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York EMC Services Ltd

Potential Changes to Electromagnetic Environment - Household Environment (copy 1 of 1)

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for

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1 HOUSEHOLD ENVIRONMENT

1.1 About this document

This report is one of a series of four documenting the investigation and analysis of potential changes to the electromagnetic environment implied by the findings of research funded by the Radiocommunications Agency. This report is concerned with the effects that household appliances will have on the electromagnetic environment in a typical domestic setting. It is intended that the data presented in the report will be used by Quotient Associates Ltd to enable an economic analysis of EMC studies. Consequently no conclusions or recommendations are given in this report.

1.2 Introduction

CISPR14 (EN 55014 [1]) specifies EMC tests for household appliances and electric tools. The standard has a long history that can be traced back to 1937. Although the standard has been regularly updated, some of the test methods and associated frequency ranges are outdated compared to standards with less history. The current standard does not test for radiated field in the same way as more modern standards (eg CISPR 22/EN 55022 [2]) and only tests up to 300MHz. Unintentional emissions above 300MHz are effectively unregulated.

A court case arose out of the inadequacy of the EN 55014 standard [3]. Reference [3] shows that because a hairdryer could pass EN 55014 but fail the generic emissions standard there is a good argument to say that the hair dryer, even though it meets EN 55014, does not meet the essential protection requirements of the EMC Directive [4]. This has yet to be tested in court, as the defendants in [3] pleaded guilty. If the anomaly in standards is allowed to continue then further court cases and associated costs may ensue.

The latest research [5] makes the recommendation that “Radiated field requirements up to 1GHz should be included as a matter of urgency for all products”. A widespread example of interference above 300MHz from CISPR 14 products is hair dryers interfering with television reception [3]. A further problem area is that no test is required for battery operated toys. Many toys have small inexpensive DC motors fitted that produce surprisingly high levels of radiated noise over a broad frequency band.

This report presents simple scenarios to evaluate the possible impact of the main recommendation of the research on electromagnetic disturbances in the household environment. The data will be presented in a before and after research format so the economic impact of the research can be accessed. The 'before' scenario is based on likely emission levels between 300 MHz and 1 GHz from household appliances, electric tools and motor driven toys. The 'after' scenario assumes that appropriate modification is made to CISPR 14 to make it consistent with levels for radiated emissions contained within CISPR 22 Class B (EN 55022 Class B), the general standard covering electromagnetic emissions within a domestic environment.

1.3 Scenario Description

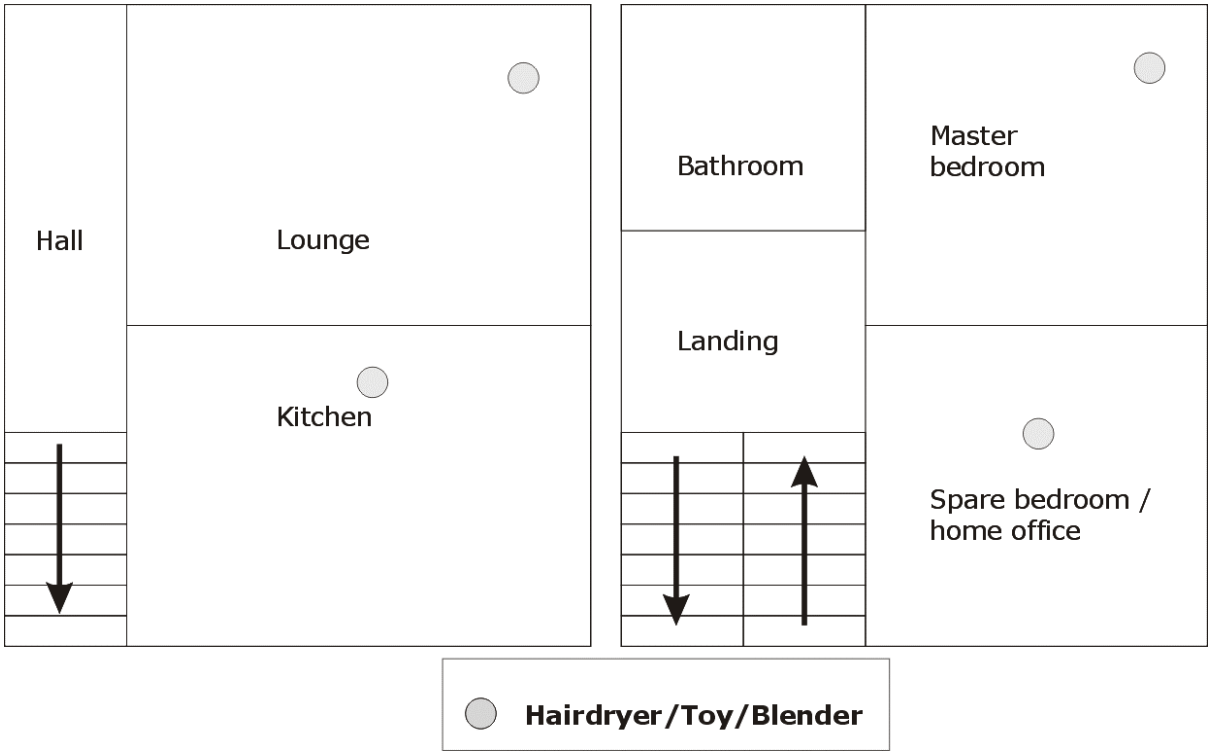

Figure 1 - Typical House.

The typical house used in the other reports in this series is shown in Figure 1 and will be used in the analysis presented in this report. The household devices in question are ones containing small DC motors. The commutator arcing from the motors can cause significant emissions above 300 MHz. Two examples of this occurring are the toy train of the CISPR14 report [5] and a hairdryer that was the centre of a recent court case [3]. The toy train was found to be emitting 20 dB above the EN 55022 Class B limit and the hairdryer was found to be emitting 19 dB above the limit. It is assumed here that not all DC motor driven devices

will emit to this level and that the average emission will be less than 20 dB above the limit. To establish the average emission an extensive measurement campaign would be required which is beyond the scope of this project. It will therefore be assumed that an average device might emit at 10 dB above the EN 55022 Class B level.

The house is populated with the following motor driven devices:

1. Hand held food blender in kitchen
2. Child's toy in lounge
3. Hairdryer in master bedroom
4. Model train layout in spare bedroom

In reality none of the devices will be operated continuously and it is unlikely that the house will be occupied for the full day. Therefore for the purposes of this study it is assumed that the house is occupied for six waking hours during a working day (one hour in the morning, five hours in the evening). During this time it is assumed that:

- the hairdryer is operated for 10 minutes
- the blender is operated for 10 minutes
- the toys are operated for 60 minutes

The total disturbance time out of 360 minutes is therefore 80 minutes. Therefore part of the house will be disturbed for a maximum of 22% of the time. The areas of disturbance from the sources are shown in Table 2 and Table 3. However, it should be noted that operation of the devices unlikely to be correlated - simultaneous operation of all devices would be rare.

Table 1 presents key technical parameters for the victim radio services under consideration. The list confines itself to services that operate between 300MHz and 1GHz, as the main proposal of the research was to limit radiated emissions in that range. Previously there was no mandatory test to limit emissions above 300MHz.

Service	Frequency	Minimum field strength (dBµV/m)	Co-channel interference protection ratio (dB)	Noise bandwidth
DVB-T	470-590 MHz (Band IV) 598-854 MHz (Band V)	56 (Band IV) 60 (Band V)	4	8 MHz
Mobile	880-915 MHz, 925-960 MHz (GSM-900)	37.3	9	200 kHz

Table 1 - Parameters of key broadcast and telecommunications services.

The protection ratios in Table 1 are for co-channel interference, ie the protection of one signal (eg an FM broadcast) from another signal of the same type (another, weaker, FM broadcast). Where signal/noise ratios are available, these have been used instead to calculate the disturbance areas given in Table 2 and Table 3. Pearce *et al* [6] finds that DVB-T is very susceptible to wideband noise - a protection ratio of 20dB may be appropriate.

1.4 Modelling

1.4.1 Assumptions

Firstly it is assumed that the victims are in the far-field with respect to the noise sources. As an EM (Electromagnetic) wave propagates from its source, energy is exchanged between the E (Electric) and H (Magnetic) fields until the far-field ratio (E/H = 377 Ω) is reached; this takes a few wavelengths to happen. As the radiating mechanism for the noise sources is not known (ie whether they emit predominantly E fields from antenna-like structures or H fields from current loops) the E/H ratio in the near-field is also not known; this is a larger problem for lower frequencies. EMC standards allow measurements to be taken 3m from a device under test at frequencies down to 30 MHz, which are assumed to be far-field measurements. At separations of less than 3m, this assumption may not be valid for a particular device. However, when averaged over a large number of devices, any errors are likely to cancel out.

The decay of field strength with distance is assumed to be free-space. It is assumed that the radiating devices are at the same height in the room as the antennas that receive the interfering signal. Internal walls are assumed to attenuate the disturbing signal by 5dB.

1.4.2 Results - DVB-T Reception

The disturbance calculation assumes that TV antennas are mounted on the rear of the TV rather than on the roof of the house. A roof mounted antenna is negligibly affected, due to the directionality of the antenna, the increased separation from the noise sources and the attenuation due to ceilings and the roof. However, the model does not include a loft conversion; in such a case, the reduction in separation and number of attenuating barriers may increase the range of interference such that a roof mounted antenna (on this or neighbouring houses) is affected. The assessment of disturbance is made for different reception strengths. The lowest, 56 dBµV/m, is the smallest useable signal without disturbance for Band IV reception.

The total disturbance coverage for different DVB-T signal strengths is shown in Figure 2 for devices emitting 10 dB above CISPR 22 limits (left) and for devices meeting the CISPR 22 limits (right). The total disturbance coverage areas for the two cases are presented in Table 2 as a function of received DVB-T signal strength.

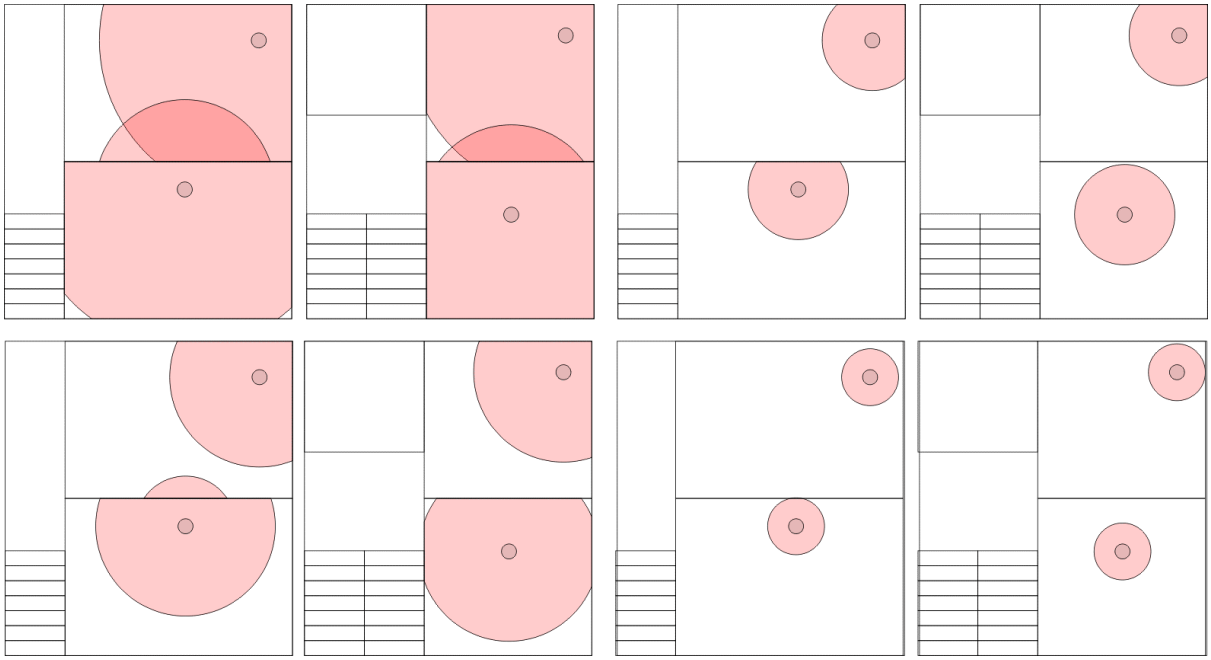

Figure 2 - Region of disturbance for DVB-T signal strengths of 76 (top) and 81 dBµV/m (bottom), left hand side drawings show devices emitting 10 dB above CISPR 22 limits, right hand side drawings show devices just meeting CISPR 22 limits.

Received DVB-T signal strength (dBµV/m)	Area of house disturbed (%)		Difference in disturbance area (%)
	Devices emitting 10 dB above CISPR 22 limits	Devices meeting CISPR 22 limits	
56	100	100	0
61	100	100	0
66	100	93	7
71	100	47	53
76	93	20	73
81	47	8	39
86	20	3	17
91	8	< 1	7
96	3	< 1	2

Table 2 - Total possible disturbance area for devices emitting 10 dB above CISPR 22 limits and for devices just meeting CISPR 22 limits.

1.4.3 Results - GSM900 Reception

The assessment of disturbance is made for different reception strengths. The lowest, 37.3 dBµV/m, is consistent with the minimum level experienced by an indoor mobile handset within the intended coverage area of a mobile network. The total disturbance coverage for different GSM900 signal strengths is shown in Figure 3 for devices emitting 10 dB above CISPR 22 limits (left) and for devices meeting the CISPR 22 limits (right). The total disturbance coverage areas for the two cases are presented in Table 3.

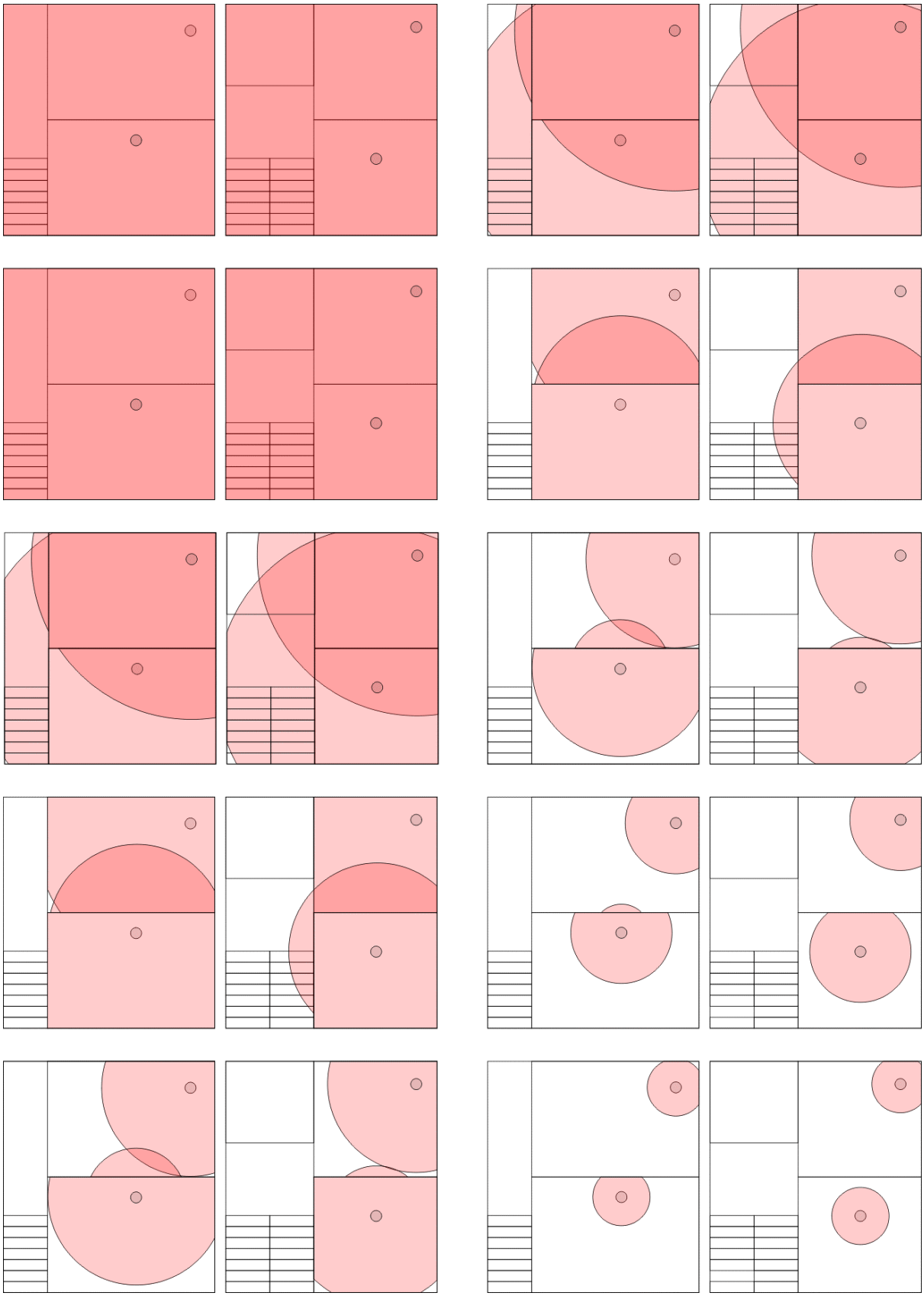

Figure 3: Region of disturbance for GSM900 signal strengths of 47.3, 52.3, 57.3, 62.3 and 67.3 dBµV/m (top to bottom), left hand side drawings show devices emitting 10 dB above CISPR 22 limits, right hand side drawings show devices just meeting CISPR 22 limits.

Received GSM900 signal strength (dBµV/m)	Area of house disturbed (%)		Difference in disturbance area (%)
	Devices emitting 10 dB above CISPR 22 limits	Devices meeting CISPR 22 limits	
37.3	100	100	0
42.3	100	100	0
47.3	100	100	0
52.3	100	99	1
57.3	100	82	18
62.3	99	33	66
67.3	82	15	67
72.3	33	4	29
77.3	15	2	13
82.3	4	< 1	4
87.3	2	< 1	2

Table 3 - Total possible disturbance area for devices emitting 10 dB above CISPR 22 limits and for devices just meeting CISPR 22 limits.

REFERENCES

1 BS EN 55014-1:2001 Incorporating Amendment No. 1, "Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus", Part 1: Emission.

2 BS EN 55022:2003 Incorporating Amendment No. 2, "Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement",

3 "EMCTLA Comments on the HOT UK Prosecution" available from <http://www.compliance-club.com/archive1/030115.htm>

4 "Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility" (89/336/EEC), Official Journal of the European Communities, No. L 139/19, May 1989.

5 R Marshall, "Study into how CISPR14 Part 1 (Emissions from household appliances, electric tools and similar apparatus) may be improved to make it more relevant and accessible", Radiocommunications Agency Report AY4395, available from <http://www.radio.gov.uk/topics/research/topics/emc/cispr14final.pdf>, June 2003

6 D A J Pearce, A G Burr, T Whitehouse and I D Flintoft, "Further Work into the potential effect of the use of Dithered Clock Oscillators on Wideband Digital Radio Services", Radiocommunications Agency Report AY4092, March 2002.