Investigate and study the Effect Of Electromagnetic Radiations Emitted From 400KV High Voltage Transmission Lines On Human Health

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Abstract

High Voltage transmission lines are a channels for electric power transmission at extra high voltage .So, in the vicinity of the transmission network lines arises electromagnetic fields which its intensity dependent on the amount of current that flowing in the conductor and the distance to the conductor. Nowadays, people are highly concerned about the effects of high voltage transmission lines on their health. Probable risk for leukemia, breast cancer, neuropsychological disorders and reproductive outcomes has been reported due to this exposure. In this research it has been analyzed the magnetic field at ground level under 400 kV network extended in Tikrit city with a common configuration .The aim of research is to investigate the probability of health hazards of the exposure to electromagnetic fields emitted from high voltage transmission lines. research had been conducted in two ways ,mathematical calculation and practical measurements and comparing these measurements with the international standards reference values. results indicate that they fall within the safe limits recommended by the World Health Organization, and this means that there is no risk of exposure to these areas if the exposure is for a short time and is within acceptable limits.

Keywords: EHV transmission lines, magnetic field, the negative health effects .

1. Introduction :

Humans are continuously exposed to electromagnetic fields (EMF) emitted from some sources such as electric transmission lines , telecommunication and radio-television antennas. Thus, EMFs of various frequencies are ubiquitous in our environment. Power transmission lines and high voltage cables carrying electrical currents with very low frequency produce electromagnetic fields. Scientists have wondered for a long time about the health hazards resulting from these fields on peoples and the living organisms . So ,a lot of researches have been conducted on this topic[1].

However, the results of researches, did not give any definitive conclusions for the development of clear rules and unambiguous of this issue. Based on the researches and studies , the World Health Organization classified electromagnetic fields as the fields which may be cause some disease. With the increasing awareness of people about the negative health effects caused by electromagnetic fields emitted from high power transmission lines, investigations on this issue had been raised day by day. Several research articles presented survey results showing that the exposure to magnetic fields increases the cancer occurrence[2]. Studies linked the childhood leukemia to transmission line generated magnetic field exposure. This triggered research in both biological and electrical engineering fields. The biological research were studied the magnetic field effect on cells and performed statistical studies in order to determine the correlation between field exposure and cancer occurrence[3].

Nowadays, a multi-line power system is present in our neighborhood to satisfy increasing need for electric power**.** To distribute power from the power plant to the load center it will be required a network starting from the transmission line until the consumer, so that in the vicinity of the transmission line and distribution network it will be a strong electromagnetic field caused by currents that are drawn by their Conductors [4]. 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[5,6].

Figure (1) shows how the electric field is concentrated into human bodies because of the conductive material, mainly water, that allows the field to carry a current to earth, parallel to the electric field lines. On the other hand, magnetic fields induce circular currents perpendicular to the magnetic field lines. The dotted lines show the directions of the induced currents, parallel to the electric field and perpendicular to the magnetic field .The fields are oscillating at (50Hz), so the induced currents within our bodies are also oscillating at this frequency [7].

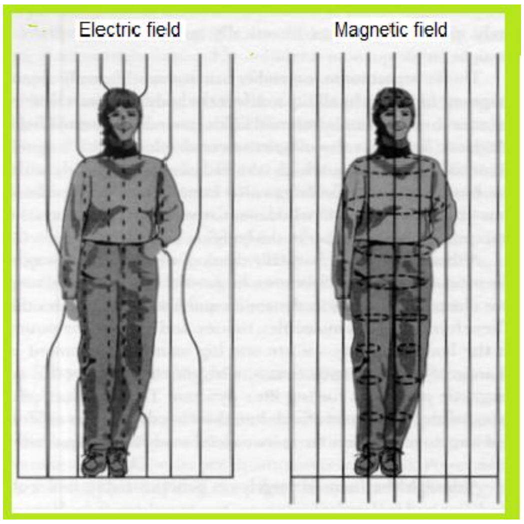

Fig.(1): Low frequency electric and magnetic fields induce weak electric currents in humans body [7].

1.1 Standard guidelines limits :

There are European and ICNIRP (International Commission on Non-Ionizing Radiation Protection) standards. In these criteria, the frequencies of different Electromagnetic fields have a "reference value". In 1990, the World Health Organization (WHO) set the limit values for the fields electric and magnetic fields are shown in table (1) [8]

Table (1): Recommendation limits the strength of electric and magnetic fields [8].

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

Investigation of magnetic field has been performed in three steps:

- Mathematical calculation.
- Practical measurement.
- Comparison the results with the international standard limits values .

2. Experimental work :

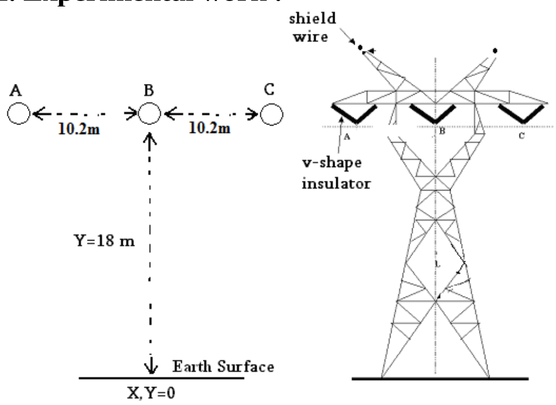

Fig. (2). Transmission line with single horizontal configuration

The magnetic field of overhead high voltage lines can be found by superimposing the individual contributions of the phase conductors .The geometry considered to evaluate the magnetic field at p (*x*,*y*) is illustrated in figure (3).

The electric current in a cylindrical transmission line conductor generates magnetic field surrounding the conductor. The magnetic field lines are concentric circles. At each point around the conductor, the magnetic field strength or intensity is described by a field vector that is perpendicular to the radius drawn

2.1 Mathematical Calculation :

The magnetic field generated by the 400KV transmission lines had been calculated under the line in one meter above the ground surface. conductors are arranged horizontally, average conductor height is 18 m, distance between conductors is (10.2)m as shown in figure (2).

from the center of the conductor. [9] .The magnetic field vector is perpendicular to the radius of the circular magnetic field line. The H field vector is divided into horizontal and vertical components. The location of both the observation point and the conductor is described by the x ,y coordinates.

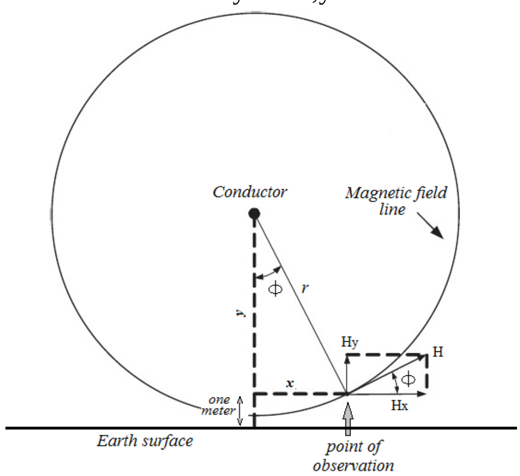

Fig. (3) : Geometry to find the magnetic field at the point p (*x* , *y*) due to the phase conductor

The magnetic field intensity is calculated by using the ampere law as shown in Equ.(1):[9].

$$H = \frac{I}{2.\pi.r} = \frac{I}{2\pi\,[\,(X)^2 + (Y)^2]^{1/2}} \qquad (1)$$

Where :
H: is the field intensity in A/m
I :is the current in the conductor
r: is the distance from the conductor
(X,Y) : are the coordinates of the observation point.
The horizontal and vertical components of the field are calculated from the triangle formed by the field vectors. The angle is calculated from the triangle formed with the coordinate's differences :[10].

$$\cos(\phi) = \frac{x}{r} = \frac{x}{(x^2 + y^2)^{1/2}} \qquad (2)$$

$$\sin(\phi) = \frac{y}{r} = \frac{y}{(x^2 + y^2)^{1/2}} \qquad (3)$$

$$Hx = H.\cos(\phi) = \frac{I}{2\pi r}\,\frac{x}{(x^2 + y^2)^{1/2}} \qquad (4)$$

$$Hy = H.\sin(\phi) = \frac{I}{2\pi r}\,\frac{y}{(x^2 + y^2)^{1/2}} \qquad (5)$$

In a three-phase system, each of the three-phase currents generates magnetic fields. The phase currents and corresponding field vectors are shifted by 120^0. The three-phase currents are :

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

The three-phase line generated field intensity is calculated by substituting the conductor currents and coordinates in the equations describing the horizontal and vertical field components. This produces three horizontal and three vertical field vectors. The horizontal and vertical components of the three-phase line generated magnetic field are the sum of the three-phase components:[10]

$Hx = Hx_1 + Hx_2 + Hx_3 \qquad (6)$

$Hy = Hy_1 + Hy_2 + Hy_3 \qquad (7)$

Where Hx is the horizontal component of three-phase generated magnetic field, Hy is the vertical component of three-phase generated magnetic field,Hx_1, Hx_2, Hx_3are the horizontal components of phases 1, 2, and 3 generated magnetic field, and Hy_1, Hy_2, Hy_3 are the vertical components of phases1, 2, and 3 generated magnetic field. The vector sum of the horizontal and vertical components gives the three-phase line generated total magnetic field intensity: [10]

$H_{3phase} = [(H_x)^2 + (H_y)^2]^{1/2} \qquad (8)$

$B_{3phase} = \mu_0.H_{3phase} \qquad (9)$

$\mu_0 = 4\pi.\,10^{-7}$ H/m

The mean current in the conductors at the moment of the measurements was 482 A (approximately 60% of its full load value) with a light unbalance between phases (485, 472, and 488 A for the phases A, B, and C, respectively).

2.2 Practical measurements :

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

Fig.(4) :Electromagnetic field tester (EMF tester) type band pass ac gauss meter

This device is a low cost, portable, single axis model with large, easy-to-read 3½ digit display. What makes this meter unique is the very narrow band pass filter which only allows the calibration frequency to be read. Which gives very accurate readings without distortion from harmonics. The device specifications data are indicated in table(2).

Table(2):The(EMF Tester) specifications data

Axis	Range	Resolution	Frequency	Accuracy
1	0-199.9 mG	0.1	50/60 ±6 Hz	3%

3. Results and Discussion :

Mathematical calculations and practical measurements are conducted in both sides of the transmission line in a step of 10 m from the center line as indicated in figure (5).

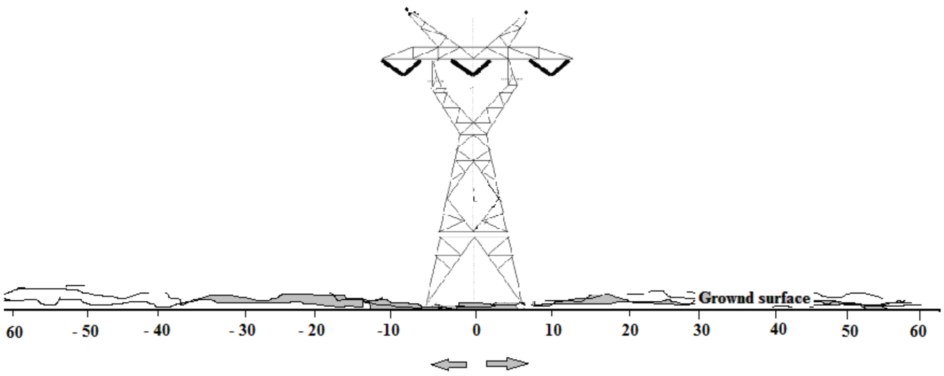

Fig. (5) : direction of magnetic field measurement points.

Table (3): 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)
- 50	1.8	1.7
- 40	2.3	2.2
- 30	3.1	2.41
- 20	4.9	3.6
- 10	5.2	4.7
0	7.6	7.36
10	6.1	6.0
20	5.7	5.5
30	4.2	4.0
40	3.5	3.3
50	2.1	1.9

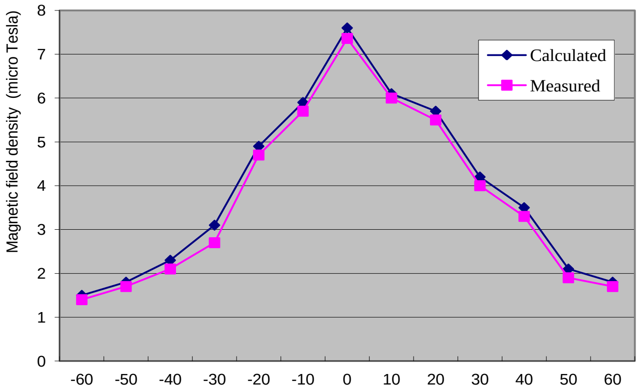

fig. (6) : Graphical representation of calculated and measured results

Results of calculated and measured magnetic fields under the transmission line are shown in table (3) , where the maximum magnetic field for the existing line is 7.6 μT which is very close to the measured value 7.36 μT . And the graphical representation of results illustrated in figure (6). High values of electromagnetic field (EMF) can cause negative health effects to peoples who have been exposed to these fields due to working in substations or living close to high power transmission lines , so there is a need and obligation according to WHO to calculate and measure these fields. In some countries as a result of their work safety standards for power transmission lines established on the electric and magnetic fields.

4. Conclusion :

The measurement of magnetic fields and implementation of new techniques that enhance the reduction of the exposure to this field which induced by the power lines have been the concern of many researchers for the past years; this lead to the publication of many studies and development research in this subject .

In this work a mathematical model for calculations of magnetic field density (B) in a high voltage power transmission line 400 KV has been conducted .the comparison of measurements with the international standard reference values of electromagnetic fields arising from the extension of high-tension transmission lines 400 KV in Tikrit city didn't exceed the international standard exposure limits(within the acceptable exposure limits) . So we can conclude that there is no risk due to exposure to electromagnetic fields if the exposure is for a short time and for discontinues periods .

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بحث ودراسة تأثير الإشعاعات الكهرومغناطيسية المنبعثة من خطوط نقل القدرة الكهربائية 400 كيلو فولت على صحة الانسان

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الملخص

خطوط الضغط العالي هي قنوات لتوزيع الطاقة الكهربائية في نظام الجهد العالي .ونتيجة لمرور التيار في موصلات هذه الشبكة ، ينشأ مجال مغناطيسي في محيطها وشدة هذا المجال تعتمد على كمية التيار المار في الموصل و المسافة إلى الموصل. وقد تساءل العلماء منذ فترة طويلة حول الآثار الناجمة من هذه المجالات على صحة الناس والكائنات الحية والمخاطر المحتملة للإصابة بسرطان ألدم وسرطان ألثدي والاضطرابات العصبية كنتيجة لهذا التعرض. ولذلك فقد تم إجراء الكثير من الأبحاث حول هذا الموضوع. في هذا البحث تم حساب شدة المجال المغناطيسي عند مستوى سطح الأرض والمنبعثة من خطوط نقل القدرة 400KV الممتدة في محيط مدينة تكريت. النتائج التي تم الحصول عليها تشير إلى أن شدة المجال المغناطيسي المتولد تقع ضمن الحدود المسموح بها المحددة من قبل منظمة الصحة العالمية ، وهذا يعني انه ليس هناك خطر من التعرض لهذه المجالات اذا كان التعرض لفترة قصيرة ويقع ضمن الحدود الآمنة

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