

Chapter 4

SUPPRESSION OF ELECTRICAL INTERFERENCE ON AIRCRAFT

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Introduction

1. Many of the items of equipment used in aircraft electrical installations are liable to interfere with the operation of radio equipment, and it is necessary to provide means for counteracting this interference. The causes of interference due to the electrical installation may be classified as follows:—

- (1) High tension discharge (engine ignition systems).
- (2) Sparking at brushes (generators, motors, etc.).
- (3) Sparking at contacts (relays, switches, etc.).
- (4) Intermittent or rubbing contacts (loose connections).
- (5) High-frequency alternating current (electronic equipment).

2. The disturbance, set up by these causes, originates as a result of radiation of electromagnetic waves at radio frequencies. Such radiation, which is normally continuous (although the energy radiated is not uniform), may take place from all circuits connected, or adjacent to the system. A radio receiver can consequently be affected by this radiation whether or not the receiver power supply is derived from the same source of supply as the interfering apparatus.

3. Interference can be radiated from apparatus which is inadequately screened, or it can be conducted along and radiated from unscreened wiring connected to the apparatus, unless a suppressor is interposed between the interfering source and the unscreened wiring (*para.* 12). This interference can be picked up by a receiver aerial or by inadequately screened parts of the receiver, by conduction along the power supply leads to the receiver, or by a combination of these effects.

4. There are two methods which may be adopted for the suppression of radio interference on aircraft. One method is to enclose the whole of the electrical and ignition installation in a complete and electrically continuous metallic sheath or screen. This method, which relies solely on the screen to prevent radiation, must be carried out with the utmost thoroughness to be successful, and if the receiver should be fed from the same supply as the electrical installation, provision must be made to prevent interference entering the receiver by way of the power supply leads.

5. The other method of suppression is to confine the interference to a local circuit at or near the source. This involves completely screening the apparatus which produces the interference, and inserting a suppressor between the screened apparatus and the unscreened wiring. The suppressor should be fixed as near as possible to the

apparatus and connected to it by screened cable. This latter will ensure that the apparatus, the suppressor and its connecting cable form one complete interference screen.

Ignition system

6. Interference caused by an aircraft ignition system can be suppressed only by effective screening of the whole ignition system, including the magneto (with armature), contact breaker, distributor, H.T. and L.T. cables, sparking plugs, ignition switches and junction boxes. A possible exception may be made in the case of the starting ignition equipment. The screening must form a continuous metallic sheathing of low and unvarying resistance. The sheathing must be securely bonded at each end, and at intermediate points to the engine frame and main earth system of the aircraft. Two approved methods of screening are available, involving in one case metal-braided cables and in the other a screening harness.

7. Screened cables are braided with copper or phosphor-bronze wire, suitable end fittings being provided to connect the braid to the screen of the magneto, sparking plug, or other apparatus.

8. The term screening harness is applied to the system employing metallic conduits, partly rigid and partly flexible, in which unbraided high-tension cables are enclosed. The connections to the magnetos and sparking plugs are made by means of flexible conduits comprising a metallic tube of interlock section covered with a woven braid of copper or phosphor-bronze wire. In the harness system the magneto switch lead and the H.T. cable of the starting magneto or booster coil may be similarly screened, but the general practice is to use metal-braided cables for these circuits.

9. In many aircraft, the starting magneto or H.T. booster coil and its associated switches and cables are only partly screened. In order to prevent interference from the main magnetos being conducted to, and therefore radiated from, this partially screened portion of the ignition system, an isolating spark gap is inserted in each starting magneto or booster H.T. lead. This gap is enclosed in a cylindrical metallic screen and is mounted as near as possible to its associated magneto and earthed or bonded to the airframe by a rigid support. When this method of suppression is employed,

screened cable is used between main magneto and isolating gaps, and unscreened or plain cable between isolating gaps and starting magnetos or booster coils.

10. Starting booster coils of the low-tension type, operated from the aircraft d.c. supply, are extensively used. The connections between the L.T. booster coil, which is fully screened, and the L.T. circuits of the main ignition system are made with screened cables. In order to prevent ignition interference being transferred to, and radiated from, the aircraft electrical wiring, a suppressor is inserted between the booster coil and the electrical supply.

11. All joints in the screening system must remain thoroughly tight under all conditions of vibration and temperature change. The contact surfaces must be electrically perfect, and free from paint, enamel, or grease. Where cables, conduits, and such items as isolating spark gaps are bonded to the engine or airframe, all paint, enamel, anodizing or similar protective coating must be removed from beneath the bonding clamps. Intermittent vibratory contact between screened cables or conduits and any metal part of the airframe must be avoided, and such parts must be either bonded or definitely insulated, using insulating bushes or sleeves where necessary.

Electrical system

12. The most satisfactory method of suppressing interference from aircraft electrical systems, and that which is normally used, is described in para. 5. Each interfering source is enclosed in a metal screen, and a suitable suppressor connected between each source and the unscreened wiring system. The connection between suppressor and source of interference is by screened cable. The metal screen of the cable must be efficiently connected to the suppressor case and the apparatus screen, and the whole bonded to earth.

13. The general service wiring on certain types of aircraft is enclosed in metal conduit or channel; in some cases this enclosure is mainly for mechanical protection and electrical screening of the wiring is not complete, and such cases must be treated as unscreened wiring.

14. The suppressors used are of the low pass filter type, and the essential considerations in their design are:—

RESTRICTED

- (1) The suppressor should provide adequate suppression of interference over the frequency range in Service use.
- (2) The operation and reliability of the apparatus to which the suppressor is connected must not be affected in any way. It is of particular importance that the resistance, and therefore the d.c. voltage drop, should be of a low order.
- (3) The weight and dimensions should be as small as possible, whilst satisfying considerations (1) and (2).
- (4) The suppressor must be sound mechanically, and capable of operating continuously under all conditions.

15. Effective suppression over the required frequency is provided by choosing suitable values of inductance and capacitance, and avoiding as far as possible the introduction of stray capacitances and inductances. The effect of the length of the leads on the capacity of a condenser can be considerable at high frequencies, and it is thus necessary that condenser leads should be kept as short as possible. In this connection, condenser leads are those parts of the internal wiring of a suppressor which carry only condenser currents. In most suppressors the condenser lead is kept short by arranging that the d.c. current-carrying conductor, to which the condenser is connected, passes as close as possible to the point where the connection emerges from the condenser case.

16. The design of the inductances varies with the type of suppressor. In order to obtain the required inductance with minimum d.c. resistance, use is made of iron dust cores, or laminations of silicon iron.

17. When a suppressor is fitted to an engine-driven generator, screened cable is used between the generator and suppressor; the carbon pile voltage regulator is connected to the unscreened side. In this instance the metal body of the generator forms the screen against direct radiation from the interference source. The cables between the generator and suppressor must also be screened. In cases where the regulator itself produces interference, e.g., with Tirrill types, it must be screened and connected between the generator and the suppressor.

18. In some instances, particularly with heavy current suppressors, the input choke of the suppressor is omitted, the impedance of the interfering source and wiring being utilized in its place. This is possible, however, only where condensers of relatively high capacity are used in the suppressor; this type of suppressor is known as π section. Details of individual suppressors will be found in A.P.4343C, Vol. 1, Sect. 5, Chap. 10.

INSTALLATION

19. Suppressors should be installed as near as practicable to the source of interference, and where the suppressor case is labelled, the end marked SCREENED should be connected to the source of interference. Care must be taken that all screening, electrical and earthing connections are of low and unvarying resistance. Screening of the cables from the interfering source to the suppressor is usually by means of metal braiding, and care should be taken in the assembly of the screening glands to ensure that the screen is complete, that the contact between the metal braiding and the screens is of low resistance, and that no ends of braiding are unclamped.

20. Cable fittings for use with suppressors are to be demanded separately to suit the cables being used.

SERVICING

Ignition systems

21. The joint surfaces between the connectors and the sparking plugs and between the connectors and the H.T. cables or harness flexible conduits should be thoroughly cleaned. All the remaining joints in both the H.T. and L.T. circuits of the ignition system should be inspected and tightened where necessary.

Location of interfering sources

22. Tests for the efficiency of the ignition and electrical screening in aircraft should be made using the normal aircraft receivers and aerials. Where radar equipment is installed, that equipment must also be used for such tests. The radar equipment should preferably be operated from a ground testing a.c. generator driven by a suitably screened engine.

23. The engine should be run at a speed sufficiently high to cause the generator to charge the aircraft battery. On multi-engined aircraft each engine must be run up in turn.

24. If any interference is detected, it will be necessary to determine whether it is from the electrical or ignition system. This can usually be determined by switching off each magneto in turn. If this does not give sufficient indication, the engine speed should be reduced to approximately 1,000 r.p.m., and both magnetos switched off together.

25. If the interference ceases immediately, the source of the interference is the ignition system. If the interference persists, the source is either the generator, or some other engine-driven electrical equipment such as the tachometer generator (if of the d.c. commutator type), or any other electrical apparatus that is switched on.

26. If the interference is from the ignition system, a test should be made to determine whether the interference is from the H.T. or L.T. circuit by disconnecting the primary or L.T. wires from the main magnetos. If the interference ceases, check the tightness of all the joints in the screening of the L.T. circuits, and clean the bonding surfaces in the joints if necessary.

27. If the interference persists, the source is on the H.T. side and each magneto should be switched off in turn in order to ascertain, if possible, which of the magneto systems is causing the interference. The source may be localized approximately by consideration of the frequency of the interference in pulses in the output from the radio receiver. If the impulses are of a comparatively low frequency, the interference is most probably due to one or two loose joints in the sparking plug cables or flexible conduits. If, however, the interference impulses are of a high frequency, corresponding to the magneto spark frequency, the source will be in that part of the system common to all the sparking plugs, i.e., the magneto, the main harness

flexible conduits and the starting magneto or booster coil circuits.

28. Detach the starting magneto or booster coil H.T. leads from the main magnetos. If the interference ceases, examine the centre of the isolating spark gap and ensure that the spark points are correctly spaced. Re-assemble the spark gap, and ensure that it is correctly bonded. Attach the H.T. cables to the main magnetos and test again.

29. If, however, the interference persists after detaching the H.T. starting cables from the main magnetos, check the tightness of all the joints on the magnetos and harness main conduits.

Suppressors

30. It is essential that the efficiency of all circuit connections, as well as all bonding and screening arrangements, should be maintained. In particular, great care should be taken to ensure that internal connections of suppressor are perfectly tight and securely locked. Inspection should also be made for any signs of seepage of wax from the condensers. Normally, no repairs can be undertaken in Service, apart from the rectification of small obvious faults such as a broken wire; certain types also have easily renewable tubular condensers.

31. When testing the insulation resistance of a circuit which includes a suppressor, an erroneous result will be obtained unless the test voltage is kept constant and a reading taken when the indicator has reached a steady value. With an insulation resistance tester, the handle speed controls the voltage of the tester; this speed must be kept during the period of the test, and must not give more than 250 volts. The recommended tester is the Type C (Stores Ref. 5G/152), in which the voltage is limited to 250 volts by the incorporation of a slipping clutch.

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