DEPARTMENT OF ENERGY & CLIMATE CHANGE

Power Lines: Demonstrating compliance with EMF public exposure guidelines

A voluntary Code of Practice

This document replaces “Power Lines: Demonstrating compliance with EMF public exposure guidelines – A voluntary Code of Practice” published by DECC in February 2011

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About this voluntary Code of Practice

This Voluntary Code of Practice concerns situations where it is necessary to demonstrate compliance with the exposure guidelines that apply to public exposure to power frequency electric and magnetic fields (EMFs) in the UK.

Current Government policy on electric and magnetic fields (EMFs)[1],[2] is that power lines should comply with the 1998 ICNIRP Guidelines[3] on exposure to EMFs in the terms of the 1999 EU Recommendation[4], and this Code of Practice implements this policy. As and when either ICNIRP issue new Guidelines or the EU revise the Recommendation, it will be for Government to consider those changes and to decide whether to adopt them or not. If Government policy changes, this Code of Practice will also be changed accordingly, but until that happens, the present policy as reflected in this Code of Practice remains in force.

This Code of Practice has been developed following publication of the Government response to the Stakeholder Advisory Group on extremely low frequency electric and magnetic fields (ELF EMFs)(SAGE) First Interim Assessment: Power Lines and Property, Wiring in Homes and Electrical Equipment in Homes, published in June 2007[5]. This Code of Practice has been agreed by the Department of Energy and Climate Change with the Department of Health, the Energy Networks Association, the Welsh Assembly, the Scottish Executive, the Northern Ireland Executive and the Health and Safety Executive. It sets out what will be regarded as suitable evidence of compliance with these exposure guidelines as far as the electricity system is concerned.

There are further Government policies relating to EMFs from overhead power lines, specifically that as a precautionary measure they should, where reasonable, have optimum phasing. That is the subject of a companion Code of Practice "Optimum phasing of high voltage double-circuit power lines".

This Code of Practice applies in England, Wales, Scotland and Northern Ireland.

What are the electricity industry and Government agreeing?

The Electricity Industry[6] agrees that whenever evidence is required of compliance with EMF exposure limits, it will provide evidence according to this Code of Practice. *Government* agrees that such evidence will be regarded as sufficient to demonstrate compliance. Situations

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[1] Letter with ten-point annex from Parliamentary Under Secretary of State for Public Health to the Chairman of the National Radiological Protection Board, 22 July 2004

[2] "Government response to the Stakeholder Advisory Group on extremely low frequency electric and magnetic fields (ELF EMFs) (SAGE) recommendations.", Written Ministerial Statement 16 October 2009

[3] ICNIRP (1998). Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Phys, 74(4), 494-522.

[4] COUNCIL RECOMMENDATION of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC)

[5] SAGE First Interim Assessment http://www.emfs.info/NR/rdonlyres/39CDF32F-E92B-4E2E-AD30-A2B0006B8ED5/0/SAGEfirstinterimassessment.pdf

[6] This Code of Practice is agreed between Government and the Energy Networks Association (ENA). Formally, therefore, it binds only the member companies of ENA. However, Government and ENA hope that all network operators will follow these provisions.

where the need for evidence of compliance with exposure limits may arise include applications for development consent for overhead power lines under the Planning Act 2008 and under Section 37 of the Electricity Act 1989, for compulsory purchase under schedule 3 to that Act, for necessary wayleaves under schedule 4 to that Act, and for planning permission for electricity equipment and equivalent situations under the relevant legislation in Scotland and Northern Ireland.

Direct and Indirect Effects

The Exposure Guidelines deal with both direct effects of fields on the body, primarily the induction of currents in the body, and indirect effects, such as microshocks, contact currents, and surface charge effects, which are all a consequence of charging and discharging of objects by the electric field.

Direct effects are protected against by quantitative exposure limits known as basic restrictions. The remainder of this Code of Practice details these quantitative limits and how they are applied.

While indirect effects are more tangible due to effects such as microshocks, they have historically given rise to less concerns than direct effects. For indirect effects, while the Guidelines give a cautionary reference level of 5 kV m^{-1} for the general public as a trigger to fuller assessment of compliance with the exposure guidelines, using that as a limit is not the most appropriate way of dealing with indirect effects. Rather, there is a suite of measures that may be called upon in particular situations, including provision of information, earthing, and screening, alongside limiting the field which should be used to reduce the risk to the public of indirect effects. In some situations, there may be no reasonable way of eliminating indirect effects, for instance where erecting screening would obstruct the intended use of the land. The approach to addressing indirect effects of electric fields will be the subject of a separate voluntary Code of Practice to be developed between the industry and the Health Protection Agency.

What are the values of the public exposure limits?

The 1998 ICNIRP exposure guidelines specify a basic restriction for the public which is that the induced current density in the central nervous system should not exceed 2 mA m^{-2}. The Health Protection Agency specify[7] that this induced current density equates to uniform unperturbed fields of 360 µT for magnetic fields and 9.0 kV m^{-1} for electric fields. Where the field is not uniform, more detailed investigation is needed. Accordingly, these are the field levels with which overhead power lines (which produce essentially uniform fields near ground level) shall comply where necessary. For other equipment, such as underground cables, which produce non-uniform fields, the equivalent figures will never be lower but may be higher and will need establishing on a case-by-case basis in accordance with the procedures specified by HPA. Further explanation of basic restrictions, reference levels etc is given by the Health Protection Agency[7].

Where do these limits apply?

[7] "Application of ICNIRP Exposure Guidelines for 50 Hz Power Frequency Fields"
http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733805036?p=1158934607693

Government policy is that the 1998 ICNIRP guidelines apply in the terms of the 1999 EU Recommendation. This specifies that Member States should:

> "II. (b) implement measures according to this framework……when the time of exposure is significant….. "
>
> "III (c) may take into account criteria, where appropriate, such as duration of the exposure….."

The preamble states:

> "(9) This recommendation …..applies, in particular, to relevant areas where members of the public spend significant time in relation to the effects covered by this recommendation;"

The Written Ministerial Statement of 16 October 2009 states (paragraph 42):

> *"... In this regard, the UK Government considers that exposure for potentially significant periods of time might reasonably be regarded as referring to residential properties, and to properties where members of the public spend an appreciable proportion of their time. "*

The clear steer from these statements is that there will be certain environments in which the public exposure is potentially for a significant period of time and where compliance with the ICNIRP general public guidelines will be required. In other environments, where exposure can be deemed not to be for a significant period of time, the ICNIRP occupational guidelines, rather that the ICNIRP general public guidelines, shall be deemed to apply.

In order to provide precision for the network companies, local planning officers and the public, in terms of assessing which guidelines apply it is appropriate to look across to any readily available tools in the planning system. All regions of the UK are covered in planning by a "Use Classes" regime which extends development control to changes in use of buildings or land. It would therefore be appropriate to draw on the classification used there to provide clarity.

The thrust of concern where public guidelines should apply is to residential uses. This would embrace use classes variously described as "dwellinghouses", "houses", "houses in multiple occupation" and "residential institutions". It should sensibly be taken more broadly as also embracing other residential properties which may not fall within a particular use class e.g. flats or hostels. A less clear cut case exists for extending it to schools but given the health concern is very much orientated towards childhood sickness it would seem prudent to behave in a precautionary manner and include non-residential uses such as schools, crèches and day nurseries.

In each case, for practical application of the guidelines the definition should also be taken to include the curtilage of the building concerned.

When is specific evidence of compliance required?

The Energy Networks Association will maintain a publicly-available list on its website of types of equipment where the design is such that it is not capable of exceeding the ICNIRP exposure

guidelines, with evidence as to why this is the case. Such types of equipment are likely to include:

- overhead power lines at voltages up to and including 132 kV
- underground cables at voltages up to and including 132 kV
- substations at and beyond the publicly accessible perimeter

Compliance with exposure guidelines for such equipment will be assumed unless evidence is brought to the contrary in specific cases.

For all other equipment (e.g. overhead power lines and underground cables at voltages of 275 kV and 400 kV), when evidence of compliance with exposure guidelines is needed, the following will be provided:

- A calculation or measurement of the maximum fields (ie directly under the line, or directly above the cable)

If this maximum value is less than the ICNIRP guideline levels, it may be assumed that all fields and exposures from that source will be compliant. If this maximum value exceeds the ICNIRP guideline levels, then it is also necessary to provide:

- A calculation or measurement of the field at the location of the closest property at which the public exposure guidelines apply

For overhead lines only, in addition:

- A statement as to compliance with the Code of Practice on phasing, including a justification in the terms of that Code of Practice if the line does not have optimum phasing.

What conditions is compliance assessed for?

Government policy is that the ICNIRP guidelines for the general public will be observed in areas where the land use is such that exposure might be for a significant period of time. Therefore, it is not appropriate to assess compliance for extreme, rare, or unlikely situations. Accordingly, for the purposes of compliance with Government policy, field levels will be assessed:

- For electric fields: for nominal voltage and, for overhead lines, design minimum clearance (excluding reduced clearances that occur only during exceptional ice loading);
- For magnetic fields: for the highest rating that can be applied continuously in an intact system (i.e. including ratings which apply only in cold weather, but not including short-term ratings or ratings which apply only for the duration of a fault elsewhere in the electricity system) and, for overhead lines, design minimum clearance;
- For both electric and magnetic fields: for 1 m above ground level on a plain, level surface;
- For both electric and magnetic fields: for the 50 Hz field only, ignoring harmonics.

Assessments may be offered for other conditions as well, eg abnormal operating conditions, but these are not required, and compliance with Government policy will be assessed for the above conditions.

Should compliance be demonstrated by calculations or measurements?

For sources that have a defined geometry that lends itself to calculations, such as overhead power lines and underground cables, calculations will usually be the preferred method of demonstrating compliance. For sources with a more complex geometry, measurements may be preferred.

Measurements are acceptable if they can be performed for, or scaled to, the above conditions.

Calculations are always acceptable if performed in accordance with the following specification and do not need to be supported by measurements, although measurements may be offered in addition.

Details of acceptable calculations

Calculations performed in accordance with the following will be regarded as acceptable evidence of field levels:

- for linear sources such as overhead lines and underground cables, are based on the infinite-straight-line approximation;
- are of the unperturbed field;
- take account of the correct conductor(s) number, type and size;
- ignore zero-sequence and negative-sequence currents, and voltages and currents induced in the sheath, ground or earth wire;
- for electric fields, treat the ground as a perfect conductor;

and in addition, specifically for overhead lines:

- take account of the basic tower geometry for the design of line in question, but ignore variations in conductor spacing at angle towers etc.

More detailed evidence will also be acceptable if offered but is not required, including:

- Calculations based on the actual conductor geometry rather than the infinite straight line approximation;
- Calculations taking account of perturbations to the electric field from conducting objects.

Committing to Good Practice

This is a voluntary Code of Practice, supplemented by the companion Code “Optimum phasing of high-voltage double-circuit power lines”. Industry and Government are commited in their efforts to demonstrate assessment and compliance with EMF public exposure limits.

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