Application Note
Considerations For RF Safety Surveys

Notice:

The information contained herein is intended as a general guide. Because of the highly individual nature of many radio frequency applications it is possible that more specific information is required to carry out an accurate risk assessment of any given site or application. Consequently any information provided is not intended to be relied upon except as accompanied by specific expert or legal advice

Introduction

Unlike the U.S. or Australia where safety guidelines, and standards for measurement procedures and equipment are published, we have safety guidelines in the UK but no standard on how to assess compliance with them.
This means that anyone commissioning a survey is at the mercy of the technical competence of the surveyor in that, measurement method, the equipment used, how it is calibrated, levels of measurement uncertainty etc. are all down to the competence of the surveyor. It is probably true to say that many individuals or organizations undertaking RF safety surveys do not have a written procedure to work against.

Anyone commissioning a RF safety survey has a number of points to consider.

1) What type of equipment e.g. radar, base station etc. is to be surveyed?

Ideally technical information about the transmitter should be known, for telecommunications and broadcast surveys information such as maximum output power, antenna gain, orientation of antenna (direction and downtilt) are relevant.

Is the survey to be on the equipment itself or just over a specific area e.g. an area where people can gain access?

This determines how the survey is carried out. If a piece of equipment is to be surveyed then any number of measurements at various distances from the equipment may be necessary. Alternatively measurements may be required just where an operator stands or where people can gain access e.g. if it is physically impossible under normal circumstances to approach within say 3m of an antenna why take measurements inside the 3m distance.

2) What is the required frequency range?

The biggest area of confusion here is for mobile phone base station surveys. Mobile phone frequencies are fairly easily defined, currently at around 900MHz or 1800 MHz with the forthcoming 3G system at around 2100MHz.
The problem is that base station antennas are often located along with antennas for some of the many other radio systems in use today. Antennas for paging systems, VHF radio systems used by fire brigades, police, ambulance, utility companies etc. will be located alongside cellular antennas. These are often overlooked but they all contribute to field strength levels and operate at typically in the VHF band. Microwave equipment such as point-to-point links used to transmit signals from base station to base station may add more confusion as it is debatable whether they should be included in a safety assessment. Frequencies are high up to tens of GHz and add to the complexity and cost of a survey. Generally power levels are very low and the antennas are designed to transmit a relatively narrow 'beam' well above the ground, never the less it is often microwave dishes at a site that cause public concern.
Generally speaking the wider the frequency range the higher the cost of the survey. If a survey can be limited to say 300kHz to 3GHz this will keep this aspect of the cost considerations to a minimum.

3) What is the required measurement sensitivity?

There are two main types of equipment that can be used for RF safety surveys. 'Narrow-band' equipment consists of a relatively narrow-band antenna and a spectrum analyser. Although necessary for measuring very low field strengths this technique is time consuming, expensive and complicated. This is because the equipment is not capable of instantaneously summing all signals received in a multiple signal environment and

equally, it is not capable of instantaneously summing the net effect of signals received from all directions. Multiple measurements and calculations are therefore required, also if a wide frequency range is required then a greater number of antennas have to be used. As a result, the most cost effective method of measurement employs 'broadband' equipment.

The essential characteristics of broadband equipment are:

It is specifically designed for safety assessment.
Isotropic probes mean signals received from all directions are evaluated.
Broadband probes measure signals received at all frequencies (within the designated range). It should be noted that it is the total field strength that should be used for assessing compliance with safety guidelines not the field strength from individual signals.

It consists of a relatively simple to use meter and probe combination. It has no frequency selection capability (other than the frequency range of the measurement probe) and has a minimum sensitivity and measurement range appropriate for comparison with current safety guidelines. Minimum sensitivity is limited to about 0.5 V/m or 0.05 μW/cm^2. This equates to around 0.01% and 0.02% of ICNIRP general public guidelines for the approximate mobile phone frequencies of 900 and 1800MHz. It certainly can be argued that this level is sufficiently low for general public surveys i.e. Why do you need to measure below 0.01% and 0.02% of the safety guideline?
Surveys based on 'occupational' limits are different. The sensitivity of the broadband equipment is not an issue as measurements will be taken close to antennas and the field strengths will be proportionally higher consequently using broadband equipment is the norm.

It should be noted here that the measurement uncertainty for either method can be very large, at least 3dB (50%) or higher. The level of uncertainty should be quoted on the survey report and it may limit the maximum exposure level (MPE) e.g. the MPE may be considered to be the level quoted in the safety guideline minus the level of uncertainty.

4) Is it necessary to measure both the Electric & Magnetic field?

Safety guidelines recommend that if a measurement is carried out in the 'near-field' of an antenna then it is necessary to measure both fields. This 'near-field' extends a few meters from the antenna depending on both frequency of operation and the design of the antenna. As a rule of thumb measurement of magnetic field is only undertaken at frequencies under 300 MHz but this is mainly due to limitations of measurement equipment.

5) Do the levels of individual signals need to be compared?

If comparison of individual signals is required a 'narrowband' survey is required using a spectrum analyzer to view individual signals. It should be noted that this approach is not technically correct, as the *combined* level of *all* signals should be assessed.

6) What safety guidelines should be applied?

There is no specific legislation in the UK covering RF and microwave exposure however the UK Government does have an advisory body on the subject – the National Radiological Protection Board (NRPB). It is the guidelines set by the NRPB that have traditionally been used to establish maximum permissible exposure levels. Over recent years however guidelines issued by the International Commission on Non Ionising Radiation Protection (ICNIRP) have for telecommunications surveys become the *de facto* standard. This is because over much of the relevant frequency range ICNIRP exposure levels are lower than those issued by the NRPB and include two tiers, public and occupational.

7) Is public access possible to the area or equipment to be surveyed?

If public access is possible then guidelines issued by ICNIRP for the general public should be used as the basis for the survey.

It should be noted that the ICNIRP guidelines state 'the occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions'. This may not be the case for a number of contractors who may be required to visit a roof top site – roofing contactors, air conditioning engineers, painters etc. Additional issues apply regarding people fitted with implantable medical devices such as pacemakers as it is possible these devices may be affected by radio frequency radiation.

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