NON-IONISING ELECTROMAGNETIC FIELDS ON OFFSHORE INSTALLATIONS

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INTRODUCTION

The concern over the effects of occupational exposure to non-ionising electromagnetic fields (EMF) has greatly increased in recent years. A great deal of knowledge is known about the thermal effects of radiofrequency EMF's and at the moment, many epidemiological and laboratory studies are being performed on extremely low frequency (ELF) and very low frequency (VLF) EMF's. Some studies have reported an increased risk of leukaemia and other cancers in children living close to overhead power cables and power industry electrical workers.

Wertheimer and Leeper reported cancer links in children residing near overhead power cables as early as 1979 (1) and many subsequent studies have continued to make similar associations (2,3,4,5 and 6). These studies suggest that prolonged exposure to higher than normal magnetic fields increases the occurrence of certain cancers in both children and adults. The most common associations are between EMF's and leukaemia, other haematopoetic cancers, brain cancers, central nervous system cancers or melanomas.

Studies of adults living near overhead lines by Youngson et al (7)) and working in the electricity industry by Armstrong et al (8) and Savitz & Loomis (9) have also shown associations with certain cancers. The epidemiological studies are incomplete in several areas and many have been openly criticised. As yet, there is no conclusive laboratory evidence but studies are ongoing (10,11,12). The Hendee and Boteler study (12) suggested that " EMF's might be cancer promoters but are unlikely to be cancer initiators".

In addition to ELF studies, there have been many reports investigating exposure to EMF's from visual display units (13) with equivocal results. Laboratory studies have reported conflicting results and as yet the hazard, if any, is still uncertain (14). Reports have also recorded exposure levels of operators in broadcast radio stations showing a variety of levels dependant on the occupation (15).

In December 1992, the Commission of the European Communities proposed a council Directive on the minimum safety and health requirements regarding the exposure of workers to the risks arising from physical agents including electric and magnetic fields at frequencies up to 300 GHz (16). The proposed Directive contains a set of ceiling levels expressed as fundamental dosimetric quantities and action levels expressed in terms of electric field strength, magnetic field strength and power density.

On offshore oil producing installations there are many sources of electromagnetic fields operating at a variety of different frequencies. These include transformers and generators capable of large power generation, numerous switch rooms, radiofrequency communications including microwave and satellite links. Due to the confined work areas, the switch rooms and transformer rooms are frequently used as office areas by engineers and technicians. This paper the results of these fields on several offshore platforms and compares the measured fields with the proposed CEC directive.

METHODS

Three different field strength meters and a VDT adapter were used for the measurements to cover the broad frequency range available on offshore installations. These include the Holaday HI-3600-02 power frequency field strength meter used for measuring both electric and magnetic fields in the frequency range 30-300 Hz. The Holaday HI-3600 VDT Radiation Survey adapter fits onto the aforementioned field strength meter and is sensitive to electric fields between 2 - 300 kHz and to magnetic fields between 8 - 300 kHz. The Holaday HI-3000 broadband isotropic field strength meter uses two probes. The electric field probe is sensitive to frequencies between 0.5 MHz - 5 GHz and the magnetic field probe between 5 - 300 MHz. The higher frequency RAHAM Model 4 Isotropic Wideband Electromagnetic radiation hazard meter measures the electromagnetic field in terms of power density in the 10 MHz - 26 Ghz range.

RESULTS

The results clearly fit into three different categories, including power generation and distribution system measurements, VDU measurements and telecommunication equipment measurements. The maximum electromagnetic fields from the power production were summarised and are tabulated below :

Area	Maximum Magnetic Field (μT)	Maximum Electric Field ($V.m^{-1}$)
Platform A	181.95	120.0
Platform B	227.98	651.0
Platform C	2590.43	31.0
Platform D	816.15	522.0
Platform E	532.67	1400.0

Table 1 Summary of maximum levels of magnetic and electric fields at 60 Hz found on offshore platforms.

The maximum levels measured were typically found close to the transformers and the incoming supplies from those transformers to the distribution boards and were all found in the switch rooms and transformer rooms of the oil processing package. From the table, the maximum level of magnetic field found throughout the platforms measured was 2.6 mT on Platform C. This exceeds the first action level of 333 μT recommended by the CEC for this frequency as do levels on Platform D and Platform E. The levels found on Platform C not only exceeds the first action level but also the hazardous activities level of 1 mT for this frequency. The maximum electric field of 1.4 $kV.m^{-1}$ found on Platform E near a VDU screen, is within the recommendations by the CEC (10 $kV.m^{-1}$).

At the time of measurements, the load on the drilling package was minimal on all but one of the platforms (platform C) and the subsequent levels were lower than those in processing. The maximum magnetic field found in the drilling package was found on platform D and was 129.92 μT. Power is produced at 6.8 or 11 kV for all the processing applications and at 600 V for the drilling applications. Induction welding is used frequently on offshore installations and levels were found to be no greater than 9.24 μT.

The maximum ELF electric and magnetic fields near VDT's found on the platforms are summarised and presented below in table 2.

Position	Electric Field Strength ($V.m^{-1}$)	Magnetic Field Strength ($mA.m^{-1}$)	Magnetic Flux Density (nT)
Platform A	120	439	553
Platform B	138	2014	2530
Platform C	16	444	558
Platform D	102	2411	3030
Platform E	1400	1852	2327

Table 2 Summary of maximum ELF measurements in front of VDU screens on offshore platforms.

Throughout the platforms, the maximum magnetic field measured near a VDU was found to be 3030 nT (3.03 μT) and the maximum electric field was 1.4 $kV.m^{-1}$. The maximum magnetic field measurements are much lower than those found in the switch rooms and are well below the recommendations by the CEC of 333 μT for the magnetic flux density.

Similarly for VLF magnetic and electric fields, the CEC draft proposal recommends that the magnetic flux density does not exceed 20 μT and the electric field does not exceed 614 $V.m^{-1}$ for the frequency range 1-300 kHz. Again the results are summarised and presented below in table 3.

Position	Electric Field Strength ($V.m^{-1}$)	Magnetic Field Strength ($mA.m^{-1}$)	Magnetic Flux Density (nT)
Platform A	94	250	314
Platform B	37	411	516
Platform D	81	358	450
Platform E	8	46	58

Table 3 Summary of maximum VLF measurements in front of VDU screens on offshore platforms.

Clearly the VLF levels found near VDU's are well within the recommendations by the CEC even those measurements taken close to the screen. The maximum levels from the telecommunications equipment on the four platforms are presented below in table 4.

Platform	Electric field strength ($V.m^{-1}$)	Magnetic field strength ($mA.m^{-1}$)	Magnetic flux density (nT)	Power Density ($mW.cm^{-2}$)
Platform A	N	77	97.33	20
Platform B	N	N	N	2
Platform D	141.42	510	640.74	N
Platform E	316.20	390	486.68	N

Table 4 Summary of maximum radiofrequency measurements found on the platforms where N is negligible and approximately equal to the background.

The majority of the maximum levels were found near the outside aerials but on platform E, maximum levels were found near some of the handheld radiofrequency sources. The maximum electric field strength was found to be 316 $V.m^{-1}$ at a frequency of 156 MHz. At this frequency, the CEC recommendation is 61.4 $V.m^{-1}$ and therefore the electric field found at this frequency is much greater than the first action level and is even greater than the hazardous action level (3 times the first action level) of 184.2 $V.m^{-1}$.

The higher frequency measurements of power density produced maximum levels of 20 $mW.cm^{-2}$ near a VHF aerial on Platform A. None of the other sources produced power density levels exceeding the CEC action level of 1 $mW.cm^{-2}$.

CONCLUSION

The majority of the levels measured were found to be below the recommendations by the CEC for all frequencies measured although some did exceed them. On three platforms, levels at ELF were found to exceed the recommendations with a maximum of 2.6 mT found on one platform which is approximately 8 times the CEC recommendation of 333 μT. Levels measured near the telecommunications equipment also exceeded recommendations on isolated incidences. Throughout the measurements, the time dependency of the exposure has not been taken into account and clearly this greatly reduces the overall exposure.

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