



## Engineering Recommendation G92

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Guidelines for Best Practice in relation to Electric and Magnetic Fields (EMFs) in the Design and Management of Low Voltage Distribution Networks

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## **Guidelines for Best Practice in relation to Electric and Magnetic Fields (EMFs) in the Design and Management of Low Voltage Distribution Networks**

### **1. INTRODUCTION**

The generation, distribution and use of electricity produces power-frequency electric and magnetic fields (EMFs). Distribution Network Operators (DNOs) already operate their networks in compliance with the relevant public exposure limits for EMFs, reflecting Government policy. Since 2004, those exposure limits have been the 1998 Guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) as adopted in the terms of the 1999 Recommendation of the European Union. How industry assesses and demonstrates its compliance with these guidelines is detailed in a Code of Practice published by the Department of Energy and Climate Change (originally in February 2011, revised version in March 2012). This is the only formal requirement on DNOs in relation to EMFs applicable in England, Wales, Scotland and Northern Ireland.

However, it is legitimate to question whether there are any further reasonable measures DNOs may take to help reduce EMF exposures for the public as a precautionary measure in addition to the exposure limits. This was considered in the UK through an independent stakeholder process known as the Stakeholder Advisory Group on Extremely Low Frequency Electric and Magnetic Fields (SAGE) which ran in the late 2000s. EMFs and high-voltage transmission lines were addressed in SAGE's First Interim Assessment published in 2007, and low-voltage distribution networks in its Second Interim Assessment from 2010. Government responded to both Assessments, and it is Government's response that constitutes EMF policy in the UK. That policy, as it relates to high-voltage transmission lines, has been implemented through the Codes of Practice on demonstrating EMF compliance and on optimal phasing of dual-circuit overhead lines. For low-voltage distribution networks, most of SAGE's recommendations consisted of endorsing and continuing existing industry best practice where there is a recognition that EMFs are an extra reason for these practices. Government agreed that most of these recommendations were sensible and should be adopted, and stated:

"The Government will discuss with the electricity industry the possibility of reinforcing such existing best practice through the development and adoption of one or more Engineering Recommendations across industry."

This Engineering Recommendation (ER) therefore constitutes the implementation of the Government response to SAGE's Second Interim Assessment for low-voltage distribution networks, and therefore captures EMF policy relating to these networks, beyond the key requirement of compliance with existing exposure guidelines.

In preparing this ER, regard has been taken of the following –

- the analysis and discussion of the various options and issues in SAGE's Second Interim Assessment
- the Government response, which sets out which of SAGE's recommendations Government expects to see implemented and which it does not.

The aim of this document is to provide guidance to DNOs, and hence also transparency to the public, on best-practice measures DNOs are expected to consider and continue in order to help reduce public exposure to EMFs. Most of these measures constitute existing industry best practice. It should be remembered that abnormally high EMFs when detected, can sometimes be an indication of a network problem, either an existing or an incipient fault, that it is in the interest of the DNO to identify and rectify in any case.

Further information on how distribution networks produce EMFs can be found in SAGE's Second Interim Assessment or on the electricity industry's website [www.emfs.info](http://www.emfs.info).

Where there are alternatives shown in this document, individual DNOs should be consulted to ascertain their specific policy.

## **2. ENGINEERING MEASURES APPLICABLE TO FINAL-DISTRIBUTION CIRCUITS**

### **Balanced loads**

DNOs should make reasonably practicable efforts to balance the loads across the phases on three-phase final distribution circuits. DNOs should also assist customers who take a three-phase supply to balance the loads across the phases to the extent reasonably practicable, e.g. by providing information and advice.

### **Broken neutral conductors**

DNOs should investigate broken neutral conductors or indications that a neutral may be broken or have unusually high impedance, and should repair broken neutrals to improve network reliability and safety. Indications of a broken neutral include unusually high magnetic fields, caused by the neutral current following a different path to the substation from the phase currents, thus creating an unbalanced or net current in the cable.

#### *Note on interpretation:*

*Not every instance of a high magnetic field is attributable to a broken neutral, but when receiving a report of a magnetic field that is unusually elevated for the circumstances, DNOs should consider whether this could be an indication of a broken neutral.*

### **Redundant cables**

DNOs should disconnect redundant cables, when they are assessed as genuinely redundant, and when work is being done on the circuit anyway.

## **3. ENGINEERING MEASURES APPLICABLE TO FINAL-DISTRIBUTION SUBSTATIONS**

### **Siting**

DNOs should make reasonably practicable efforts not to site new final-distribution substations directly against living areas of homes etc (this is intended to cover homes, other residential properties, schools, libraries, and other public spaces with similar levels of occupancy). This will normally be good practice for non-EMF reasons (e.g. audible noise, vibration, access etc).

*Note on interpretation:*

*“Reasonably practicable” efforts will depend on the specifics of each site, but will not entail significant extra cost. Utilising the available space within a development site so that a substation is not directly against living areas but is at a more distant but equally convenient location within the site would normally be expected. Using space for a substation that would otherwise be used for other desirable purposes as part of the master-planning of the development, thereby detracting significantly from the overall benefit of the development, would probably not be expected.*

It is recognised that the DNO often has only limited influence over the layout of a development site.

## **Design**

DNOs should use compact designs of final-distribution substations where reasonably practicable, both for new substations and when refurbishing or replacing older substations.

*Note on interpretation:*

*“Compact” designs will usually be “unit” substations although any similarly compact design is included. If use of “unit” substations is not suitable, e.g. because the capacity required is too great, or would entail significant extra cost, there is no requirement to use them regardless.*

If a “unit” substation or similarly compact design is not reasonably practicable, DNOs should arrange the components in the substation in the lowest-exposure layout that is reasonably practicable.

*Note on interpretation:*

*This could involve, for example, not locating the LV Board immediately adjacent to residential areas of adjoining properties, not routing the busbars or cables between the transformer and the LV Board adjacent to such residential areas, and keeping those busbars or cables as compact as reasonably practicable. When refurbishing or replacing some but not all components of an existing substation, reasonably practicable opportunities should be taken to reduce the exposures from those components, but there is no requirement to refurbish or replace more of the substation equipment than would otherwise be the case.*

## **4. MEASURES RELATING TO CUSTOMER CONCERNS**

### **Concerns in general**

DNOs should always investigate instances of EMF exposures that are abnormally high for the circumstances when notified of them. There is no rigid definition of how high EMFs have to be to warrant investigation.

*Note on interpretation:*

*The only quantitative limits on EMFs are the public exposure guidelines, currently 360  $\mu$ T and 9 kV/m. Other values that are sometimes mentioned, such as a magnetic field of 0.4  $\mu$ T, do not have any formal status, and fields above this value do not necessarily indicate any problem or require investigation. However, the spirit is that when EMFs are abnormally high with no obvious explanation, this can be an indication of a network problem, such as a high-impedance joint or broken neutral, undesirably large currents in an earth connection, or*

*badly unbalanced loads, and it is situations that could be a pointer to such problems that should be investigated.*

### **Concerns about final-distribution substations**

When requested by a customer or other member of the public to do so, DNOs should consider instances of final-distribution substations producing elevated exposures to EMFs, and, where practically feasible, should offer options for reducing the exposures at the consumer's choice and cost.

It is recognised that in many instances, the only options that could be offered would entail considerable expense and may not be feasible for a customer to take up. But DNOs should nonetheless always be prepared to offer, in good faith, the best available option for reducing EMFs from substations when requested.

#### *Note on interpretation:*

*When exposures are below the public exposure limits, as all exposures from final-distribution substations are, there is no requirement on DNOs to reduce the fields, and therefore there is unlikely to be any justification for DNOs expending significant resources on reducing the fields. This measure relates to offering the customer the option of reducing fields at their own cost.*

## **5. MEASURES RELATING TO INTERNAL DNO PROCEDURES AND STAFF**

### **Staff awareness of EMF issues**

DNOs should aim to ensure that all relevant staff have an adequate awareness of EMF issues, including where relevant, of how elevated exposures can be an indication of system network problems. The relevant staff are those who are likely to receive and handle customer concerns, and therefore might include staff answering telephones at call centres, staff with designated EMF responsibilities, and front-line engineering staff who may interact with the public. ENA will aim to provide suitable training material to assist DNOs.

#### *Note on interpretation:*

*DNOs are entitled to make their own internal arrangements for how their customer concerns are handled, whether that is through call centres, a larger number of engineering staff, or a smaller number of specialists. The requirement is that whichever member of staff a customer is likely to express any EMF concern to, should have a suitable level of awareness of EMF issues.*

### **Inclusion of EMF issues in investment and maintenance decisions**

DNOs should consider creating systems whereby instances of substations producing particularly high EMF exposures are recorded, so that EMF issues can be factored in to future investment and maintenance decisions for that substation.

#### *Note on interpretation:*

*It is recognised that in practice, it is likely only to be rarely that EMF issues carry enough weight to influence investment decisions, but the principle is that such issues should be captured so that they can at least be considered.*

## 6. REFERENCES

SAGE First Interim Assessment	First Interim Assessment: Power Lines and Property, Wiring in Homes, and Electrical Equipment in Homes Date of issue: 27/04/2007
SAGE Second Interim Assessment	Second Interim Assessment 2009 – 2010: Electricity Distribution (including low-voltage and intermediate-voltage circuits and substations) and Report on Discussions on Science. Date of issue: 08 / 06 / 2010
Government Response to First Interim Assessment	Government response to the Stakeholder Advisory Group on extremely low frequency electric and magnetic fields (ELF EMFs) (SAGE) recommendations
Government Response to Second Interim Assessment	Government response to the Stakeholder Advisory group on extremely low frequency electric and magnetic fields (ELF EMFs) (SAGE) Second Interim Assessment on Electricity Distribution (including low-voltage and intermediate-voltage circuits and substations) and Report on Discussions on Science
1998 ICNIRP Exposure Guidelines	Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics April 1998, Volume 74, Number 4:494-522
1999 EU Recommendation	Council Recommendation of 12 July 1999 (1999/519/EC)
Code of Practice	Power Lines: Demonstrating compliance with EMF public exposure guidelines - A voluntary Code of Practice, March 2012