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Analyzing the Health Risks Resulting from Extending the 400kV High Voltage Transmission Lines on the Human

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Abstract

Although it is difficult to imagine life without electricity, there are compiling confirmations show that exposure to magnetic fields correlated electricity and radio frequencies pose magnificent hazards to human health. The most economist method to transfer electricity from power generation stations to users is by measures of high power transmission lines, buoyed by big transmission towers. The cables laced between the towers radiate magnetic and electric fields. In this research study, the magnetic field at ground level under 400 kV network lines extended in residential places have been conducted in two ways, mathematical calculation and practical measurement then the obtained results analyzed and compared with the international standards reference values. the reason of chose this type of transmission line is frequently using. The results indicate that they fall within the safe limiter commended by the World Health Organization. the strength of radiation increasing with high of sea level and moisture ratio because of air ionization

Keywords: High voltage transmission lines, magnetic field, negative health effect.

تحليل المخاطر الصحية الناجمة من امتداد خطوط نقل القدرة الكهربائية 400 كيلو فولت على الانسان

الخلاصة

على الرغم من أن الحياة على كوكبنا اصبحت مستحيلة بدون كهرباء، إلا ان هناك أدلة تشير إلى أن التعرض للمجالات الكهرومغناطيسية المرتبطة بالكهرباء والاشعاعات الكهرومغناطيسية الناتجة عن انتشار الموجات الكهرومغناطيسية ذات الترددات العالية المستخدمة في الاتصالات وتكنولوجيا الهاتف النقال تشكل مخاطر كبيرة على صحة الإنسان. ان أسهل وسيلة لنقل الطاقة الكهربائية من محطات التوليد الى المستهلكين هي عن طريق خطوط نقل الضغط العالي المعلقة على أبراج نقل الطاقة الكهربائية الكبيرة التي قد تمتد لمسافات بعيدة وقد تمر في المناطق السكنية مما قد يسبب مضارا صحية على السكان من جراء انبعاث اشعة كهرومغناطيسية ناتجة عن مرور التيارات الكهربائية العالية في موصلات الضغط العالي الممتدة في هذه المناطق. في هذا البحث تم حساب شدة المجال المغناطيسي عند مستوى سطح الأرض المنبعثة من خطوط نقل القدرة 400KV لمعرفة مدى الاضرار الصحية الناتجة عن مرور هذه الشبكات الكهربائية في المناطق السكنية وان اختيار هذا النوع من خطوط النقل هو الاكثر استخداما. تم اجراء البحث بالحسابات الرياضية والقياسات العملية. ومن خلال مقارنة نتائج القياس مع المعايير الدولية، تبين أنها تقع ضمن الحدود الآمنة الموضوعة من قبل منظمة الصحة العالمية. علما ان شدة الاشعاع تزداد كلما كان الارتفاع عن مستوى سطح البحر أكبر وايضا مع زيادة الرطوبة بسبب تأين الهواء.

الكلمات الدالة: خطوط نقل الضغط العالي، المجال المغناطيسي، الآثار الصحية.

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Introduction

Electrical and magnetic field (EMF) occur during the production, transmission, distribution and use of electricity. The strength of electromagnetic fields is referred to as 'field intensity'. By analogy we could call the heat generated by a heater or a radiator a heat field (or thermal field) [1]. A voltage drops between objects and their surroundings induce electrical fields as a results of repulsion or attraction among electrical charges. When a light bulb is plugged into a power outlet and connected to the electricity grid, it creates an electrical field, even when the light switch is switched off. In short, anywhere where there are electrical lines, electrical fields exist [2]. The electrical field intensity is measured in volts per meter. A magnetic field develops when there is an electric current. It is only when a light bulb lights up (i.e. when current flows through the wire) that a magnetic field occurs in addition to the electrical field. The magnetic field is related to the current that flows through the electric wire. The magnetic field intensity is commonly expressed in microtesla (μT)[3].

Electric fields are inversely proportional with distance and are also can be blocked by many of building materials, but not glass, therefore rarely to detect too high electric fields from power line inside the building, but they may be high near windows, outside areas, for example, gardens, playgrounds, etc. Living within 200 meters from the power transmission lines where electromagnetic fields can be high enough to impose negative health affect [4]. Scientists have wondered for a long time about the health hazards resulting from electromagnetic fields on peoples and the living organisms.

So, a lot of researches have been conducted on this topic [5]. Electromagnetic field (EMF) is a form of energy emitted by charged particles. In classical physics, EMF is considered to be produced when charged particles are accelerated by forces acting on them. Electrons are responsible for emission of most EMF because they have low mass, and therefore are easily accelerated by a variety of mechanisms [6].

Health Effects

Normally electric currents present in the human body and play a significant role in the ordinary physiological functions. Nerve cellsuse electric impulses to convey their signals. The frequency and strength of electromagnetic fields dominant the effects of such fields on human body. These fields pass through human body if they are induced by low frequency signals, but they penetrate into thin surface layer of the tissue when these fields generated by radiofrequencies Electric fields at low frequency affect the scattering of electric charges at the tissues of surface, which cause the flow of electric currents in the human body. Meanwhile, electric currents circulate within human body because of the magnetic fields of low frequencies as shown in Figure (1). The power of the outsider magnetic field and the extend of the current loop will determine if nerves and muscles can be stimulated [6].

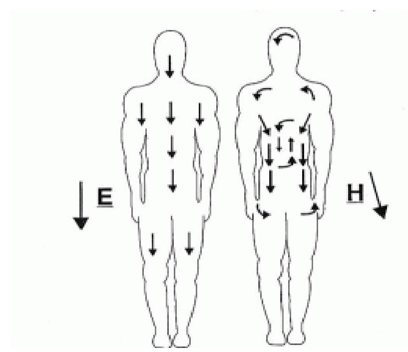

Fig. 1. Low-frequency magnetic fields induce circulating currents within the body

Standard guidelines limits

There are many standard guidelines limits such as (International Radiation Protection Association International No Ionizing Committee radiation) Health and the World Health Organization (WHO) set the maximum values corresponding to electric and magnetic fields as shown in Table (1)[6]

Table 1. Recommendation limits of electric& magnetic fields [1]

Organization	Public Area E(kv/m B(µT)		Occupational E(kv/m B(µT)
ICNIRP	5	100	10 500 500
European Union	5	100	10 500 500

Literature Review

Since 1981 several studies have been conducted over the past three decades in order to assess the potential risks associated with exposure to electromagnetic fields. The first study dealt with electric fields. Various reports were presented on the reduction of pineal melatonin and N-acetyl transferee (NAT) and synthesis of melatonin enzyme, when exposed to electric fields for about for one month 22 hours a day [1-7]. Other studies did not find any biological effects because of exposure to electromagnetic field [8]. As attention budged from electric to magnetic fields enormous number of studies asses the effects of ELF-EMF on melatonin levels in different animal tissues [9].

Yellon and Wilson et al. [10], reported a reduction of both in pineal and plasma melatonin in Djungarian hamsters when exposed to a 100-µT magnetic field. Beside that Wilson reported an increases in the concentration of nor epinephrine in the supra schismatic nuclei, the central rhythm-generating system. Kato et al. [11] noticed that a decrease in pineal and plasma melatonin concentrations without any dose-response relationship when exposing rats male for 8 weeks to a 50-Hz circularly polarized sinusoidal magnetic field using increasing intensities. The researchers repeated the above study, but with a vertical magnetic field and deduced no effect on melatonin levels [12-13]. The same researchers found a phase delay in the nocturnal peak time of melatonin in hamsters. Some authors have reported an increase in night time melatonin levels [14]. In Selmaoui and Touitou [15], a study aims to compare short and long terms exposure effects.

Method of Analysis

Mathematical Calculations

The magnetic field has been calculated under the transmission line at a height of (1) meter above the ground level. The vector of magnetic field is vertical to the magnetic field spherical line radius. This vector is consisting of horizontal and vertical components. The location of the observation point and the conductor is defined by the coordinates p(*x,y*).The geometry considered to evaluate the magnetic field at p(*x,y*) is depicted in Figure (2). A magnetic field with a contour of concentric circles around the conductor is caused by the flow of an electric current through a cylindrical conductor of a transmission line. The magnetic field at each point around the conductor is calculated by a field vector, which is vertical to the radius drawn from the conductor center.

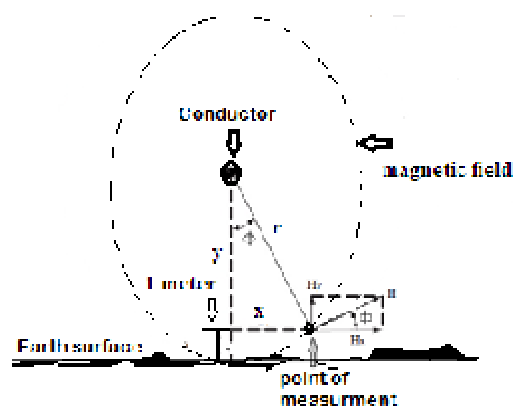

Fig. 2. Geometry to find the magnetic field at the point p (*x* , *y*)

By using ampere's law [10], we can calculate the magnetic field intensity as follows:

$$H = \frac{I}{2\pi r} = \frac{I}{2\pi\sqrt{(X^2+y^2)}} \quad \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

H: represents the field intensity in (A/m),
I: represents the current in the conductor,
r: represents the distance from the conductor, and p(X,Y) represents the observation point coordinates.

The magnetic field components (horizontal and vertical) can be computed from the triangle formed by the field vectors, where the coordinate's differences used to find the value of the angle as:

$$H_x \quad = H.\cos\emptyset = \frac{I}{2\pi r}.\frac{x}{\sqrt{(X^2+y^2)}} \ldots\ldots\ldots\ldots\ldots (2)$$

$$H_y \quad = H.\sin\emptyset = \frac{I}{2\pi r}.\frac{y}{\sqrt{(X^2+y^2)}} \ldots\ldots\ldots\ldots\ldots (3)$$

For a system with the three-phase currents the induced magnetic fields are shifted by 120^0, and the three-phase currents can be described by the following equations:

$I_1 = I$, $I_2 = I.e^{-120}$, $I_3 = I.e^{-240}$

The field intensity can be evaluated by replacing the conductor's currents and coordinates in the equations 2 & 3. The total magnetic field intensity can calculated as follows:

$$H_{3p} = \sqrt{(H_x)^2 + (H_y)^2} \ldots\ldots\ldots\ldots\ldots (4)$$

$$B = \mu_0.H = 4\pi.\ 10^{-7} \ldots\ldots\ldots\ldots\ldots (5)$$

$$.H_{3p} = \sqrt{(H_x)^2 + (H_y)^2} \ldots\ldots\ldots\ldots\ldots (6)$$

The mean current in the conductors at the moment of the measurements was 465 A (which approximately75% of its full load value).

Practical Measurements

Figure (3) shows the measurement points in which the conductors are horizontally arranged, average conductor height is 28 m, distance between conductors is 5.2m.

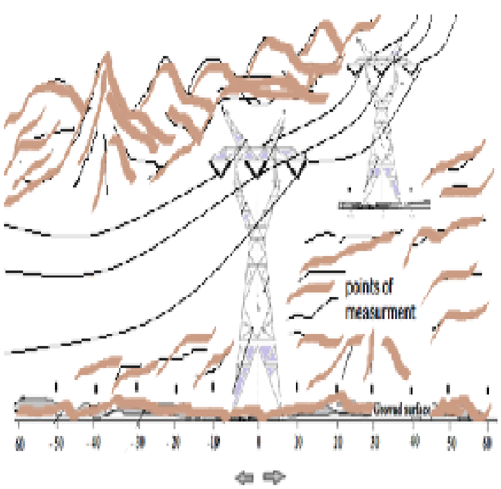

Fig. 3. Magnetic field measurement points

Practical measurements are conducted by using the electromagnetic field tester EMF Tester type (DT1180) illustrated in Figure (4).

Fig. 4. Measurement of Electromagnetic field by using (EMF Tester type –DT 1180)

Results and Discussion

Transmission lines produce electromagnetic fields. These fields are created by electricity passing through a conductor. These electromagnetic fields are on the one hand dependent to the distance from the source and on the other hand dependent on the flow of power at the source. They are composed of two fields: electric field and magnetic field [19-21]. Results of calculated and measured magnetic fields under the 400 KV transmission line tower are shown in Table (2), where the maximum calculated magnetic field in this study case is 7.8μT which compare very well with the measured value 7.42μT. The graphical representation of results illustrated in Figures (5) and (6).

Table 2. Compare calculated and measured magnetic flux density (B) in micro Tesla at (1 m) under 400 KV overhead horizontal line with 485,472, and 488 A in each phase respectively

Distance from the line center (m)	Calculated B (μT)	Measured B (μT)
-60	1.56	1.43
- 50	1.6	1.56
- 40	2.4	2.2
- 30	3.0	2.41
- 20	4.8	3.6
- 10	5.1	4.7
0	7.8	7.42
10	6.0	6.0
20	5.6	5.5
30	4.1	4.0
40	3.4	3.3
50	2.2	2.1
60	1.76	1.67

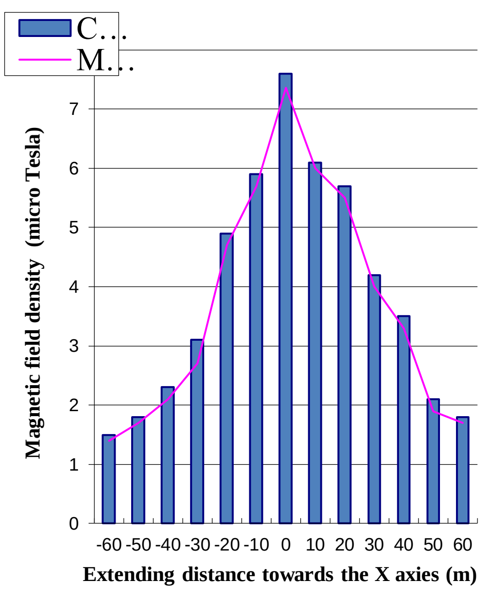

Fig. 5. Graphical representation of calculated and measured results

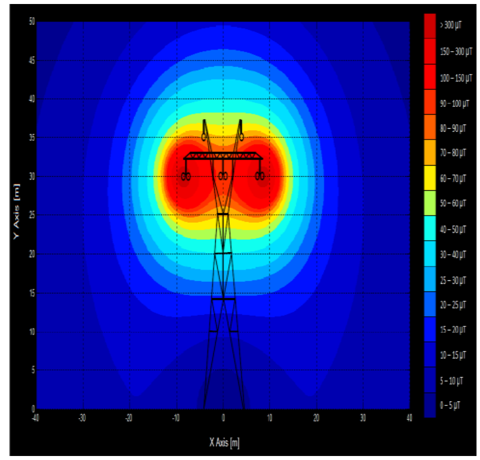

Fig. 6. Distribution of magnetic field around the 400kv high voltage transmission line

From obtained results we can conclude the following:

- The magnitude of the magnetic field has a highest value under the power lines exactly and decrease rapidly with increasing of distance away from the lines. Regarding human exposure, the most critical points are those within or close to the line center, where the magnetic field above safe level.
- These measurements fell well within the threshold limit for occupational exposure 500μT and 100μT for publication recommended by the ICNRP indicated in Table (1). This lead to fact that there is no risks from exposure to these fields for a short and discontinues periods.
- Burring power lines underground is not thorough solution because the magnetic field remains largely unaffected by using this option. Research and investigation evidence must be firmly established before expensive are made. The procedure for making decisions based on health concerns is greatly benefited from the international expert bodies following the process of reviewing and assessing research findings.
- According to Figure (6), the safe zone for residential people is 60m from the line center of the high voltage 400kv transmission lines.

Conclusions

High voltage power transmission lines can benefit all users of electricity, but affected only people lives within unsafe zone of the power transmission line. The analysis showed that it is efficient to use the double complex numbers method and the multiple expansion to get the equations for the magnetic field. Other techniques such as the efficient current simulation or solving a multi-objective optimal power flow can be used to determine as well that magnetic fields in power lines. This lead to many studies and development researches in this subject .People exposed to high levels of electromagnetic field (EMF) as working in substations or living close to high power transmission lines can cause negative health effects to them, so there is a need and obligation according to WHO to calculate and practically measure these fields for a high voltage power transmission line 400 KV has been conducted. In comparison of measurements with the international standard reference values of electromagnetic field didn't exceed the international standard exposure limits. A conclusion can be made that there is no risk due to exposure to these fields if the exposure is for a short time and for discontinues periods. Electromagnetic field levels can be reduced by increasing the distance between the power transmission lines and the public that can be set by the table of clearance. This measure will help reducing the magnetic field effect on human, but does not reduce the magnetic fields levels. To reduce the electromagnetic field levels is by decreasing the source current by increasing the voltage, which leads to decrease in current as a result the magnetic fields will be minimized.

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