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Suitable Performance of the Magnetic Field Induced Near High Voltage Overhead Transmission Lines

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Abstract – Magnetic field is produced by electric currents flow conductors of overhead power lines. In order hand, when load current increases, the magnetic field increases excessively. Many researcher works show that the magnetic field can have harmful effects on humans and can interrupt electric and electronic systems. Overhead transmission lines are known as major sources of magnetic field due to their eddy currents run counter. Transmission lines can produce strong magnetic fields around itself. So, many peoples that live near the high voltage overhead power lines are concern about the harmful effects of magnetic fields in the environment and human health. This article presents a numerical calculation of magnetic field around overhead transmission lines under different types of lines pattern such as high voltage (HV) 60kV, also extremely high voltage (EHV) 220kV, then 400kV single circuit three phase overhead transmission lines. The effect of load current at the magnetic field intensity in addition to the difference of circuit lines configurations and the phase conductors arrangement. The variation of height of conductors and the height of observation point in the magnetic field under power lines are discussed.

Keywords – Overhead Transmission Line, Magnetic Field, Load Current Magnitude, Conductor Height, Phase Arrangement.

I. Introduction

In emerging areas of the world, the continuing growth in electricity consumption has formed great substantial energy demands. The plant systems construction are aimed at transit of much power sources by extremely high voltage transmission and distribution lines is accelerated in order to meet the human population electrical demand. The produced fields that are generated under overhead power lines can cause currents to flow through the people living and interfere substances nearby this power lines. As a result, the magnetic induction strength beneath the circuit lines within the right-of-way corridor must be assessed and analyzed simply [1-3]. Some numerous research works, standards, and guidelines have been developed based on the recommendations reported in these related studies, to identify the safety exposure limits of electromagnetic fields under normal regular operating and fault conditions [4–8].

The magnetic field around overhead power lines during normal network operating environment is evaluated in our work using the quasi-static simulation method. In order to increase electric transmission potential, it was decided to augment by providing additional overhead lines. The impact of low frequency electric and magnetic fields on inhabitant's health and many significant findings on electromagnetic interferences has become more increasingly prevalent in the recent years [9–13].

One of the most significant issues is assuring the safety limits of persons who live in close proximity areas where such as an electromagnetic fields exist. In the European Union (EU), the recently established Hygiene Standard HN 104:2011 "Human protection against electromagnetic fields induced by overhead power lines" is now valid, it notices that the actual values of magnetic field strength must never exceed 32A/m or also 40µT in residence environments, otherwise inside residential and public utility structures must be account 16A/m or 20μT. These levels should never be surpassed, irrespective of the duration of a persons exposure to an electromagnetic fields [14].

The human population increment in the world as a result of increased demand for the electric energy consumption, which requires the construction of new electric transmission lines [15-16]. The latter has become an essential partner in our daily life, our technological and economic development. Despite all the benefits associated with its use, we are constantly immersed in electric and magnetic fields created by overhead transmission lines. Therefore, these electric and magnetic fields have raised serious questions about the effects on human health and the environment associated with resulting high levels of the fields strength [17]. The accurate assessment of electric and magnetic fields produced by high voltage overhead transmission lines is very important in several areas of research, necessary in many applications of the design, maintenance, electric and electronic equipment processes [18]. The quasi-statique regime of extremely low frequency electromagnetic fields, requires that the magnetic field analysis be performed separately from the electric field analysis, and are created independently. Therefore, the magnetic field of overhead power lines is based and has great association by the currents flow in conductors [19]. The alternating electric and magnetic fields generated by these power lines induce currents with very high induced current levels, unwanted effects may contain a risk and cause a hazard to human body in long term [20]. Indeed, the scientific community generally must attempt to accurately measure and quantify these undesirable effects, in order to find the solutions that limit and reduce the undesirable impacts when exposed to extremely low frequency electromagnetic fields near a high voltage electric power lines. Researches results have shown that magnetic field produced by overhead power lines has negative effects on living organisms and electronics systems operations. So many people are very worried about the harmful effects of magnetic fields near overhead transmission lines [21]. The damaging impacts of lines magnetic fields have been approved by many simulation modulation and laboratory experimentally [22-23]. In these studies electric power lines are suggested as the most important source for producing magnetic field [24]. Today, in many residential regions, the power lines are passed through along great cities. So, many peoples are concerned about dangerous effects of the magnetic field resulted under overhead power transmission lines [25]. The magnetic fields have harmful and negative effects on the operation of communication systems, electric and electronic devices [26]. But environmental and biological effects of the magnetic fields are not investigated completely. The main purpose of this article which comes our study covers a numerical analysis simulation and examination of the magnetic field around high voltage overhead transmission lines, in order show many factors affect the magnetic field.

II. Materials and Method

As populations around the world increase, there is a never ending need to provide electricity that maintains high standards of living and with the large expansion of wind on the power plant systems, there is a requirement to upgrade the transmission and distribution lines.

The size (voltage) and location (overhead or underground) was also assigned to each student. This report stayed away from commenting on the health implications of being exposed to electric or magnetic fields. Instead the report will display the steps required to measure the magnetic field at any point of distance away from the overhead line. From the graphs that will be produced, the reader will gain a clear view of the exposure to magnetic fields in relation to the distance from a transmission line, and the task was to calculate and evaluate of the magnetic field levels in its vicinity.

The measurement and calculation of the magnetic field will be based along the height 1 meter above ground line. This analysis will therefore show the magnetic fields exposure to anyone walking around the area of overhead lines.

A. *Magnetic Field Calculation*

The electric field intensity produces by HV and VHV overhead transmission lines mainly depends on the rated voltage carried by phase conductors, while the magnetic field density is produced by the current carry through the phase conductors. When the energy production is generated electric and magnetic fields, so that the electromagnetic fields are invisible lines of exerted forces that are created with the production of electricity. In the circuit line loading current is flowed of power. Therefore, if large power units are required, as well as the voltage is stepped it up. On other way, the higher current, elsewhere the stronger electromagnetic forces will be carried. There is big concern for living people in close proximity of these structures when current and voltage transmission increase.

For electric fields the force between two charges can be written as:

$$F = \frac{q}{4.\pi.\varepsilon_0.d^2} a_r \tag{1}$$

Where, q: is the charge, ε_0: is the permittivity of free space, a_r: is the unit vector in the direction from the charge (q).

The magnetic induction brought on by current I circulating via phase conductors of power line with infinity length, Ampere law may be used to compute easily and in precise way [27].

The magnetic field of phase conductors in the power line is calculated generally according to this expression defined below shown in equation (2):

$$\mathrm{H} = \frac{I}{2\pi r} \tag{2}$$

The magnetic field is dependence related to the current not voltage. In order hand, overhead transmission lines can generate huge great amounts of magnetic field under power transmission lines [28-29]. For accurate evaluation of the magnetic fields around a long wire, induce by overhead power lines are derived from the application of Ampere's law, that is the best method for this context [30], its definition is shown in equation (3):

$$\oint B.dl = \mu_0 I \tag{3}$$

Where B is the magnetic flux density, I is the current of conductor wire, and μ_0 is the magnetic permeability of free space equal to $4\pi*10^{-7}$. So, the magnetic field around a long wire forming conductor can calculated using following equation:

$$\vec{B} = \frac{\mu_0 I}{2\pi r} \vec{a}_\phi \tag{4}$$

Where, r is the distance from arbitrary point to center of wire.

a and r can show based on following equation in the Cartesian system was described completely in ref [31]. The magnetic field around a transmission overhead line is based on magnetic field equation was computed uniformly by describe method steps.

It implies that the integral of magnetic field around a closed circular contour is equal to the electric current enclosed by surrounded contour, where (H) is the magnetic field intensity, and (I) is enclose current, is defined by these expressions:

$$I = \oint_c H.dl \tag{5}$$

$$B = H\mu_0\mu \tag{6}$$

Here, the relation (6) considers the relationship obtained between the magnetic induction B and the magnetic field H, μ_0: is the magnetic permeability of vacuum ($4\ \pi.\ 10^{-7}$), μ: is the relative permeability. From (5) and (6) can be got expressions for the intensity and the magnetic field for a cylindrical conductor with flowing current, with r: radius of the conductor cross-section:

$$H = \frac{i}{2\pi r} \tag{7}$$

$$B = \mu_0\mu \frac{i}{2\pi r} \tag{8}$$

Relations (7) and (8) are valid in the case of axial symmetry. A screened current travels along the circular close loop axis. Whereas, if movable concentrator has a vacuum. However, these equations no longer explain the field in region around the power line. The values of magnetic induction vector B (r) and the magnetic field strength H (r) will take on different values depend on the radius r. In this case, the integral (5) will retain its value. Near the space, the field will have maximum values, and with opposite minimum.

In this analysis of magnetic field calculation under high voltage overhead power lines, the following simplifying assumptions were applied [32]: The conductors of electric power lines are horizontals and parallel to a flat ground on an infinite distance; the average height of conductors is taken into consideration as the tower height minus 2/3 of the sag; the influence of the line towers and metallic objects encountered which act as screens is neglected; and the effect of varying environmental conditions on the soil resistivity is ignored.

B. Principle of Magnetic Field Calculation Method

The entire spectrum of electromagnetic phenomena is defined by Maxwell equations according to plans studies certain processes are neglected, uncoupled laws as well the basic design models are performed [33]. For this project we have selected the magnetostatic representation form where the source current was assumed to be account as quasi-static in symmetric balanced system. The magnetic induction strength of electric power lines is generated by induced currents in the phase conductors, and the potential vector being known is given the comprehension of every physical parameter in the simulation phase, where:

$$\mathrm{ROTH} = \mathrm{J} \tag{9}$$

$$\mathrm{B} = \mathrm{ROT\ A} \tag{10}$$

2D spatial development of defined electromagnetic phenomenon is described by this magnetostatic formula:

$$\mathrm{ROT}\left[1/\mu\mathrm{ROTA}\right] \tag{11}$$

This equations aftermontioned explain the magnetostatic technique of straight conductor traversed by current close loops [34]. Due to this concept, in this prepared study we will apply to previous observe the magnetic field of overhead power transmission lines for various power line layouts, the effect of loading current *I* circulates in the phase conductors on the magnetic induction values was analyzed. The basis cause of the magnetic field is the current flows in the line conductors. Ampere's law mentioned that integral of magnetic field intensity *H* around any close path in contour space is equivalent to the current surrounded by this path. The purpose present notion utilizes two-dimension elements to signify precisely the magnetic field magnitude of power line, considering the conductors carrying current is parallel to conducting flat ground surface [35, 36].

When calculate the magnetic field at ground level near power transmission line, it is considered an overhead power line in single circuit horizontal configuration, long, straight and parallel to the flat ground plane with electric current running through it, a circle loop of radius(*r*) in plane perpendicular at phases conductor axis, centered on it. For reasons of symmetry, on assume the magnetic field is constant throughout the circle [37]. The loading currents moving in believed infinitely, length and straight horizontal conductors caused magnetic field induced around is achieved by directly using Ampere's law and the superposition theorem for the magnetic partial components. In this part of the study work we applied the conductors image concept, while taking the penetration depth α into consideration. In the fact, the conductor images are positioned at a complicated depth below the ground plane, at a distance equal to height of overhead reel conductors and the depth of penetration. The currents influence created in line conductors should be included in this present computation [38]. The expression of penetration depth that explains the image theorem is given by:

$$\alpha = \sqrt{2}\delta e^{-i\pi/4} \tag{12}$$

$$\delta = 503\sqrt{\frac{\rho_g}{f}} \tag{13}$$

Where, δ: the fictive skin depth of earth plane in m, ρ_g: the resistivity of ground in Ω.m, and *f*: the injected power frequency in Hz.

Together with conductor crossing among the location (x_n, y_n) and carry current, then the horizontal and vertical components of the magnetic flux density at the desired point (d, h) is calculated by the following expressions:

$$\hat{B}_{xn} = -0.2 * \hat{I}_n\left[\frac{(y_n - h)}{r_{cn}^2} - \frac{(h + y_n + \alpha)}{r_{in}^2}\right] \tag{14}$$

$$\hat{B}_{yn} = -0.2 * \hat{I}_n\left[\frac{(x_n - d)}{r_{cn}^2} - \frac{(x_n - d)}{r_{in}^2}\right] \tag{15}$$

With, $$r_{cn} = \sqrt{(x_n - d)^2 + (y_n - h)^2} \tag{16}$$

$$r_{in} = \sqrt{(x_n - d)^2 + (h + y_n + \alpha)^2} \tag{17}$$

Where, I_n is the current circulating in the phase conductors; r_{cn} is the distance between each reel conductor and observation point P; r_{in} is the distance between each image conductor and observation point P; α is the depth of penetration.

We repeat equations (14) to (17) for N parallel current-carrying conductors in electric power line, on contains the total magnetic flux density at consider position (d, h) can be measured and analytic calculated by using following expressions:

$$\hat{B}_x = \sum_{n=1}^{N} \hat{B}_{xn} \quad (18)$$

$$\hat{B}_y = \sum_{n=1}^{N} \hat{B}_{yn} \quad (19)$$

$$B_{rms} = \sqrt{B_x^{\ 2} + B_y^{\ 2}} \quad (20)$$

The currents system in the line phases has been assumed under balanced operation is proceeded theorically within symmetrically and in direct positive sequence. The current magnitude in line is I=1000A in phase shift rotate equal to 120 between each other, at a nominal frequency of f = 50Hz. On suppose the current run guard wires is negligible, and on considered the earth is homogenous as well as have electrical resistivity of 100.Ω.m.

III. Results and Discussion

Fig.1 presents the schematic geometry of 63kV overhead transmission line, describes the position of phase conductors and its placement in power line, defines the design structural parameters and the geometric coordinates of this proposed power line, is usually used in many populated cities which are introduced as the most important source for producing a magnetic field, the diameter of line wires is 28.14mm. The load current with magnitude of 2000A is used in the simulation of magnetic field at 1m above the ground around the selected 63kV transmission line in accurate way.

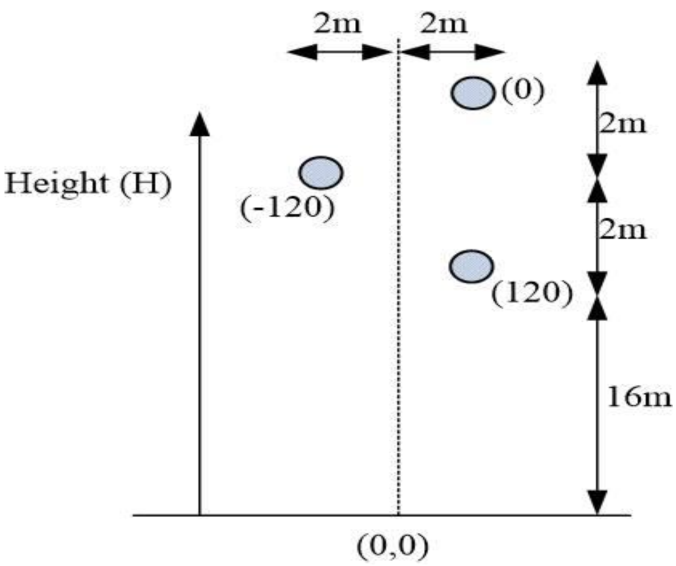

Fig. 1 Schematic geometry configuration of proposed 63kV overhead power transmission line

The presented figures are executed the lateral profile of magnetic field distribution under high voltage overhead transmission line, it is very clear that the maximum value of magnetic field is register in center distance of power line under the middle phase conductors at the symmetry point(x=0m), then decreases rapidly in symmetric way for significative increase of lateral distance, until reach lower values almost negligible when moves away from the conductors, very far from the center line. Figs.2-4 illustrate the distribution of magnetic field lateral profile under 63kV transmission line as shown in Fig.1 in several conductor heights (H) as a function of the distance.

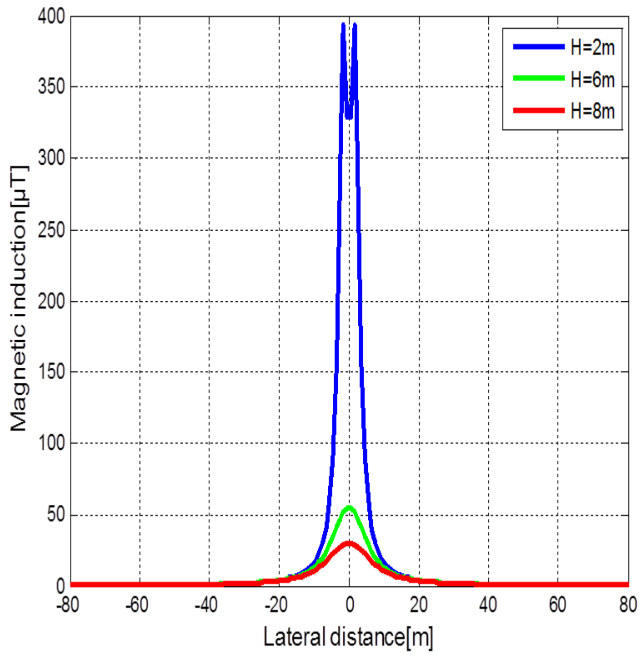

Fig. 2 Magnetic field lateral distribution as a function of different heights (H= 2, 6, and 8m)

Fig.2 shows the lateral profile of magnetic induction distribution at height 1m above the ground level as a function of different heights of phase conductors H= 2, 6 and 8m. On observe the maximum magnetic flux density values corresponding to these conductors heights are B= 393.6, 54.82 and 30.06µT, respectively. It is clear that as the heights of conductors increase, the maximum magnetic field decreases in symmetrically and continuous manner with a significative increase in the lateral distance of power line, to register the maximum values in the center distance under the middle phase conductors, then decrease rapidly to reach the smaller values when one moves away from the conductors, a very far from the center power line in all this conductors heights. It see an opposite relationship between the magnetic induction and the height of conductors for all edges sides of transmission line. According to this curve, on note the maximum magnetic flux density is found to be about B=393.6μT corresponding to minimum height of conductors H=2m. On the other hand, the minimum magnetic flux density is found to be about B=30.06μT corresponding to maximum height of conductors H=8m in all the right of way acceptable corridor of the high voltage three-phase overhead power line.

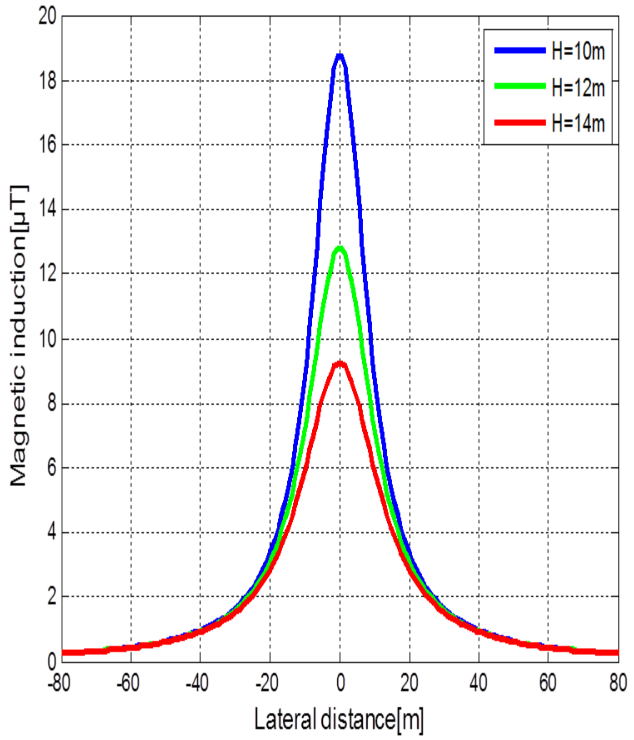

Fig. 3 Magnetic field lateral distribution as a function of different heights (H=10, 12, and 14m)

Fig.3 shows the lateral profile of the magnetic induction distribution at height 1m above the ground level as a function of different heights of phase conductors H=10, 12 and 14m. On observe evidently that the maximum magnetic flux density values corresponding to these conductors heights are B=18.77, 12.77 and 9.23μT, respectively. It is clear that as the heights of conductors increase, the maximum magnetic field decreases in symmetric and continuous manner with a significative increase in the lateral distance of the power line, to reach the maximum values in the center distance under the middle phase conductors, then decrease rapidly to get the lesser values when one moves away from the conductors, a very from the center line in all the conductors heights. According to this curve, on detect that the maximum magnetic flux density is found to be about B=18.77μT corresponding to minimum height of conductors H=10m. On the other hand, the minimum magnetic flux density is found to be about B=9.23μT corresponding to maximum height of conductors H=14m in all corridor edges of transmission line.

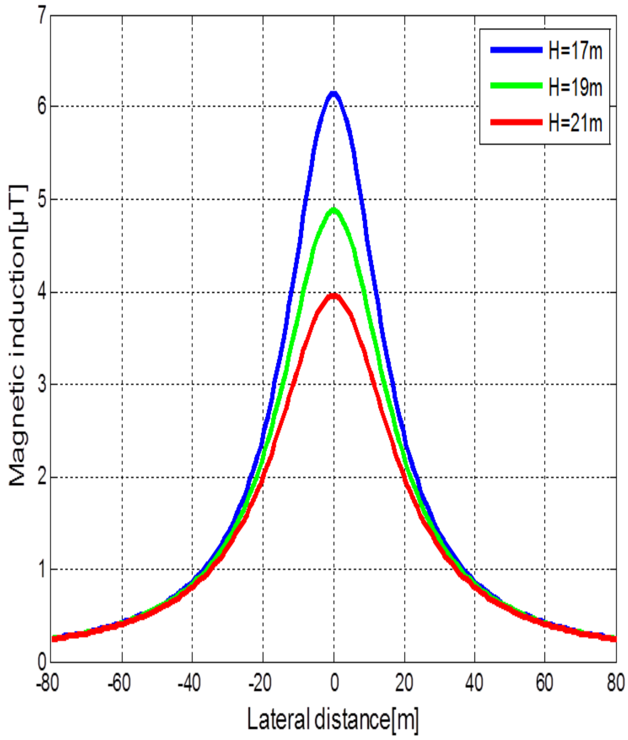

Fig. 4 Magnetic field lateral distribution as a function of different heights (H=17, 19, and 21m)

Fig.4 shows the lateral profile of magnetic induction distribution at 1m height above the ground level as a function of different heights of phase conductors H=17, 19 and 21m. On observe the maximum magnetic flux density values corresponding to these heights of conductors are B= 6.14, 4.87 and 3.95μT, respectively. It is clear that as the heights of conductors increase, cause the maximum magnetic field decreases in symmetrically and continuous manner with the lateral distance of circuit line increases, to register the maximum values in the center distance under the middle phase conductors, then decreases laterally rapidly to reach the lower values when one moves away from the conductors, a very far from the center power line in all this conductors heights. According to this curve, on observe the maximum magnetic flux density is found to be about B=6.14μT corresponding to minimum height of phase conductors H=17m. On the other hand, the minimum magnetic flux density is found to be approximately about B= 3.95μT corresponding to the maximum height of conductors H=21m in all acceptation range of overhead transmission line.

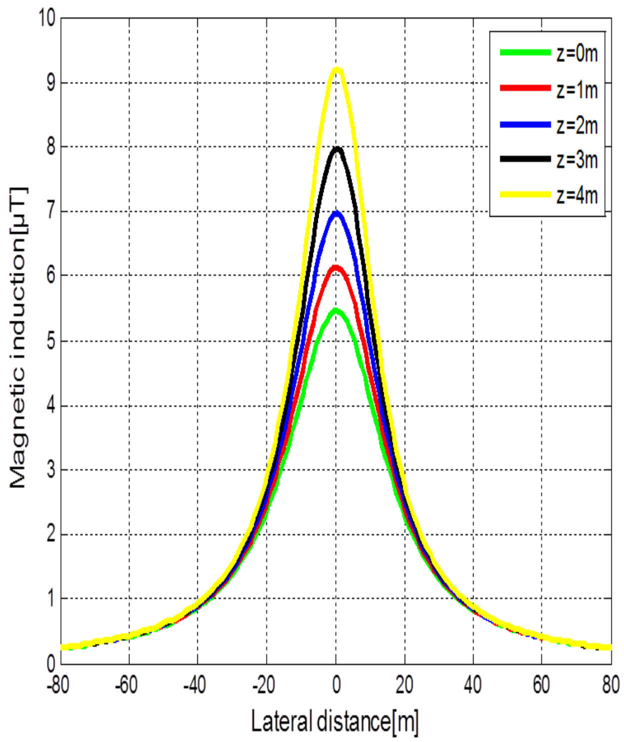

Fig. 5 Magnetic field lateral distribution in observed point heights above the ground level (z= 0, 1, 2, 3 and 4m)

Fig.5 shows the lateral profile of magnetic induction as a function of different observation point heights of conductors above the ground level z=0, 1, 2, 3 and 4m. The maximum magnetic flux density values corresponding to these heights of observation point (calculation point of the magnetic field) are B=5.44, 6.13, 6.96, 7.97 and 9.20μT, respectively. Accordinate to the curve it is very clear that as the observed point heights above the earth increase, the maximum magnetic field intensity increases, in symmetric and continuous manner, to reach the higher values in the center distance under the middle phase conductor, then decreases rapidly with a significative increase of the lateral distance, to register the lower values when one moves away from the line conductors, a very far from the center power line. On observe the maximum magnetic flux density is found to be about B=9.20μT corresponding to maximum observed point height above the ground level z=4m. On the other hand, the minimum magnetic flux density is found to be about B=5.44μT corresponding to minimum observed point height above the ground z=0m. This variation is a linearity relationship between them. On notice according to this simulation results obtained that the magnetic induction values under high-voltage three-phase overhead transmission line, depending on the distance to several levels starting with the beginning level z= 0m at the ground surface, therefore on show noticeably two-dimensional plot of lateral profile of the magnetic field distribution for this five following levels as a function of the lateral distance of overhead transmission line.

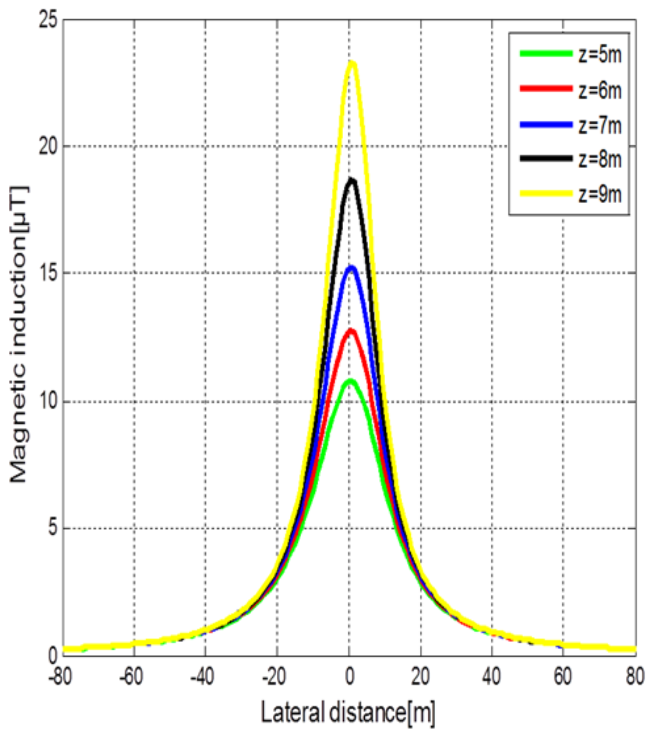

Fig. 6 Magnetic field lateral distribution in observed point heights above the ground level (z=5, 6, 7, 8 and 9m)

Fig.6 shows the lateral profile of magnetic induction as a function of different observation point heights of conductors above the ground z= 5, 6, 7, 8 and 9m. The maximum magnetic flux density values corresponding to these heights of observation point are B= 10.76, 12.72, 15.27, 18.67 and 23.24μT, respectively. According to the curve it is very clear that as the observed point heights increase, the magnetic field increases greatly, to register the higher values in the center distance under the middle phase conductor, after decreases rapidly with a significative increase in the lateral distance of power line, until recorder the lower intense values when one moves away from the phase conductors, a very far for the center line. On observe that the maximum magnetic flux density is B=23.24μT corresponding to maximum observation point height z= 9m, and the minimum magnetic flux density is B=10.76μT corresponding to the minimum observation point height z= 5m.

This figures presented below show that the geometrical model schemes and diverse phases arrangement for single circuit three phase overhead power transmission lines, are illustrated the arrangement of phase conductors and the geometric coordinates using both one and two conductors per phase also earth wires situation in the proposed power lines. According to the line parameters and circuit line configurations, we trace the lateral profile of the magnetic field distribution under overhead power lines at 2m above ground with change currents flowing in the line conductors and at different heights, with proportion to the power lines lateral distance along span length. To detect and evaluate the magnetic field intensity behaviour beneath high voltage overhead transmission lines with variation the factors that effect in the magnetic induction values, in order to compare the simulation results obtained with exposure limits levels established by international standards, legislations and guidelines for the general public.

The towers geometry model from 60kV, 220kV single circuit overhead transmission lines with the phases arrangement and the line data coordinates are illustrated detailed in Figs.7-8, respectively, is presented the geometrique parameters and the characteristiques of this power lines, show the position of the phase conductors and the situation of observation point above ground in order manner. Fig.7 demonstrates the geometries of three circuit lines configurations of 60kV overhead transmission line. On observe clearly in this figure: (a) horizontal power line, (b) vertical power line, and (c) triangular power line, respectively.

Fig.8 shows the geometries model schematic of two proposed circuit lines configurations of 220kV overhead transmission line. On define in this curve: (a) vertical power line, (b) horizontal power line.

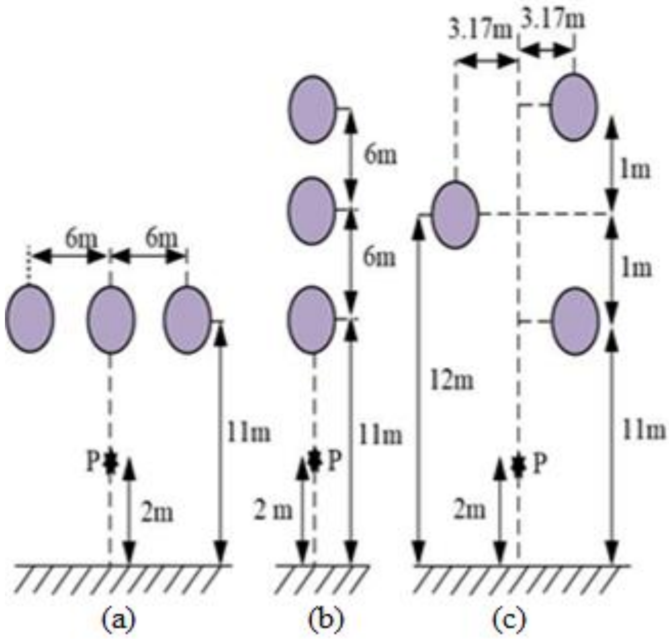

Fig. 7 Different configurations for single circuit 60kV line

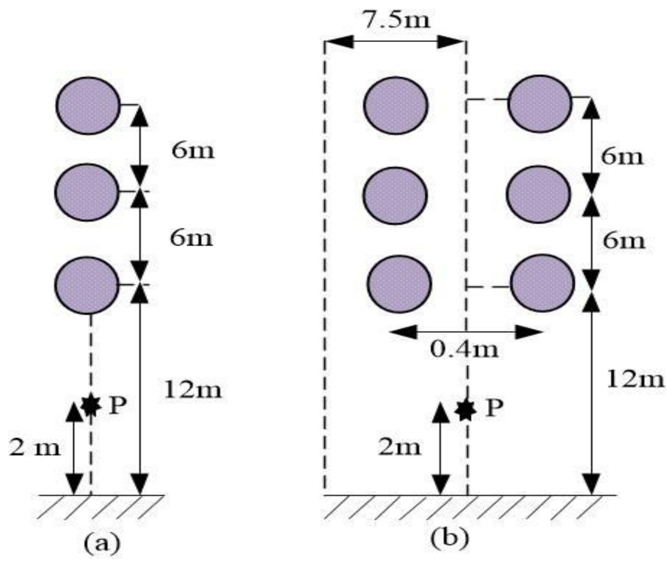

Fig. 8 Different configurations for single circuit 220kV line

Figs. 9, 10 and 11 show that the magnetic induction for 60kV overhead power line at 2m above the ground level increases in the same manner according to high magnitude of load current in the line conductors with differing phases arrangement horizontal, vertical and triangular single circuit three phase power line configurations. It is marked that the magnetic field intensity created by horizontal circuit line is greater a comparing to the magnetic field intensity produced by vertical and triangle circuit lines. In addition, on note that the magnetic induction strength generated by triangle circuit line is lower than the magnetic field get in vertical circuit line.

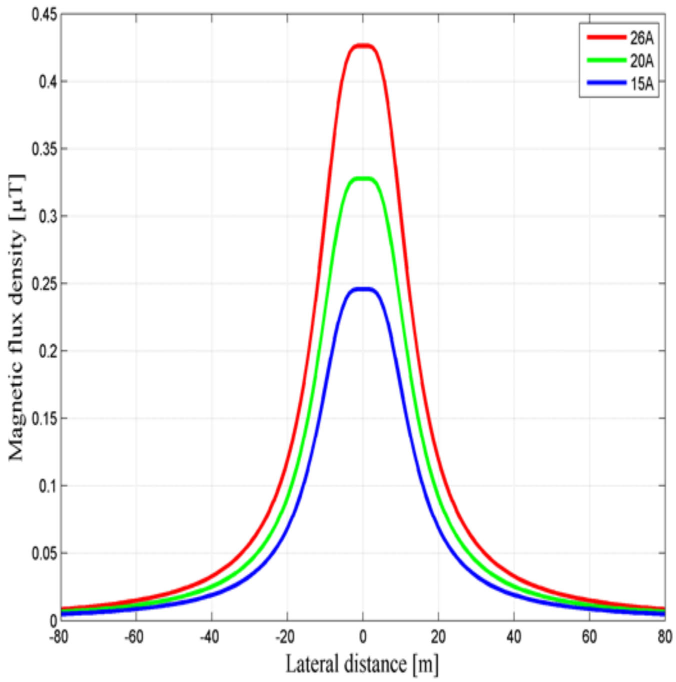

Fig. 9 Lateral distribution of the magnetic field in 60kV horizontal overhead power transmission line

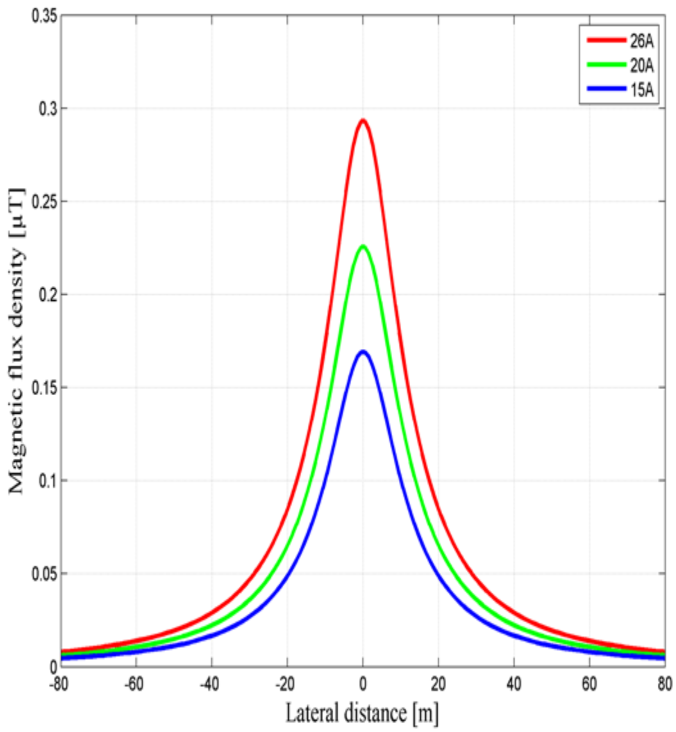

Fig. 10 Lateral distribution of the magnetic field in 60kV vertical overhead power transmission line

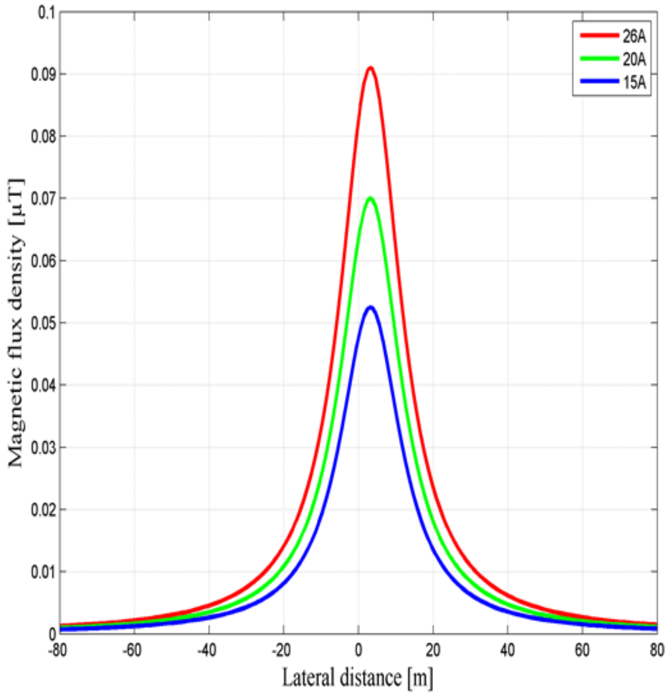

Fig. 11 Lateral distribution of the magnetic field in 60kV triangular overhead power transmission line

Figs. 12 and 13 present the lateral profile of magnetic field distribution for different load currents and two line configurations vertical and horizontal phases arrangement for 220kV overhead transmission line at height 2m above ground, this curves explain that the magnetic field increases consequently in accordance with increasing the current values around 220kV overhead power line in all corridor range right of way transmission line.

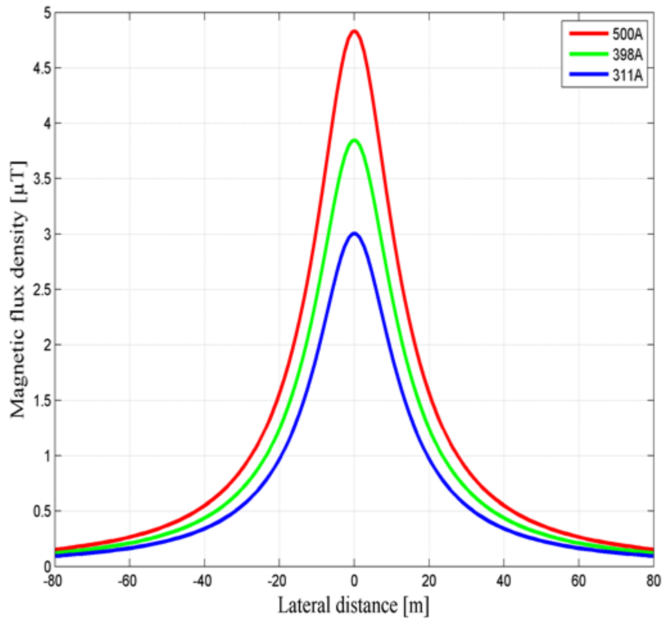

Fig. 12 Variation of the magnetic field lateral profile from 220kV vertical arrangement overhead power line

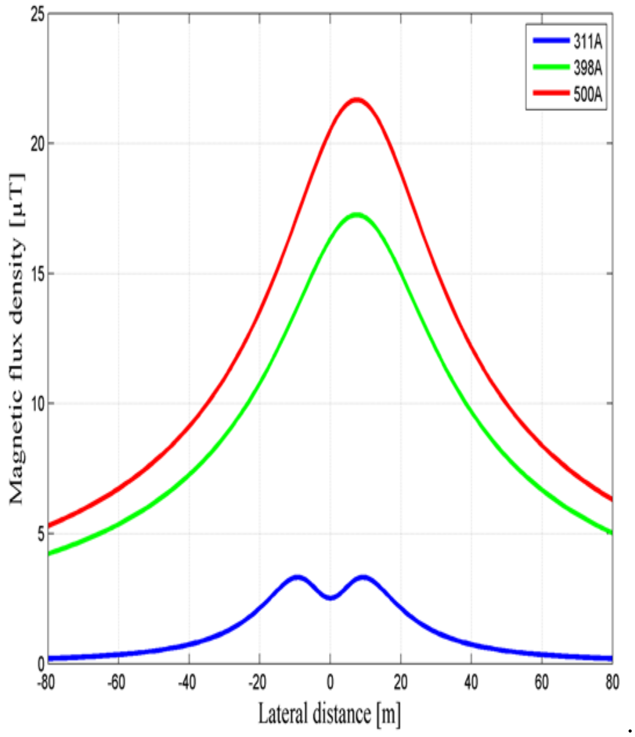

Fig. 13 Variation of the magnetic field lateral profile from 220kV horizontal arrangement overhead power line

For comparison the simulation results of magnetic field intensity at height 2m above ground for 220kV overhead power lines with numerous load currents and phase conductors arrangement. It is recording that the magnetic induction generated by 220kV power line from horizontal configuration creates the greatest magnetic field a compare that caused by vertical configuration because all phase conductors are close to the ground level. It is clearly result for 220kV overhead single circuit power line that an appropriate arrangement of the phase conductors can produce some field cancellation and reduction of the magnetic field. The calculated maximum values of the magnetic induction strength not exceed and lesser 100µT exposure levels limits recommended by ICNIRP standards accepted for the general public exposure.

The proposed structure design of 400kV overhead transmission line is shown precise detail in Fig.14. On observe in each phase we have bundle of two conductors separated by 0.4m positioned horizontally, was demonstrated with the line coordinates and geometric caracteristiques. Considering arranged overhead phases bundles are substituted for equivalent single conductors. In overhead 400kV power line two cases are exerted, the first case the conductors of power line are situated in height 16.4m above the ground. In other way, for the second case the conductors are positioned in height 50m from the ground level.

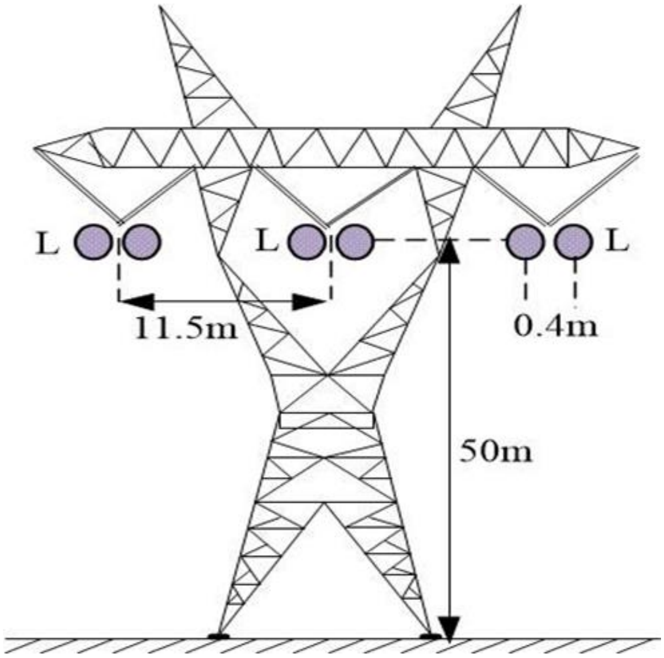

Fig. 14 Geometry of single circuit 400kV overhead line

Figs. 15 and 16 present the magnetic induction under 400kV overhead transmission line, on observe in this curve the power line causes significant magnitudes with raise currents loading flow in the phase conductors. On show clearly that the magnetic field values for various currents at heights of 16.4m and 50m above the ground in observation point height of 2m are lower and not exceed the safety limit of 100µT for the general public exposure, especially for high-tech current 420A. The magnetic field intensity generated a close and in the vicinity of high voltage overhead power lines has a great association a lot and much dependence in current induces of phase conductors.

However, conveniently this pattern of tower support most mountainous and hilly regions, hence, the magnetic field of power line doesn't touch by the population living in proximity residence areas. On note that the power transmission line is more close to the ground, the magnetic induction is strong producing due to when we move farther from the place where the magnetic field originated, it gets weaker. It refers to the circulation current in the phase conductors along the lateral distance. Remarque that the height of conductors above ground from overhead power line increases, the magnetic induction decreases gradually in symmetric manner at both edges sides of overhead transmission line, and then reduces laterally significant to register lesser and smaller values for moving very distant from the center of power line.

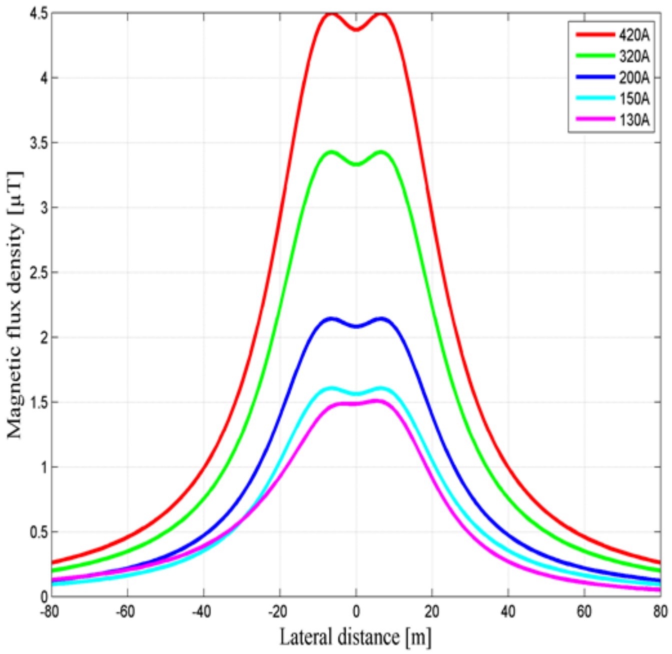

Fig. 15 Variation of magnetic induction profile for many currents at height 16.4m between the ground and 400kV line

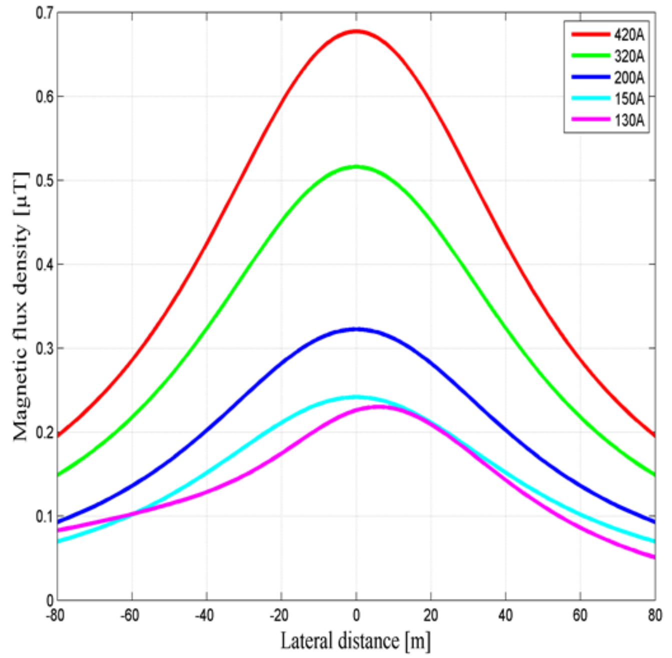

Fig. 16 Variation of magnetic induction profile for many currents at height 50m between the ground and 400kV line

IV. CONCLUSION

This article explains the efficiency of employment the magnetostatic modules and usage GARSON method in quasi-static analysis of low frequency magnetic field generated under 63kV, 220kV and 400kV overhead transmission lines obtained by coding programs developed in MATLAB software for the purpose of accurate calculation and evaluation of the magnetic fields lateral profile produced nearby of three phase overhead power lines. Many applications were presented in this study work for different current levels and various circuit lines configurations are discussed. On show that the maximum value of the magnetic field is register under middle phase in the center line, after decreases progressively for the lateral distance increases to take smaller values a very far from the power line center. In a standard operation conditions, the magnetic induction strength changes depending upon how remote from the middle phase for many percentages of current values and phases arrangement of circuit line, then the safe margin corridor around this power lines can be detected easily. Moreover, the magnetic flux density drops as the load capacity decreases noticeable in full range transmission line. When the clearance between the conductors of power line and ground level contains its minimal value, on generate the magnetic field achieves its highest intensity in all span length. But just below the line tower height, the magnetic flux density to be at its lowest intensity value due to the maximal separation between the phase conductors and ground. In this present study part, it is observed obvious that the magnetic induction generated by 400kV overhead power transmission line are really quite important, and greater instead of those provided by 220 and 60kV power lines, this behaviour is not based only on the voltage supply, but for the goal that single circuit 400kV transmission line among most huge power station connected grids contrary to the 220 and 60kV power lines, a large load current was conveyed. Typically, for people sitting within overhead transmission lines, the acceptable exposure levels for the magnetic field is influenced by the height of conductors, phase spacing between conductors, the line current, the height of observation point, and the configuration of circuit lines. According to the simulation results obtained, on observe that the magnetic induction and current are found to have a strong linear connection and great dependence. On the other hand, the magnetic field strength grows for instance the current increases consequently in the full span length, with respect to the current amount that flow through them, it is proportionate.

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