Optimum Phasing of high voltage double-circuit Power Lines

A voluntary Code of Practice

This document replaces "Optimum Phasing of high voltage double-circuit Power Lines: A voluntary Code of Practice" published by DECC in February 2011

March 2012

About this voluntary Code of Practice

This Voluntary Code of Practice sets out key principles for the electricity industry to undertake optimum phasing (defined in more detail below) of all new high voltage (132 kV and above) double-circuit power lines, and to convert existing power lines where practicable.

The introduction of optimum phasing for high voltage power lines was recommended to Government by the Stakeholder Advisory Group on extremely low frequency electric and magnetic fields (ELF EMFs) (SAGE) in its First Interim Assessment: Power lines and Property, Wiring in Homes, and Electrical Equipment in Homes, published in June 2007[1].

In the Government's response to that report published on 16 October 2009[2], it supported the SAGE recommendation and agreed to work with the electricity industry to introduce optimum phasing of high voltage overhead power lines in those circumstances where this would significantly reduce public exposure to ELF EMF and would be cost effective to do so.

It is central Government's responsibility to determine what national measures are necessary to protect public health. Acting on the advice of the Health Protection Agency, the Government expects all power lines to comply with the 1998 International Commission on Non-Ionizing Radiation Protection (ICNIRP)[3] guidelines on Electromagnetic Fields (EMFs) in the terms of the EU recommendation[4].

The aim of this Code and its companion Code of Practice "Power Lines: Demonstrating compliance with EMF public exposure guidelines" is to introduce assurance and clarity for the public, local authorities, the electricity industry, statutory stakeholders and relevant consenting bodies about how public exposures to the electric and magnetic fields produced by high voltage power lines will be reduced and monitored, and the measures the electricity industry will utilise to calculate and demonstrate compliance with assessment field levels in accordance with ICNIRP exposure limits to protect public health. The companion Code also outlines procedures for assessing EMF compliance for underground cables and substations.

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

International Exposure Guidelines

International electromagnetic field (EMF) public exposure guidelines are set at levels designed to protect people from known harmful effects of EMF. The ICNIRP guidelines were published in 1998 and adopted by a European Council Recommendation in 1999. The Recommendation

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

[2] Government response to SAGE report published 16 October 2009 http://www.dh.gov.uk/dr_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_107123.pdf

[3] International Commission on Non-Ionizing Radiation Protection Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Phys, 74(4), 494-522 http://www.icnirp.org/

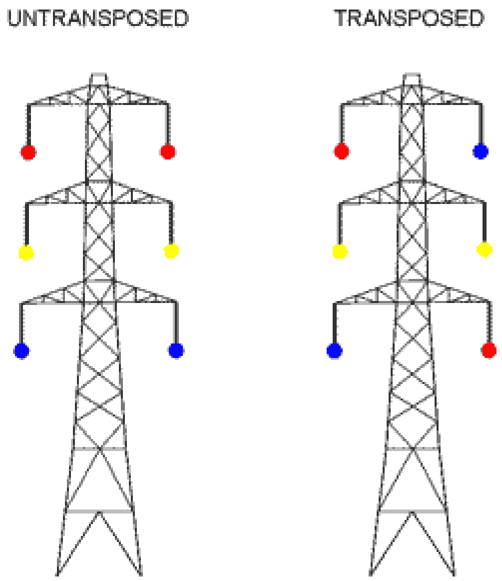
[4] COUNCIL RECOMMENDATION of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC) http://ec.europa.eu/health/ph_determinants/environment/EMF/emf_en.htm

provided a common framework by which the guidelines could be introduced into each Member State according to local arrangments or regulatory practice.

What is "optimum phasing"?

Many power lines carry two separate electrical circuits, one each side of the line (some power lines have only a single circuit and phasing is not relevant for these lines). Each circuit produces a magnetic field. The direction of that field is determined partly by the order of the three "phases" or bundles of conductors that make up that circuit. The fields produced by the two separate circuits can either reinforce each other or partially cancel each other. "Optimum phasing" can be defined as the relative phasing (or order of the three phases) of the two circuits that, to the sides of the line, produces the greatest degree of cancellation between the magnetic fields produced by the two circuits, and hence the lowest resultant magnetic field.

The phases are usually referred to by the colours red, blue and yellow. "Untransposed" phasing has the same order each side, "transposed" phasing the opposite order:



For the normal situation where the currents flow in the same direction in both circuits, the optimum phasing – the phasing that produces the lowest resultant field to the sides of the line - is transposed.

If the currents consistently flow in opposite directions, the optimum phasing becomes untransposed. For some lines, the currents in the two circuits vary independently and one or the other can change direction, sometimes daily, e.g. as a result of changing demand for electricity, sometimes less often, e.g. as a result of changing use of different power stations or the construction of new power stations. In these situations, it is not possible to identify an optimum phasing, and the existing phasing should be retained. In general, optimum phasing will be assessed for the relative direction and size of load flows in the two circuits which represent normal operating conditions for that line and which is likely to be so for a period of years.

When is it reasonable or unreasonable for industry to implement this measure in practical terms?

A power line is connected at its ends to a substation by "downleads" as shown in the picture.

The order of these downleads determines the phasing of the line. It will normally be reasonable for the electricity industry to achieve optimum phasing for high voltage power lines when it can be done by means of reconfiguring these downleads. This would apply to new power lines and to the conversion of existing power lines.

Sometimes, the land space available and the need to preserve electrical clearances between the downleads means that it is not possible to achieve optimum phasing on an existing power line just by reconfiguring downleads. Achieving optimum phasing would then require a new structure such as a phase-transposition tower or gantry. It will normally be unreasonable to achieve optimum phasing where this requires the electricity industry to introduce such new structures.

The phasing of a line also affects its electrical characteristics, and this can affect the overall stability of the part of the power network it is connected to. The requirements on network stability are specified in the National Electricity Transmission System Security and Quality of

Supply Standard (NETS SQSS 2009)[5]. It will normally be unreasonable to achieve optimum phasing where it would conflict with the requirements of this Standard.

What is the electricity industry agreeing to undertake?

In practice, this means the electricity industry[6] will agree to:

- Design and construct new high voltage electric lines to include optimum phasing, unless this is unreasonable;
- Convert existing electric lines to optimum phasing when they are undergoing maintenance that involves replacing the conductors, unless this is unreasonable; and
- Where necessary, "unreasonable" will be interpreted in terms of the cost-benefit analysis presented in the SAGE First Interim Assessment (2007)[7].

How will Government monitor compliance with this Code?

The electricity industry will report to the Department of Energy and Climate Change at intervals of three years from December 2010, with the 2010 figure being taken as the baseline figure identified in the SAGE First Interim Assessment:

- High voltage power lines with optimum phasing;
- High voltage power lines without optimum phasing; and
- High voltage power lines for which optimum phasing is not applicable.

The industry will also make this reporting information available to the general public and other interested parties on the website of the Energy Networks Association http://energynetworks.org/electric-and-magnetic-fields/

Committing to Good Practice

This is a voluntary Code of Practice, and is supplemented by the companion Code "Power Lines: Demonstrating compliance with EMF public exposure guidelines". Industry and Government are commited in their efforts to demonstrate assessment and compliance with EMF public exposure limits.

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[5] NETS SQSS http://www.nationalgrid.com/NR/rdonlyres/149DEAE1-46B0-4B20-BF9C-66BDCB805955/35218/NETSSQSS_GoActive_240609.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.

[7] The general principles of SAGE's cost-benefit analysis can be found in SAGE Supporting Paper S6 (2007) and the application of these principles to phasing in Supporting Paper S19.

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