

ICST_2016_Paper_FRI_MURDI YA-min.pdf

by

Submission date: 02-Nov-2018 02:51PM (UTC+0800)

Submission ID: 1031529488

File name: ICST_2016_Paper_FRI_MURDIYA-min.pdf (293.93K)

Word count: 2109

Character count: 10610

MITIGATION OF 150 kV ELECTROMAGNETICS FIELDS EXPOSURE AT RESIDENSIAL AREA

Fri Murdiya¹, Firdaus¹, Dian Yayan Sukma¹ and Febrizal¹

¹Dept. Electrical Engineering, Universitas Riau

frimurdiya@gmail.com, febrizal@gmail.com, and Ya2n@yahoo.com

4

*Corresponding Author

Received: 10 October 2016, Accepted: 4 November 2016

Published online: 14 February 2017

Abstract: The effects of electromagnetic fields (i.e. electric fields and magnetic fields) to the human health have become a big environmental problem to the Electric Company. The electric field strength threshold and magnetic field of 150 kV on the transmission system through the Riau Province is needed to be studied, to check whether it has been fill up the recommendations of IRPA/INIRC, WHO 1990. C.95-2000. This report provided information about magnetic field condition, base on the measurement and calculation of the electric field with the impedance characteristic equation, and then, it were compared with the recommendation of IRPA/INIRC, WHO 1990. The highest magnetic field of 0,00009 Tesla and this value is shown lower than recommended magnetic field of 0,0001 Tesla (standard value), however the electric field of 70 V/m, it is shown lower than standard (5 kV/m). Base on standard; the electromagnetic field of 150 kV overhead power lines in Riau province is safe for human healthy. Magnetic field mitigation efforts are still needed for the consideration of psychological factors and the height building structure is exposed by overhead transmission lines. It is recommended that the addition of a wire loop under the transmission lines, installation of the wire loop can reduce the magnetic field up to 30%.

Keywords: electromagnetic field, recommendations of IRPA/INIRC,WHO 1990, mitigation magnetic filed.

1. Introduction

150 kV Overhead lines (OL) pass through residential areas, agriculture (rice fields, gardens), forest and scrub. The existence of this OL will be negative impacts on the environment, such as social impact, public unrest (psychology) and also influence to the electronic equipment. In addition, the negative impact can also lead to electrical shock, which could be possibly derived from plants that touch on the OL. The tendency of the negative effects is caused by the effects of electromagnetic field. The electromagnetic fields exposures cause the symptoms of stress, due to shocks from electrostatic discharge or by contact with electrically charged objects. So, this affects on the psychological aspects (fear, etc.) and environmental comfort. Primarily, it is a very big influence on the people who have less knowledge about electricity.

2. Related Works/Literature Review

Recommendations of IRPA/INIRC,WHO 1990, SNI 04-6950-2003 and IEEE std. C95.6-2000 suggest the electromagnetics exposure for human healthy at level of magnetic field and electric field of 0,0001 Tesla and 5 kV/m, respectively[4,7-9].

However, long-term exposures of magnetic field of 10 mG (1.0 micro.T) and it are higher than 10 mG exposures indicating the psychology effect or stress response. [1,2]. The safety issue of electromagnetics field exposure should be a reasonable cost with the good reliability [5]. However, many people live under overhead lines. It is needed the technology to reducing the electromagnetic field exposure to the human body. In this paper, it will describe how to reduce the electromagnetic field exposure under overhead lines.

3. Material & Methodology

3.1. Data

This study was conducted to investigate the measurement of electromagnetic field as much as 67 points with FH 51 Gauss (Teslameter) with height of 1 meter from the ground, and also presented about some reviews which are related to the mitigation of the electromagnetic field. Thus far, a number of literatures have been taking based on the standards and recommendations issued by the IRPA / INIRC and WHO.

3.2. The Electromagnetic fields threshold

Recommendations from IRPA / INIRC to the exposure limit of the electromagnetic field on the controlled environment and also public for the frequency 50/60 hz as depicted in Table 1 [4,7].

Table 1. IRPA / INIRC recommendations

Classification	Electric field (kV _{rms} /m)	Magnetic Flux (T _{rms})
• Controlled environment	10	0,5 x10 ⁻³
1. Whole day	30 ^{a)}	5 x10 ⁻³ ^{b)}
2. Short time	-	25 x10 ⁻³
3. Human body	5	0,1 x10 ⁻³
• General:	10	1 x10 ⁻³

Notes

- a) Exposure time for the electric field strength of 10-30 kV / m can be calculated using the formula: $t \leq 80 / E$ where t = exposure time (hours) and E = electric field strength (kV / m)
 - b) Maximum exposure time for each day is 2 hours
 - c) Applicable for the open space such as recreation places, ground, etc
 - d) Exposure limits may exceed for few minutes per day depend on the prevention condition.
- Base on IRPA guidelines, it require the electric field strength and magnetic field density of 5 kV / m and 0.1 mT, respectively, for the residential areas.

3.3 WHO recommendation

On 1990 WHO give a recommendation for the electromagnetic fields [4], it was presented in Table 2.

Table 2. Threshold value for the electric field

Electric Field Density (kV/m)	Exposure Time (minutes)
5	Unlimited
10	180
15	90
20	10
25	5

For general public WHO 1990 recommended the maximum exposure level of 100 μT for magnetic field and 5 kV/m for the electric field.

3.4 Calculation of magnetic field without mitigation [3,11]

Authors, title

Ampere's law can be applied to determine magnetic flux density at the point (x_j, y_j) , it was generated by the wire with unlimited length. The formula is presented as follow:

$$\vec{B}_{ij} = \frac{\mu I_i}{2\pi r_{ij}} \vec{\varphi}_{ij} \text{ Tesla} \quad (1)$$

Magnetic field without mitigation is the initial field generated by each phase wire on the OL without the influence of wire mitigation which produced by current flowing in each phase wire. In the case of three-phase systems as in figure 4 with a magnetic flux density with no mitigation is the total flux density of each phase wire,

$$\vec{B}_j = \sum_{i=1}^n \frac{\mu I_i}{2\pi} \left[\frac{(x_i - x_j)\vec{a}_y - (y_i - y_j)\vec{a}_x}{(x_i - x_j)^2 + (y_i - y_j)^2} \right] \quad (2)$$

$$B_x(x_j) = \frac{\mu}{2\pi} \sum_i^n I_i \frac{y_i - y_j}{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (3)$$

$$B_y(x_j) = \frac{\mu}{2\pi} \sum_i^n I_i \frac{x_i - x_j}{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (4)$$

where; n = total wires, \vec{a}_x = vector at x axis, \vec{a}_y = vector at y axis. The total magnetic flux density in vector;

$$\vec{B} = B_x \vec{a}_x + B_y \vec{a}_y \quad (5)$$

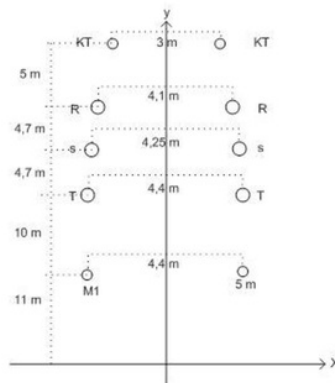


Figure 1. Overhead transmission lines of 150 kV with loop wires under phase wires

3.5 Calculation of mitigation magnetic field [3]

Induced current in the wire loop mitigation is very affecting to the magnetic field mitigation. With mitigation wire placement in the coordinates (x_{m1}, y_{m1}) and (x_{m2}, y_{m2}) as presented on Figure 2, then the amount of flux that penetrates the field of wire loop mitigation are presented as:

Authors, title

$$\phi = \int_{x_1}^{x_2} B_n dx$$

$$= \frac{-\mu I l}{4\pi} \sum_{i=1}^n \ln \frac{(x_{m2} - x_i)^2 + (y_{m2} - y_i)^2}{(x_{m1} - x_i)^2 + (y_{m1} - y_i)^2} \quad (6)$$

Where B_n is magnetic field density and μ is the permeability in a medium. The induction current I_{mit} leads to magnetic field density B_m at the coordinat points,

$$\vec{B}_m = B_{mx} \vec{a}_x + B_{my} \vec{a}_y \quad (7)$$

$$B_{mx} = \frac{\mu I_{mit}}{2\pi} \left[\frac{(y_{m1} - y_j)}{(x_{m1} - x_j)^2 + (y_{m1} - y_j)^2} - \frac{(y_{m2} - y_j)}{(x_{m2} - x_j)^2 + (y_{m2} - y_j)^2} \right] \quad (8)$$

$$B_{my} = \frac{-\mu I_{mit}}{2\pi} \left[\frac{(x_{m1} - x_j)}{(x_{m1} - x_j)^2 + (y_{m1} - y_j)^2} - \frac{(x_{m2} - x_j)}{(x_{m2} - x_j)^2 + (y_{m2} - y_j)^2} \right] \quad (9)$$

The magnetic field is the opposite of the original magnetic field mitigation. The most important thing is the magnetic field caused by the wire mitigation is a quantity vector and always changing with the time, as well as the original magnetic field which is a quantity vector and also change with the time. So, the magnetic field results of mitigation can be defined as follows,

$$\vec{B}_r = \vec{B} + \vec{B}_m \quad (10)$$

4. Results and Discussion

1 From the magnetic field strength measurement by using the tool FH 51 Gauss / Teslameter and calculation of the electric field strength on the OL of 150 kV by using impedance characteristic equation for transmission lines [6] (where: $h = 17$ m and a cross-section area ACSR = 150mm²) as depicted as follow [10].

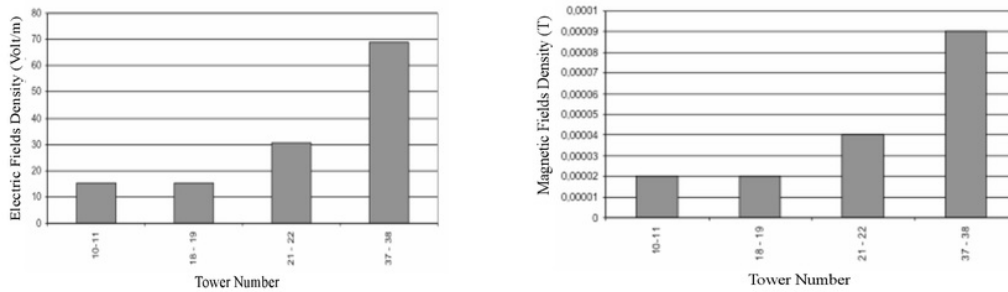


Figure 2. Electric and magnetic fields at GI PLTA Koto Panjang - GI Bangkinang

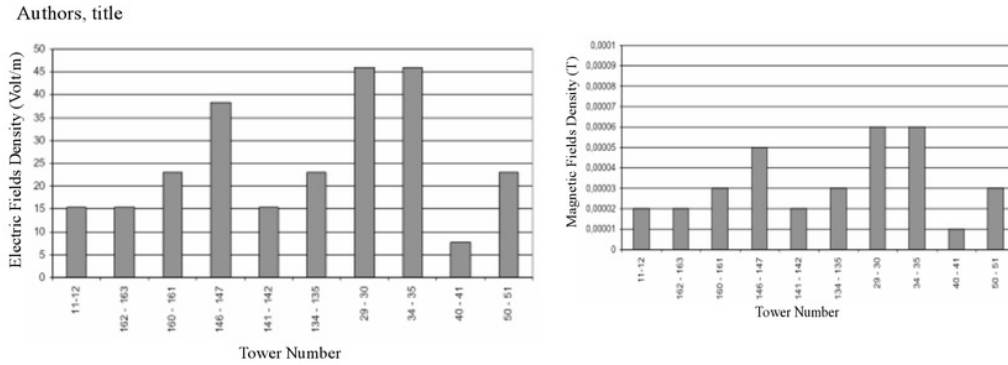


Figure 3. Electric and magnetic fields at GI Duri - GI Dumai

Base on figure 2, the graph of density magnetic field to GI PLTA Koto Panjang - GI Bangkinang between 37-38 tower with the highest density is 0.00009 Tesla, and it is still below the threshold recommended by the IRPA / INIRC, WHO1990 is 0.0001 Tesla. According to figure 2 also the graph of the electric field strength to GI PLTA Koto Panjang - GI Bangkinang is between 37-38 tower with the highest electric field strength of 70 V / m, below the threshold recommended by IRPA / INIRC, WHO1990 is 5kV / m. Base on both of the graph (i.e. magnetic field density and electric field strength), the weather (drizzle) can enhances the value of a electric field strength and magnetic field density. Figure 3 is presented the electric and magnetic fields at GI Duri - GI Dumai with the values are lower than at figure 2.

By using equation 1-10, from the measurement as presented in Figure 4 for configuration as like as Figure 1.

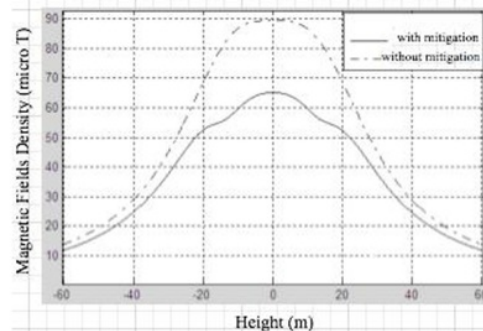


Figure 4. Magnetic field distribution on OL

With the wire loop installation can reduce the magnetic fields up to 30%. To get a better security due to exposure to a magnetic field, metal materials such as zinc roof and fence should be grounded to avoid the induced residual stress such as the residual voltage. The grounding system value should be lower or base on standard.

5. Conclusion

From the measurement and calculation of the magnetic field and electric field in the OL at Riau, it is still below the threshold of 0.0001 Tesla, the highest value of the magnetic field is under the OL of 0.00009 Tesla, while the electric field is also still below the threshold of 5 kV / m, and the highest value of the electric field is under the OL of 70 V / m.

Authors, title

7

Environmental was affected to the increasing of the electric field strength and magnetic field density. Based on measurements and calculations, the OL at Riau is safe based on a recommendation of IRPA / INIRC, WHO 1990.

Wire loop installation can reduce the magnetic fields of up to 30%. Metals such as zinc and fences must be grounded to avoid the residual stress of the voltage.

Acknowledgement. -

References

Journal Papers

- [1] Lennart Hardell, Cindy Sage, 2008 "Biological effects from electromagnetic field exposure and public exposure standards", *Biomedicine and Pharmacotherapy*, Elsevier, Vol. 62 pp. 104-109 (2008).]
- [2] Abbas Ali H Pour Feizi, MA Ahmad Arabi, 2007 "Acute Childhood Leukemias and Exposure to Magnetic Fields Generated by High Voltage Overhead Power Lines - A Risk Factor in Iran", *Asian Pacific Journal of Cancer Prevention*, Vol 8 (2007)
- [3] A. A. Dahab, F. K. Amoura, 2005 "Comparison of Magnetic-Field Distribution of Non compact and Compact Parallel Transmission-Line Configurations" *IEEE Transactions On Power Delivery*, Vol. 20, No. 3, July 2005

Conference Proceedings Papers

- [4] K.T. Sirait, Parouli Pakpahan, 1995 " Sekilas Mengenai Medan Elektromagnetik pada Saluran Transmisi Tegangan Tinggi ", Seminar Terbuka Jaringan Listrik Tegangan Ekstra Tinggi dan Permasalahannya, ITB, Bandung *in Indonesian*
- [5] Masao Taki, 2013 "Assessment of Possible Health Risks of Electromagnetic Field Exposure due to Emerging Technologies", 2013 International Symposium on Electromagnetic Theory .

Book

- [6] Kraus, Jhon D, 1992: "Electromagnetic", Mc Graw Hill International.
- [7] N.N, 2003 " Saluran Udara Tegangan Tinggi (SUTT) dan Saluran Udara Tegangan Ekstra Tinggi (SUTET)- Nilai Ambang Batas Medan Listrik dan Medan Magnet" SNI-04-6950-2003, Badan Standarisasi Nasional *in Indonesian*
- [8] N.N, 2000 "IEEE std. C95.6-2000 for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz" IEEE Std.
- [9] N.N, 1989 " Interm Guidelines on Limit of Exposure to 50/60Hz Electric and Magnetic Field" Radiation Health Series No.30, National Health and Medical Research Council, Australia.
- [10] Fri Murdiya, Suwitno, 2007, "Penelitian medan elektromagnetik di Riau", Laporan Penelitian Dosen Muda-DP2M Dikti *in Indonesian*

Book Chapters

-

Online

-

Thesis

- [11] Arsyia Husin Saputra, 2006, "Studi Mitigasi Medan Magnet pada Saluran Transmisi Sirkuit Tunggal 500 kV, Skripsi Teknik Elektro ITB-Bandung *in Indonesian*

Patent

-

Appendix

Appendixes, if needed, appear after Reference.

ORIGINALITY REPORT

9%

SIMILARITY INDEX

4%

INTERNET SOURCES

9%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

1 Ranković, Aleksandar. "Novel multi-objective optimization method of electric and magnetic field emissions from double-circuit overhead power line : Optimization of EMF from Double-Circuit OHPL", International Transactions on Electrical Energy Systems, 2016. **2%**
Publication

2 www.scribd.com **1%**
Internet Source

3 W.L. Cotten, K.C.K. Ramsing, C. Cai. "Design Guidelines for Reducing Electromagnetic Field Effects from 60-Hz Electrical Power Systems", IEEE Transactions on Industry Applications, 1994 **1%**
Publication

4 www.estech.org **1%**
Internet Source

5 openbooks.ifmo.ru **1%**
Internet Source

Alexander Barvinok. "The geometric maximum

6

traveling salesman problem", Journal of the
ACM, 9/1/2003

Publication

1%

7

www.cei.ie

Internet Source

<1%

8

Umar Khayam, Reynaldi Prasetyo, Syarif
Hidayat. "Electric field analysis of 150 kV
compact transmission line", 2017 International
Conference on High Voltage Engineering and
Power Systems (ICHVEPS), 2017

Publication

<1%

9

F. Capone. "Does exposure to extremely low
frequency magnetic fields produce functional
changes in human brain?", Journal of Neural
Transmission, 03/2009

Publication

<1%

10

El Dein, Adel Z.. "Optimal Arrangement of
Egyptian Overhead Transmission Lines'
Conductors Using Genetic Algorithm", Arabian
Journal for Science and Engineering, 2014.

Publication

<1%

11

Martino Grandolfo. "Worldwide standards on
exposure to electromagnetic fields: an
overview", The Environmentalist, 06/2009

Publication

<1%

12

X. L. Chen, S. Benkler, N. Chavannes, N.
Kuster. "Full human body exposure

<1%

assessment in low frequency electromagnetic fields", 2010 Asia-Pacific International Symposium on Electromagnetic Compatibility, 2010

Publication

13

G. Mazzanti. "Uncertainties in the calculation of continuous exposure of general public to magnetic field from ac overhead transmission lines", IEEE Power Engineering Society General Meeting, 2005, 2005

<1%

Publication

14

Grandolfo, M.. "Extremely low frequency electromagnetic fields: Environmental exposure levels, epidemiological studies and risk assessment", Bioelectrochemistry and Bioenergetics, 199303

<1%

Publication

Exclude quotes Off

Exclude matches Off

Exclude bibliography On