Electric and Magnetic Field Exposure Level Assessment for 132KV High Voltage Power Lines Safety Zone Areas

تقييم مستوى التعرض للمجال الكهربائي والمغناطيسي ضمن محرمات خطوط الضغط العالي132KV

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Abstract

The electric and magnetic field effect on human health and environment is a matter concerned in recent years. In this work, electric and magnetic field exposure level assessment has been made for a residence and safety zone areas near a sample of 132KV power line in Baghdad city. GIS spatial analysis maps are introduced using Arc Map GIS version 10, the utilization of such maps is very important for exposure assessment and further future studies. Statistical analysis for measurements data was made using IBM SPSS Version 22. The maximum electric and magnetic field exposure level was 110 V/m and 193 mG respectively. The magnetic field exposure in this study is greater than standard limits issued by Switzerland and lower than standard limit issued by USA (Florida) and ICNIRP. There is no national Iraqi limits. Exposure level exposure values unveil the necessity of imposing new recommendations and limits and reducing exposure level in residential areas as low as possible.

Key words: Electric field exposure, Magnetic field exposure, Power line, GIS and Environmental pollution.

الخلاصة

تأثير التعرض إلى المجال الكهربائي والمغناطيسي على صحة الإنسان والبيئة أصبح محط اهتمام الكثير في السنوات الأخيرة. في هذا البحث تم إجراء تقييم لمستوى التعرض في المناطق السكنية والمحرمات القريبة من أحد خطوط الضغط العالي 132KV في مدينة بغداد. تم رسم خرائط التحليل المكاني باستخدام نظم المعلومات الجغرافية GIS Version 10 ، استخدام هذه الخرائط ضروري لمعرفة مستوى التعرض في جميع المواقع التي تظهر على الخارطة وكذلك لإجراء الدراسات المستقبلية لدراسة تأثير هذا النوع من التعرض. بينت نتائج القياس إن أعلى مستوى للتعرض للمجالين الكهربائي والمغناطيسي 110 V/m و 193 mG على التوالي. بينت النتائج أيضا إن مستوى التعرض للمجال المغناطيسي أعلى من المحددات المستخدمة في سويسرا ولكن اقل من المحددات المستخدمة في الولايات المتحدة (فلوريدا) والمحددات المقترحة من قبل منظمة ICNIRP. لا يمتلك العراق محددات خاصة بهذا الشأن وعليه من الضروري تبني محددات مستندة إلى نتائج بحوث أخرى معمقة بهذا الخصوص وتقليل مستوى التعرض في المناطق السكنية لأدنى حد ممكن.

الكلمات المفتاحية: المجال الكهربائي، المجال المغناطيسي، خطوط الضغط العالي، نظم المعلومات الجغرافية والتلوث البيئي.

Introduction

The relevant natural electric and magnetic field has a known effect on human health, plants growth, birds immigration path are example to such effect (Bhattacharya, 2013).With the urbanization and wide spreading of power lines to provide the daily need of electricity, environment encounter with the electromagnetic field (EMF) at every moment. Every instrument using electricity may also generate electric and magnetic field comparable with power transmission lines, describes the intensity of electric and magnetic field at varying distances from the source of generation. From 1960's different studies are conducted to identify the effects of electromagnetic field on living world. Mixed opinion results from these studies. Positive, negative and no change are reported (McKee, 1978; Foster, 1999; Ahlbom, 2001 and Habiballah, 2006). Overhead power transmission line covers vast area of residence areas usually. Intensity of electric and magnetic field arises from power transmission line depend on load, voltage, and height of the conductors from the ground. The aim of this work is to assess the exposure level to electric and magnetic field in safety zones residential areas of overhead transmission lines (OHTL) in the capital city (Baghdad). The work focuses on vulnerable locations like school's classes and facilities, kindergartens, and houses. The research importance comes from the absence of such local researches which deal with the trespass of 132KV safety zones during the last years. Statistical methods have been used for exposure level calculations in the selected areas and compared with standard limits and research results which were applied for other cities around the world. Geographical Information System (GIS) has been used for introducing the spatial analysis of electric and magnetic field exposure level and distribution around one of 132KV overhead power line in Baghdad as a sample for the study. Methodology used in the research may be applied for exposure assessment in other Iraqi cities. There are no Iraqi standard limits for electric and magnetic field associated with high voltage power lines; this research is an important step to leap toward issue a new local standard limits.

Materials and Method

Measuring instrument type SPECTRAN NF-5035 has been used to measure the electric and magnetic alternating fields with frequency range (0 to 30 MHz). Global positioning system device type GARMIN GPS 62st has been used for locate the geographical positions in decimal degree. The 3062 meter long double circuit 132KV OHTL which connect Al-Mashtal and Al-Faraby substation s in Baghdad was selected as a sample to apply the methodology suggested in this study as shown in figures (1 and 2), measurements includes safety zones, sample locations in residence areas, and substations networks. Spatial analysis method using GIS version 10.2 is used for extremely low frequency (ELF) electric and magnetic fields exposure mapping. The inverse distance weighted (IDW) interpolation spatial tool has been used for electromagnetic field exposure level calculation in unknown areas. IDW is the process of estimating an unknown value by using values that are already known. IDW method is widely used in GIS atmosphere analysis applications, the reason behind that is less distortion with high accuracy maps obtained when enough measuring points are available (Seung Won, 1997). Statistical calculation are made using IBM SPSS version 22 software.

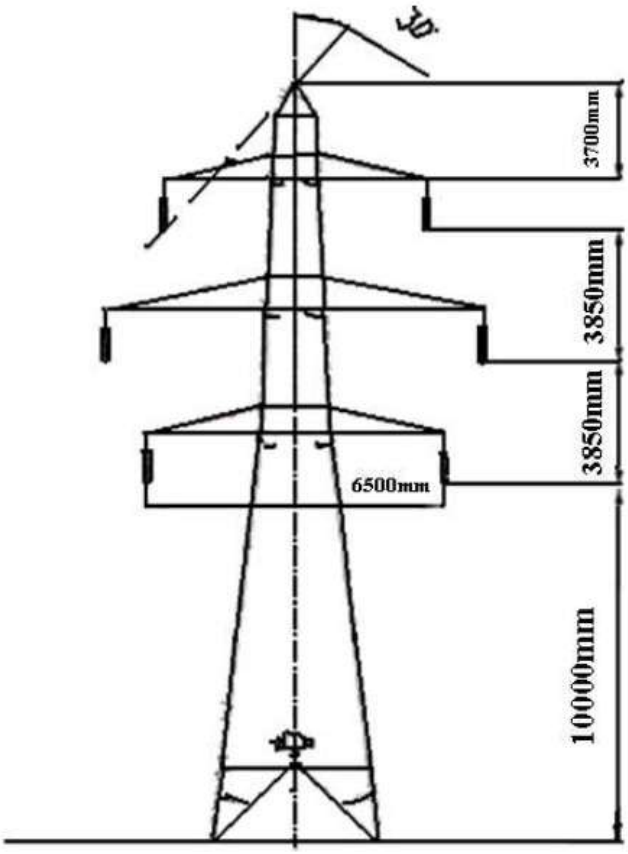

Figure (1) Double circuit 132 KV power line (MOE, 2006 and Alkhazraji, 2011)

Figure (2) Al-Mashtal and Al-Faraby power substation s and 132KV OHTL

Results and discussion

Statistical calculations results for electric field (E) exposure in Al-Mashtal power substation are shown in table (1), minimum and maximum exposure level was 1.6 and 110 V/m respectively, percentile 80 was 21 V/m, while, percentile 90 was 100.5 V/m, this reveals to existence of limited higher hotspots area in comparison with substation whole area. Statistical calculations results for magnetic field (B) exposure Al-Mashtal power substation are shown in table (2), minimum and maximum exposure level was 0.3 and 193 mG respectively, percentile 50 (median) was 4.7 mG, while, percentile 95 was 63 mG, this reveals to existence of limited higher hotspots area in comparison with substation whole area. The electric field hotspot area is lower than the magnetic field hotspot area as the difference between maximum and minimum value is larger. The electric and magnetic fields exposure contour maps in Al-Mashtal substation are shown in figures (2 and 3), these maps can be used for expecting exposure level at any location using latitude and longitude data in decimal degrees.

The exposure level in residential area along the 132KV power line has been measured and GIS map also has been plotted as shown in figure (4). The residential area subdivided into three zones: zone I represent the highest exposure zone within 12 meter for each side of power line. Pedestrians, cars and peddlers are the exposed samples in such zone. Houses and other facilities are within zone II within distances 12-35 meter form power line. Zone III within distances 35-90 meter from power line. Maximum exposure level in mG is shown if figure (4) for each zone.

There is no national Iraqi standard limit to protect people from exposing to high level of electric and magnetic fields, for this reason samples of other standard limits used by other countries are used in this study as shown in table (3). The comparison between exposure level in sample area and other standard limits is shown in table (4).

Table (1) Statistical results for Electric field in Al-Mashtal power substation , V/m

N, Samples	Valid	74
	Missing	0
Mean		22.1041
Std. Error of Mean		3.78827
Median		9.0000
Mode		2.00
Std. Deviation		32.58790
Skewness		1.967
Std. Error of Skewness		.279
Kurtosis		2.334
Std. Error of Kurtosis		.552
Range		108.40

Minimum		1.60
Maximum		110.00
Percentiles	10	2.0000
	20	3.0000
	30	5.6000
	40	7.2000
	50	9.0000
	60	11.0000
	70	14.0000
	80	21.0000
	90	100.5000

Table (2) Statistical results for Magnetic field in Al-Mashtal power substation , mG

N, Samples	Valid	99
	Missing	0
Mean		15.2598
Std. Error of Mean		2.99827
Median		4.7000
Mode		2.00
Std. Deviation		29.83243
Skewness		4.547
Std. Error of Skewness		.243
Kurtosis		24.147
Std. Error of Kurtosis		.481
Range		192.70
Minimum		.30

Maximum		193.00
Percentiles	10	1.0000
	20	1.4000
	30	1.9000
	40	2.5000
	50	4.7000
	60	8.0000
	70	14.0000
	80	23.0000
	90	33.0000
	95	63.0000

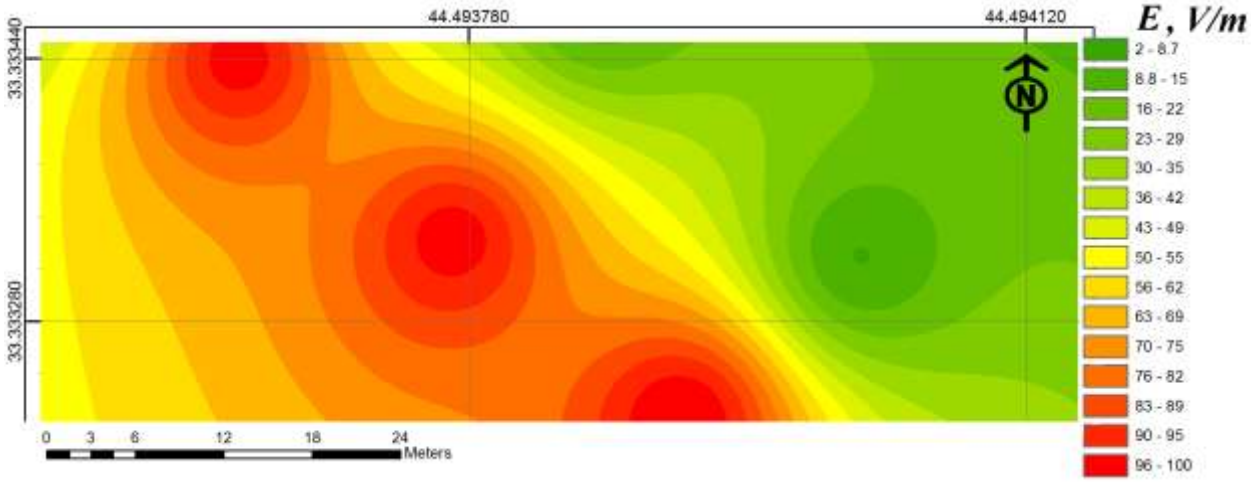

Figure (2) Electric field distribution in Al-Mashtal substation power network

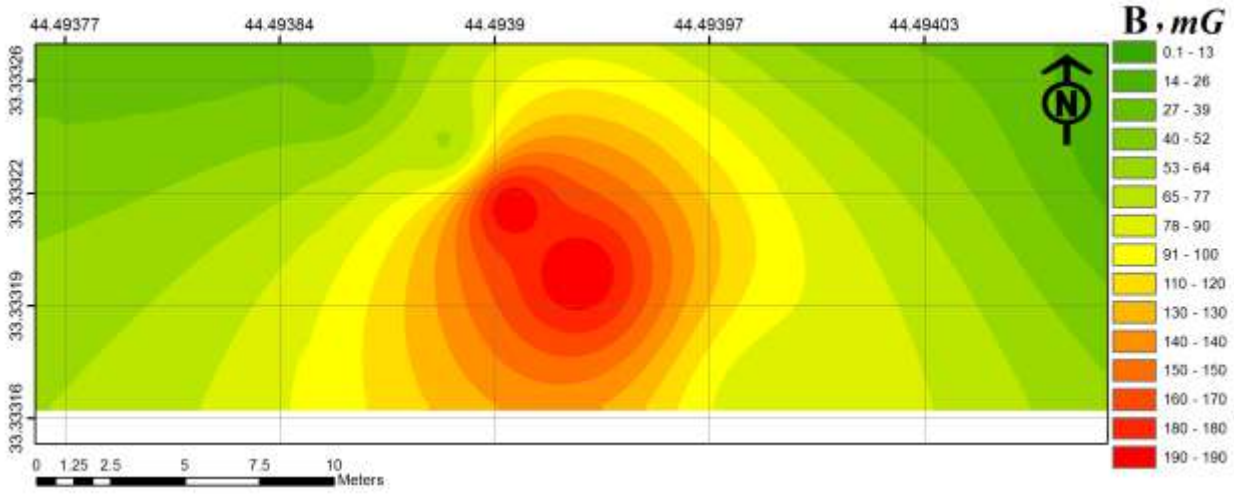

Figure (3) Magnetic field distribution in Al-Mashtal substation power network

Figure (4) Magnetic field exposure zones in residential area

Table (3) samples of national limits for some countries (Alaboudi, 2013)

EMF exposure limits lower than ICNIRP set by different countries.

Belgium	4x lower than ICNIRP
Greece	60-70% ICNIRP for land based antennas
Italy	6 V/m - Areas where people stay for 4 hours & more
	10 μT 24 hours median value. Limit for daily exposure duration >4 hours 3 μT 24 hours median value. New power lines and new premises
Lichtenstein	0,6 V/m for base stations after 2012
Lithuania	6 V/m for RF
Luxemburg	3 V/m for public exposed to RF long time
Poland	7 V/m RF E-Field
	60 μT – for residental areas ELF
Slovenia	3x lower than ICNIRP for RF Fields, new instalations close to sensitive areas (schools, kindergarten, hospitals, …) 12.9 V/m limit is applied for GSM.
	10 μT limit is applied for power frequency
Switzerland	precautionary factors 10 to 100 are applied for single instalation in "sensitive areas". 6 V/m instalation limit is applied for GSM.
	1 μT - for new ELF installations: exemptions possible if all reasonable measures taken.

Table (4) Maximum exposure in study area compared with some standard limits

Standard limits			Residence	Al-Mashtal substation	Al-Faraby substation
ICNIRP	Switzerland	USA (Florida)			
2000 mG	10 mG (1 μT)	150 mG	21.5 mG	193 mG	183 mG
5 KV/m	-	2KV/m	0.00198 KV/m	0.11 KV/m	0.105 KV/m

Conclusions and recommendations

The maximum magnetic field exposure in the study residential area is greater than standard limits issued by Switzerland and lower than standard limit issued by USA (Florida) and ICNIRP. Magnetic field exposure in sample power substation s is greater than limit issued by Switzerland and USA (Florida) but lower than ICNIRP limits. Maximum electric field exposure is lower than all limits. GIS maps for Electric and magnetic fields exposure shall be used to avoid high level exposure locations in power substations, to minimize the possible health effects, professional workers should alternate with more than one shift of other workers. High voltage power network and substations in other Iraqi cities should subjected to the same scenario suggested by this research to locate hotspot areas, many

changes in the distribution of facilities such as facilities locations, workers rooms and administration rooms are changed according the plotted electric and magnetic field GIS maps.

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