosening the pulley-mounting bracket bolts and turning the adjusting screw until the belts reach the proper tension. Tighten the bolts that secure the pulley-mounting bracket to the bracket support.

Alternator-Water Pump Belt Tightening

To tighten the alternator-water pump belt, loosen the mounting and adjusting strap bolts and pivot the alternator (or belt tightener) away from the engine until the belt reaches the desired tension. Tighten the adjusting strap bolt and then the mounting bolt.

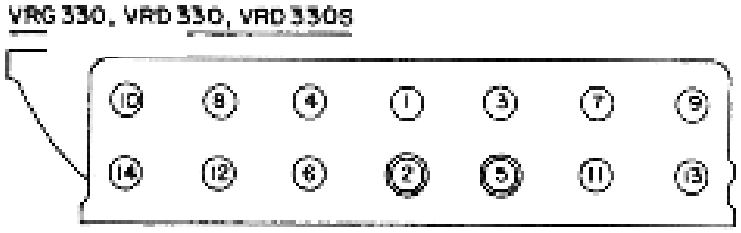
TORQUE RECOMMENDATIONS

The values specified below are to be used only in the absence of specified torquing instructions and are not to be construed as authority to change existing torque values. A tolerance of +3% is permissible on these values, which are for oiled threads. Reduce torque by 20% if new plated cap screws are used.

HEAT-TREATED MATERIAL SAE GRADE 5 AND GRADE 8

NOTE: INCREASE VALUES 1/3 FOR DRY THREADS

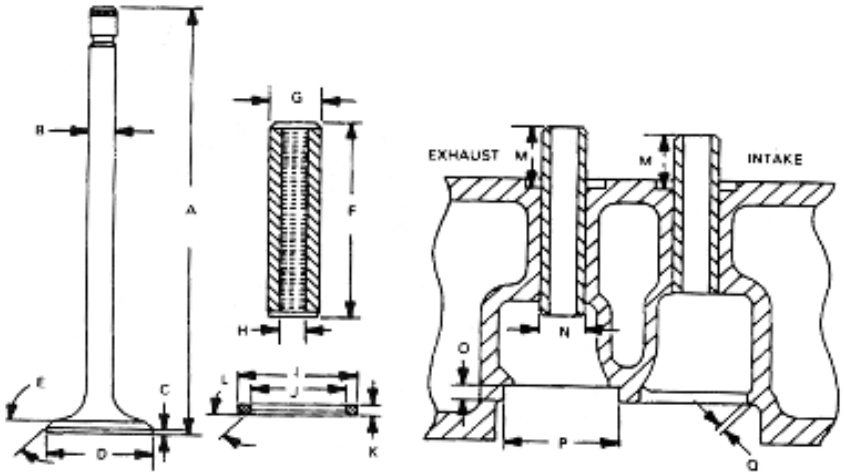
Thread Size	Grade 5 3 radial dashes on bolt or cap screw head		Grade 8 6 radial dashes on bolt or cap screw head	
	Lbs.-Ft.	N-m	Lbs.-Ft.	N-m
1/4-20	6	8.13	9	12.2
1/4-28	7	9.5	11	14.91
5/16-18	13	17.6	18	24.4
5/16-24	15	20.34	21	28.47
3/8-16	24	32.54	34	46.09
3/8-24	27	36.61	38	51.52
7/16-14	38	51.5	54	73.21
7/16-20	42	56.9	60	81.35
1/2-13	58	78.6	82	111.17
1/2-20	65	88.1	90	122.02
9/16-12	84	113.9	120	162.69
9/16-18	93	126.1	132	178.96
5/8-11	115	155.9	165	223.7
5/8-18	130	178.3	185	250.82
3/4-10	205	277.9	290	393.18
3/4-16	230	311.8	320	433.86
7/8-9	305	413.5	455	616.89
7/8-14	335	454.2	515	698.24
1-8	455	616.9	695	942.28
1-14	510	691.5	785	1064.30
1-1/8-7	610	827	990	1342.24
1-1/8-12	685	928.7	1110	1504.91
1-1/4-7	860	1166	1400	1898.12
1-1/4-12	955	1294.8	1550	2101.49
1-3/8-6	1130	1532.05	1830	2481.11
1-3/8-12	1290	1748.98	2085	2826.84
1-1/2-6	1500	2033.7	2430	3294.59
1-1/2-12	1690	2291.3	2730	3701.33
1-3/4-5	2370	3213.25	3810	5165.59
2-4-1/2	3550	4813.09	5760	7809.41



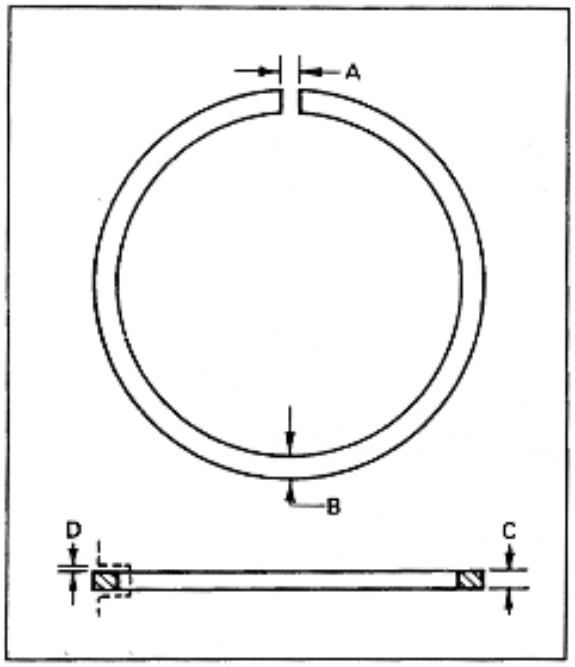
CYLINDER HEAD TORQUING SEQUENCE

TORQUE		
	Ft.-Lbs.	**N-m**
Cylinder Head Cap Screws	205–215	277–291
Main Bearings	130–135	176–183
Flywheel	65–69	88–94
Connecting Rods	44–46	60–62
Crank Pulley Screws	37–39	50–53
Spark Plugs	20–23	27–31
Vibration Damper	27–29	37–39
Alternator Pulley Nut	40–60	54–81
Alternator Battery Terminal Nut	2–3	2.7–4
Rocker Arm Cover	8	11
Rear Oil Seal Screw	13	18

CLEARANCES AND TOLERANCES



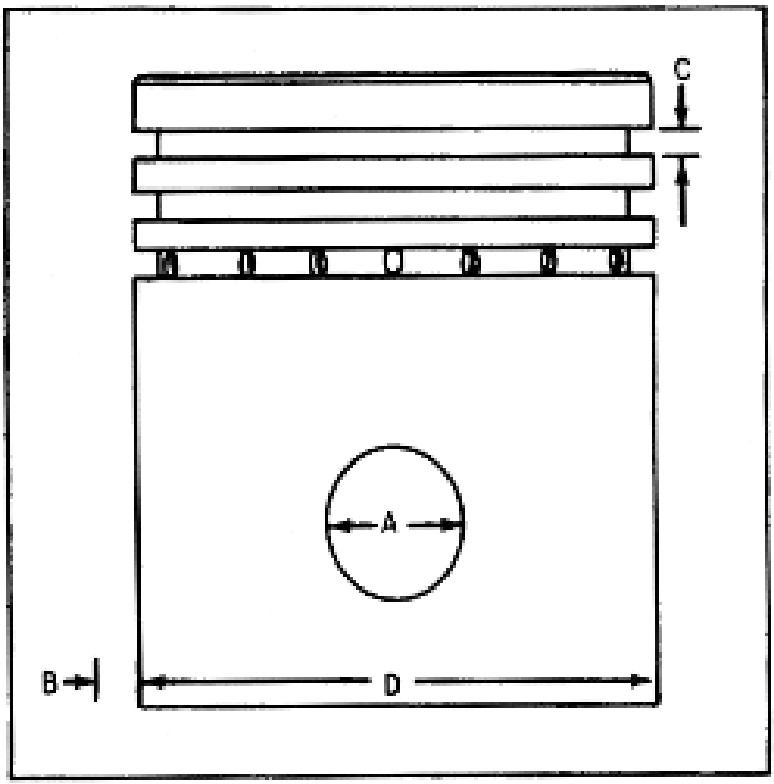
VALVE TRAIN, VALVE PORT CLEARANCES			
		Inches	mm
Valve Length	Intake and Exhaust	5.3935–5.4185	136.99–137.63
Valve Stem Diameter	Intake Exhaust	.372–.373 .371–.372	9.45–9.47 9.42–9.45
Valve Lip Thickness	Intake and Exhaust	.053–.073	1.35–1.85
Valve Face and Seat Runout (Maximum)		.002	.05
Valve Head Diameter	Intake Exhaust	1.615–1.63 1.508–1.518	41.02–41.53 38.30–38.56
Valve Face Angle	Intake and Exhaust	44° 30 ft. + 15 ft.	
Guide Length	Intake Exhaust	2.396–2.41 2.62–2.64	60.86–61.37 66.6–67.1
Guide OD	Intake and Exhaust	.6255–.626	15.888–15.900
Guide ID	Intake and Exhaust	.374–.375	9.50–9.53
Guide to Stem Clearance	Intake Exhaust	.001–.003 .002–.004	.03–.08 .05–.10
Exhaust Seat Insert OD		1.6270–1.6275	41.326–41.339
Exhaust Seat Insert ID		1.385–1.390	35.18–35.31
Exhaust Seat Insert Depth		.207–.209	5.26–5.31
Intake Seat Angle and Exhaust Seat Insert Angle		45°–45° 30 ft.	
Guide Extend Above Head	Intake Exhaust	.834–.854 .928–.948	21.18–21.69 23.57–24.08
Guide Bore in Head		.6245–.6250	15.862 -15.875
Exhaust Seat Insert Counterbore Depth		.217–.220	5.51–5.59
Exhaust Seat Insert Counterbore Diameter		1.624–1.625	41.25–41.28
Intake Seat Width		.060–.083	1.52–2.11
Exhaust Seat Insert Width		.074–.102	1.88–2.59
Spring Free Length	Intake Exhaust	2-9/16 + 1/16 2-9/16 + 1/16	65.07 + 1.59 65.07 + 1.59
Valve Closed Spring Length	Intake Exhaust	1-29/32 @ 59 + 4# 1-29/32 @ 59 + 4#	48.45 @ 27 + 1.8 kg 48.45 @ 27 + 1.8 kg
Valve Open Spring Length	Intake Exhaust	1-1/2 @ 95 + 4# 1-1/2 @ 95 + 4#	38.25 @ 43 + 1.8 kg 38.25 @ 43 + 1.8 kg



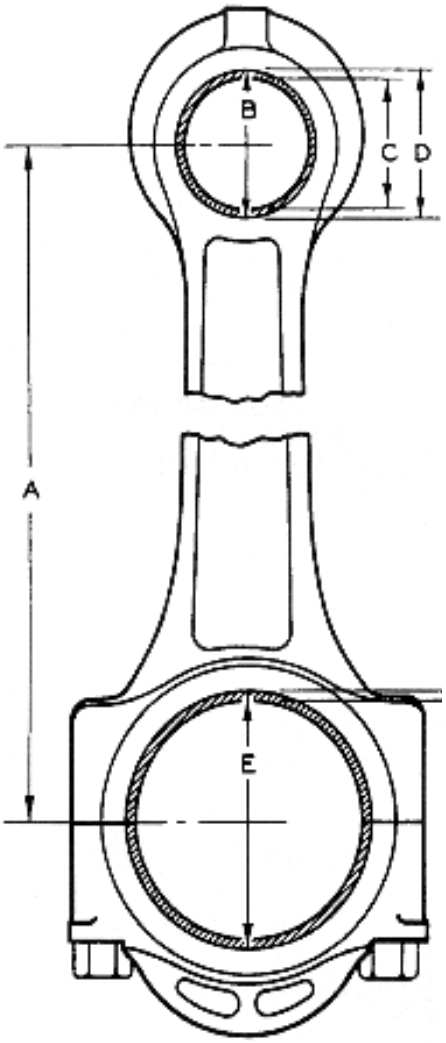
CAUTION

Compression rings of A54E Series engines which are notched on the inner edge must be installed with the notch toward the top of the piston. Compression rings of A54E Series engines which are notched on the outer edge must be installed with the notch toward the bottom of the piston. Some rings are stamped TOP or include a center punch mark which must be installed toward the top of the piston.

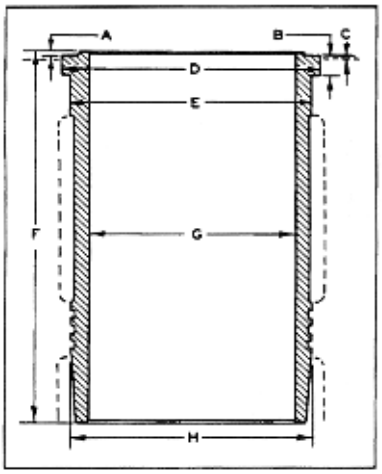
TYPICAL PISTON RING		
	All Engines Inches	**All Engines mm**
A. RING GAP–		
Top	.010–.023	.25–.58
2nd	.010–.023	.25–.58
3rd	.010–.023	.25–.58
B. RING WALL–		
Top	.168–.178	4.27–4.52
2nd	.149–.168	3.78–4.27
3rd	.135–.145	3.43 -3.68
C. RING WIDTH–		
Top	.0930–.0935	2.362–2.375
2nd	.0930–.0935	2.362–2.375
3rd	.1860–.1865	4.724–4.737
D. SIDE CLEARANCE–		
Top	.0025–.0040	.064–.102
2nd	.002–.004	.05–.10
3rd	.0015–.0035	.038–.089



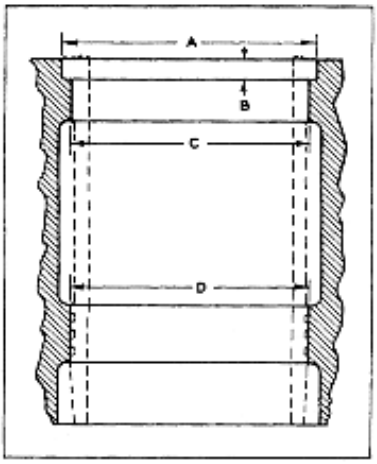
TYPICAL PISTON		
	A54E	
	Inches	mm
PISTON PIN DIAMETER	1.2495–1.2497	31.737–31.742
A. Piston Pin Bore	1.2499–1.2502	31.747–31.755
PISTON PIN FIT	.0002–.0007	.005–.018
B. Running Clearance	.0023–.0053	.058–.135
C. Groove Width		
Top	.096–.097	2.44–2.46
2nd	.0955–.0965	2.426–2.451
3rd	.188–.189	4.77–4.80
D. Skirt Diameter	3.8707–3.8727	98.316–98.367



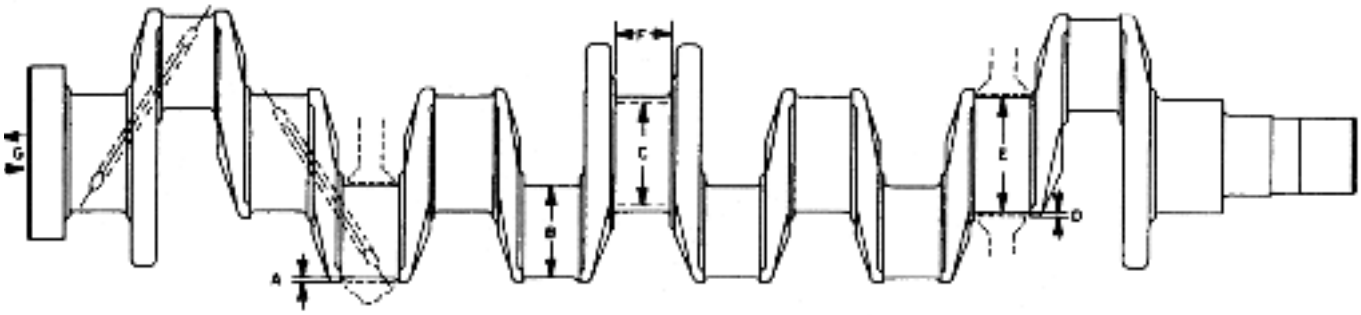
CONNECTING ROD		
	Inches	**mm**
A – Rod Length, Center to Center	6.999–7.001	177.77–177.83
B – Small End Finish Size	1.3745–1.3755	34.912–34.938
C – Bushing Bore Diameter	1.2501–1.2506	31.753–31.765
D – Bushing Press in Rod	.0035–.0060	.089–.152
E – Large End Finish Size	2.5883–2.5893	65.743–65.768
F – Bearing Wall Thickness	.0748–.0753	1.90–0.343
Rod Side Clearance	1.3655–1.3675	34.684–34.735
Weight Variation Per Set	1/4 oz.	7.09 grams
Bearing Running Clearance	.0007–.0037	0.018–0.094



CYLINDER SLEEVE		
	Inches	mm
A – Heat Dam Projection	.030–.034	.76–.86
B – Flange Height	.345–.346	8.76–8.79
C – Sleeve Projection	.001–.004	0.03–0.10
D – Flange Diameter	4.558–4.560	115.77–115.82
E – Sleeve Diameter Below Flange	4.290–4.300	108.97–109.22
F – Sleeve Length Less Heat Diameter	7.620	193.55
G – Bore Diameter	3.875–3.876	98.43–98.45
H – Sleeve Diameter Lower Seal Area	4.277–4.279	108.64–108.69
Sleeve Bore Maximum Out of Round	.002	.051
Sleeve Bore Taper Maximum	.002	0.05
Sleeve Seal Area to Crankcase Diameter	.002–.005	0.05–0.13

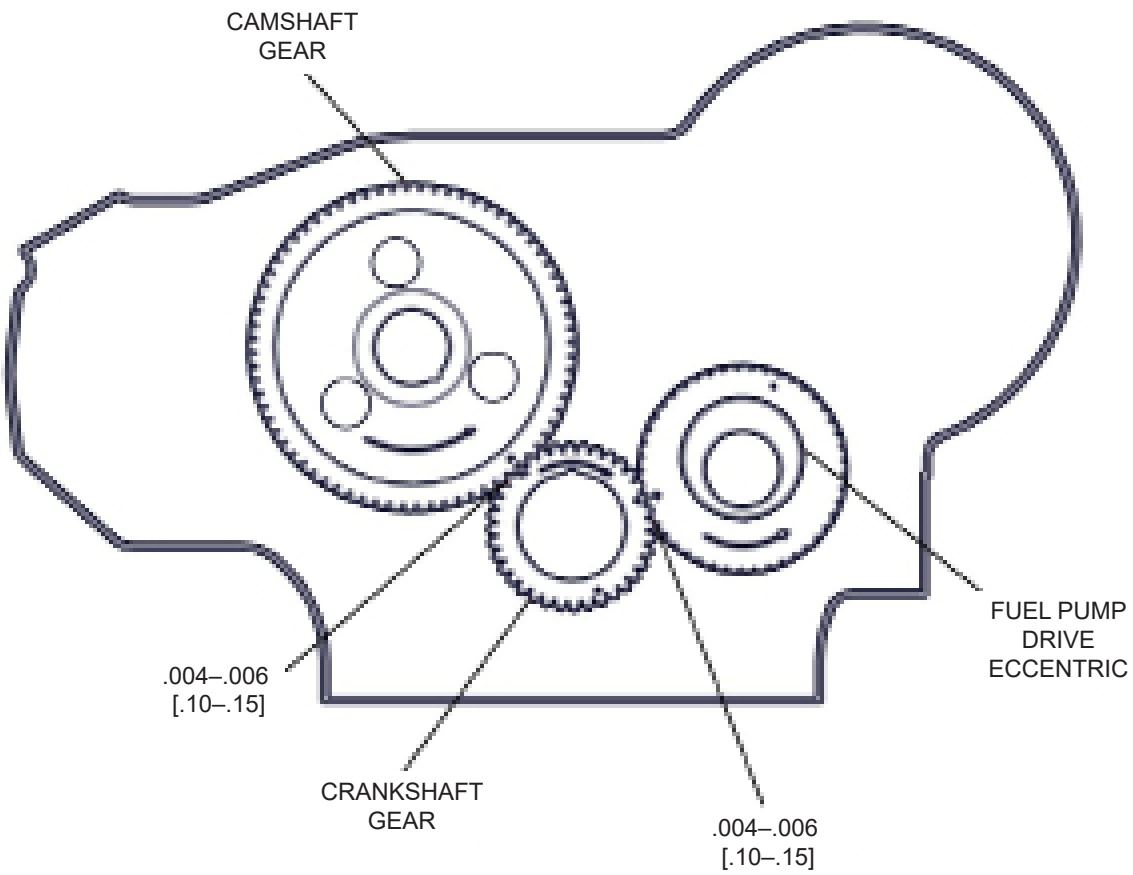


BEARING		
	Inches	mm
A – Counterbore Diameter	4.562–4.563	115.87–115.90
B – Counterbore Depth	.342–.344	8.69–8.74
C – Case Upper Bore	4.370–4.380	111.00–111.25
D – Case Lower Bore	4.281–4.282	108.74–108.76
Main Bearing Journal Bore	3.191–3.192	81.05–81.08
Camshaft Bearing Bore	2.1245–2.1255	53.962–53.988
Camshaft Outboard Bearing Bore in Gear Cover (Special Application Only)	1.502–1.503	38.15–38.18



TYPICAL CRANKSHAFT		
	Inches	**mm**
A – Connecting Rod Bearing Running Clearance	.0007–.0037	.018–.094
B – Connecting Rod Bearing Journal Diameter	2.436–2.437	61.87–61.90
C – Main Bearing Journal Maximum Undersize	.020	.51
D – Main Bearing Running Clearance	.002–.005	.05–.13
E – Main Bearing Journal Diameter	2.9974–2.9984	76.134–76.159
F – Crank Thrust Length	1.5025–1.5045	38.164–38.214
G – Crankshaft End Play	.0045–.0095	0.114–0.241
H – Connecting Rod Journal Width	1.375–1.379	34.93–35.03
Main and Rod Journal Maximum Taper	.0006	.015
Main Bearing Shell Thickness	.0943–.09408	2.395–2.408
Thrust Bearing Width	1.495–1.498	37.97–38.05

CAMSHAFT, VALVE LIFTERS, ROCKER ARMS		
	Inches	**mm**
Cam Journal Diameter	2.000–2.001	50.80–50.83
Cam Journal Running Clearance	.002–.004	.05–.10
Cam End Play	.004–.012	.10–.30
Cam Bushing ID	2.003–2.004	50.88–50.90
Special Application Bushing ID	1.378–1.379	35.00–35.03
Cam Lift–Intake –Exhaust	.302 .302	7.67 7.67
Thrust Plate Thickness	.176–.180	4.47–4.57
Valve Lifter OD	.6240–.6245	15.850–15.862
Valve Lifter Bore ID	.6250–.6265	15.875–15.913
Valve Lifter Running Clearance	.0005–.0025	.013–.064
Rocker Arms–ID	.7445–.7455	18.910–18.936
Rocker Arm Shaft–OD	.7425–.7435	18.860–18.885
Rocker Arm Running Clearance	.001–.003	.03–.08



BACKLASHES		
	Inches	mm
Crankshaft Gear to Camshaft Gear	.004–.006	.10–.15
Crank Gear to Idler Gear	.004–.006	.10–.15

FLYWHEEL HOUSING		
	Inches	mm
Pilot Bearing Bore Runout	.005	.13
Flywheel Face Runout	.008	.20
Flywheel Housing Bore Runout	.008	.20
Flywheel Housing Face Runout	.008	.20

HORSEPOWER DERATES		
Condition	Continuous Duty	Intermittent Duty
Altitude Naturally Aspirated	Deduct 3% for each 1,000 ft. above 1,500 ft.	Deduct 3% for each 1,000 ft. above 500 ft.
	Deduct 3% for each 305 m above 457 m	Deduct 3% for each 305 m above 152 m
Altitude Turbo Charged	Deduct 3% for each 1,000 ft. above 3,000 ft.	Deduct 3% for each 1,000 ft. above 1,500 ft.
	Deduct 3% for each 305 m above 914 m	Deduct 3% for each 305 m above 457 m
Temperature	Deduct 1% for every 10°F above 100°F	Deduct 1% for every 10°F above 85°F
	Deduct 1% for every 5.5°C above 38°C	Deduct 1% for every 5.5°C above 29°C
Duty Ratings and Standards	The load and speed that can be applied without interruption except for normal maintenance.	The highest load and speed that can be applied under specific conditions of varying load and/or speed.

All ratings are corrected to 500 ft. (152 m) altitude, 29.38 Hg (746 mm), and a temperature of 85°F (29°C).

Natural gas ratings are based on the use of 1,000 Btu LHV gas. Propane ratings are based on the use of 2,335 Btu HD-5 propane.

BASIC ENGINE DATA — A54E		
Number of Cylinders	6	
Compression Ratio	8:1	
Firing Order	1–5–3–6–2–4	
Number of Main Bearings	7	
Engine Length, Power Unit	68.9 inches	175.0 cm
Engine Width, Power Unit	31.9 inches	81.0 cm
Engine Height, Power Unit	74.9 inches	190.2 cm
Lube Oil Capacity with Filter only with Filter and Cooler (if applicable)	 16.6 quarts 17.5 quarts	 15.7 liters 16.6 liters
Coolant Capacity– Engine Only with Oil Cooler (if applicable)	 16.25 quarts 17.0 quarts	 15.4 liters 16.1 liters
Cylinder Compression @ Crank Speed (200 RPM)	170–200 PSI	12–14 kg/cm²
Spark Plug Gap	0.025 inch	.64 mm
Ignition Timing	Nonadjustable	
Valve Clearance–Cold Intake Exhaust	 .027–.033 inch .027–.033 inch	 .69–.84 mm .69–.84 mm

Physical dimensions are for reference only. Final product data may differ slightly.

INSTALLATION

Scope

These are general installation requirements. For more specific requirements, contact the Customer Service Department at Arrow Engine Company.

Automatic Starting

We recommend the use of jacket water heaters for installations which are subjected to unscheduled automatic starts and instantaneous loading.

Space Requirements

To ensure adequate access for engine installation, ventilation and in-service maintenance, the engine location must be carefully considered.

The engine described in this manual requires a minimum of 24 inches (60.9 cm) between engines or between the engine and wall. End clearance required to remove the camshaft is 36 inches (91.4 cm). Sufficient overhead clearance is required to permit the use of a chain hoist for removal of heavy engine parts. The heaviest part of the A54E engine is the short block which weighs approximately 460 lbs. (209 kg). The A54E long block weighs approximately 600 lbs. (272 kg).

Cover all engine openings until installation, to prevent foreign objects from entering the engine.

STATIONARY INSTALLATIONS

Engine Foundations

Most stationary engine applications require a foundation or mounting base. This base isolates the engine from the surrounding structure and absorbs or inhibits vibrations. A base provides a permanently accurate surface upon which the engine (and usually the driven equipment) may be mounted and aligned. To serve these purposes, the foundation must have a suitable size and mass, rest on an adequate soil or bearing surface, be provided with an accurately finished mounting surface for the engine, and be equipped with properly sized retaining bolts in the correct locations to secure the engine firmly in position.

Mounting

No engine will perform properly if incorrectly installed and misaligned.

Any misalignment of mountings imposes stresses on the engine structure with possible damage to flywheel housing, flywheel, crankshaft and thrust bearings.

Because of the variety of power applications, the A54E Series engines will be found mounted in both mobile and stationary applications. In all cases it is most important that proper mountings be selected for the specific application. If the engine and driven equipment have separate foundations, alignment is critical. To ensure proper alignment, inspect foundations for weld spatter, burrs, foreign matter or uneven surfaces. It is plainly a waste of time to attempt alignment if the foundation is not level and clean.

Alignment

It is always desirable to have shims under both the engine and driven equipment, so future alignment at time of rebuilding or replacement will not present a problem.

The nature of any shimming procedure is essentially to cut and try. Use easily cut steel or brass shim stock to make up trial shim pads. Remember the area of the shim pad must be large enough to support the weight of the engine when the bolts are tightened.

After the engine has been leveled and tightened down, the driven equipment can be aligned. Where the driven equipment is mounted permanently, the engine must be aligned relative to the driven equipment.

When the engine and driven equipment are mounted on a common skid base, shims should be used under both units to compensate for roughness and unevenness of the skid rails. The will also provide shims under drive and driven units for final alignment. Usually the heaviest machine is permanently mounted and the lightest aligned to the heaviest.

The correct aligning procedure may vary slightly with different types of drive equipment. Many manufacturers of driven equipment will specify the preferred method to align their equipment. In general, the object is the same: to make the driven shaft concentric with the driver shaft.

Use steel chocks to fill larger gaps so that only the last few thousandths of an inch must be filled out with thinner shim stock.
Always use shims that are wide enough to permit the full base mounting area to bear on them.
The full width of the mounting base must be supported, not just the outer edge.

Preparing Unit for Service

Inspect all identification and data plates and follow all servicing instructions. Compare data plates with information contained in invoices or packing slips to ensure receipt of equipment as ordered.

Remove catalyst, because oil can damage the unit.

Inspect entire engine for damage, loose connections, broken or sharply bent lines, and loose nuts or bolts. If tape or temporary coverings are torn or missing from engine openings (such as intake, exhaust, water or fuel), perform a thorough inspection to determine the possible presence of foreign objects in these openings.

The steps needed to bring an engine into active service are basically the same for a new engine or one that has been in storage. In addition to a detailed visual inspection, check for free rotation. Wipe down or wash away any accumulated dust and dirt from the exterior before removing engine opening covers. Engines that have not been rotated for some time should be oiled through the spark plug openings and cranked by hand before running. Any resistance to free cranking should be investigated; rust and corrosion can cause engine seizure that cannot be cleared without engine disassembly.

CAUTION

Never attempt to start an engine that has been stored without first inspecting the intake passages and manifolds for thickened preservative oil.

Crank the engine over with the spark plugs out. Oil, water or preservative compound trapped in the cylinders would lead to a hydraulic lock. Continue to crank engine with the starter until liquid is no longer ejected from the openings.

Fill the crankcase with the proper grade and viscosity of oil to the full mark on the oil level dipstick.

If conditions permit, fill the cooling system with soft water. After the cooling system has been checked and any leaks have been repaired, drain a portion of the water and add an inhibitor or antifreeze as required. Soluble oil may be used as an inhibitor. Use one ounce of oil per gallon of coolant. Check battery connections for proper polarity, Pour the acid into the dry batteries and see that the battery plates are covered with solution.

Connect the batteries and control wires. When a dry charge battery is used, the battery should be charged prior to use.

COOLING SYSTEM

Cooling System Design

Premature engine component failures and abnormal engine performance can often be traced to improper design or sizing of radiators or other coolers.

NOTE: Arrow Engine Company will not be responsible for engine or component failure when the following cooling system design and application recommendations are not followed.

Recommendations for Specifying a Radiator or Other Cooler for Continuous-duty Operation

1. Base the water flow and temperature drop across the radiator core or cooler on the jacket water pump curve.

2. Pressure drop through the radiator core or cooler with full water flow at rated speed must not exceed 3 to 5 PSI (.21 to .35 kg/cm^2).

3. Allow a 15% reserve for variations in application and environment conditions, i.e., wind direction, dirt and debris. This 15% is in addition to normal cooling system design fouling factors.

4. If a 50-50 solution of ethylene glycol could be used, the radiator core or cooler area should be 15% reduction in the heat transfer coefficient for ethylene glycol when compared with water.

5. Select a radiator or cooler for the highest ambient or raw water temperature condition expected. For radiators, an allowance must be made for air temperature rise across the engine with a blower fan or in the engine room if a suction fan is used.

6. Radiators and surge tanks must have 7 PSI (49 kg/cm^2) pressure caps.

7. Provision must be made for desertion of the coolant, such as a divided top tank or separate surge tank.

8. Provision must be made for a balance line connection to the suction side of the water pump to prevent pump cavitation.

9. An adequate coolant expansion area must be provided in the radiator or in a separate surge tank.

10. Maximum back pressure into the radiator or cooler should not exceed 5 PSI (.35 kg/cm^2) at 1,800 RPM.

11. Maximum inlet head to the jacket water pump is 20 feet (6.1 m) of water.

Recommendations for Specifying a Radiator or Other Cooler for Intermittent or Standby Operation

Same as for continuous-duty operation, except:

1. Use 200°F (93.3°C) instead of 185°F (85°C) engine outlet temperature.

2. Allow a 5% instead of a 15% reserve for variations in application and environmental conditions.

Recommendation for Specifying a Radiator or Other Cooler for Torque Converter Application

When the engine cooler is also used for cooling a torque converter, the core or cooler surface should be at least 30% larger than the core required for the engine alone.

Cooling System Capacity

To prevent rust when using water alone, either use a recommended corrosion preventive or inhibitor, or add one ounce of soluble oil for every gallon of coolant in the cooling system.

COOLING SYSTEM CAPACITY			
Ethylene Glycol	Radiator Glycerine (G.P.A.)	Freezing Points	
		°F	°C
16%	37%	20	-7
25%	55%	10	-12
33%	70%	0	-18
39%	81%	-10	-23
44%	92%	-20	-29
48%	100%	-30	-34

COOLING CAPACITIES — ENGINES ONLY (Does Not Include Radiator or Heat Exchangers)	
A54E without oil cooler	16.25 quarts
A54E with oil cooler	17.0 quarts

Cooling System Installation Recommendations

After the cooler installation is competed and prior to filling the cooling system, clean all dirt and welding spatter from low points in the system. Flush all accessible piping sections and the cooler to remove as must dirt as possible.

After filling the system, check closely for leaks. Tighten all clamps and fittings prior to engine start-up to avoid coolant loss at start-up.

The following installation suggestions are offered to improve cooling system performance and make future maintenance easier and quicker:

1. Mount all cooling system components with at least enough clearance to permit normal maintenance and to allow for removal and replacement of accessories at the front of the engine without having to disrupt the cooling system.

2. Use suitable couplings so portions of the cooling system can be disconnected and moved aside as a unit during engine repair and maintenance. This avoids removal of individual pieces of pipe and the need to work backward to reach a given connection.

3. Provide convenient drainage points to remove water from both fresh water and raw water systems.

4. Provide easy to open accessible air vents to bleed air from cooling system piping and allow for immediate priming of the system.

5. Mount all belt-driven auxiliary water pumps so belts can be tightened easily. Locate pump couplings and drive pulleys so packing can be removed and replaced without major disassembly or pump removal.

6. Keep the system clean!

7. Avoid electrolysis; use zinc anodes or other cathodes for system protection.

Air Intake System

Large quantities of air are required for all internal combustion engines. Exact combustion air requirements for A54E engines can be obtained from Arrow Engine Company.

Certain factors must be considered to ensure an adequate supply of clean combustion air. These are as follows:

1. Air requirements for engines installed in heated, air conditioned buildings may upset heating and ventilating calculations unless combustion air is supplied via an external air inlet.

2. If an external air inlet is required, it must be suitably designed to supply intake air in the proper temperature range (high intake air temperature results in power loss while extremely cold intake air may hinder starting of automatic standby units). It must also be designed to prevent pick-up of exhaust gas materials or exhaust from other industrial operations (such as foundry dust or paint spray), to prevent pick-up of flammable vapors, and to prevent entry of rain and water.

3. All ducting, as well as air cleaner to manifold connections, must be airtight to avoid drawing in unfiltered air.

4. The restriction through the air intake system must be kept to a minimum. Air duct restriction must never exceed five inches of water column. Restricted inlets, sharp or numerous bends and undersized ducting will all increase restriction unnecessarily.

5. Engine heat radiation will affect ambient air temperatures in building installations. Properly located intake and exhaust fans may be required to ventilate engine rooms.

Engine Fuels

Natural gas and liquefied petroleum gas (LPG) are combustible gases, and can be explosive if leaked and contained in a confined area. Keep cigarettes and all other flame sources away from these areas.

Depending on your engine and fuel system configuration, your engine is designed to run on natural gas, liquid LPG, or vapor LPG. The fuel requirements for each are discussed in this section.

The operator must select the fuel type (natural gas or LPG). Once fuel inlet pressure is set, no other adjustments are required.

Fuel Supply Pressure

Following are the requirements for the fuel supply to Arrow LSI-certified engines:

- Fuel supply pressure to the fuel system inlet must be 8–16 inches H_2O (2–4 kPa).
- If natural gas and vapor LPG supply pressure is higher than 16 inches H_2O (4 kPa), the packager must install a primary pressure regulator upstream of provided fuel system (not provided with system) to meet the pressure requirements listed above.
- A 10-micron fuel filter with 99% efficiency is strongly recommended (not provided with system). Failure to properly filter the fuel may cause damage or plugging to fuel system components and void the warranty.
- The following fuel filters are recommended:
  Raw natural gas: Oxion, Inc. Model M150
  Vapor LPG and pipeline natural gas: Maxitrol Model GF60-1-88
- All low-pressure fuel lines should be one-inch ID and free from sharp bends or kinks.
- All pipe threads in the fuel system should be sealed with thread sealant specified for the fuel type (NG and/or LPG).
- All fuel system components should be properly supported with brackets and isolated from severe (> 5 g) vibration.
- All fuel system components, fuel lines, and electrical wiring should be a minimum of 12 inches from exhaust system components and properly shielded from direct radiant heat. The final package should provide air circulation around fuel system components to prevent overheating.

- Installation of a manual shut-off valve at the fuel supply source is strongly recommended to allow the fuel to be shut off when the engine is being serviced.

Natural Gas

Your engine is certified to run on natural gas of pipeline-quality. If your natural gas supply does not meet this specification, your engine is operating as a noncertified engine. See the U.S. EPA Legal Requirements section of this manual.

Arrow Engine requires that the natural gas comply with the following specifications; otherwise, the fuel system and engine warranties may be void.

- Hydrogen: < 500 mg/10 kWh
- Chlorine and fluorine compounds (typically chlorofluorocarbons): < 100 mg/10 kWh
- Silicon: < 5 mg/10 kWh
- Ammonia: < 50 mg/10 kWh
- Oil or hydrocarbons in liquid (mist form): < 5 mg/10 kWh
- No liquid water is permitted at the inlet of the engine-mounted fuel system

Liquefied Petroleum Gas

To maintain emissions compliance and the engine warranty, use commercial-grade HD-10 or better LPG. Liquid LPG is drawn off of the bottom side of an LPG tank or cylinder and is a liquid until it has passed through the regulator/vaporizer, at which point it is vaporized to a gas. If you connect vapor LPG to a liquid LPG fuel system, you may starve the engine for fuel, causing it to produce low power and excessive emissions.
Vapor LPG is drawn off of the top side of an LPG tank or cylinder. Only a fuel pressure regulator (not a vaporizer) is required for vapor LPG, However, the LPG tank/cylinder must have enough internal surface area to vaporize (boil) LPG at the rate required by the engine.

NOTE: Must use one-inch lock-off on vapor propane supply line.

Gaseous Fuel Regulator Guidelines

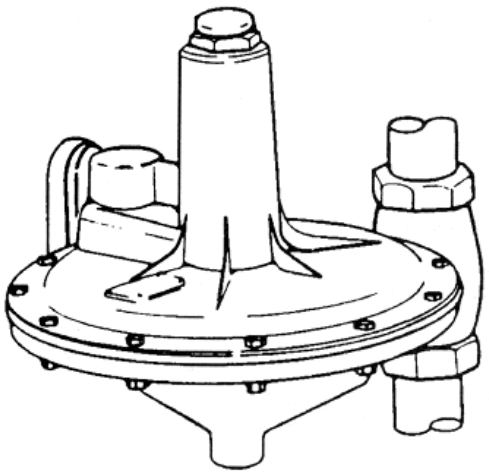
Pressure regulators are designed to control the pressure of the gas as it enters the engine. Through an arrangement of a diaphragm and springs, the pressure of the natural gas coming to the engine is lowered and controlled. This supplies a constant steady supply of gas to the gas inlet.

There are two types of pressure regulators in the fuel system: a high-pressure line, or “Big Joe”, regulator mounted near the main fuel line, and a low-pressure engine regulator.

The line regulator brings the pressure in the lines leading to the engine regulator to 5–10 PSI (.35–.70 kg/cm^2). The engine regulator sets the gas pressure to the fuel system inlet at 8–16 inches of water column (less than 1 PSI). From the engine-mounted regulator, the gas flows into the fuel system inlet. Air is mixed with the gas, and it flows into the engine to be burned.

Gas pressure to this engine supply regulator must be 5–10 PSI (.35–.70 kg/cm^2). Low gas pressure will starve the engine of fuel and reduce engine output. High pressures could damage the regulator, allowing excessive fuel to flood the cylinders. This could lead to detonation and serious engine damage. It at possible, avoid fueling any gas operated equipment off of the supply line between the line regulator and the engine regulator. The supply pressure to the engine could be disrupted. If there is no way to avoid such an installation, add a second line regulator close to the engine and increase the pressure from the first line regulator by 10 PSI (.70 kg/cm^2) to compensate for the pressure loss.

Regulators must be spaced according to the inner diameter of the pipe used. As a rule of thumb, the maximum allowable distance between regulators is eight times the pipe ID. [For example, with a 2-inch pipe, the maximum distance between the regulators is 16 inches (406.4 mm)]. Regulators must be mounted in an upright position.
The maximum pressure drop across a line regulator is generally 50–75 PSI (3.5–5.3 kg/cm^2). Consult the regulator manufacturer for specific information.



Exhaust System

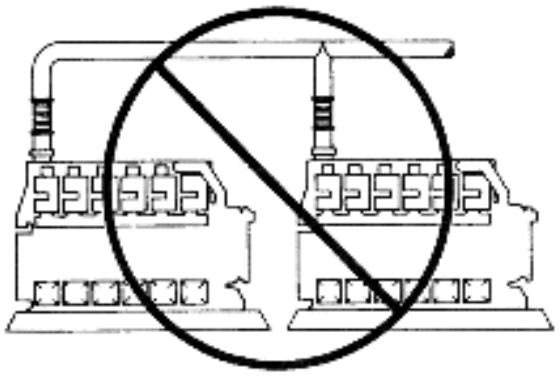
The huge quantities of combustion air consumed by the engine must be efficiently removed after combustion occurs. Therefore, every possible provision must be made to minimize exhaust system back pressure.

The maximum allowable back pressure for a A54E engine is 20 inches of water column.

Some of the adverse effects of excessive back pressure are loss of power, smoking, poor fuel economy, excessive valve temperatures, and engine coolant overheating.

If exhaust back pressure is found to be excessive, check for undersized piping, undersized or inefficient silencer or muffler, or excessive bends or damaged catalyst.

Multiple exhaust connections to a common header are not recommended, because this can result in erratic operation and engine damage. Never connect the exhaust system of more than one engine.



It is advantageous in every installation to locate the silencer as close to the engine as possible.

Attention must be given to adequate silencing of the engine, because unnecessary noise is a public nuisance. Objectionable noise is unnecessary today because of the available mufflers which can be used for silencing.

Exhaust flow requirements for A54E engines can be obtained from you Arrow sales engineer.

Lubrication Oil System

Lubricating oil specification recommendations are contained in the Preventive Maintenance section of this manual. The installation should include adequate provisions for draining lube oil.

Angular Operating Limits

Angular operating limits must be adhered to for successful operation in any engine application. Caution users when job requirements are such that the engine might be tilted. Obviously, loss of oil pressure, even for brief periods, can have destructive results. The maximum angular operating limit for all A54E engines is 25 degrees in any direction for intermittent periods only.

LUBE OIL CAPACITIES		
A54E with filter only	16.5 quarts	15.6 liters
A54E with filter and cooler	17.5 quarts	16.6 liters

Checking Flywheel and Housing Runout and Crankshaft End Play

Even with the best maintenance, an engine can encounter trouble if such things as proper mounting, alignment with other equipment, flywheel and housing runout and sufficient crankshaft end play are disregarded in the initial installation or in subsequent engine relocations. Although flywheel and flywheel housing runout and crankshaft end play are firmly established within limits at the factory, such things as rough handling or improper installation of power takeoffs or clutches may adversely affect these clearances. These items should always be checked prior to engine start-up.

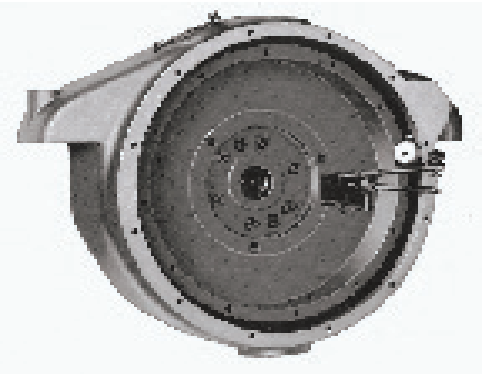
A major factor in obtaining long service life from any engine and clutch, or power take-off assembly, is the proper alignment of the flywheel housing, flywheel and pilot bearing bore. Distortion or lack of a common center on either of these parts will set up destructive forces to bearings, crankshaft, clutch, and the driven equipment.

In addition, because of normal manufacturing tolerances, when an engine is installed in a mounting formerly occupied by another engine, it is not safe to assume that the drive shaft of the power take-off will automatically line up with a coupling located for the previous engine. In such circumstances, either the engine mounts must be shimmed or adjusted, or the driven mechanism must be relocated and adjusted a few thousandths of an inch to bring the entire drive line from crankshaft bearings to driven shaft coupling into alignment.

Housing Bore Runout

Perform the following check for flywheel housing bore concentricity:

1. Support a dial indicator as shown and check the runout of the housing bore all the way around.



HOUSING BORE RUNOUT

2. If the flywheel housing is out of alignment, loosen all of the flywheel housing bolts and proceed as follows.

3. Use a small bar inserted in a bolt hole to correct misalignment until the runout does not exceed .008-inch (.203 mm) total indicator reading. If the misalignment cannot be corrected in this manner, the housing may have to be re-doweled.

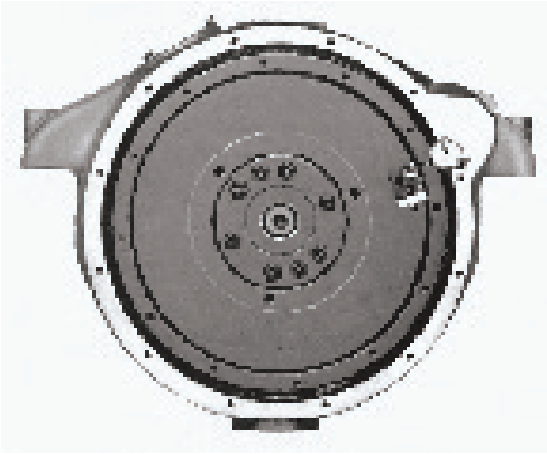
4. Tighten bolts partially, working back and forth across the housing. Recheck flywheel housing bore concentricity with a dial indicator.

Housing Face Runout

Relocate the dial indicator as shown to indicate the flywheel housing face.

1. Housing face runout should not exceed .008-inch (.203 mm) total indicator reading. If correction is required, it should be done with a cutting tool mounted on a radial arm and firmly attached to the flywheel. Thus, by rotating the crankshaft by means of a suitable drive, the cutting tool will dress the housing face into a plane in alignment with the crankshaft flange.

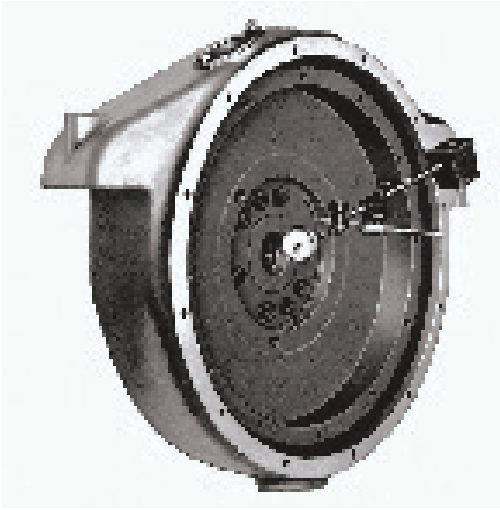
2. When making the above inspection, it is important not to be misled by the end play of the crankshaft. To prevent this, use a pry bar to bring the shaft into full forward position at each point where the indicator reading is taken.



HOUSING FACE RUNOUT

Pilot Bearing Bore Runout

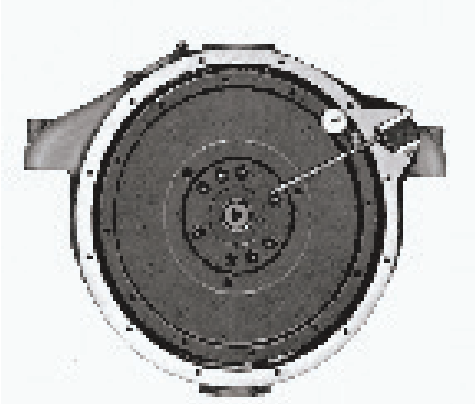
Mount a dial indicator on the flywheel housing as shown and check the runout of the pilot bearing bore. Runout should not exceed .005-inch (.127 mm) total indicator reading.



PILOT BEARING BORE RUNOUT

Flywheel Face Runout

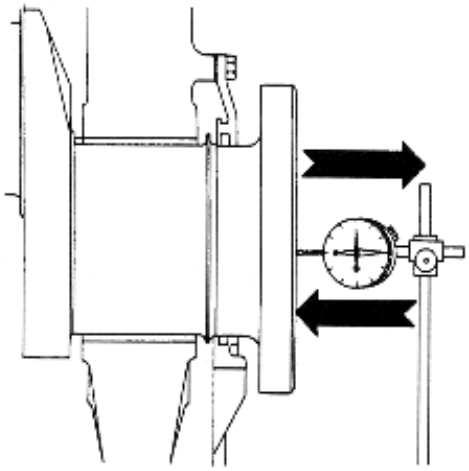
Remount the dial indicator as shown to measure the runout of the flywheel face. To re-emphasize, each reading must be taken with the crankshaft moved all the way forward. Unless rough handling has somehow distorted the wheel or crankshaft flange, maximum runout should not exceed .008-inch (.203 mm) total indicator reading.



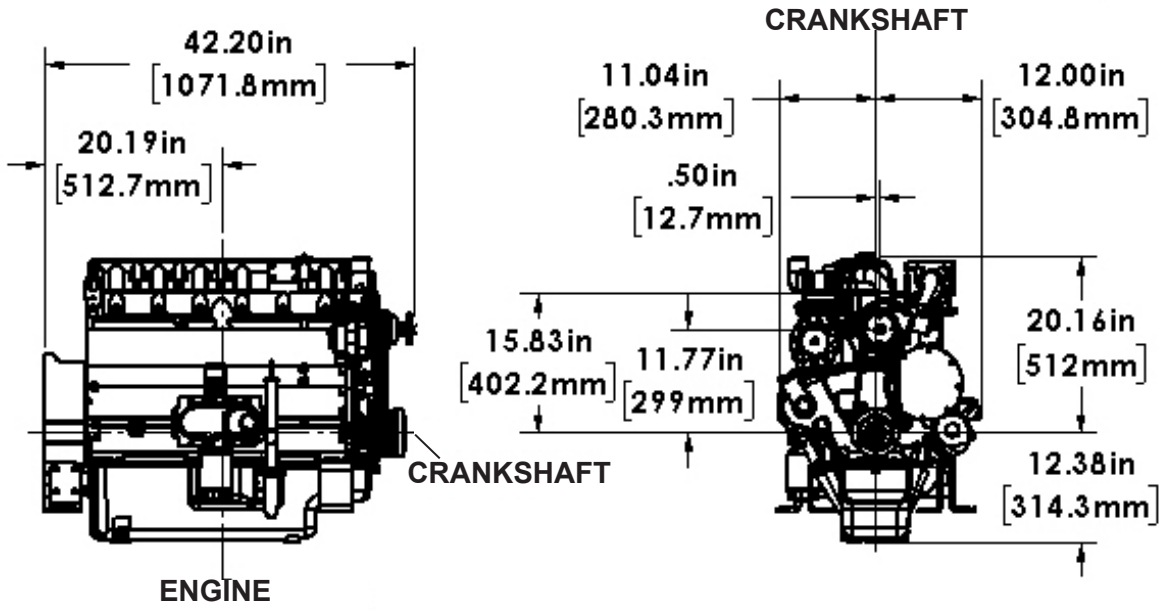
FLYWHEEL FACE RUNOUT

Crankshaft End Play

Measure crankshaft end play with a dial indicator mounted on the crankcase. Use a small pinch bar to move the crankshaft fully forward. Set the indicator at zero and use the bar to thrust the shaft to fully reard. Check the end play reading on the dial indicator. End play must be within .0045–.0095 inches (0.1114–0.241 mm).



CRANKSHAFT END PLAY



A54E INSTALLATION DIMENSIONS

Maintenance Schedule

Maintenance Item	Weekly	750 hours/ 1 mo.	1,500 hours/ 6 mos.	5,000 hours/ 7 years
Check air filter restriction indicator (if equipped). Clean filter if red.	X			
Check oil and coolant levels.	X			
Check belts for tension and condition.	X			
Check battery.	X			
Check fuel hoses and fittings for gas leakage.	X			
Inspect/drain volume tank/separator.	X			
Clean/inspect/replace air filter element.[1]	X			
Check hoses.		X		
Inspect/clean the PCV system.		X		
Check/adjust/replace spark plugs (gap 0.025-inch).		X		
Change oil and oil filter.[2]		X		
Check/adjust valve lash.		X		
Clean oil cooler (if equipped).			X	
Check antifreeze concentration.			X	
Inspect/replace fuel filter.			X	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).			X	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O at EFR inlet).			X	
Inspect fuel lock-off valve(s).			X	
Replace pre-catalyst and post-catalyst oxygen sensors				X
Lubricate clutch at the manufacturer's recommended intervals.	X			

[1] Perform sooner in dusty or extreme conditions.
[2] Oil sampling program recommended for proper oil change intervals.

DTC Fault Codes

SPN	Description	FMI	Fault	SFC
51	TPS Data Drift High	0	ThrottlePos_IR_Low	558
51	TPS Data Drift Low	1	ThrottlePos_IR_High	559
51	Throttle fault	5	ThrottleValveDrive_Fault	556
51	Throttle Status	12	LSeriesThrottleStatusFault	557
98	Engine Oil Level	1	LowOilLevelFault	573
100	Oil Pressure Low	1	LowOilPressureFault	195
100	Oil Pressure Voltage High	3	OilPRangeHigh	192
100	Oil Pressure Voltage Low	4	OilPRangeLow	191
100	Oil Pressure Fault	15	OilPressureSensorFault	196
102	MAP Sticking	2	MAP_STICKING	345
102	MAP Voltage High	3	MAPRangeHigh	342
102	MAP Voltage Low	4	MAPRangeLow	341
102	MAP Data Drift High	20	MAP_IR_HI	343
102	MAP Data Drift Low	21	MAP_IR_LO	344
105	MAT Higher Than Expected	0	MAT_High_Temp	233
105	MAT Voltage High	3	MATRangeHigh	231
105	MAT Voltage Low	4	MATRangeLow	232
105	In Range MAT fault	10	MAT_IR_Fault	234
110	ECT Over Heat Fault	0	ECTOverHeatFault	265
110	ECT Warmup Slower than Expected	1	ECT_WarmupSlower	266
110	ECT Voltage High	3	ECTRangeHigh	261
110	ECT Voltage Low	4	ECTRangeLow	262
110	ECT Insufficient activity	10	ECT_IR_Fault	264
110	ECT Over Temp Fault	18	ECTOverTempFault	263
111	Engine Coolant Level	1	LowCoolantLevelFault	572
168	Battery Voltage Higher Than Expected	0	SysVoltRangeHigh	165
168	Battery Voltage Lower Than Expected	1	SysVoltRangeLow	166
168	DRVP Higher than Expected	20	DRVP_High	169
190	Engine OverSpeed	0	OverSpeed	429
629	CPU Load Higher than Expected	9	CPU_HighLoad	621
629	SRAM Memory Fault	11	SRAMFault	623
629	Flash Memory Fault	31	FLASHFault	622

DTC Fault Codes

SPN	Description	FMI	Fault	SFC
632	Natural Gas Fuel Lock-off Short Open Fault	5	NaturalGasLock-off_Fault	251
632	Low Fuel Pressure	7	LowFuelPressure	476
632	FuelShut-offStuckOpen	12	FuelShut-offStuckOpen	475
636	Crank Sensor Sync Fault	2	CrankSyncFault	423
636	Crank Sensor Other Fault	11	CrankFault	425
854	UEGO* Heater Short to battery fault	3	UEGO_HtrShortToBattFault	452
854	UEGO Heater Short to gnd fault	4	UEGO_HtrShortToGNDFault	451
854	UEGO Htr Open Fault	5	UEGO_HtrOpenFault	463
854	UEGO Heater Temperature Control	7	UEGO_HtrControl	139
854	UEGO Heater Temperature LTE	16	UEGO_HtrLwrLimit	136
854	UEGO Heater Temperature HTE	18	UEGO_HtrUprLimit	137
970	External Shutdown	1	ExternalShutdownFault	571
1213	MIL Open / Short Fault	5	Check Engine Light	253
1268	Spark 1 Open Primary	5	Ign1OpenPrimary_Fault	842
1269	Spark 2 Open Primary	5	Ign2OpenPrimary_Fault	845
1270	Spark 3 Open Primary	5	Ign3OpenPrimary_Fault	848
1271	Spark 4 Open Primary	5	Ign4OpenPrimary_Fault	852
1272	Spark 5 Open Primary	5	Ign5OpenPrimary_Fault	855
1273	Spark 6 Open Primary	5	Ign6OpenPrimary_Fault	858
1391	delta Pressure - Voltage High	3	deltaPRangeHigh	473
1391	delta Pressure - Voltage Low	4	deltaPRangeLow	474
1391	deltaP Higher Than Expected	16	deltaP_HigherThanExpected	477
1391	deltaP Lower Than Expected	18	deltaP_LowerThanExpected	478
1391	deltaP Zero Offset Fault	20	deltaP_ZeroOffsetFault	479
1442	EFR Valve Drive fault	5	EFRValveDrive_Fault	635
1675	Starter Control Relay Fault	5	StarterCtrlRelay_Fault	653
1675	Auto Crank attempt failed	11	StarterCtrl_NoCrank_fault	652
1675	Auto Crank attempts exceeded	12	StarterCtrl_NoStart_fault	651
1695	Adaptive Learn Correction on Hi Limit	16	FuelAdaptRangeHi	471
1695	Adaptive Learn Correction on Lo Limit	18	FuelAdaptRangeLow	472
2434	EGT Higher Than Expected	0	EGT2OverTempFault	741
* **NOTE:** UEGO = Universal Ex. Gas Oxygen Sensor				

DTC Fault Codes

SPN	Description	FMI	Fault	SFC
2434	Engine EGT -Voltage High	3	EGT2RangeHigh	742
2434	Engine EGT -Voltage Low	4	EGT2RangeLow	743
3056	UEGO IP Fault	0	UEGO_IPDiag	443
3056	UEGO SNS Short to BATT Fault	3	UEGO_SNSShortToBattFault	455
3056	UEGO SNS Short to GND Fault	4	UEGO_SNSShortToGNDFault	454
3056	UEGO SNS Open Fault	5	UEGO_SNSOpenFault	453
3056	UEGO O2 Failed on Rich Side	16	UEGOO2FailedRich	466
3056	UEGO O2 Failed on Lean Side	18	UEGOO2FailedLean	465
3217	PreCat O2 input high	3	O2PreCatRangeHigh	225
3217	PreCat O2 input Low	4	O2PreCatRangeLow	226
3217	PreCat O2 Heater Short Open Fault	5	PreO2Heater_Fault	183
3217	O2 Closed Loop Correction Fuel Multiplier On High Limit	16	O2CLCorrectionOnHighLimit	142
3217	O2 Closed Loop Correction Fuel Multiplier On Low Limit	18	O2CLCorrectionOnLowLimit	141
3227	Postcat O2 Voltage High	3	O2PostCatRangeHigh	181
3227	PostCat O2 Voltage Low	4	O2PostCatRangeLow	182
3227	PostCat O2 Heater Short Open Fault	5	PostO2Heater_Fault	187
3227	PostCat O2 Failed on Rich Side	15	PostO2FailedRich	185
3227	PostCat O2 Failed on Lean Side	17	PostO2FailedLean	186
3509	XDRP (+5V) Voltage HTE	3	XDRPRangeHigh	161
3509	XDRP (+5V) Voltage LTE	4	XDRPRangeLow	162
516131	Propane Gas Fuel Lock-off Short Open Fault	5	PropaneLock-off_Fault	252
520555	UEGO INRC Short to Batt Fault	3	UEGO_INRCShortToBattFault	458
520555	UEGO INRC Short to GND Fault	4	UEGO_INRCShortToGNDFault	457
520555	UEGO INRC Open Fault	5	UEGO_INRCOpenFault	456
520556	UEGO SR Short to BATT Fault	3	UEGO_SRShortToBattFault	462
520556	UEGO SR Short to GND Fault	4	UEGO_SRShortToGNDFault	461
520556	UEGO SR Open Fault	5	UEGO_SROpenFault	459
520700	TSC1 Message Time Out Fault	9	TSC1RxTimeoutFault	662

Engine Identification

Engine Part Number _____

Engine Serial Number _____

Engine Application _____

Purchased From _____

In-service Date _____

Engine Hours at Delivery _____

2024 Prime Engine and Emissions Control Warranty Statement

ARROW ENGINE COMPANY U.S. EPA-CERTIFIED LSI A-SERIES CONTINUOUS-DUTY LIMITED WARRANTY

CONTINUOUS-DUTY DEFINITION: The highest load and speed which can be applied, subject to Arrow Engine Company's ratings in effect at time of sale.

I. TERMS OF EXPRESS LIMITED WARRANTY

Arrow Engine Company warrants that it will repair or replace, at its election and expense, any part of an engine, or product (hereinafter referred to as "Products") manufactured by Arrow Engine Company, which proves to have had a defect in material or workmanship. There are no other warranties express or implied.

Arrow Engine Company (Arrow) warrants that your U.S. EPA-certified Large Spark-Ignited (LSI) engine, including the emissions control system, meets the following conditions:

1. The engine is designed, built, and equipped so that it conforms with the U.S. EPA's emissions requirements for nonroad constant-speed mobile and stationary engines at the time of sale to you, the ultimate purchaser.

2. Your engine is free from defects in materials and workmanship that may keep it from meeting the U.S. EPA's requirements for nonroad constant-speed mobile and stationary engines.

II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY

Manufacturer's Warranty Coverage

The warranty period begins on the date the engine or equipment is placed into service. Operating hours will be determined by the engine control module's (ECM) internal hour meter.

Base Warranty Period

The engine's base warranty period is:

1. 2,500 hours or one year, whichever comes first, after the initial new Products start-up date; or

2. 18 months after the original shipment date of the covered Products by Arrow Engine Company.

Standard Emissions-related Components

Three (3) years or 2,500 hours for Large Spark-Ignition (LSI) engines, whichever comes first, for the components listed under the standard 2,500 hour/3-year warranty.

High-Cost Emissions-related Components

Five (5) years or 3,500 hours, whichever comes first, for the components listed under the Extended 3,500 hours/5 years warranty.

III. ARROW ENGINE COMPANY'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Arrow Engine Company shall be responsible for:

A. The repair or replacement, at Arrow Engine Company's election of covered defective parts and all reasonable labor required (at Arrow Engine Company's specified labor rates and repair times) regarding a warranted failure during the express limited warranty and term. All such labor shall be provided by Arrow Engine Company's authorized contractor or distributor.

B. Reasonable and necessary travel (total mileage not to exceed 300 m) and documented expenses incurred by Arrow Engine Company's authorized contractor or distributor, at its sole discretion.

C. Replacement of lubricating oil, coolant, filter elements, or other normal maintenance items for the products that are contaminated and/or damaged as a direct result of a warranted failure.

NOTWITHSTANDING THE FOREGOING, ARROW ENGINE COMPANY SHALL NOT BE RESPONSIBLE FOR ADDITIONAL OR INCIDENTAL LABOR OR OTHER COSTS ASSOCIATED WITH WARRANTY CLAIMS.

IV. OWNER/DISTRIBUTOR'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

A. As the certified LSI engine owner, you are responsible for the performance of the required maintenance listed in your Operations Manual. Arrow recommends that you retain all receipts covering maintenance of your certified engine, but Arrow cannot deny warranty solely for the lack of receipts or for failure to ensure the performance of all scheduled maintenance.

B. As the certified LSI engine owner, you should be aware that Arrow may deny your warranty coverage if your certified engine or a part has failed due to abuse, accidents, neglect, misuse, improper service or maintenance, wrong or contaminated fuel, use of any starting aid, improper cooling concentration or unapproved modifications.

C. Arrow engines are designed to operate on commercial-grade LPG and pipeline-quality natural gas. Arrow engines can also operate on nonpipeline (wellhead) gas with a methane content of at least 45% by volume AND an energy content of 700 -1,600 Btu per SCF. Use of any other fuels may result in your engine package no longer operating in compliance with EPA emissions requirements and may void your warranty.

D. You are responsible for initiating the warranty process. Arrow suggests that you present your certified LSI engine to an Arrow Authorized Dealer or OEM as soon as any problem exists. The warranty repairs should be completed by the Dealer or OEM as expeditiously as possible.

E. The operation and maintenance of the Products within the guidelines established by Arrow Engine Company.

F. Making the Products available to Arrow Engine Company's authorized contractors or distributors for any warranty repair, during normal business hours.

G. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium overtime schedule.

H. All costs incurred as the result of removal or reinstallation of the Products as may be required to affect any warranted repair.

I. All administrative costs and expenses resulting from a warranted failure.

J. Any costs of transportation, towing, repair facilities, or associated costs.

K. Loss of revenue and loss of/or damage to real and/or personal property.

L. Compliance with all local, state and federal laws.

M. Warranted repairs not to exceed 50% of the product (Engine) replacement cost without prior approval from Arrow Engine Company. Replacement cost equates to distributor net price from Arrow Engine Company at time of sale.

V. EMISSIONS-RELATED COMPONENT LISTS

Components covered until first scheduled maintenance interval:

Spark Plugs

Components covered under the Standard 2,500 hour/ 3-year warranty:

- Crank Sensor
- EFR Pressure Sensor
- Engine Coolant Temperature (ECT) Sensor
- Ignition Coil (each)
- Manifold Absolute Pressure/Intake Air Temp (TMAP) Sensor
- Positive Crankcase Ventilation (PCV) Valve
- Pre-Catalyst Wide-range Oxygen Sensor
- Post-Catalyst Switching Oxygen Sensor

Components covered under the Extended 3,500 hour/ 5-year warranty:

- Intake Manifold
- Exhaust Manifold
- Catalyst
- Wiring Harness
- EFR Valve Assembly
- Electronic Throttle
- Engine Control Module

VI. LIMITATION OF ARROW ENGINE COMPANY'S OBLIGATIONS

The obligations of Arrow Engine Company under this express limited warranty shall be waived and voided, and Arrow Engine Company shall not, thereafter, be responsible for the following:

A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, use, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Arrow Engine Company; or

B. Any failure resulting from unauthorized modifications or repairs of the Products or;

C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or

D. Failure of owner to promptly provide notice of a claimed defect–all warranty claims must be authorized, documented, and submitted within 30 days of the failure date while under the warranty period; or

E. Failure of Products for which Arrow Engine Company did not receive properly completed start-up reports; or

F. Repairs of a covered failure performed with nongenuine Arrow Engine Company parts; or

G. Repairs of a covered failure performed by nonauthorized contractors or distributors; or

H. Failure to make Products available to Arrow Engine Company or its authorized representatives, or

I. Failure to supply documents such as drawing and specifications relating to the specific application of the Products.

VII. APPLICABILITY AND EXPIRATION

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Arrow Engine Company shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

The foregoing sets forth Arrow Engine Company's only obligations and owners exclusive remedy for breach of warranty, whether such claims are based on breach of contract, tort (including negligence and strict liability), or other theories, and the foregoing is expressly in lieu of other warranties whatsoever expressed, implied, and statutory, including without limitation, the IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

Notwithstanding the preceding, in no event shall Arrow Engine Company be liable for any direct, special, incidental or consequential damages (whether denominated in contract, tort, strict liability, negligence or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based no breach of contract, tort (including negligence and strict liability), or other theories must be commenced within one (1) year after the cause of action accrues or it shall be barred.

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Preventive Maintenance Checklist

Engine S/N _____ PM Date _____ ECM Hours _____

PM Type _____ ☐ Hours
_____ ☐ Months/Years

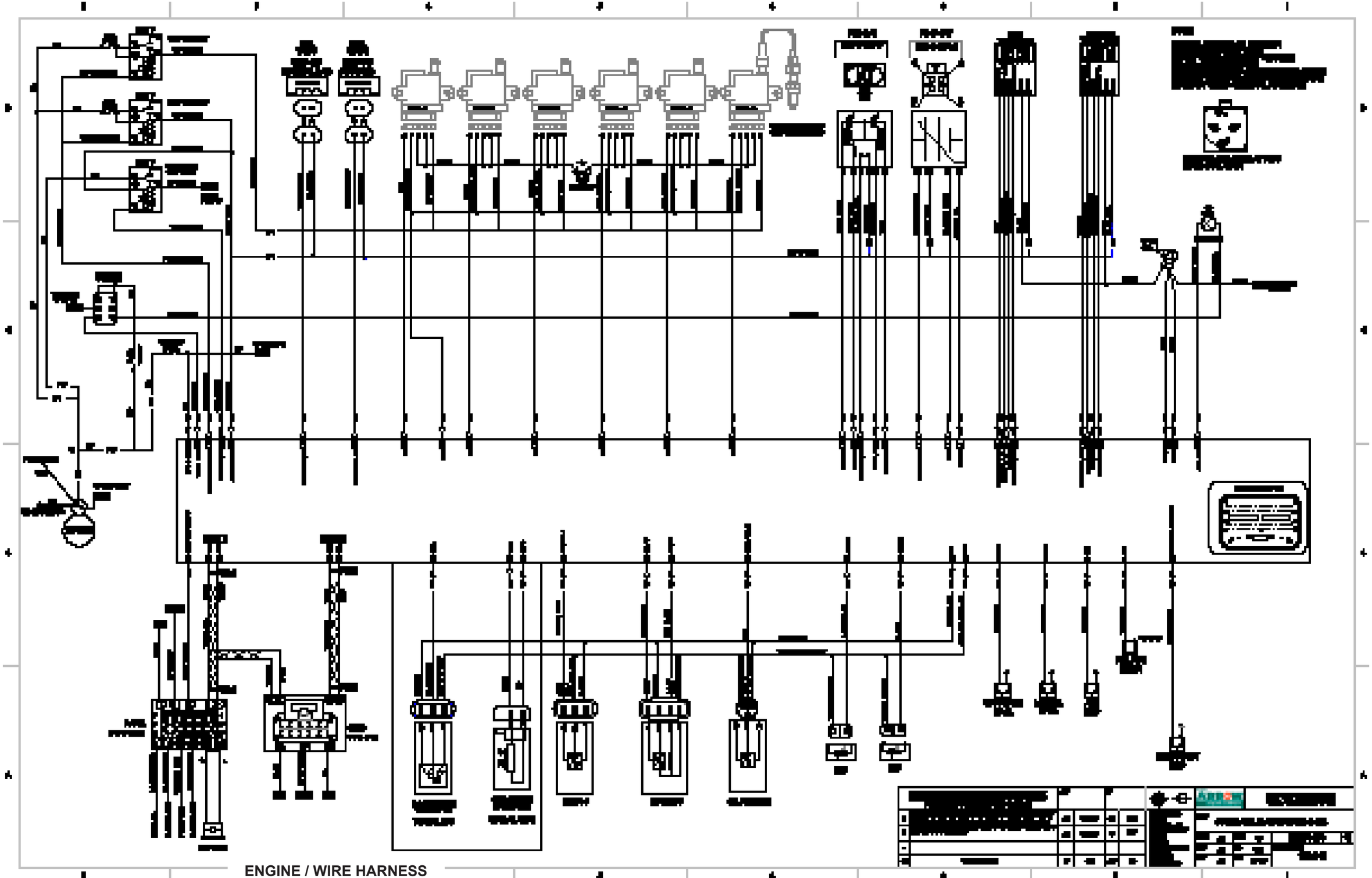
Symbols ☑ PM Complete
☒ Needs Attention

Maintenance Item		Comments
Check air filter restriction indicator (if equipped). Clean filter if red.	☐	
Check oil and coolant levels.	☐	
Check belts for tension and condition.	☐	
Check battery.	☐	
Check fuel hoses and fittings for gas leakage.	☐	
Inspect/drain volume tank/separator.	☐	
Clean/inspect/replace air filter element.	☐	
Check hoses.	☐	
Inspect/clean the PCV system.	☐	
Check/adjust/replace spark plugs (gap 0.025-inch).	☐	
Change oil and oil filter.	☐	
Check/adjust valve lash.	☐	
Clean oil cooler (if equipped).	☐	
Check antifreeze concentration.	☐	
Inspect/replace fuel filter.	☐	
Inspect NG fuel regulator (8–16 in H_2O at EFR inlet).	☐	
Inspect LPG primary vaporizer/regulator (8–16 in H_2O AT EFR inlet).	☐	
Inspect fuel lock-off valve(s).	☐	
Replace oxygen sensor.	☐	
Replace coolant.	☐	

Notes:

Maintenance Log

PM Interval (Hours)	PM Date	ECM Hours	PM Comments	Performed By (Initials)
750				
1,500				
2,250				
3,000				
3,750				
4,500				
5,250				
6,000				
6,750				
7500				
8,250				
9,000				



ENGINE / WIRE HARNESS
PART NUMBER WR15002

THIS PAGE INTENTIONALLY LEFT BLANK

ENGINES

A-SERIES	A32	A42	A54 A54E	A62 A62 Turbo A62 Genset
C-SERIES	C-46	C-66	C-96	C-106
KP-SERIES	KP3 KP3TA	KP4 KP4TA	KP6 KP6TA	KP8 KP8TA
VRD-SERIES	VRD30	VRD40	VRD60	VRD100

COMPRESSION PRODUCTS

Compressor Frames VRC-2 VRS-2 VRS-4	CNG Compressor Frames and Packages VRC-CNG	Vapor Recovery Units VRU-1 VRU-2	Gas Lift Packages Electric HP Gas Engine (VR, A-Series, CAT)	Custom Compression Packages

GAS PRODUCTS

Coalescers

REPLACEMENT PARTS

Waukesha	145G/F817	140G/F554	F18	H24	WAK/1197

ARROW ENGINE
ENGINES & COMPRESSION

ARROW ENGINE COMPANY
2301 E. Independence St., Tulsa, OK 74110
www.arrowengine.com

A54E-POM-JAN2024