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Norfolk Vanguard Offshore Wind Farm

The Applicant Responses to First Written Questions

Appendix 12.1 – Vattenfall and National Grid EMF Information (Q 12.7)

Applicant: Norfolk Vanguard Limited
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Photo: Kentish Flats Offshore Wind Farm

Norfolk Vanguard & Boreas Wind Farm Connections- EMF Information

What are electric and magnetic fields?

Electric and magnetic fields (EMFs) are produced wherever electricity is used. Electric fields are produced by voltage, which is the pressure behind the flow of electricity. It can be likened to the pressure of water in a hose. The operating voltage of most equipment is a relatively constant value. Magnetic fields are produced by current, which is the flow of electricity. Current, which is measured in amperes or amps, can be likened to the flow of water in a hose when the nozzle is open, and varies over time. Generally, the higher the power and the current, the higher the magnetic field. Electric fields are measured in volts per metre (V/m) and magnetic fields are measured in microteslas (µT).

Most electricity supply in the UK is alternating current (AC) with a frequency of 50 cycles per second or 50 hertz (Hz). EMFs always have the same frequency as the electricity that produced them, so the EMFs produced also alternate direction with a frequency of 50 Hz. Some cables however use direct current (DC), which have the same direction all the time. This is the same as the earth's natural magnetic field and these are known as 'static fields' and have a frequency of 0 Hz.

The Norfolk Vanguard and Boreas connections could use either High Voltage Direct Current (HVDC) or High Voltage Alternating Current (HVAC) technology to transfer the power generated by the wind farms to the National Grid. DC and AC EMFs have different effects; therefore, each has a separate and distinct set of exposure limits.

Underground cables, irrespective of frequency, have an earthed metallic shield, which protect them from damage but also prevents electric fields escaping from the cable. Magnetic fields are not shielded in the same way as electric fields and will be produced outside the cables.

Do EMFs affect health?

Direct Current

The available evidence from studies of humans and animals has been reviewed by Public Health England and internationally by the World Health Organization and the International Agency for Research on Cancer. None of these expert bodies has identified any health risk for humans or animals exposed to DC magnetic fields.

Alternating Current

Though the weight of evidence is against there being any effect on human health from exposure to EMFs there is some limited scientific evidence suggesting a possible link between unusually high average exposures to AC (50 Hz) magnetic fields and childhood leukaemia. Based on this evidence, magnetic fields are classed by the World Health Organization (WHO) as 'possibly' carcinogenic.

What are the exposure limits?

The UK has a carefully thought-out set of policies for managing EMFs, which includes both numerical exposure guidelines to protect against established effects of EMFs at relatively higher levels, and precautionary policies to provide appropriate protection against the possibility of long-term effects of EMFs at lower levels, including, specifically, the possibility of a risk for childhood leukaemia.

Public Health England (formerly the Health Protection Agency – HPA) recommends limits for exposure to EMFs based on those from the International Commission on Non-Ionizing Radiation Protection (ICNIRP – 1994 & 1998). These guidelines are based on reviews of all the science regarding potential health effects of EMFs and provide limits for continuous public and occupational exposures. The public exposure limit is 360 µT for 50 Hz AC magnetic fields, and 40,000 µT for DC magnetic fields.

National Grid has been engaged by Vattenfall to assess the EMF aspects of this project, which is the subject of this information sheet. The project as a whole and all other aspects of it remain the responsibility solely of Vattenfall.

Will the Norfolk Vanguard Wind Farm Project be compliant with limits?

Vattenfall's policy is only to design and install equipment that is compliant with the relevant exposure limits. To ensure this, all of the equipment for the Norfolk Vanguard Wind Farm Project capable of producing EMFs has been assessed in accordance with the provisions of the Government's Code of Practice on Compliance.

If an HVAC connection is used, both a Cable Relay Station (CRS) and new AC substation would be required to reduce losses and ensure the project can connect to the National Grid. The types of equipment contained within both of these stations means that they are not capable of produce electric or magnetic fields that exceed the ICNIRP limits outside the parameter fence.

Where HVDC technology is used, neither a CRS nor an AC substation will be required. However, a DC Converter Station is needed to convert DC to AC power so that it can connect to the National Grid. The DC Converter station contains some specialised equipment which could potentially exceed the exposure limits if located close to the perimeter fence. This will be considered in the detailed design to ensure that the design fully complies with the public exposure limits.

High voltage underground cables are assessed for compliance with the exposure limits on a case-by-case basis, taking account of maximum power flows and minimum burial depth to ensure that the calculated magnetic fields represent. the maximum magnetic field the cables could possibly produce.

These calculations have been performed for the Norfolk Vanguard project but also taking account of the potential future Norfolk Boreas project. The calculated fields are shown below and are a small fraction of the ICNIRP limits.

Calculated AC Magnetic Fields

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (μT)	29.7	4.11	0.26	0.03
% ICNIRP exposure limit	8%	1%	<1%	<1%

Calculated DC Magnetic Fields

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (μT)	33.7	1.27	0.26	0.06
% ICNIRP exposure limit	<1%	<1%	<1%	<1%

Summary

- All of the relay stations, substations and cables will be compliant with the UK exposure limits set to protect members of the public against electric and magnetic field exposure.
- This applies irrespective of whether DC or AC cable connections are used.

Where can I get further information?

More information is available from National Grid's website at www.emfs.info, or from the EMF helpline on 0845 702 3270 or emfhelpline@nationalgrid.com.

Alternatively you can contact the Norfolk Vanguard project team directly on info@norfolkvanguard.co.uk or 01603 567995.

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Vattenfall and Ørsted Circuit Crossings- EMF Information

In response to local concerns, Ørsted and Vattenfall have jointly commissioned an independent study and resulting report which explores the 'worst case' electric and magnetic fields (EMFs) which may result where it is proposed the power cables from the large wind farms will cross.

Onshore, buried cables from offshore wind farms will necessarily cross other infrastructure, including other power cables. This summary report provides information on the electric and magnetic fields (EMFs) which could occur where power cable circuits cross, specifically assessing the crossing of Ørsted's Hornsea Project Three and Vattenfall's Norfolk Vanguard and Norfolk Boreas offshore wind farms, which are typical of the next generation of offshore wind projects in development by Vattenfall and Ørsted. It represents a conservative assessment of EMFs at such crossings, assessing the worse case parameters for this case study.

Summary of results

- The study found that the maximum calculated AC magnetic fields were 50.7 microtesla (µT) which is 14% of the UK exposure limit values; the maximum calculated DC magnetic fields were 60.8 µT which is less than 1% of the UK exposure limit.
- All of the cable crossing scenarios irrespective of whether DC or AC cable connections are used will be compliant with the UK exposure limits set to protect the health of members of the public against electric and magnetic field exposure.
- As the magnetic field is mainly dependant on cable rating, burial depth and phase separation, all cable crossings with similar or less onerous design parameters will also be compliant.

What are electric and magnetic fields and what policies and exposure limits apply?

EMFs are produced wherever electricity is used. Underground cables, irrespective of frequency, have an earthed metallic shield, which protects them from damage but also prevents electric fields escaping from the cable. Magnetic fields are not shielded in the same way as electric fields and will be produced outside the cables.

Electricity can be transmitted either via High Voltage Direct Current (HVDC) or High Voltage Alternating Current (HVAC) technology producing EMFs of the same frequency.

The UK has a carefully thought-out set of policies for managing EMFs, which includes numerical exposure limits to protect against established effects of EMFs. Public Health England (PHE), formerly the Health Protection Agency, (HPA) recommends limits for exposure to EMFs based on those from the International Commission on Non-Ionizing Radiation Protection (ICNIRP – 1994 & 1998)[1,2]. These guidelines are based on reviews of all the science regarding potential health effects of EMFs and provide limits for continuous public and occupational exposures. DC and AC EMFs have different effects on humans; therefore, each has a separate and distinct set of exposure limits to protect against exposure. PHE issued guidance on the application of exposure limits, which stated that the public exposure limit is 360 µT for 50 Hz AC magnetic fields, and 40,000 µT for DC magnetic fields[3]. In the UK the Earth's DC magnetic field measures around 50 µT, and the background AC magnetic field in a home ranges between 0.01- 0.2 µT.

More information on the science, exposure limits and policies can be found at www.emfs.info.

[1] https://www.icnirp.org/cms/upload/publications/ICNIRPstatic.pdf
[2] http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf
[3] http://webarchive.nationalarchives.gov.uk/20140713082604/http://www.hpa.org.uk/Publications/Radiation/NPRBArchive/DocumentsOfTheNRPB/Absd1502/

National Grid has been engaged by Vattenfall and Ørsted to assess the EMF aspects of this case study, as described in this summary report. The projects as a whole and all other aspects of them remain the responsibility solely of Vattenfall and Ørsted.

Where onshore wind farm circuits cross onshore, will these be compliant with exposure limits?

The electricity industry's policy is only to design and install equipment that is compliant with the relevant exposure limits. To ensure electricity Industry remain with the exposure limits the Government produced a Code of Practice on EMF compliance which sets out the approved calculation methodology for assessing compliance for new and existing electricity assets. This methodology takes account of maximum power flows and minimum burial depth to ensure that the calculated magnetic fields represent the maximum magnetic field that the electrical infrastructure could possibly produce.

There are multiple possibilities for cable crossing points i.e. AC or DC, which cables are on top, where they cross, the crossing angle – so the calculations in this summary report are the worst-case scenarios typical of the next generation of Vattenfall and Ørsted offshore wind projects in development in the UK.

If both cable routes that cross use the same power transmission technology, i.e. AC and AC or DC and DC, the fields can combine to add or subtract from one another. However, if different technologies are used, i.e. AC and DC, the magnetic fields do not interact with one another. In that scenario, the installations of the HVAC and HVDC cables can be considered separately.

These assessments represent the worst-case scenario for two crossing points, one where both transmission systems use HVAC technology and the other where both use HVDC technology. The parameters modelled are included in the tables below and are conservative as maximum rating, minimum burial depth and most acute crossing angle (45°) were taken and the most highly loaded circuits were located on top which produced the highest magnetic fields.

The calculated fields are shown below and are a small fraction of the AC and DC ICNIRP limits.

Cable design parameters

	2 x HVAC routes		2 x HVDC Routes	
	'On Top'	**'On Bottom'**	**'On Top'**	**'On Bottom'**
Number of circuits	6	12	2	4
Maximum load current per circuit	1620A	900A	2220A	1400A
Maximum circuit spacing at crossing	15.0m	10.0m	15.0m	10.0m
Spacing between phase centres	0.313m	0.25m	0.43m	0.25m
Cable formation in trench	Flat	Trefoil	Flat	Flat
Depth of burial, to circuit centres	0.8m	2.8m	0.8m	2.8m

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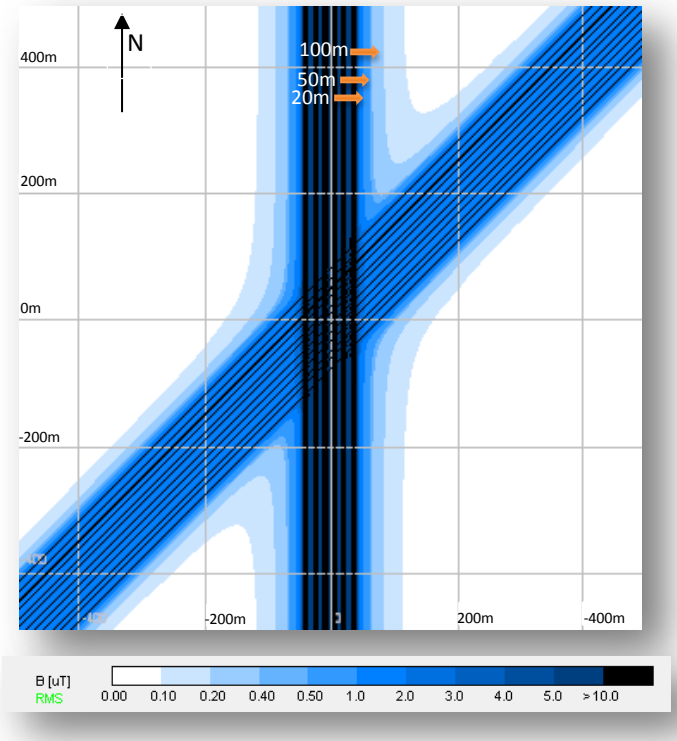
AC magnetic field calculations for HVAC cable crossings



Calculated worst-case AC Magnetic Fields

	Distance perpendicular from outer cable (m)			
	Peak	20m	50m	100m
Magnetic field (μT)	50.7	1.14	0.49	0.23
% ICNIRP exposure limit*	14%	<1%	<1%	<1%

*AC public exposure limit of 360μT

Worst-case calculated magnetic fields from AC circuits: The two cable routes modelled include 6 circuits running in a North-south direction with each circuit rated at 1620A; and 12 circuits which run underneath in a North East-South West direction with 900A rated circuits. Coloured bands represent magnetic field. Each square represents 200m distance. The orange arrows indicate the distance perpendicular from the outer cables that correspond to the table above.

The maximum calculated magnetic fields at various distances from the outer cable are included in the table and demonstrate that all AC magnetic fields are below the UK exposure limits

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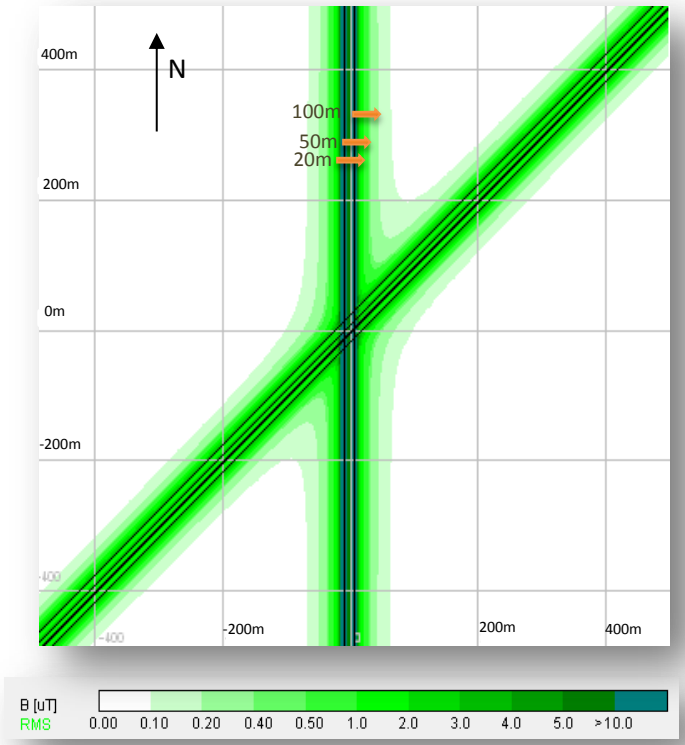
DC magnetic field calculations for HVDC cable crossings



Calculated worst-case DC Magnetic Fields

	Distance perpendicular from outer cable (m)			
	Peak	20m	50m	100m
Magnetic field (µT)	60.8	1.46	0.57	0.23
% ICNIRP exposure limit*	<1%	<1%	<1%	<1%

*DC public exposure limit 40,000µT

Worst-case calculated magnetic fields from DC circuits: The two cable routes modelled include 2 circuits running in a North-south direction with each circuit rated at 2220A; and 4 circuits which run underneath in a North East-South West direction with 1400A rated circuits. Coloured bands represent magnetic field. Each square represents 200m distance. The orange arrows indicate the distance perpendicular from the outer cables that correspond to the table above.

The maximum calculated magnetic fields at various distances from the outer cable are included in the table and demonstrate that all DC magnetic fields are below the UK exposure limits.

Where can I get further information?

More information is available from National Grid's website at www.emfs.info or from the EMF helpline on 0845 702 3270 or emfhelpline@nationalgrid.com.

Alternatively you can contact the Norfolk Vanguard project team directly on info@norfolkvanguard.co.uk or 01603 567995 or Hornsea Project Three on contact@hornsea-project-three.co.uk or 0800 0288 466.

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