

Restricted

Air Force Head-Quarters

NENE INSTRUCTION NO. 9

Technical Order

Application: NENE 2-VH

FUEL SYSTEM - MAINTENANCE OF FILTERS

Introduction

1. This instruction has been raised to record certain defects that have occurred during operation of the Nene. Reasons for these defects have been found in partially and fully blocked fuel system component filters.
2. There are several filter units placed at various stages of the Nene fuel system with each filter designed to protect vital section operating characteristics.
3. The first protective filter is the main low pressure unit mounted at the bottom of the wheelcase. This filters the main primary fuel supply to the engine. It is a star shaped felt element designed for complete protection to fuel system components. However, several other small filters exist in the system as a further safeguard. Each pump has a small wire strainer in its inlet union housing for initial protection and another small wire wound filter in the metering orifice to protect delivery pressure fuel to the servo piston chamber. The barometric pressure control unit has a small wire wound filter situated in its pump servo pressure fuel connection housing. Each burner has a small wire wound filter fitted in its primary pressure connection housing.
4. These small wire wound filters in the pumps, B.P.C., and burners, are of extreme importance as the fuel passing through them is supplied to very small metering units which rely on consistent uniform flow for efficiency.

Low Pressure Fuel Filter

5. No cases of partial or complete blockage of low pressure filters have occurred to date on the Nene 2-VH. This is due mainly to the excellent initial fuel filtering protection given by the streamline filter units fitted on tanker delivery hoses. Contamination of the low pressure fuel filter is then entirely dependent on the efficiency of refuelling equipment in regard to stopping foreign matter. It is consequently important to ensure that streamline filters are serviced regularly. If they are kept in an efficient condition no trouble should ever be experienced in regard to fouling of the low pressure filter element. A symptom of low pressure filter blockage shows itself normally in inability to obtain full engine power.
6. The following precautions and inspection requirements are to be adhered to. All other instructions on servicing of these filters being hereby cancelled.

7. There are no really satisfactory methods of cleaning these felt filter elements. Once they are impregnated with foreign matter or plain sludge it is impossible to remove all of it. If attempts are made to brush or rub the surface of the element it will have the effect of forcing some of the particles of dirt further into the wool and, in addition, will tend to tear the outer fibres. Trichlorethylene or similar de-greasing agents must not be used. Washing filters in such liquids results in the natural greases being removed from the wool fibres with their resultant brittleness. These brittle fibres could then break off and be carried into the fuel system and consequently clog some of the smaller wire filters. Extreme care is therefore to be taken when removing and refitting filters to ensure that the surface or ends of the element are not even slightly damaged. New elements are to be fitted at each complete overhaul or when an inspecting unit considers that an element is damaged or contaminated with foreign matter. Filter inspection laid down at present is at engine installation and minor inspections. Dismantling of the filter unit should be avoided as much as possible outside these times.

8. If new filter elements are not available then the following method of cleaning a blocked element can be done as an emergency measure only. The element is to be sealed at each end by two flat plates held together by a bolt passing down the centre of the element. This end seal is to prevent sludge washed off the outside finding its way into the centre. The sealed element can then be swilled in petrol to remove sludge and foreign matter. Care is to be taken that the cleaning is confined to swilling and no attempt is made to clean the felt surface by physical means.

9. Reports from overseas state that the existing method of sealing the ends of the filter element is considered unsatisfactory with possibility of foreign matter by-passing the filter. The filter element has been re-designed with more efficient end sealing and modification action will be taken to introduce these elements as soon as supplies are available.

Pump Filters

10. No trouble has been experienced to date with blockage of pump inlet strainers or orifice wire filters and it is not considered necessary to lay down inspection of these before pump complete overhaul for the following reasons:-

- (a) The wire strainer is of a relatively large area and can cope with any normal passage of foreign matter that may in rare cases by-pass the low pressure filter. Access to this pump inlet filter is gained by removing the inlet flexible hose and removal of the inlet union housing from the pump body.

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10. (b) The wire wound filter in the servo chamber metering orifice is not in the main pump high pressure fuel flow and does not suffer from blockage for this reason. This filter is extremely difficult to remove and can easily suffer damage when attempts are made.
- (c) Inspection carried out to date on pumps returned for investigation of faults has not revealed any degree of blockage of either pump inlet or orifice metering filters.

B.P.C. Filter

11. Trouble has been experienced with blockage of the wire wound filter on the Barometric Pressure Control Unit. Blockages have been due to extremely fine pieces of metal and fibre matter. The metal particles have probably originated from various fuel system units as a result of insufficient attention to cleaning when the units were first assembled. The small fibre particles appear to have originated from the low pressure filter element. The wire wound filter in the B.P.C. is of an extremely fine filtering capacity and when first inspected may appear to be quite clean. It is necessary in most cases to inspect it with a magnifying glass to reveal the foreign matter obstructing it.

12. Blockage of this filter has a direct effect on the performance of the B.P.C. unit as it affects the twin pumps servo piston fuel delivery past the B.P.C. half-ball valve. Complete blockage of the filter would therefore make the B.P.C. inoperative with consequent lack of correction on engine R.P.M. with altitude. Partial blockage of the filter would cause sluggish operation of the B.P.C. with relevant varying reaction on engine R.P.M. over altitude.

13. A practical method of checking cleanliness of the B.P.C. filter is to run the engine at 8000 R.P.M. and check the R.P.M. rise when the fuel pump emergency switch is placed "ON". Nene Instruction No. 1 lays down only "a rise in R.P.M.". No tolerance of R.P.M. range change is given as it varies considerably with pump efficiency and is not a critical factor in the operation of the Nene fuel system. Normally the rise in R.P.M. will take within 2-3 seconds and average R.P.M. increase will be approximately 800. However, rises over a 200 to 1500 R.P.M. range can still be obtained from a serviceable Nene fuel system.

14. When carrying out the engine running check at 8000 R.P.M., the following R.P.M. reactions, with use of the fuel pump emergency switch, can be used as a guide for assessing blockage of B.P.C. filters:-

- | | | |
|-----|--|------------------------------|
| (a) | No change in R.P.M. | - completely blocked filter. |
| (b) | Small R.P.M. rise, i.e.,
under 200 | - major filter blockage. |
| (c) | Sluggish R.P.M. rise (over
any of normal range) | - partially blocked filter. |

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15. Due to the variations on engines of the total R.P.M. rise and the fact that this can be accepted as normal it is not possible to give detail information above that referred to in paragraph 14 (a), (b) and (c). It may also be found that an engine giving no R.P.M. rise with this check may have a serviceable B.P.C. unit with clean filter and the reason for the lack of R.P.M. rise being associated with a defective fuel pump or inoperative solenoid isolating valve on the top pump.

16. However, when pilots report unusual lack of automatic control of engine R.P.M. with altitude variations or when weekly engine checks reveal symptoms as outlined in paragraph 14, sub-paragraphs (a), (b) and (c), the B.P.C. filter is to be removed and cleaned. Filters should be very carefully cleaned with a high pressure air/kerosene jet making sure that the inside flutes of the filter as well as between the wires are thoroughly cleaned out. A final inspection should be done with a magnifying glass.

17. In view of the fact that several cases of partially blocked B.P.C. filters have been found by units, removal and cleaning is now to be done at each minor inspection.

Burner Filters

18. Each duple burner fitted to the Nene 2-VH has a wire wound filter fitted in its primary fuel supply union housing. This filter is similar to the one in the B.P.C., being of fine filtering design. A case has occurred of these filters being blocked by foreign matter which included small fibre pieces in a manner similar to the B.P.C. filter.

19. If one or more of these burner filters becomes partially or completely blocked the burner efficiency suffers. It is difficult to lay down precise symptoms of fouled burner filters, but as loss of burner efficiency affects combustion efficiency the result is always a higher jet pipe temperature for a given engine condition. The following signs during engine operation may indicate burner filter defects:-

- (a) Signs of heat inside of exhaust cone with associated buckling or cracking.
- (b) Distortion and bracking of nozzle guide vanes.
- (c) Distortion of turbine wheel shroud ring with associated loss of turbine tip clearance.
- (d) High jet pipe temperatures, particularly at idling.

20. In view of the fact that several cases of burner filter blockages have occurred with subsequent damage to engines from overheating, removal and cleaning of these filters is now to be done at each minor inspection in like manner to the B.P.C. filter.

21. Blockage of burner filters may assist build-up of carbon formation on burner orifice faces but the two are not necessarily always associated. Carbon fouling of burners is usually the result of incorrect or contaminated fuel. No defects have been reported to date in connection with carbon fouling of burners and it is not proposed to introduce any standard inspection cycle of these items between overhaul times.

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