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Digital PowerLine (DPL) and Aircraft Communication Systems

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Synopsis

Modern civil and military aircraft utilise a wide variety of telecommunication systems, particularly radio, to pass information to ground base controllers, determine flight parameters, quantify physical parameters (temperature, atmospheric pressure, altitude, speed, position etc), provide telephony and data communications to and from flight crew, passengers and flight personnel etc. It is important to assess the impact of a wide variety of similar telecommunication services on those of the aircraft, particularly with respect to maintaining total integrity of the aircraft systems and thereby ensuring the highest levels of safety for the aircraft and passengers. This paper first considers, in some detail, the electromagnetic spectrum utilised by modern commercial airliners and compares this to the electromagnetic spectrum requirement of NOR.WEB's DPL system. It concludes that widespread deployment of the NOR.WEB DPL system, with certain exclusion zones will have no impact on aircraft telecommunication systems.

Introduction

If we wish to investigate the potential threat posed by a particular telecommunications system (usually referred to as the jammer) to another telecommunications system (usually referred to as the victim) we require to know the electromagnetic spectrum which it utilises. By comparing the victim spectrum with that of the jammer we can determine the potential for interference at the victim receiver(s) subject to considerations of common environment, type of system (basically two types: radio and line), proximity, sensitivity, relative power levels, propagation modes etc. It follows that if there is no common spectrum between systems then there is no potential to create a threat or victim - jammer relationship!

Aircraft electromagnetic spectrum (1)

The radio frequency bands (specific segments of the electromagnetic spectrum) utilised by a modern commercial airliner are allocated by international agreement and classified as follows:

Omega navigation	10 to 14 kHz
Automatic direction finder	190 to 1750 kHz
High Frequency	2 to 30 MHz
Marker beacon	74.85, 75 and 75.15 MHz
VHF omnidirectional range localiser	108 to 118 MHz
VHF communication	118 to 136 MHz
Glide slope	328 to 335 MHz
UHF communication	225 to 399 MHz
Distance measuring equipment	960 to 1220 MHz
Traffic alert/collision avoidance system	1030 to 1090 MHz
Global positioning system	1575 MHz
Satellite communication	1529 to 1661 MHz
Low-range radio altimeter	4.3 GHz
Microwave landing system	5.03 to 5.09 GHz
Weather radar	5.4 GHz
Weather radar	9.3 GHz

Aircraft emergency communications (UK airspace) (2)

As an example, the UK has two Distress and Diversion (D&D) Sections located at the London and Scottish Area Control Centres. They are manned by RAF control staff who are assisted in the provision of an emergency service on the International Aeronautical Emergency Frequency of 121.50 MHz by suitably equipped civil and military units and certain HM Coastguard stations. The service is available continuously to pilots flying within UK airspace who are in distress, in urgent need of assistance, or experiencing difficulties, (i.e. temporarily unsure of position) which could lead to a state of emergency.

The primary role of the D&D Sections is to provide military and civil pilots with an emergency aid and position fixing service. Autotriangulation (DF) coverage on 121.50 MHz is available over most of the London Flight Information Region (FIR) above 2000ft amsl (above mean sea level) to aircraft flying to the east and south of Manchester.

Pilots are advised to address their emergency calls on 121.50 MHz to 'London Centre' when south of 55 degrees North, and on 121.50 MHz to 'Scottish Centre' when north of 55 degrees. In the event that the aircraft equipment or the strength of the received signals are distorted to the point of being unintelligible, the pilot may be asked to adopt the Speechless Code. This entails the pilot pressing his transmit button a certain number of times and using carrier wave only transmissions which, by convention, have a predefined meaning.

It follows that for aircraft distress and emergency purposes the key elements are secure VHF radio communications on 121.50 MHz together with adequate pilot training as to his options in the event of such an emergency.

NOR.WEB DPL electromagnetic spectrum (3)

NOR.WEB's powerline telecommunication (PLT) system occupies two frequency slots:

2.2 to 3.5 MHz

4.2 to 5.8 MHz

Potential victim – jammer relationship

Quite clearly the frequency slots proposed for NOR.WEB's DPL systems do not coincide with any frequencies allocated to aircraft systems including those for navigation, direction finding, glide slope, distance measurement etc and particularly those for distress and emergency. Indeed the only common element of spectrum is in the HF band which extends from 2 to 30 MHz. The primary use of the HF band for aircraft is in 'transoceanic routing' which involves voice and/or data transmissions to routing centres whilst the aircraft is out of range of the International VHF Radio Communications Services. A typical figure for potential HF deployment is when an aircraft is over 200 nm (nautical miles) from land.

In order to ensure that these HF services are not subject to interference, DPL systems are excluded from the areas where sensitive HF receiving sites are located. Such sites are in rural locations in order to accommodate the necessary HF antenna farms and ensure as low a noise floor as possible. DPL systems are designed for deployment in urban and suburban areas, subject to the right business demographics. Also, the power spectral density of DPL systems is such that the cumulative levels of radiated emissions are below the noise floor at the aircraft receiver. Consequently DPL systems will not affect aircraft HF radio services.

Conclusions

DPL systems do not pose any threat to aircraft telecommunications systems including: electronic and radio based navigational aids, HF, VHF (including distress and safety), UHF and microwave radio communication systems (voice and data). The only common elements of electromagnetic spectrum are two small slots contained within the HF bands which are protected by the deployment of exclusion zones. It should also be noted that satellite systems such as GLOBALink/HF (4) are rapidly becoming harmonised with and, to a large extent, reducing the reliance on stand-alone HF transoceanic systems.

References

1. Aircraft electromagnetic spectrum, (Boeing Commercial Airplane Group), p 29, IEEE Spectrum, September 1996

2. Radiotelephony manual (CAP 413), UK, Civil Aviation Authority (CAA), 1999

3. NOR.WEB DPL Ltd Standards Proposals, 1999

4. ARINC Incorporated, http://www.arinc.com/Products_Services/GLOBALink/hf.htm