



Engine Storage Procedures

Single and Multi-Cylinder Engines

ESP-ML-B-MAY15

Quality Products
Engineered to Last

A Tradition of Excellence
Since 1955

Basic Requirements:

Preservation of engines and generators in storage involves several basic requirements. For new engines and generators, these are as follows:

- Protection of machined metal surfaces, cylinders, valves, bearings and so on, from the effects of both dampness and salt or other corrosive substances in the atmosphere.
- Protection of openings into the engine against the entrance of dirt, abrasive material and foreign matter of all types.
- Protection of accessory equipment including carburetors, gas regulators, ignitions, starters, alternators and fan belts against corrosion, dirt, moisture saturation and progressive deterioration.
- Protection of cooling system intercoolers and LPG vaporizers against freezing, rusting or seizure of water pump seals.
- Protection of a general nature against the elements - rain, snow and extremes of temperature.
- Protection of batteries by disconnecting and removing them to a slow charging station where they can be kept fully charged. If this is neglected, the plates may be damaged or ruined by becoming sulfated.
- Protection of the 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, a pressure sensitive tape can be used to hold the paper in position. Do not use masking tape - it is not suitable for this type of service and will be very difficult to remove after extended use. Application of protective paper should be on both inside and outside of large fixed louvered surfaces. Large open areas should have a corrugated cardboard backing for the paper.
- Protect switchboards in the same manner as the alternators. In the case of engines previously operated, additional items must be considered.
- Protection of internal engine parts - particularly bearings, cylinder walls and valves against corrosion by the products of combustion combined with atmospheric moisture and corrosion from lubricating oil contaminants.

The extent of the attention given to each of the foregoing points of possible damage depends on the judgement of the person in charge of the equipment. Generally speaking, the following factors should be taken into consideration before deciding how much or how little preservation is required.

- The period of time the equipment is likely to be inoperative.
- The severity of the weather and atmospheric conditions at the point of storage. The problems of storing equipment in a high humidity area, for example, differ greatly from storage problems in a location where the air is very dry and dusty.
- 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.



Storing New Engines:

Engines recently received from the factory and not intended to be used for an indefinite period may be stored successfully in the following manner. Engines stored outdoors or in a humid environment may require more frequent re-preservation. Circumstances may compel omitting some steps, while on the other hand, special conditions may point to greater emphasis on other steps.

Engine In Operable Condition:

- Mix an inhibitive type preservative oil with the engine lubricating oil in the proportions recommended by the manufacturer of the preservative oil. Operate engine until oil is hot. Cooling water used in this run should have inhibitor added in accordance to manufacturers instructions.
- Remove air cleaner, then using a manually operated sprayer, squirt can or other means, inject preservative oil of a suitable type into the air intake while the engine is running. Approximately one minute is ordinarily adequate. If possible, stop engine by slugging enough oil through intake to stall. Continue injecting oil until the engine stops turning.
- 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.
- For gas 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.
- Wipe engine clean and dry. Apply wax type tape or like material to all openings such as intake, air cleaners, exhaust outlets, breathers and open line fittings.
- 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.
- Apply a coating of heavy preservative compound with 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. If possible, crank the engine by hand for one or two turns about 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 preservative oil used.

Engine In Inoperable Condition:

- Open drains as required to remove oil and water.
- With hand or mechanical operated atomizing spray (do not use ordinary compressed air), inject preservation oil into each cylinder.
- Crank engine in normal direction about one quarter turn and spray each cylinder again. Do this about eight times or until engine has been turned through two complete revolutions. The purpose of this procedure is to expose each valve so it can be coated with oil.
- Depending on the judgment of the operator as to the severity of storage conditions, open valve rocker covers, gear cover plates and as many points as possible where oil may be sprayed, poured or squirted over the interior parts. Replace all plugs and covers.
- Remaining steps may be the same as listed in 5 and 6 for an operable engine.

CAUTION:

All Arrow engines received from the factory are internally protected for up to six months for storage indoors. If the storage period exceeds six months, the engine should receive additional storage preservatives. Engines stored outdoors or in a humid environment may require more frequent re-preservation.

CAUTION:

If the judgment of the operator and storage conditions warrant, the engine should be disassembled for treatment as a new engine. Ordinarily this last procedure is unnecessary except in cases where fuels containing considerable sulphur have been used or where extremely bad climatic conditions prevail.



Storing In-service Engines:

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

Engine In Operable Condition:

- Run engine until the original oil is hot. Drain.
- If practical, run the engine with a good flushing oil in crankcase and drain oil and water while still hot.
- Refill 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.
- Carry out previous instructions 5 and 6 (New Engine Storage) as the circumstances indicate.

Engines recently received from the factory and not intended to be used for an indefinite period may be stored successfully in the following manner. Engines stored outdoors or in a humid environment may require more frequent re-preservation. Circumstances may compel omitting some steps, while on the other hand, special conditions may point to greater emphasis on other steps.

Engine In Operable Condition:

- Open drains as required to remove oil and water.
- With hand or mechanical operated atomizing spray (do not use ordinary compressed air) inject preservation oil into each cylinder.
- Crank engine in normal direction about one quarter turn and spray each cylinder again. Do this about eight times or until engine has been turned through two complete revolutions. The purpose of this procedure is to expose each valve so it can be coated with oil.
- Depending on the judgment of the operator as to the severity of storage conditions, open valve rocker covers, gear cover plates and as many points as possible where oil may be sprayed, poured or squirted over the interior parts. Replace all plugs and covers.
- Remaining steps may be the same as listed in 5 and 6 for an operable engine.



Post Storage Preparation:

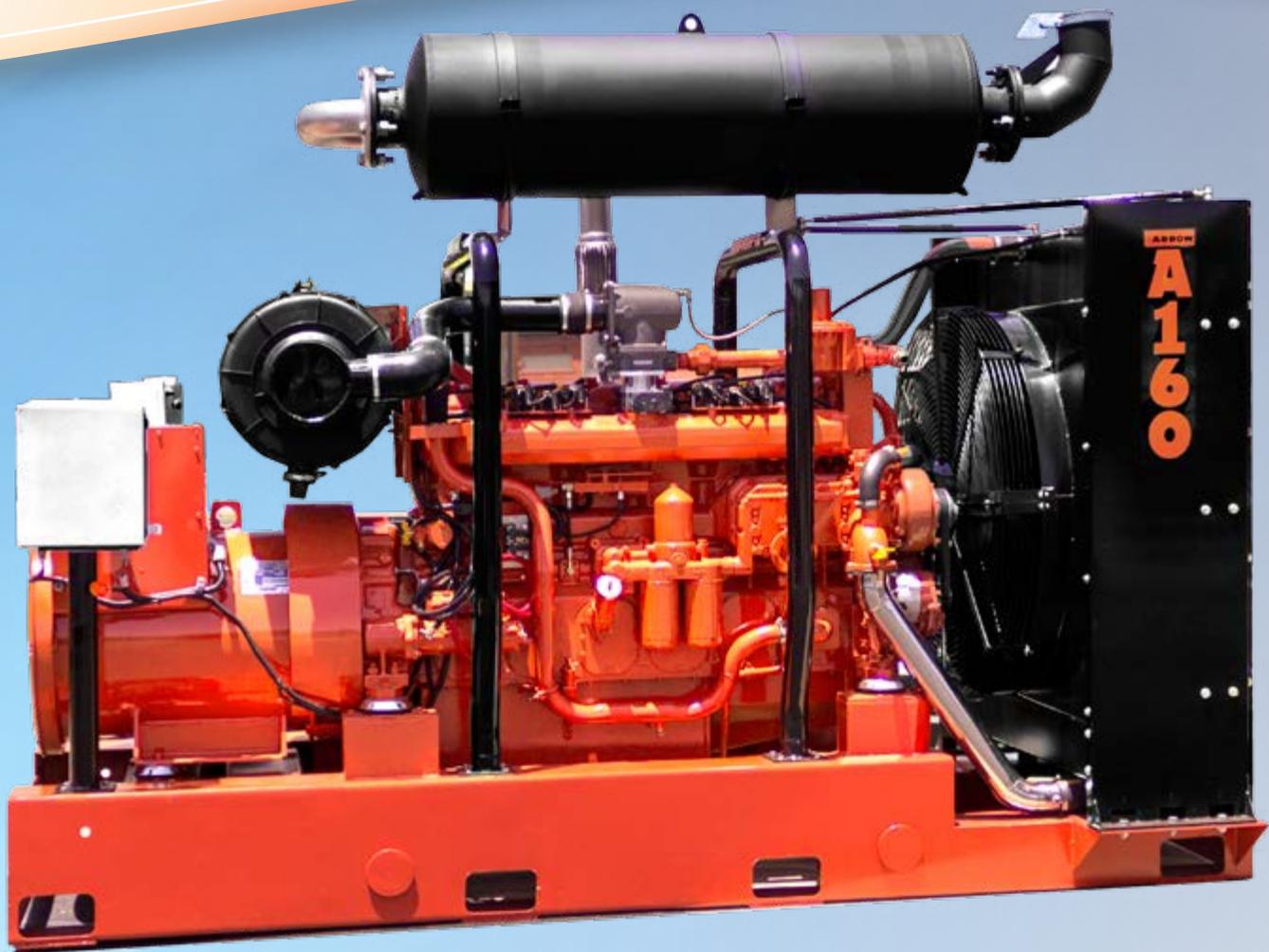
The steps needed to bring an engine into active service after storage in accordance with these instructions are about the same as those normally carried out on any new engine.

Requirements:

- Inspection, checking for free rotation, adequate cooling water or antifreeze, ample lubricating oil of the correct type and viscosity and proper adjustments.
- Accumulated dust and dirt should be wiped or washed from the exterior before removing the covers over the engine openings.
- Removal of installed protection should occur upon normal inspection of the engine generator and switch gear interiors prior to start up.
- Partial removal of oil may be necessary in the course of 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 actually running.
- Any resistance to free cranking should be investigated - rust and corrosion can cause severe seizure that cannot be forced clear without engine damage.

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 indicates possible hydraulic lock if an attempt had been made to operate. Continue to crank engine with starter until liquid is no longer ejected from openings. Inspect intake passages and manifolds for thickened preservative oil.





PRESERVATIVE OIL:

The properties making an oil suitable for preservative requirements are good aging stability; high resistance to gumming, oxidation and polymerization; low pour point and viscosity; free from acids, asphalts, resins, tars and water.

CAUTION:

All generators and switch gear which have been stored must be checked for installation resistance with a "megger" prior to being put into service. The megger used should produce 500 V.D.C. Disconnect voltage regulator, rotating diodes, suppressors and any other solid state devices which may be connected to the starter or rotor windings. The megger value should be: operating voltage \div 1000+1 (i.e. machine voltage of 480 V.A.C. \div 1000=0.480+1=1.480 megohms.) If any circuit to ground measures less than calculated value, consult the Arrow Engine Customer Service Department for any corrective measures as may be necessary.



C-SERIES	C-46	C-66	C-96	C-101	C-106	C-255
A-SERIES	A-32	A-42	A-54	A-62 A-62 Turbo A-62 Genset	A-90 A-90 Turbo A-90 Genset	A-160 A-160 Turbo A-160 Genset
K-SERIES	K6					
L-SERIES	L-795					



GAS PRODUCTS	Meter Runs Meter Skids	Volume Tanks Coalescers Structural Skids	2 & 3-Phase Separators Fuel Gas Cond. Skid	Heater Treater Indirect Heater H2S Scavenger Unit	Dehydration Unit Liquid Stabilizer
CHEMICAL PUMPS	10 Series (beam operated)	430 Series (electric)	12, 500, & 510 Series (pneumatic)	Solar Chemical Pumps	OEM & Aftermarket Spare Parts



COMPRESSION PRODUCTS	Compressor Frames VRC-2 VRS-2 VRS-4 (Coming Soon)	CNG Compressor Frames & Packages VRC-CNG	Vapor Recovery Units VRU-1 VRU-2	Gas Lift Packages Electric HP Gas Engine (VR, A-Series, Cat)	Custom Compression Packages
-----------------------------	--	--	--	---	-----------------------------------

Arrow Engine Company
2301 East Independence • Tulsa, Oklahoma 74110
fax (918) 699-2202
local (918) 583-5711

(800) 331-3662

www.ArrowEngine.com



CATERPILLAR®	G379	G398	G399	G3304	G3306
WAUKESHA®	F2895 F3521 F5108	L5790 L7042	P9390	145G/F817 140G/F554	F18 H24 WAK/1197
FAIRBANKS®	ZC-118	ZC-208	ZC-503	ZC-739	ZC-346
AJAX®	5× 6½	EA-22, 6½ × 8 CMA EA30, 7½ × 10 CMA EA-30, 7¼ × 8 CMA E-42, 8½ × 10 CMA		DP-60, 9½ × 10 CMA DP-115/230, 13½ × 16 DP-70/80/160, 11 × 14 CMA	

Waukesha®, VHP®, and VGF® are registered trademarks of GE®, Caterpillar®, is a registered trademark of Caterpillar, Inc., Fairbanks Morse® is a registered trademark of Coltec Industries, Inc., and Ajax® is a registered trademark of Cameron International Corporation.