

Measurement and study of radiation levels and its effects on living beings near electrical substations

Raghu N*, Krishna Murthy**, Nagendra K* and Trupti V N*

The electrical substations are used to step-up or step-down the generated voltage from generating stations to receiving stations while transmission of electrical power. The substations are mainly used to step down voltage and transmit electrical power. The electromagnetic fields at these substations can be harmful to living beings. The objective of this work is to measure and study the radiation levels of a particular substation using NFA1000™ solutions device used to measure radiation levels.

Keywords: *Electromagnetic field, substation, radio frequency, NFA1000™, NFA Soft.*

1.0 INTRODUCTION

The electricity is mainly generated at the remote locations of a country. The generated power is to be transmitted from remote location to the residential areas [6]. Therefore the generated power is transmitted through over head lines with support of the transmission towers.

The generation of energy is at 11 kV to 33 kV maximum because of the insulation requirement of generators. Therefore the electricity is generated with the voltage of 11 kV at most of the generating stations. This 11 kV potential is not economical to transfer the power due to more losses. Therefore to transfer this generated power high voltage transmission is preferred. The present transmission voltage levels are as follows: 66 kV, 132 kV, 220 kV, 400 kV, 765 kV and 1200 kV [2]. These high voltage transmission lines have standard clearances to avoid the hazards on living beings. The transmission lines contain electromagnetic waves surrounded by the

conductors which cause many effects on human beings, animals and plants.

Earlier days the substations were located outside the cities. Due to expansion of cities, immediate vicinity of such stations are used for residential purposes where people living in such areas are exposed to high risk [1]. Whereas Electromagnetic (EM) radiation of frequencies ranging from Extremely Low Frequency (ELF) to Extremely High Frequency (EHF) also can have adverse effect on human beings, animals and plants.

As indicated by researchers, there is no much awareness about the effects of electromagnetic radiation. People who are working near or around the substation do not have any information about the health hazards due to these radiations [2].

The radiation are present in transmission lines while transmission of power and at receiving stations. It was noticed that people are staying very near to high power, low frequency lines and

*Assistant Professor, Electrical and Electronics Engineering Department, Jain University, Kanakapura Road, Ramnagar (D) - 562112.
E-mail: raghu1987n@gmail.com, kbnagendra@gmail.com, trupti.vrn@gmail.com

**Professor, Electrical and Electronics Engineering Department, Jain University, Kanakapura Road, Ramnagar (D) - 562112.
E-mail: krishnamurthy.access@gmail.com

sub stations and they are subjected to potential hazards of EMF radiation [4].

Radiation effects are observed from very high frequency with low power and extremely low frequency with high power. This paper deals with extremely low frequency with high power measurement of radiation levels and its effects.

The receiving substations normally step down the voltage from 66 kV to 11 kV and the 11 kV power is distributed to the consumers by using different feeders. Earlier days these substations were planned to be located outside the city and feed the power to the consumers. Nowadays due to urbanization and expansion of cities, the present substations are lying inside the cities.

These kinds of stations may cause the health hazards for the human beings living surrounding to the sub stations. This illness can be direct cause or slow effects on human beings like headache, infertility [2] and cancer like blood cancer, lymphoma [8] etc..

This work is done to measure the radiation levels in the surroundings of a particular substation. The 66 kV /11 kV substations near to School of Engineering and Technology, Jain University, Bangalore is considered and the levels of both electric and magnetic fields are measured.

2.0 METHODOLOGY

The procedure followed to measure electric field (V/m) and magnetic fields(T) for power frequency as shown below. The available radio frequency (RF) signals from 50 Hz to more than 2 kHz in free space were collected by using radiation measuring device. The radiation level present in the radio frequency signals is loaded to the NFA1000TM device in the form of log files, which are analyzed by using NFAsoft.

NFA soft visualise the log file in terms of magnetic field with respect to time is shown in Figure 1.

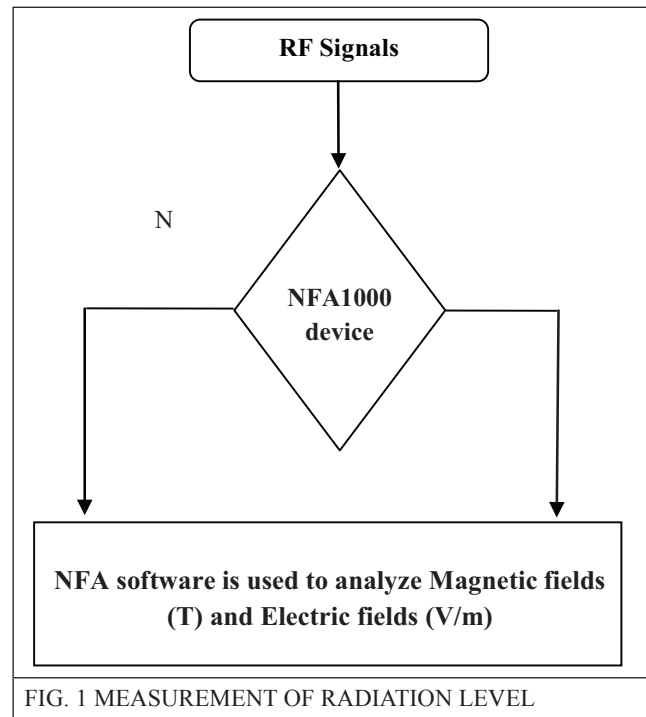


FIG. 1 MEASUREMENT OF RADIATION LEVEL

3.0 MEASUREMENTS SETUP

To measure the radiation levels of substation, a measurement setup consisting of NFA1000TM device and NFAsoft is used. This device receives the maximum radiation signals available in free space in three dimensions which are emitted from transmission lines from different directions. The measurement of radiation setup is as shown in Figure 2.

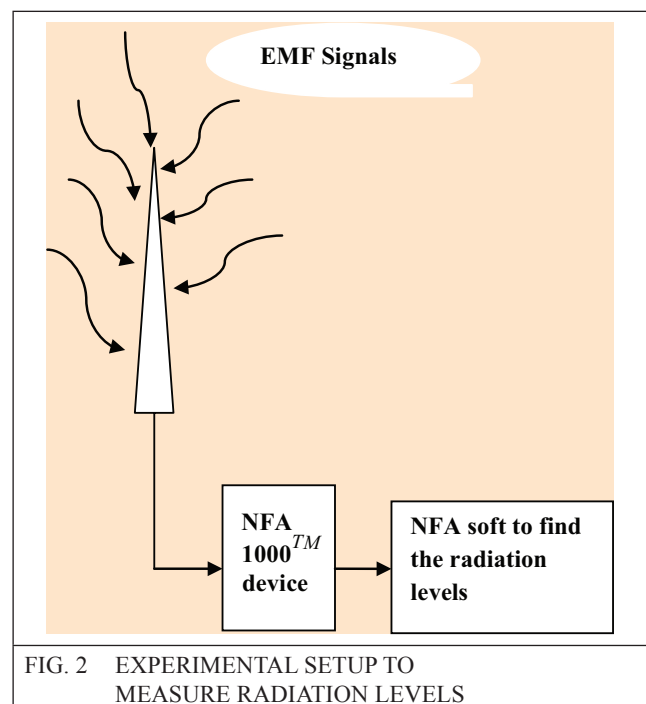


FIG. 2 EXPERIMENTAL SETUP TO MEASURE RADIATION LEVELS



FIG. 3 NFA1000™ DEVICE USED TO MEASURE RADIATION LEVELS

4.0 EXPOSURE TO SUBSTATION

Radiation emission from substation has a direct impact on human life while causing biological effects which are as shown below

1. The exposure of radiation level of $0.3 \mu\text{T}$ to $0.4 \mu\text{T}$ cause leukaemia among children's [1].
2. The exposure of radiation level 1mg or less which considered as safe for sleep [2].
3. The exposure of radiation level more than 2mG causes biological stress, breast cancer, hypertension, lupus, Asthma, brain cancers, birth defects [2], brain tumour, daily headaches [3], depression, anxiety, phobia, hostility [6], chest pain, reduce in sperm count, digestive disorders, DNA damage [7].

We are constantly exposed to some level of radiations as EHV lines, Substation, Mobile towers are near to our vicinity, causes some biological effects on human beings. These effects can be avoided by less exposure of radiation intensity areas.

5.0 RESULTS AND ANALYSIS

According to the International Commission on Non - Ionizing Radiation Protection (ICNIRP) guidelines the reference levels of a public exposure to substation and transmission lines is 5kV/m for electric field and $100 \mu\text{T}$ for magnetic field public exposure limits [1, 7, 8]. The radiation emission from transmission lines has ground clearance to avoid the effects on living bodies but substation is not given awareness about clearance. Some researchers predicted that 2.75m should be minimum distance from HV equipments ground clearance in a substation [5].

In this substation the average magnetic field level is 1.68mG and average electric field level is 256.54V/m is observed and plotted in graph as shown below Figure 3- 4. In the Figure 5 shows the radiation level in all frequency range. In the Figure 6 shows the magnetic field radiation level in measured from school of engineering and technology at the distance of 30 feet from the compound of substation.

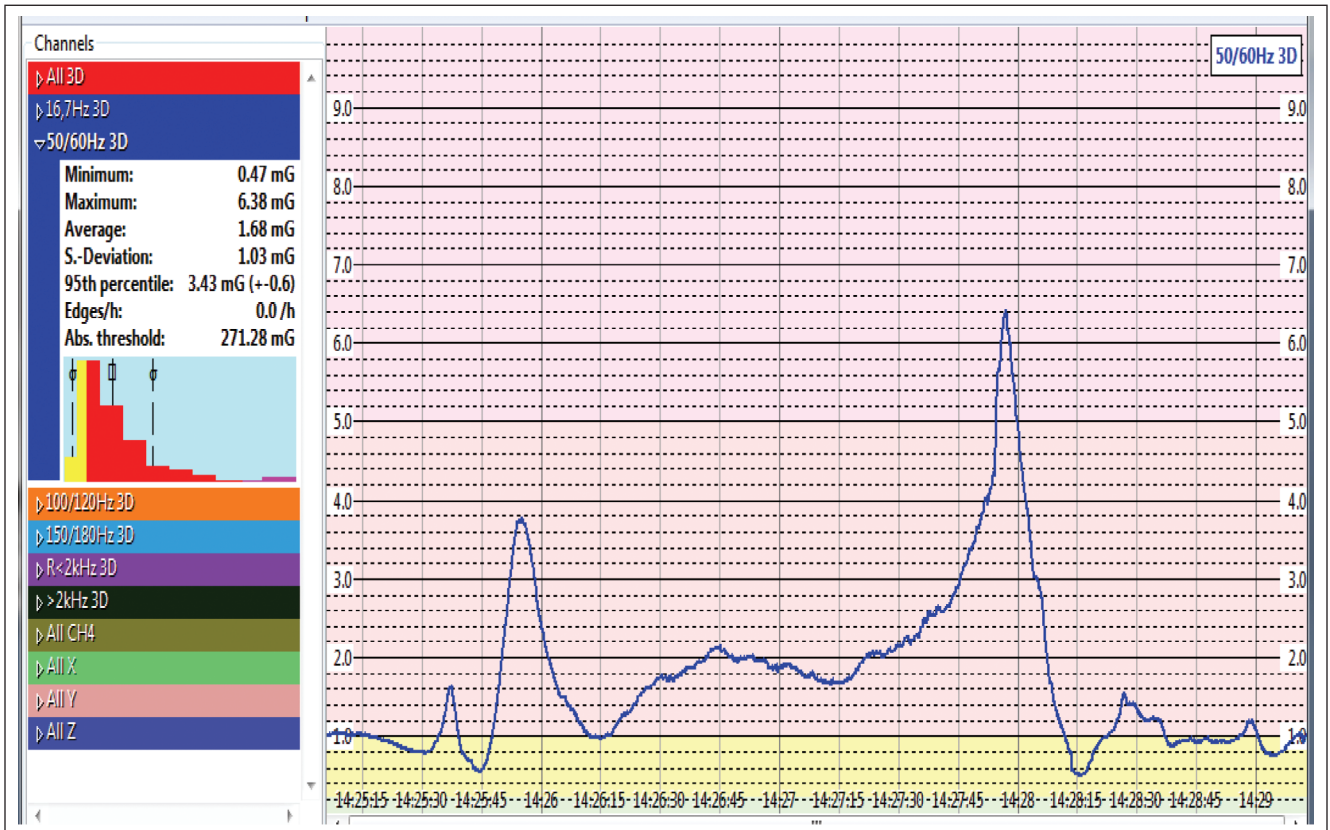


FIG. 4 MAGNETIC FIELD FIG RADIATION LEVEL AROUND THE SUBSTATION

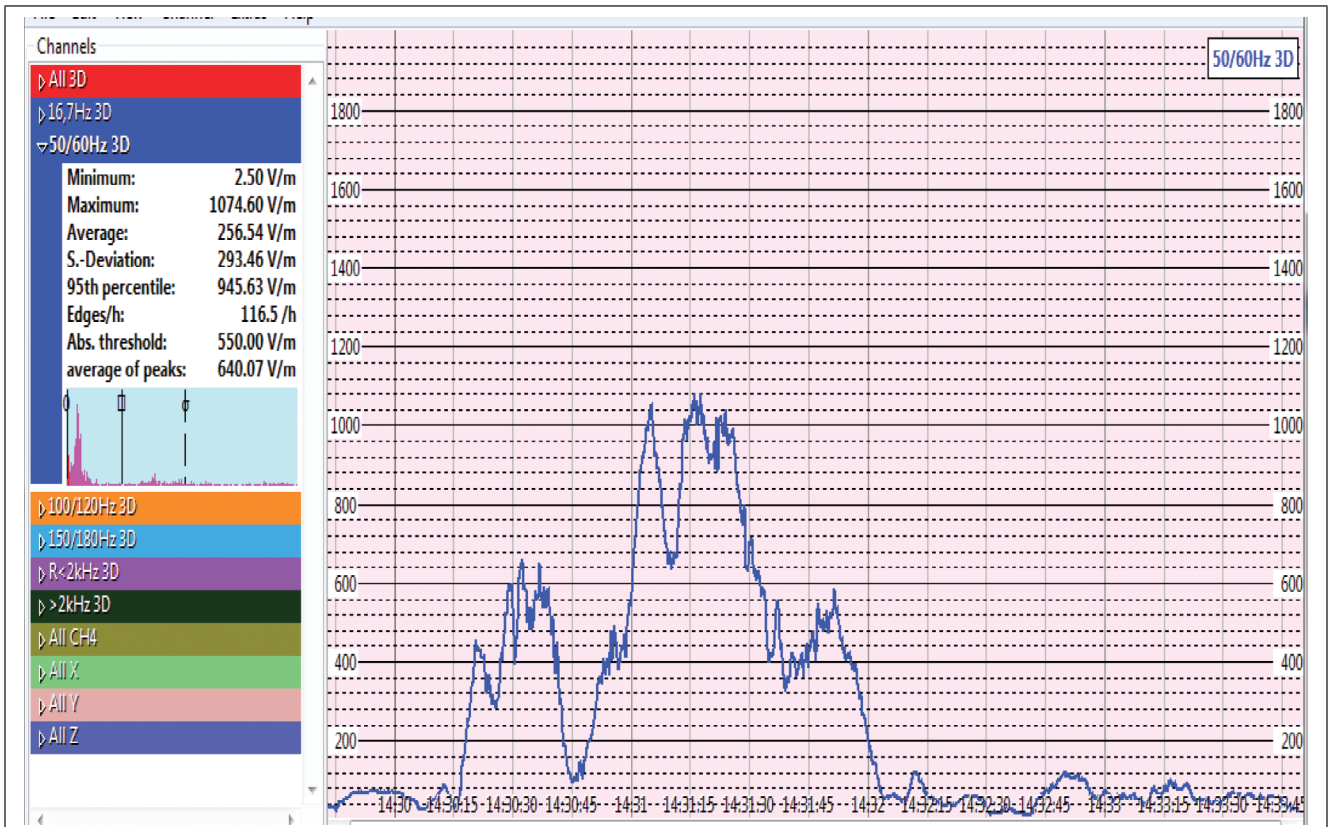


FIG. 5 ELECTRIC FIELD RADIATION LEVEL AROUND THE SUBSTATION

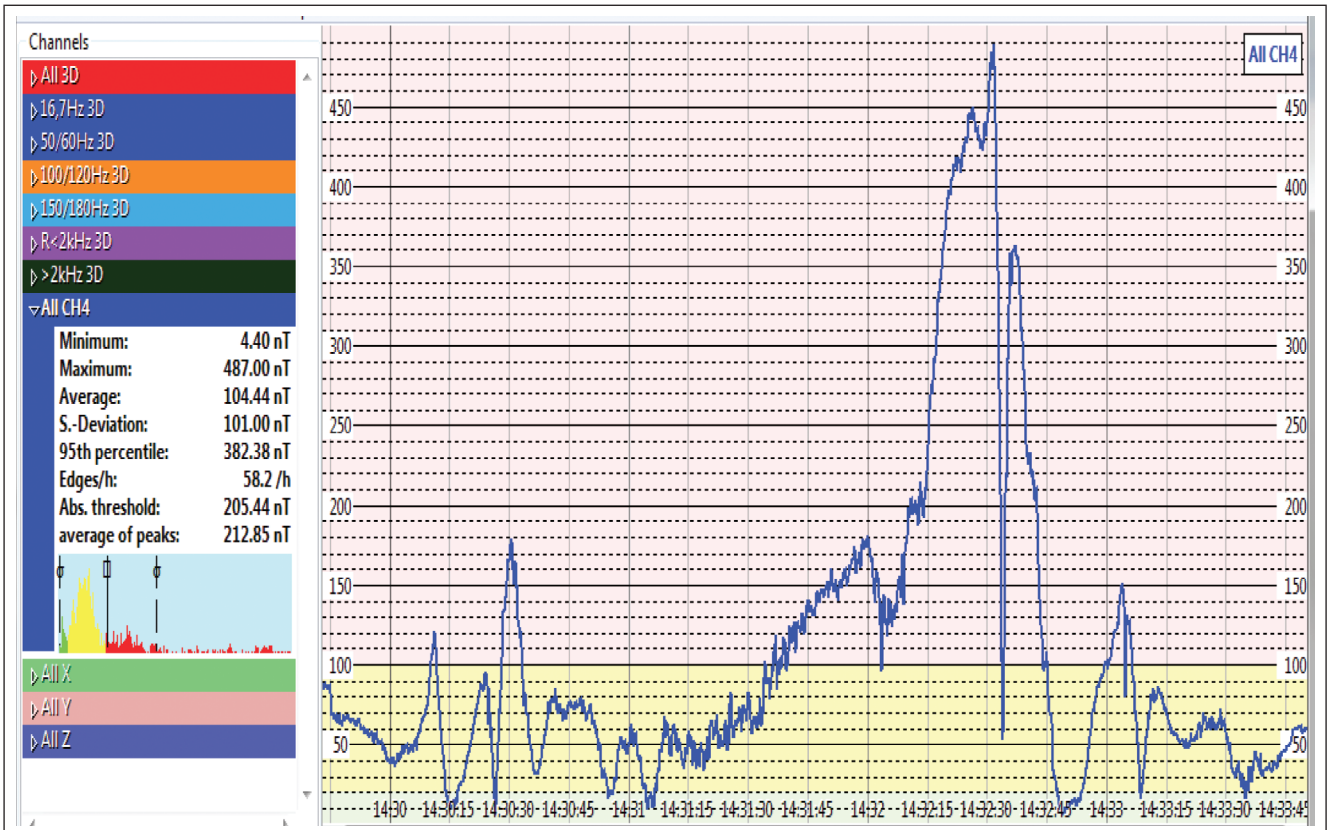


FIG. 6 RADIATION LEVEL AROUND THE SUBSTATION IN ALL FREQUENCIES

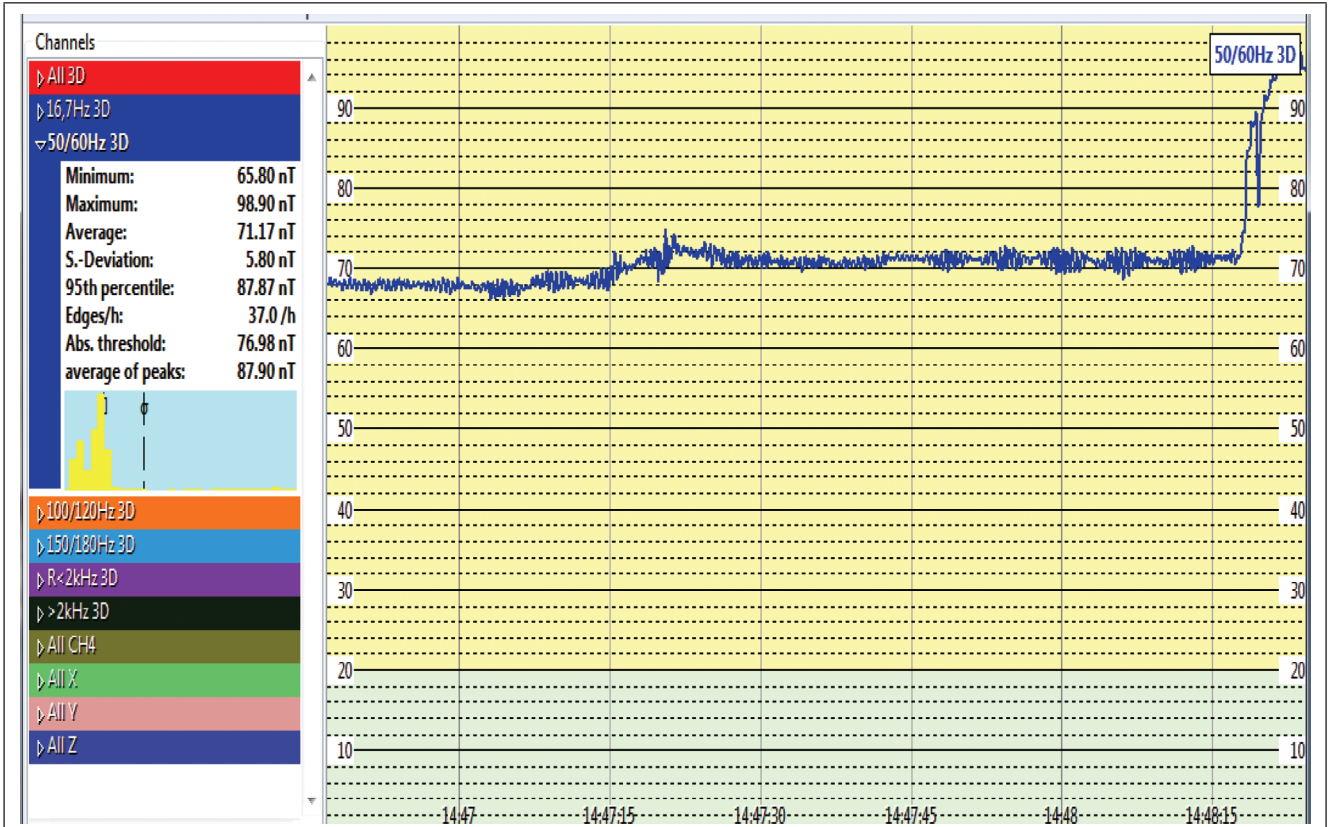


FIG. 7 MAGNETIC FIELD RADIATION LEVEL MEASURED FROM SCHOOL OF ENGINEERING AND TECHNOLOGY

6.0 CONCLUSION

The measurements show that in the immediate vicinity of substation where people are habituated the levels of radiation show that the area is within safe limits as far electric field is considered but the magnetic field is beyond safe level. Also depending on the load (as magnetic field is proportional to current in the conductors) the level may increase causing concern. Thus it may be concluded that the area in the vicinity of substation is risky further closure approach is dangerous.

FUTURE WORK

There are receiving stations of 400 kV class in and around Bangalore which is likely to cause greater concern for the area in the vicinity where people are habituated such studies need to be done. Also noise pollution near substation has a nuisance value and long term health hazard, also with the co-operation of a hospital a survey of the people living in the risky area can be conducted along with radiation measurement for a better study of the hazard involved. This may help in arriving at a realistic safe level of magnetic fields that is tolerable as the maximum level stipulated in India is 100 μ T seems to be very high and a detailed studies are required to arrive at a lower limit which is tolerable.

ACKNOWLEDGEMENT

This work is carried out with the help of group of students in the department of Electrical and Electronics Engineering, School of Engineering and Technology, Jain University.

The authors would like to thank all the faculty members, students and Prof. Suresh D, HOD, Department of Electrical and Electronics Engineering and Management of Jain University for their continuous support.

REFERENCES

- [1] G Danby, Electricity Substations and health, Science and Environment, SNO6151, 6 December 2011.
- [2] B A Rafai, A Majed and Hakami, Health hazards of electromagnetic radiation, Journal of Biosciences and Medicines, pp. 2, 1-12, 2014.
- [3] A Zamanian and C Hardiman, Electromagnetic Radiation and Human Health: A Review of Sources and Effects, High Frequency Electronics, July 2005.
- [4] Scientific committee on emerging and newly identified health risks (SCENIHR), Possible effects of Electromagnetic Fields (EMF) on Human Health, 21 March 2007.
- [5] Jignesh. Parmar, Minimum Electrical Clearance. <https://electricalnotes.wordpress.com/2011/04/22/minimum-electrical-clearance-2/>. Last accesses on July 8, 2015.
- [6] A R Zahiroddin, A R S Kandjani and N Mahdavi Hezaveh, Mental Health Status of Employees In Substations of Electromagnetic Fields at Extremely Low Frequency In Tehran, Iran. J. Environ. Health. Sci. Eng., Vol. 3, No. 3, pp. 217-221, 2006.
- [7] N Cherry, Evidence that Electromagnetic fields from high voltage power lines and in buildings, are hazardous to human health, especially to young children, Environmental Management and Design Division, Lincoln University, New Zealand, 8th April 2001.
- [8] G Kulkarni, W Z Gandhare, Proximity Effects of High Voltage Transmission Lines on Humans, ACEEE Int. J. on Electrical and Power Engineering, Vol. 03, No. 01, February 2012.