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Subject :Control of Electromagnetic interference in modern aircraft.

1. PURPOSE:

Sub rule 2 of Aircraft Rule 57 states that instrument and equipment including Radio equipment installed on aircraft shall be maintained in a serviceable condition. Besides maintenance, electromagnetic interference (EMI) also affects performance of those equipments. This part of the CAR on electromagnetic interference in modern aircraft provides a brief review of the principles of electromagnetic compatibility, special considerations given in Aircraft Systems design and maintenance of the aircraft to ensure electromagnetic compatibility.

2. DEFINITION:

ELECTROMAGNETIC INTERFERENCE (EMI) can be defined as undesirable voltage or currents which affect a system.

3. EFFECTS OF EMI:

STATIC in audio receivers, inaccuracies in instrument indications, herringbone effect in video projections, and other problems may exist when a system is susceptible to EMI. The device or component which emits the undesirable electromagnetic energy may even affect its own performance. Some sources known to emit energy which may create interference are: fluorescent lights, radio and radar transmitters, power lines, window heat controllers, induction motors, switching and light dimming circuits, pulsed high frequency outputs, and lightning. This energy can reach a circuit or system by conduction or electromagnetic field radiation. Conduction is the process in which the energy is transmitted through electrically conductive paths such as circuit wiring or aircraft metallic structure. In electromagnetic field radiation energy is transmitted through electrically non-conductive paths such as air or fiberglass. These paths create a bridge between the interference source and the susceptible receiver. Systems which may be susceptible to electromagnetic interference are, to name a few: general display and navigation instruments, computers, and radio and radar receivers.

Whether a system will have an adverse response to electromagnetic interference depends on the type and amount of emitted energy in conjunction with the susceptibility threshold of the receiving system. The threshold of susceptibility is the minimum interference signal level (conducted or radiated) which causes an adverse response distinguishable from the normal response. An interference problem will exist when the noise level is greater than the susceptibility threshold level. When the susceptibility threshold level is greater than the conducted or radiated emission level, electromagnetic interference problems do not exist. This situation is called Electromagnetic Compatibility (EMC), that is, electrical and electronic devices operate as intended and the EMI generated by them

does not interfere with the normal performance of any other device.

4. EMI CHARACTERISTICS:

INTERFERENCE, whether conducted or radiated, can be categorized by bandwidth, amplitude behaviour, waveform and occurrence.

The bandwidth of interference is the frequency range in which the interference exists. The interference bandwidth can be narrow or broad. Narrow band interference can be caused by such items as AC powerlines, computers, radio transmitters and receivers. These items all generate specified frequencies along with the unwanted harmonics of those frequencies. Broad band interference is caused by devices generating random frequencies which serve no designed purpose, but are present due to the characteristics of the electrical system. Examples of this type of interference are power supplies, light dimmers, and electric motors.

The interference amplitude is the strength of the signal received by the susceptible system. The behaviour of this signal can be reasonably stable or can be totally random. A 115 V AC power line can induce a stable sinusoidal waveform on adjacent 28 V DC power or signal lines. Examples of random interference are environmental noise and inductive switching transients. Environmental noise is the aggregate of all electromagnetic emissions present in a particular space or area of concern at any one time.

There is no one specific waveform that produces electromagnetic interference. It is the change from one signal level to another in conjunction with the rate at which it changes that determines the amount of electromagnetic energy released. More energy is released when the change in signal level and rate is increased.

The occurrence of interference can be categorized as periodic, aperiodic, or random. The periodic occurrence has a set repetition rate. Aperiodic occurrence is predictable but does not have a defined repetition rate. Random occurrence is simply unpredictable.

5. UNIT OF MEASUREMENT:

A very common unit in the measurement of electomagnetic interference is the decibel (db). The decibel is a logarithmic unit expressing the ratio of two powers, voltages or currents.

In working with dbs, it is helpful to remember that a change of 20 db implies that the voltage or current has changed by a factor of ten. Another number helpful to remember is a change of 6db. This is equivalent to a voltage or current which has changed by a factor of two.

6. EMI REDUCTION TECHNIQUES:

Planning for electromagnetic compatibility must be initiated in the design phase of a device or system. If this is not satisfactorily achieved, interference problems may arise. As described earlier, the necessary items to produce an interference problem are: (1) a noise source, (2) a coupling channel, and (3) a susceptible receiver. To reduce

the effects of EMI, atleast one of the above items must be evaluated and modified. The following lists state some general EMI reduction techniques:

(a) Suppressing Interference at Source

- **(i) Enclose interference source in metallic housing.**
- **(ii) Use transient suppression on relay coils.**
- **(iii) Twist and/or shield noisy wires.**
- **(iv) Filter noisy output leads.**
- **(v) Keep pulse rise times as slow and long as possible.**

(b) Reducing Noise Coupling

- **(i) Separate power leads from interconnecting signal wires.**
- **(ii) Twist and/or shield noisy wires (coaxial cable may need high frequencies).**
- **(iii) Keep ground leads as short as possible.**
- **(iv) Break interference ground loops by incorporating isolation transformers, differential amplifiers, balanced circuits.**
- **(v) Filter noisy output leads.**
- **(vi) Physically relocate receiver from interference source.**

(c) Increasing Susceptibility Threshold of Receiver

- **(i) Use only necessary bandwidth.**
- **(ii) Use metallic shielded enclosure.**
- **(iii) Limit sensitivity.**

After careful planning for EMC, the electrical/electronic device or system is tested in the laboratory and the airplane. If successful testing is achieved, EMC can be assured with a high level of confidence. However it should be noted that unanticipated situations creating interference problems may still arise even after careful design and successful testing. It is the exception, but can still happen. When this does occur, investigation and resolution of the problem will then take place to assure EMC.

7. **MAINTAINING EMC IN DELIVERED AIRCRAFT:**

To ensure that interference problems are kept to a minimum during the life of an aircraft, it is essential that the aircraft be maintained in an electro-magnetically compatible configuration. This can be accomplished with skilled and knowledgeable maintenance personnel following the procedures and guide lines in the aircraft technical manuals. The technical manuals most often used to help ensure EMC during maintenance are the: Maintenance Manual (Fault Isolation Manual and BITE Manual), Wiring Diagram Manual, and the Component Maintenance Manual. Some items which must be

maintained to ensure EMC are:

(i) proper wire separation between noise source wiring and susceptible wiring. (Example: ADF (Automatic Direction Finder) wiring is strategically routed in the airplane to ensure EMC. Any changes to the routing of this wiring could have an adverse affect on the system). In addition, the wire separation requirements for all wire categories must be maintained.

(ii) Wire lengths be kept as short as possible to maintain coupling at a minimum. Where wire shielding is incorporated for lightning protection, it is important that the shield grounds (pigtails) be kept to their designed length. An inch or two added to the length will result in degraded lightning protection.

(iii) Circuit grounds must not be lengthened beyond design specification. A circuit ground with too much impedance may no longer be a true ground.

(iv) With the aid of the technical manuals, grounding and bonding integrity must be maintained. This includes proper preparation of the surfaces where electrical bonding is made.

(v) Proper handling of electrostatic discharge sensitive (EDS) equipment must be maintained.

(vi) Equipment purchased for aircraft installation must have been qualified successfully to the proper EMC test category and document.

8. **CONCLUSION:**

Initial control of EMI is achieved in modern aircraft by careful design and successful testing. Routine maintenance helps to ensure that the aircraft retains electromagnetic compatibility, thereby keeping interference problems to a minimum.

Sd/-
(S. L. Srivastava)
Deputy Director General of Civil Aviation