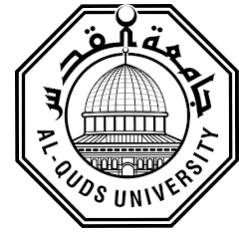


Deanship of graduate studies

Al-Quds University



**Magnetic fields from high voltage power lines in
Bethlehem District**

Fadi Hussien Othman

M.Sc.Thesis

Jerusalem – Palestine

1436/2015

**Magnetic fields from high voltage power lines in
Bethlehem District**

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**“A Thesis Submitted in Partial Full filament of the
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Al Quds University

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Environmental Studies



Thesis Approval

Magnetic fields from high voltage power lines in Bethlehem District

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Jerusalem- Palestine

1436/2015

Dedication

To my father, mother, brothers, and sisters

**To my wonderful wife and my sons Hussien , Lamar , Mayar, and
born expected**

To my friends

Declaration

I certify that this thesis, which is submitted for the master degree in environmental studies, is the result of my own research, except where otherwise acknowledged, and this thesis (or any part of it) has not been submitted for a higher degree to any university or institution

Signed:

A handwritten signature in blue ink, appearing to read 'Fadi Hussien Othman', is written over a blue horizontal line that tapers to a point on the right side.

Fadi Hussien Othman

Date:3/6/2015

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And I would thank my wife and my teachers in Environmental Studies department.

Abstract

Because of the huge request for electricity in the modern life, the transmission line networks have been extended for a long distances through countries. So some farms can be under the transmission line network. The vicinity of residences to overhead power lines has been a factor of concern for public health. Several studies has been developed in order to establish a relationship between the magnetic fields due the power lines and the health of people. The aim of this study is to investigate the result of magnetic fields levels from high voltage power lines and electric transformers and cabinets in 176 locations, 100 high voltage power lines and 76 transformers and electric cabinet distributed over the Bethlehem District, these locations includes centers of the city, highly populated areas as well as rural areas. All measurements were conducted at a high of 1 m above the ground level using spectrum analyzer (NF 5030) with 3D antennas capable of collecting magnetic field from 0Hz to 300Hz. The average magnetic field from high voltage power lines are (0.6 μT) , the average magnetic field from electric transformers are (4 μT) , the average magnetic field from electric cabinet are (28 μT), the average value of magnetic field levels from high voltage power lines and electric transformers and cabinet under the permissible level (100 μT) recommended by the International Commission on Non-Ionizing Radiation Protection for general public, maximum result of magnetic field from high voltage power lines are (3 μT) ,this value below the limit (100 μT) recommended by ICNRP , the maximum result of magnetic field from electric transformers are (8 μT) , this value are below the limit (100 μT) recommended by ICNRP , the maximum result of magnetic field from electric cabinet are (123 μT) ,this value above the limit (100 μT) recommended by ICNRP

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Definitions and abbreviations

Antenna: A device for radiating radiofrequency energy.

Averaging Time: The appropriate time period over which exposure is averaged for purposes of determining compliance with exposure limits.

Contact current: Current flowing between an energized, isolated, conductive, object and ground through an electrical circuit representing the equivalent impedance of human body.

Electric field strength: The force (E) on a stationary unit positive charge at point in an electric field, measured in volt per meter (V/m).

Electric field: The region surrounding an electric charge, in which the magnitude and direction of the force on a hypothetical test charge, is defined at any point.

Electromagnetic radiation: The propagation of time-varying electric and magnetic fields through space at the velocity of light. For the purposes of this document, the frequency range of interest lies between 0Hz and 300Hz.

ELF (Extremely Low Frequency): Frequency below 300Hz.

EMF: Electric, magnetic and electromagnetic fields.

Employer: Any person, firm, organization, or other legal entity having the overall responsibility for any work carried out in connection with the utilization of source of electromagnetic radiation, such as a RF device.

Electric cabinet: electric box placed under electric transformer which contain a lot of conductors and electricity cables.

Exposure: Exposure occurs when a person is subjected to electric, magnetic or electromagnetic fields, or contact or induced currents other than those originating from physiological processes in the body and other natural phenomena.

Electric transformer: device that use to transfer energy between two or more circuits through electromagnetic induction.

Field strength: The magnitude of the electric or magnetic field, normally a root-mean-square (rms) value.

Frequency: The number of sinusoidal cycles made by electromagnetic waves in one second, expressed in terms of Hertz (Hz). 1kHz = 1000 Hz, 1MHz = 1000kHz, 1GHz = 1000MHz

General public Exposure: All exposure to EMF experienced by members of the general public excluding occupational exposure and exposure during medical procedures.

General public: All persons other than those designated as RFworkers.

High voltage power lines: metallic lines that use to transfer high voltage electricity.

Power lines: metallic lines that use to transfer electricity.

ICNIRP: International Commission on Non-Ionizing Radiation Protection.

Isotropic Antenna: An antenna capable of radiating or receiving equally well in all directions, and equally responsive to all polarizations of electric and/or magnetic fields. In the case of transmitting coherent electromagnetic waves, an isotropic antenna does not exist physically, but represents a convenient reference antenna for expressing directional properties of an actual transmitting antenna.

Isotropic: Having the same properties in all directions.

Leakage Radiation: Any unintended or accidental radiation emitted by a RF device outside its external surface.

Magnetic Field Strength: An axial vector quantity (H) which specifies a magnetic field at any point, and is expressed in ampere per meter (A/m).

Magnetic Field: A region of space surrounding a moving charge (e.g. in a conductor) being defined at any point by the force that would be experienced by other hypothetical moving charge.

Magnetic Flux Density: A vector field quantity (B) that results in force that acts on a moving charge or charges, and is expressed in tesla (T). The magnetic field strength and the magnetic flux density are related by a constant of proportionality called the

magnetic permeability of value $4\pi \cdot 10^{-7}$, such that $B = 4\pi \cdot 10^{-7} H$. A magnetic field strength of 1 A/m is equivalent to a magnetic flux density of 1.257 μ T. In describing a magnetic field for protection purposes, only one of the quantities B or H needs to be specified

Microwave: For the purposes of this document, this applies to the portion of the electromagnetic spectrum which has a frequency range between 300MHz and 300 GHz.

Multiple-Transmitter Environment: A situation where more than one transmitter contributes a significant exposure to RF radiation at the location being examined, even from RF transmitters not the same site.

Occupational Exposure: The exposure of workers to time varying electric, magnetic and electromagnetic fields as a direct and necessary requirement of their work.

Radiating Near-Field: That region of the field, which extends between the reactive near-field region and the far-field region, wherein radiation fields predominate and the angular field distribution is dependent upon distance from the antenna.

Radiofrequency (RF): For the purposes of this document, this applies to the portion of the electromagnetic spectrum, which has a frequency range between 0Hz and 300Hz.

RF Device: For the purposes of this document, this includes any fixed machine, equipment or installation, which generates RF energy.

Chapter One:

Magnetic field in the environment

1.1. Introduction

Electromagnetic fields are present everywhere, people are exposed to electromagnetic radiation which contains waves of electric and magnetic fields moving together.

Magnetic fields are one of several types of electromagnetic radiation and are part of the electromagnetic waves spectrum.

Magnetic fields are created from natural sources, examples of natural magnetic fields are Earth's magnetic field, also known as the geomagnetic field, magnetic fields associated with the Earth are primarily dipolar, having two poles, these being the north and south magnetic poles on the Earth's surface.

On the other hand, high voltage power lines, electric transformers such as those shown in figure 1.1 are examples of man-made magnetic field sources.

Man-made sources of electromagnetic fields are found at relatively long wavelengths and low frequencies, and of the electromagnetic

People are exposed to radiation from magnetic fields from high voltage power lines at extremely low frequencies in the range of 1-300 Hz.

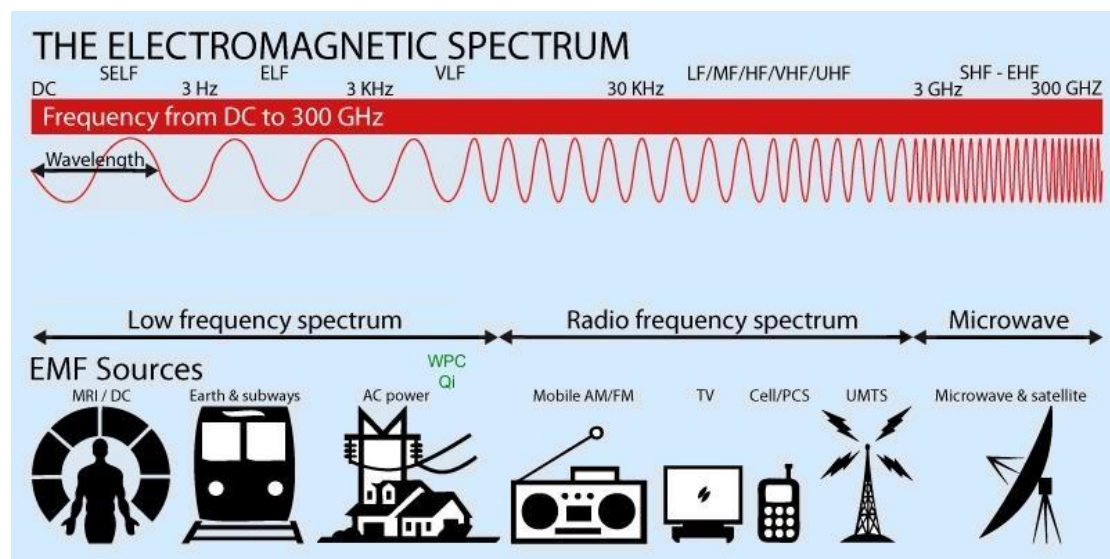


Figure 1.1: Electromagnetic spectrum

This study is concerned with the evaluation of the magnetic fields levels from high voltage power lines

Power lines, electric transformers and cabinets are distributed everywhere in order to serve whole population usually a stricter zone around power lines is provided to limit the exposure of the general public to relatively high levels of magnetic fields , measurements can be performed under power lines in order to verify that exposure levels comply with safe standards

Electrical transformers and cabinets are also used near the homes and hospitals and universities and every where the communities found, this study also investigates the magnetic field from electrical transformers to verify that exposure level comply with safety standards

Since late eighties a growing concern are possible health effect from 50-60 Hz magnetic field, emerged and became a matter of several scientific studies, research work suggested a link between these kinds of field, certain forms of leukemia and brain cancer, and also several biological disorders, these studies reveal a particular the relationship between public health and the proximity to power lines. The need for an accurate evaluation of magnetic field arising from these electrical power lines becomes obvious (Almeida,T and Anstunes C) .

In 2001, the International Agency For Research on Cancer (IARC) made overall evaluation of available scientific evidence and suggested extremely low-frequency (ELF) magnetic fields greater than 0.4 micro-Tesla (μT) be a possible cause of childhood leukemia (IARC, 2001).

1.2 High voltage transmission power lines

An over head power lines is a structure used in electric power transmission and distribution to transmit electrical energy along large distance, it consists of one or more conductors suspended by towers or poles, since most of the insulation is provided by air, over head power lines are generally the lowest cost method of power transmission for large quantities of electric energy.

Towers for support the lines are made of wood , steel , aluminum the bare wire conductors on the lines are generally made of aluminum a major goal of overhead power lines design is to maintain a adequate clearance between energized conductors and the ground so as to prevent dangerous contact with the line and provide reliable support .

They are more types of power transmission lines that use in the world:

-The largest steel pylons (275Kv – 400Kv)

-Smaller steel pylons (132Kv)

-Wooden poles (11Kv and 33Kv)

In Bethlehem, Jerusalem District Electricity Company (JDECO) used the wooden poles (11Kv and 33Kv) , (JDECO).

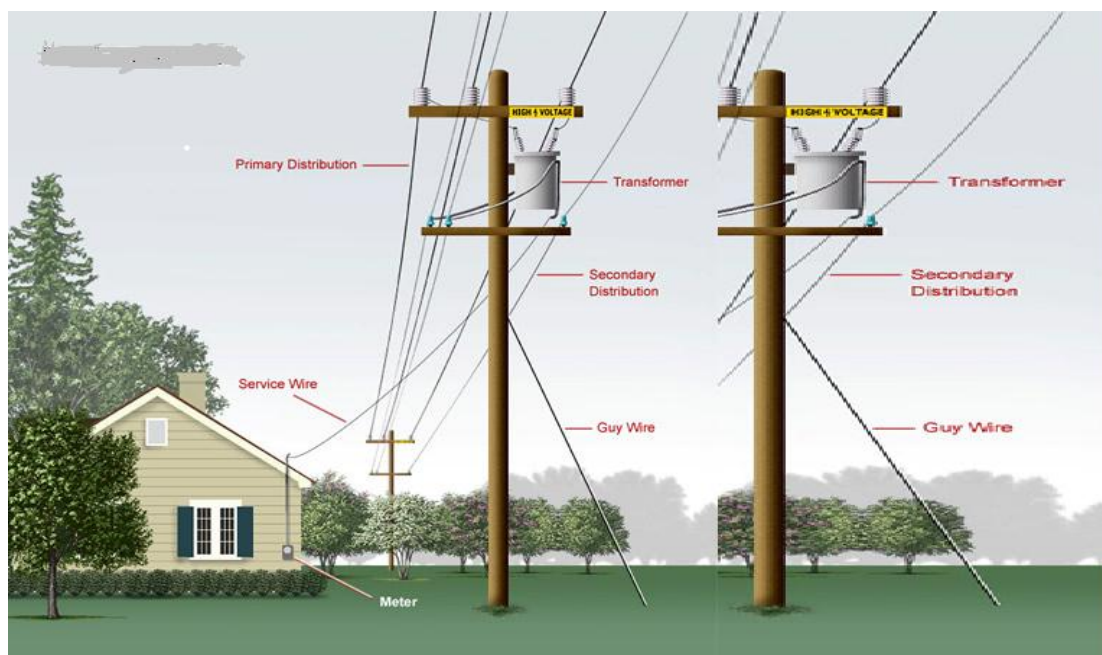


Figure 1.2: High voltage power lines

On the other hand undergrounding of over head power lines is the replacement of over head cables providing electrical power with underground cable, the using of underground power lines are more safe and reduce the magnetic fields exposure from high voltage power lines.

In Bethlehem District, Jerusalem District Electricity Company (JDECO) used over head power lines because the cost of underground power lines.

1.3 Electrical transformers

A transformer is an electrical device that transfer energy between two or more circuits through electromagnetic induction

A varying current in the transformers primary winding creates a varying magnetic field impinging on the secondary winding. This varying magnetic field at the secondary induces a varying electromagnetic force (EMF) or voltage in the secondary winding making use of faradays law in conjunction with high magnetic permeability core properties, transformers can thus be designed to efficiency change AC voltage from one voltage level to another within power net work

Transformers range in size from RF transformers less than cubic centimeters in volume to units interconnecting the power grid weighing hundreds of tons



Figure 1.3: Electric transformer

The common transformers that used by Jerusalem District Electricity Company (JDECO) are the interconnection power transformer, the interconnection transformers connect Ac networks or systems of different voltage to allow power exchange between them, this transformers offer galvanic between primary and secondary networks and can be designed as 3-phase or single phase banks depending on the end user priorities and transportation constraints.

They are also often designed to offer wide voltage regulation range.

1.4 Electric cabinets

Electric cabinet is found under each electric transformer which contain a lot of conductors and electricity cables

This electric cabinet on the ground near the road and homes without any space with people



Figure 1.4: Electric cabinet

1.5 Electric and magnetic field from high voltage power lines

Electric fields and magnetic fields can be characterized by their wave length frequency, and amplitude, the figure below shows the wave from an alternating electric or magnetic field, the direction of the field alternates from an polarity to the opposite and back to the first polarity in a period of time called one cycle wave length describes the distance between a peak on the wave and the next peak of the same polarity

The frequency of the field, measured in hertz describes the number of cycles that occur in one second; electricity in west bank used the frequency of electric power 50HZ.

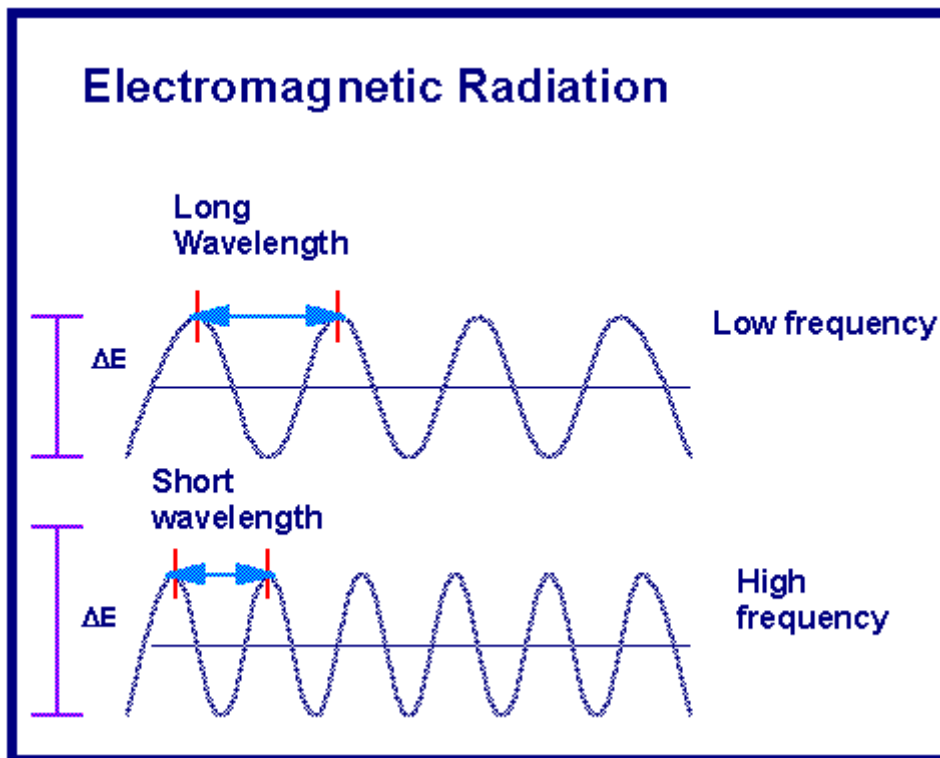


Figure 1.5: Wave length and frequency of electromagnetic radiation

Electric and magnetic field are invisible lines of force that surround any electrical device power lines, electrical wiring and electrical equipment

Electric fields are produced by voltage and increase in strength as the voltage increase, the electric field strength is measured in unit of volts per meter (V/m).

Magnetic fields result from the flow of current through wires or any electrical device and increase in strength as the current increases , magnetic field are measured in unit of Gauss (G) or Tesla (T) $1000G=1T$

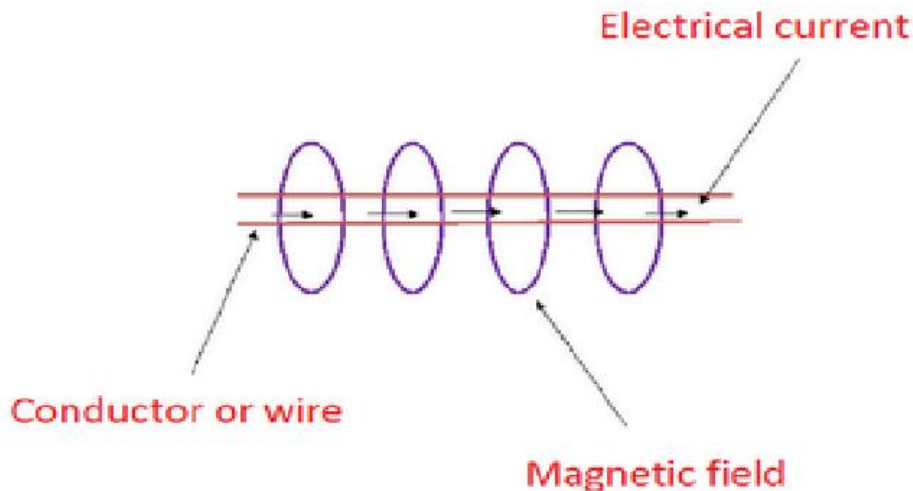


Figure 1.6: Magnetic fields from long wire

1.6 The exposure limit of magnetic fields

The limit of magnetic field exposure from high voltage power lines in 2001, the International Agency For Research on Cancer (IARC) made an overall evaluation of available scientific evidence and suggested extremely low frequency (ELF) magnetic field greater than 0.4 micro-tesla (μT) is a possible cause of childhood leukemia (IARC, 2001).

On the other hand the International Commission On Non – Ionizing Radiation Protection (ICNIRP) show that the exposure limit of magnetic field from high voltage power lines for general public exposure is $100\mu\text{T}$ (ICNIRP, 1998).

1.7 Aims and objectives

The main goal of this work is to evaluate the magnetic field from high voltage power lines in Bethlehem District

Specific objectives:

The present study has the following sub objectives:

- 1- Performing experimental measurements of magnetic field from high voltage power lines in Bethlehem District and compare this result with the world exposure limit of magnetic field

- 2- Performing experimental measurements of magnetic field from electric transformers in Bethlehem District and compare this result with the world exposure limit of magnetic field
- 3- Performing experimental measurements of magnetic field from electric cabinet under electric transformer in Bethlehem District and compare this result with the world exposure limit of magnetic field

1.8 Literature review

Habiballa,I (2006) . “ELF electric and magnetic fields exposure assessment of live-line workers for 132 KV transmission line of SEC”

This paper presents an exposure assessment study for live-line workers exposed to transmission line power frequency electric and magnetic field, a method based an amper law has been chosen to compute the external magnetic field around the transmission line, the paper concluded that the levels of worker expose to extremely low frequency electric and magnetic fields are below the recommended international standards limit for the scenarios considered in this work

Rankovic, V (2009) “Environmental pollution by magnetic field around power lines”

This study compare magnetic field from high voltage power lines and the ICNIRP guideline, this study are found to be useful discussing the comparison of the field densities on the human body at the ground level under or near the lines

Wei-jong,A(2007) " accuracy of short-term residential measurement in prediction of 72-h exposure to power frequency magnetic field in households very close to high tension transmission lines"

This study was done in Taiwan to measure the magnetic field in households close (<70m) to high tension power lines, this study indicates that the short term measurements of indoor ELF magnetic field exposure greater than 0.4 μ T

Maalej,N (2011)"external and internal electromagnetic exposures of workers near high voltage power lines"

This study was done in Saudi Arabia to assess the safety of electric line workers exposed to of a double circuit transmission for different scenarios; this study found

that the worker exposure levels to extremely low frequency electromagnetic fields are below the recommended IEEE international standards limit for studied scenarios

Farag,A(2003) " Exposure assessment of electromagnetic fields in Malaysian public schools environment"

This study was done in Malaysia to find possible risks posed by power frequency electromagnetic fields in Malaysian public schools ,this study fined the magnetic field in five school are below the recommended limit

Richard,T(2010) "magnetic field computation due to high voltage power lines using easy mac".

This study finds that for all cases considered in this paper it is observed that the values obtained are far below the maximum limit of $100\mu\text{T}$

Sohrabi,M (2010) "Living near over head high voltage transmission power lines as a risk factor for childhood acute lymphoblastic leukemia a case-control study"

This study investigate association of living near high voltage power lines with occurrence of childhood acute lymphoblastic leukemia , this study emphasizes that living close to high voltage power lines is a risk for acute lymphoblastic leukemia

Hasan,G (2011) "Investigation the influence of magnetic field emitted by high voltage transmission lines on planet growth"

This study is to investigate the influence of exposure to magnetic fields on growth of green maize, this study show that the maize growth has negative respond to magnetic field; this is proven by a depression in maize growth due to exposure to magnetic field

Ahmadi, H (2010) "electromagnetic fields near transmission lines problems and solutions'

This study find several measurements around different areas such as over head transmission lines the study concluded that the most effective solution is for the governments to reduce the radiation and for people to be near the high voltage over head lines as rarely as possible

Chapter Two:

Methods of evaluating exposure to magnetic fields

2.1 Theoretical prediction of magnetic field

The magnetic field can be defined in several equivalent ways based on the effects it has on its environment

Often the magnetic field is defined by the force it exerts on a moving charged particle it is known from experiments in electrostatics that a particle of charge q in an electric field E experiences a force $F=q E$, however in other situation, such as when a charged particle moves in the vicinity of a current carrying wire, the force also depend on the velocity dependent portion can be separated out such that the force on the particle satisfies the Lorentz force law

$$F=q(E + V \times B)$$

F is the force exerts on a moving charge

E is the electric field

V is the particles velocity

B is termed the magnetic field

2.1.2 Measuring the magnetic field from straight line currents

The magnetic field of a straight wire is shown in figure

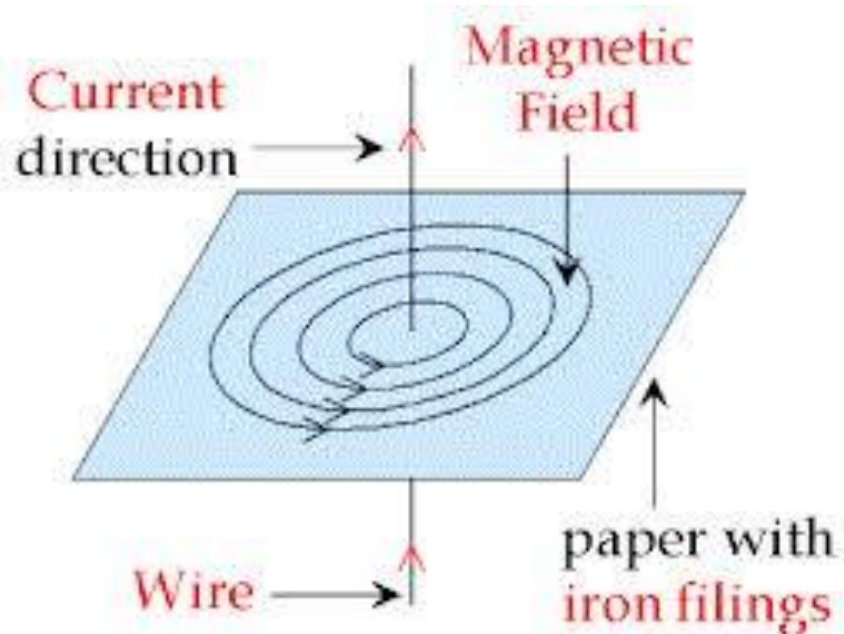


Figure 2.1: Direction of magnetic field from wire

The current is coming out of the page

The magnetic field of a steady line current is given by the

Biot-savart law

$$B(r) = \frac{\mu_0}{4\pi} \int \frac{I \times \hat{r}}{r^2} dl = \frac{\mu_0}{4\pi} \int \frac{dl \times \hat{r}}{r^2}$$

$$B = \frac{\mu_0 I}{2\pi s}$$

B is the magnetic field

μ_0 is the permeability of free space

I is the current

S is the circular path

The integral of B around a circular path of radius S , centered at the wire is

$$\oint B \cdot dl = \oint \frac{\mu_0 I}{2\pi S} dl = \frac{\mu_0 I}{2\pi S} \oint dl = \mu_0 I$$

The answer is independent of S, that because B decrease at the same rate as the circumference increase

$$B = \frac{\mu_0 I}{2\pi S}$$

2.2 Experimental determination of magnetic fields from high voltage power lines

-Analytical calculus method are used for measuring the exposure of magnetic fields by determine the magnetic fields from high voltage power lines by taken the current and voltage from the power lines and find the magnetic fields theoretically.

-Simulation method, this method depends on software programs such as charge simulation method which depend on Ampere law to compute the external magnetic fields around the transmission line.

-Experimental measurements of magnetic fields

This method finds the magnetic field using special meters that find the magnetic field at low frequency such as:

EMDEX meter that find magnetic field at low frequency

NF5030 meter.

EMDEX SNAP meter.

2.3 Safety guide line and exposure assessment

Countries set their own national standards for exposure to electromagnetic fields however the majority of these national standards draw the guide lines set by the international commission on non-ionizing radiation protection (ICNIRP)

Chapter Three:

Methodology

3.1 Methods

This study presents field survey measurements data and provides information on the levels of the magnetic fields from high voltage power lines and magnetic field from electric transformers and magnetic field from electric cabinet

All measurement were conducted by using NF 5030 spectrum analyzer. Measurement procedures were as follows

3.1.1 Measurement of magnetic field from high voltage power lines

Measurement of magnetic field from high voltage power lines were performed according to the following protocol:

- 1) All these measurements were performed in Bethlehem District in the West Bank
- 2) The measurements were taken at a high of 1meter above the ground level
- 3) The measurements were taken under the power line
- 4) The maximum value of magnetic field was taken

3.1.2 Measurement of magnetic field from electric transformers

Measurements of magnetic field from electric transformers were performed according to the following protocol:

- 1) All these measurements were performed in Bethlehem District in the West Bank
- 2) The measurement were taken at a high of 1meter above the ground level
- 3) The measurements were taken under the electric transformer
- 4) The maximum value of magnetic field was taken

3.1.3 Measurement of the magnetic field from electric cabinet

Measurements of magnetic field from electric cabinet were performed according to the following protocol:

- 1) All these measurements were performed in Bethlehem District in the West Bank
- 2) The measurements were taken at a high of 1meter above the ground level
- 3) The measurements were taken near to the cabinet
- 4) The maximum value of magnetic field was taken

3.2 Instrumentation

Measurements of magnetic field were made by using the following equipment

3.2.1 The NF5030 spectrum analyzer

This equipment function measure magnetic flux this instrument is portable spectrum analyzer that cover the rang 1Hz-300Hz with high sensitivity

This instrument is measure (three axes), the source of measured magnetic field from other sources could be identified due to the use of a small resolution band width

This instrument calculate the maximum magnetic field flux in three dimension

Chapter four:

Results and discussions

4.1 Measuring of magnetic field

This chapter describes the surveyed location in the Bethlehem city area, where measurements were made and present the magnetic field from high voltage power lines, magnetic field from electric transformers, and magnetic field from electric cabinet

The magnetic field was detected within the frequency range from 1Hz to 300Hz to detect magnetic field from high voltage power lines and transformers, the measured data were also analyzed in order to determine which of the sources the dominant were

4.1.1 Magnetic field in Bethlehem city:

The measurements were performed at 10 separate locations in Bethlehem area most measurements took place in urban and extra urban locations which were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.1 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Bethlehem city

Table 4.2 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Bethlehem city

Figure 4.1 present the magnetic field from high voltage power lines

Figure 4.2 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 8 (0.74 μT) this value below the limit recommended by ICNRP for general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric transformer were found at location 4 in table 4.2 ($3.99\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 1 in table 4.2 ($37.16\mu\text{T}$) this value below the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.1: Magnetic field from high voltage power lines in Bethlehem city

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The main street near police station	0.42
2	The main street near Arab bank	0.28
3	Aldoha industrial area	0.70
4	Alradi super market	0.31
5	Bethlehem university	0.47
6	Aljable street	0.46
7	SoS school	0.59
8	Alkarkfa street	0.74
9	Russian center	0.68
10	Mental hospital	0.71
11	Average	0.54

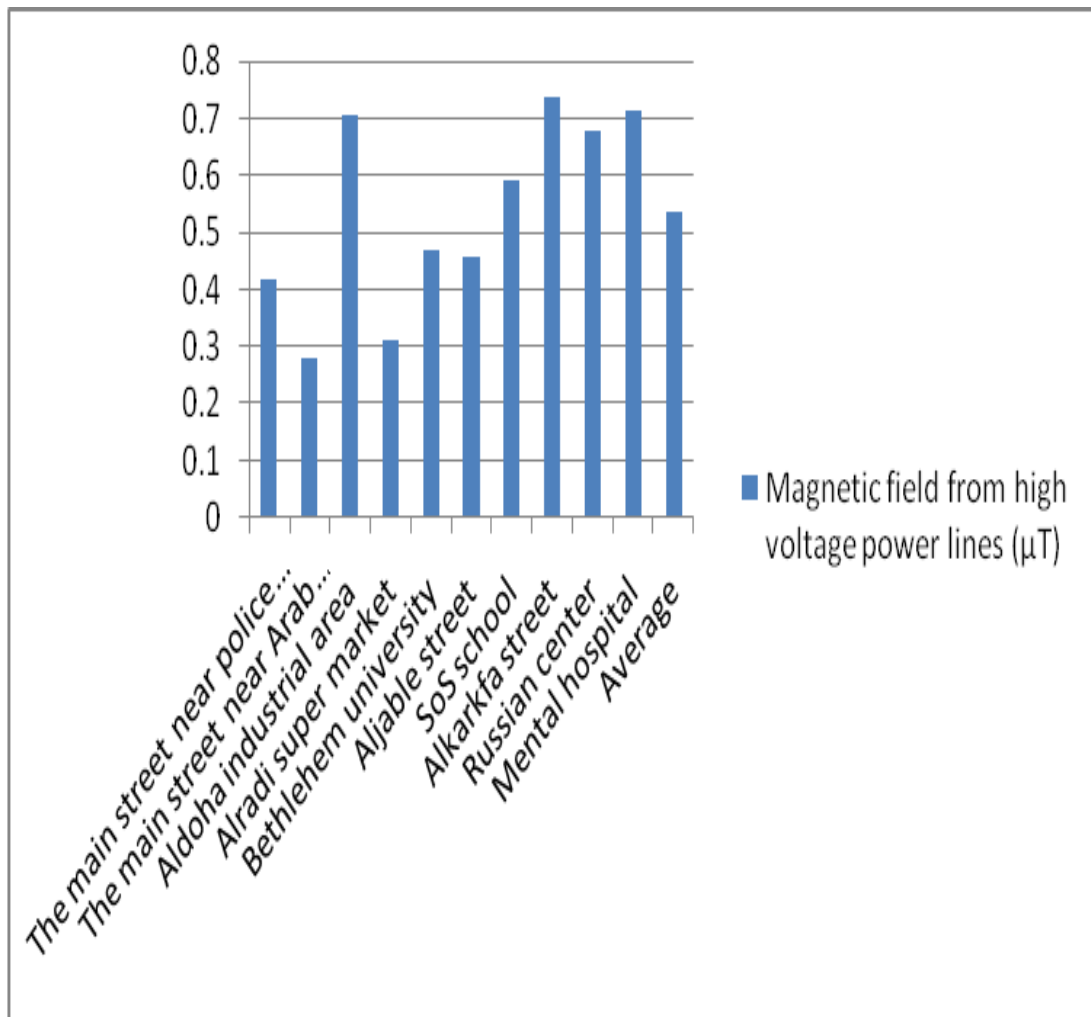


Figure 4.1: Present the magnetic field from high voltage power lines in Bethlehem

Table 4.2: Magnetic field from electric transformers and electric cabinet in Bethlehem city

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	The main street near police center	1.12	37.16
2	Arab bank	2.92	19.32
3	Alrade super market	2.98	14.71
4	Abu sror furniture	3.99	16.86
5	SoS school	1.83	14.29
6	Russian center	3.47	15.52
7	Central market	2.52	19.84
8	Islam Arab bank	2.80	27.96
9	average	2.70	20.70

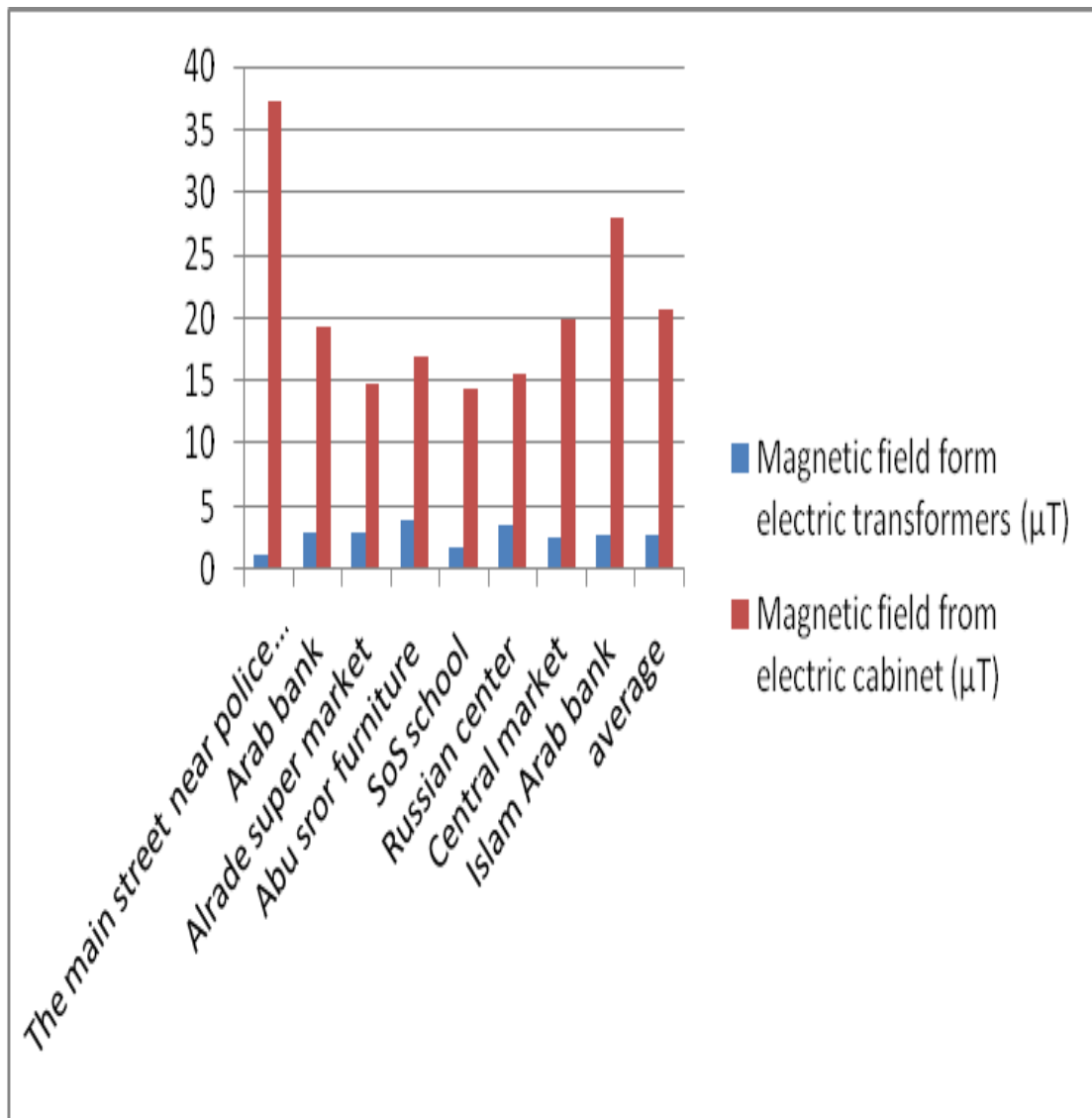


Figure 4.2: Present the magnetic field from electric transformers and electric cabinet in Bethlehem city

4.1.2 Magnetic field in Artas village

The measurements were performed at 10 separate locations in Artas village most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.3 lists the result of magnetic field from high voltage power lines, 10 location were taken at Artas village

Table 4.4 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Artas village

Figure 4.3 present the magnetic field from high voltage power lines

Figure 4.4 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 1 in table 4.3 ($2.77 \mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 1 in table 4.4 ($6.32\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 1 in table 4.4 ($71.56\mu\text{T}$) this value below the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.3: Magnetic field from high voltage power lines in Artas village

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The entrance to the village near police center	2.77
2	The entrance street	1.36
3	Khaled super market	0.68
4	Hagla monastery	1.20
5	Waste water treatment station	0.80
6	Central village of artas	0.46
7	Central village of artas	0.76
8	Artas valley	0.53
9	Hussen ibeat street	0.44
10	Solomons pools	0.49
11	Average	0.95

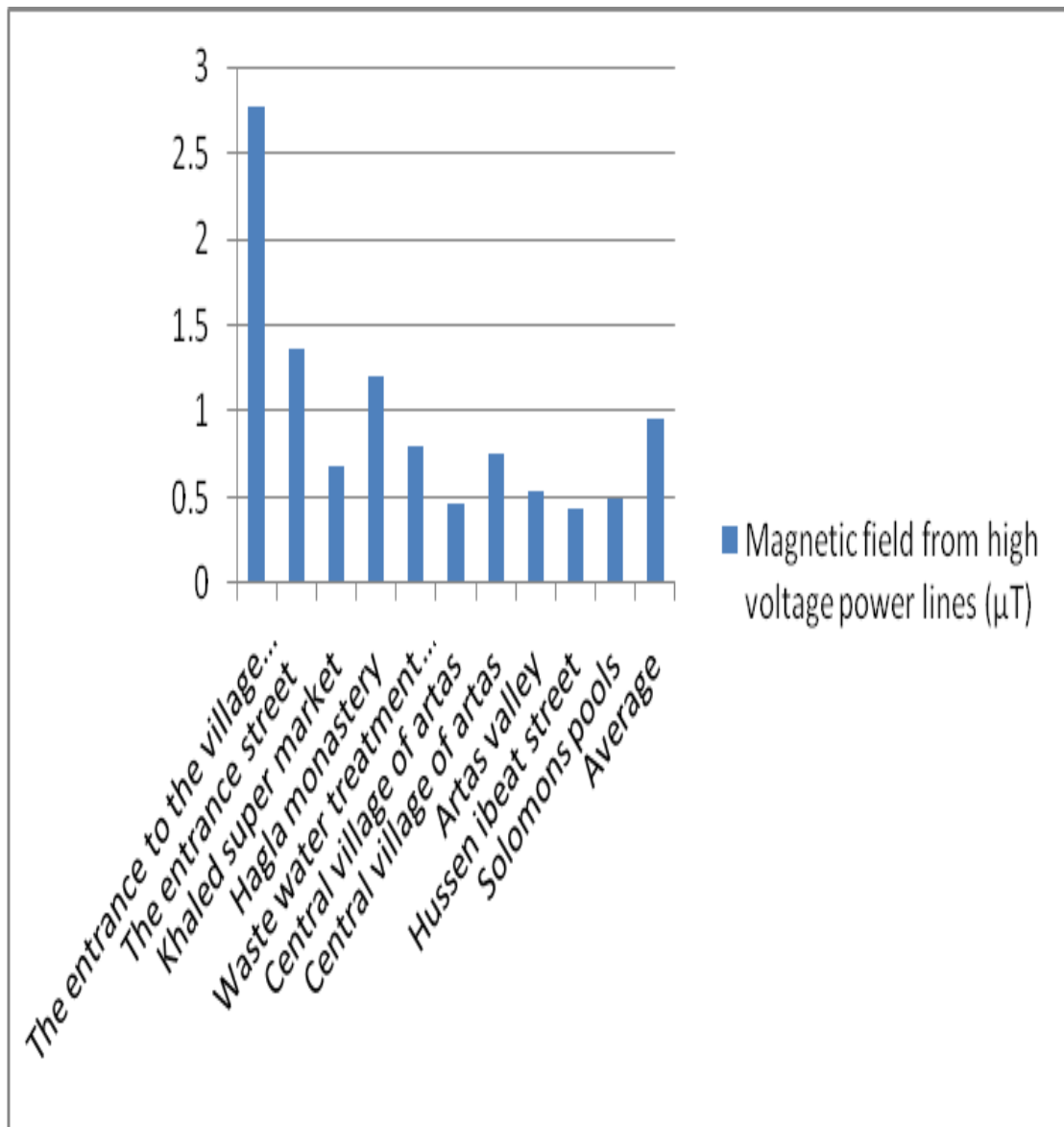


Figure 4.3: Present the magnetic field from high voltage power lines in Artas village

Table 4.4: Magnetic field from electric transformers and electric cabinet in Artas village

No	location	Magnetic field form electric transformers (μT)	Magnetic field from electric cabinet (μT)
1	The entrance to the village near police center	6.32	71.56
2	The entrance street	4.51	44.21
3	Khaled super market	2.36	46.84
4	Hagla monastery	1.57	13.10
5	Waste water treatment station	1.45	14.46
6	Central village of artas	3.21	46.38
7	Hussen ibeat street	1.81	14.38
8	average	3.03	35.85

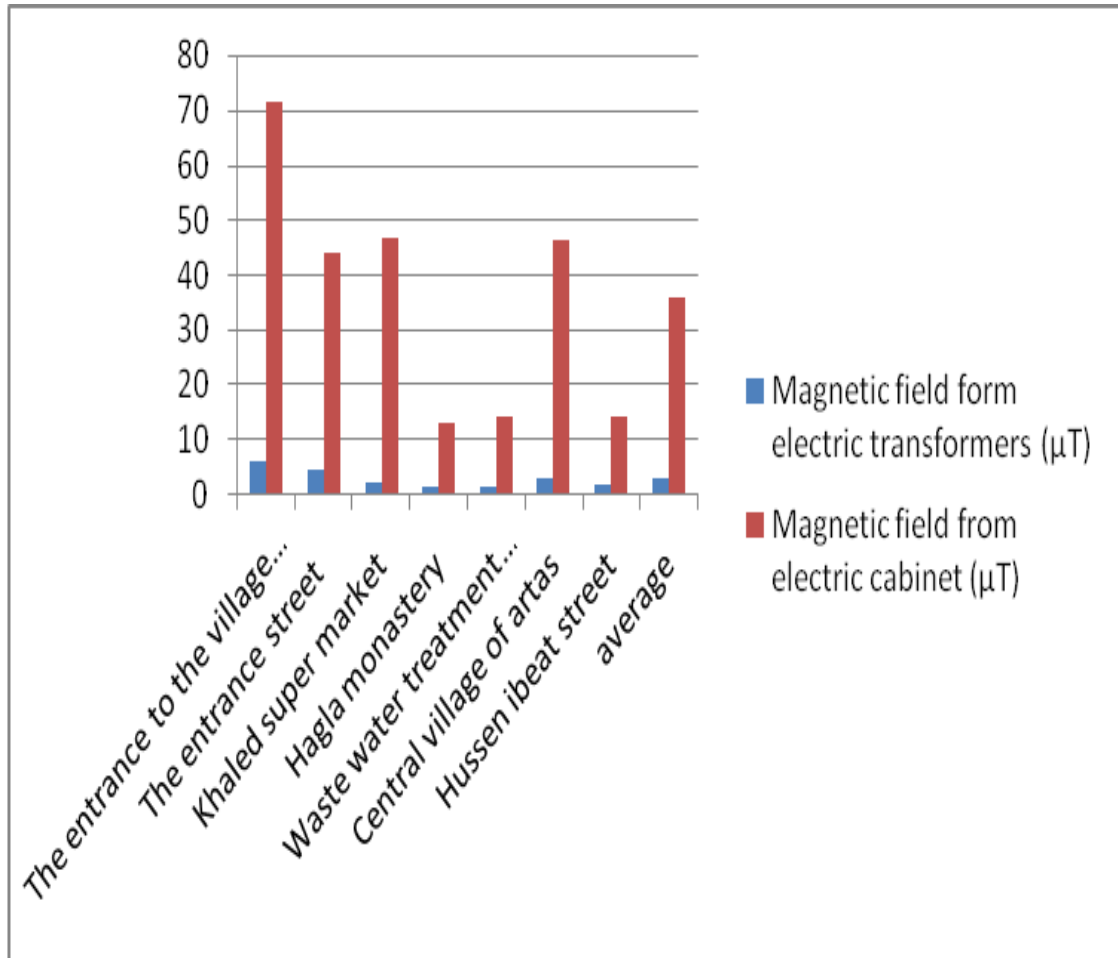


Figure 4.4 Present the magnetic field from electric transformers and electric cabinet in Artas village

4.1.3 Magnetic field in Dheisheh camp

The measurements were performed at 10 separate locations in Dheisheh camp most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.5 lists the result of magnetic field from high voltage power lines,10 location were taken at Dheisheh camp

Table 4.6 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Dheisheh camp

Figure 4.5 present the magnetic field from high voltage power lines

Figure 4.6 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 6 in table 4.5 (1.40 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric transformer were found at location 2 in table 4.6 (6.72 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric cabinet were found at location 2 in table 4.6 (122.51 μT) this value above the limit recommended by ICNIRP for the general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

Table 4.5: Magnetic field from high voltage power lines in Dheisheh camp

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	Alquds street saba building materials	0.92
2	Alsalam market	1.09
3	Girl primry school	0.46
4	The center of Dheisheh camp	1.26
5	The center of Dheisheh camp	1.28
6	The center of Dheisheh camp	1.40
7	The center of Dheisheh camp	1.22
8	Boys school	0.41
9	Bethlehem company for fuel station	0.38
10	Mograby super market	0.93
11	Average	0.94

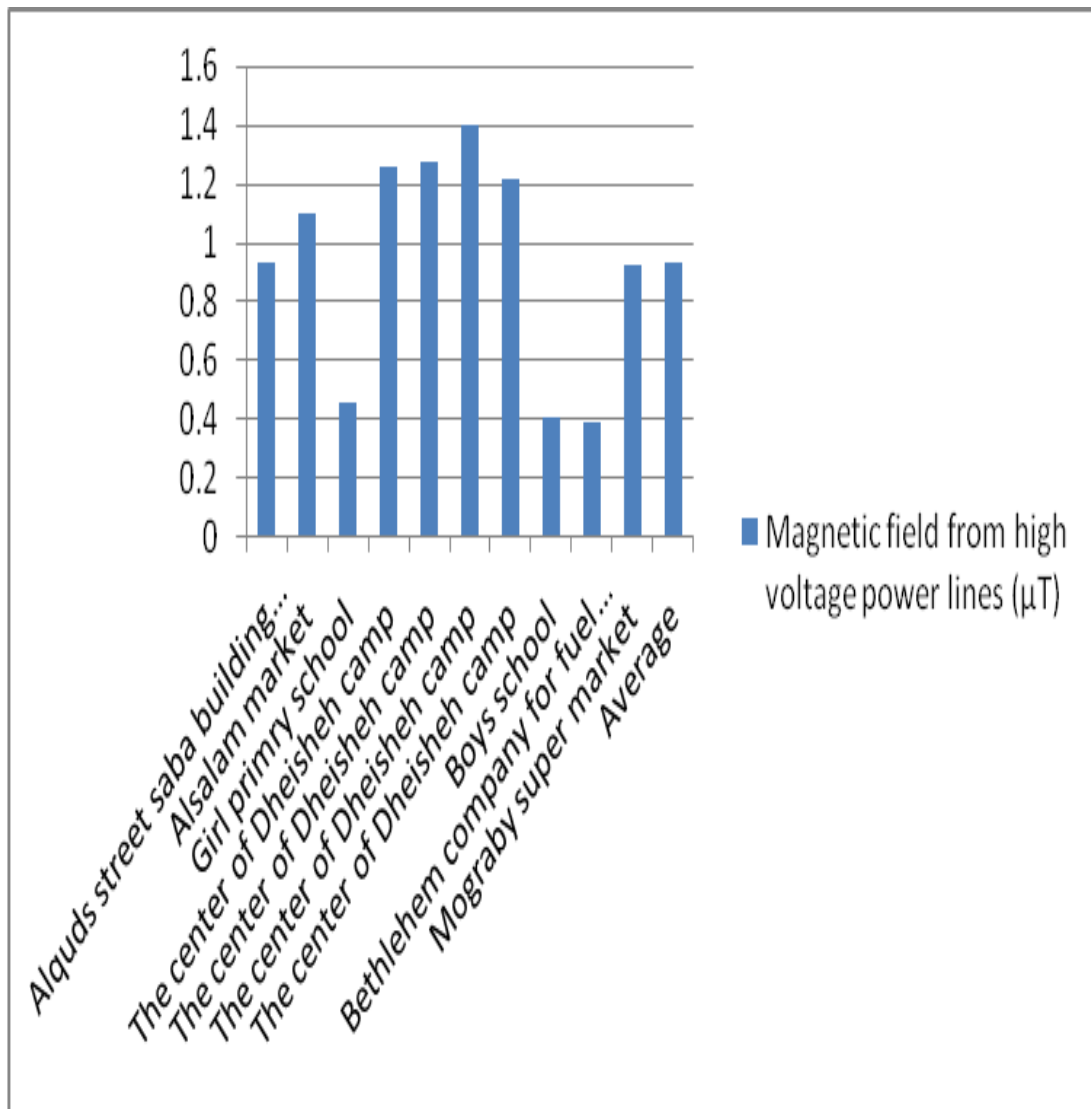


Figure 4.5 Present the magnetic field from high voltage power lines in Dheisheh camp

Table 4.6: Magnetic field from electric transformers and electric cabinet in Dheisheh camp

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	Alquds street saba building materials	2.26	10.11
2	Alsalam market	6.72	122.51
3	Girl primry school	3.78	17.05
4	Alrafaeen market	4.56	22.73
5	Bethlehem company for fuel station	5.01	27.35
6	Mograby super market	2.15	19.17
7	Boys school	2.47	23.26
8	Alamal furniture market	2.96	23.25
9	average	3.74	33.18

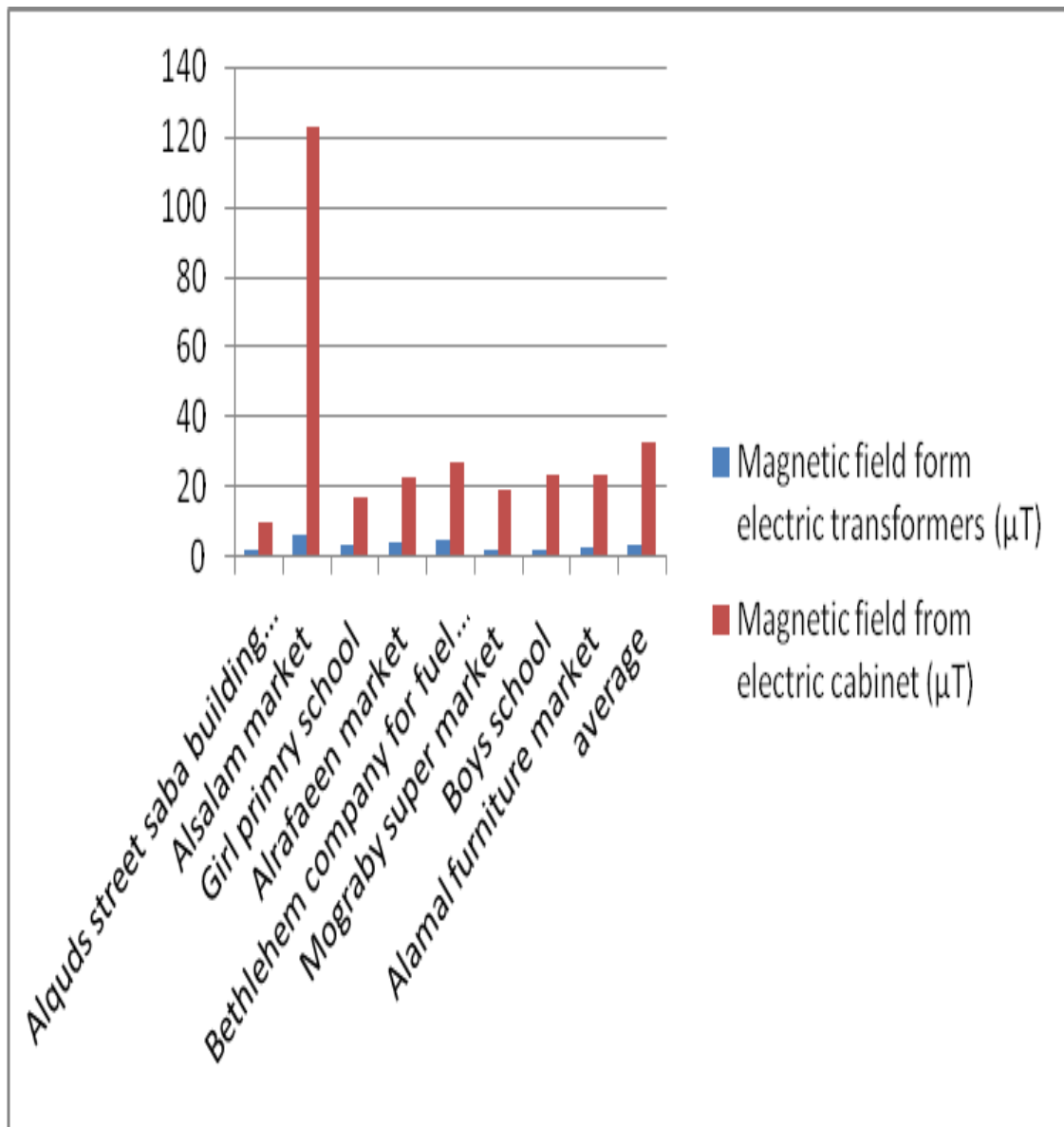


Figure 4.6: Present the magnetic field from electric transformers and electric cabinet in Dheisheh camp

4.1.4 Magnetic field in Husan village

The measurements were performed at 10 separate locations in Husan village most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.7 lists the result of magnetic field from high voltage power lines,10 location were taken at Husan village

Table 4.8 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Husan village

Figure 4.7 present the magnetic field from high voltage power lines

Figure 4.8 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 9 in table 4.7 ($0.97 \mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 5 in table 4.8 ($7.21\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 5 in table 4.8 ($41.45\mu\text{T}$) this value above the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.7: Magnetic field from high voltage power lines in Husan village

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The entrance of Husan village	0.52
2	Fuel station	0.69
3	Boy school	0.64
4	Girl school	0.26
5	Husan club	0.57
6	The center of Husan village	0.65
7	Alsalam building material market	0.51
8	Emad super market	0.35
9	Alesraa electric material market	0.97
10	Abed alrahman mosque	0.45
11	Average	0.56

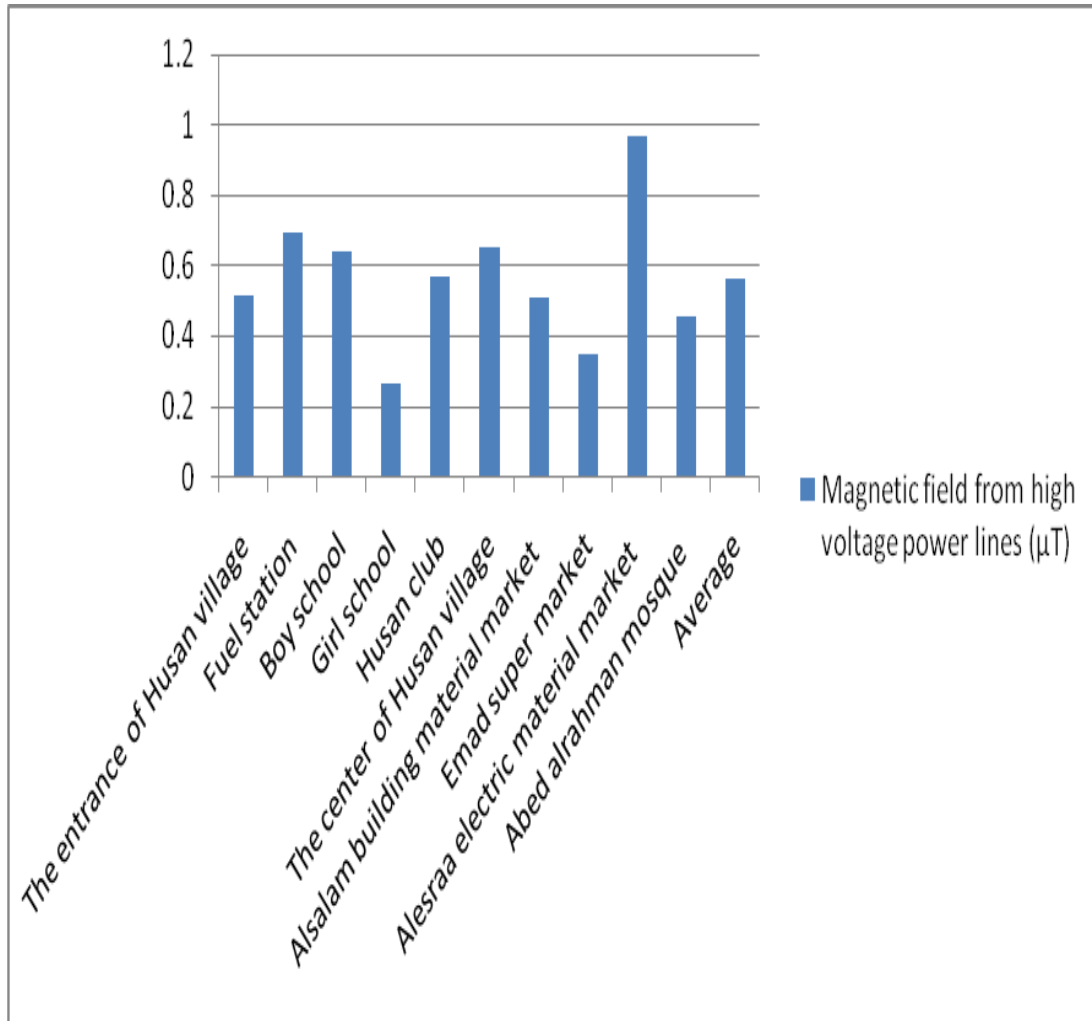


Figure 4.7: Present the magnetic field from high voltage power lines in Husan village

Table 4.8: Magnetic field from electric transformers and electric cabinet in Husan village

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	The entrance of Husan village	6.89	15.42
2	Fuel station	2.53	28.70
3	Boy school	2.35	25.81
4	Girl school	2.07	25.60
5	Husan club	7.21	41.45
6	The center of Husan village	3.05	23.35
7	Alsalam building material market	4.22	27.15
8	Alesraa electric material market	3.35	22.11
9	average	3.96	26.20

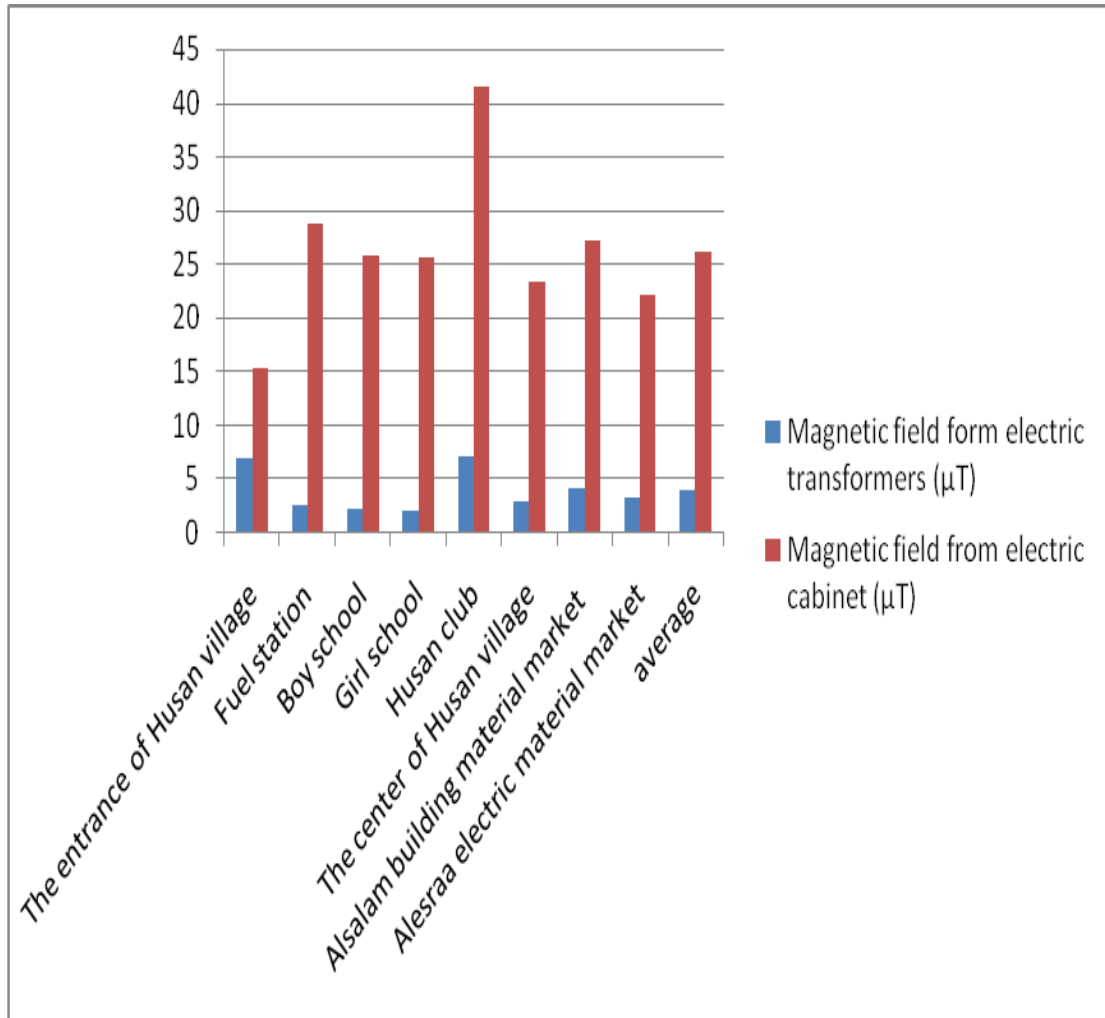


Figure 4.8: Present the magnetic field from electric transformers and electric cabinet in Husan village

4.1.5 Magnetic field in Al-khader village

The measurements were performed at 10 separate locations in Al-khader village most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.9 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Al-khader village

Table 4.10 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Al-khader village

Figure 4.9 present the magnetic field from high voltage power lines

Figure 4.10 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 5 in table 4.9 ($0.68 \mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 8 in table 4.10 ($5.56\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 2 in table 4.10 ($54.94\mu\text{T}$) this value above the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.9: Magnetic field from high voltage power lines in Al-khader village

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The entrance of Al-khader village	0.57
2	Al-khader stadum	0.41
3	Al-khader gridiron	0.58
4	Boy school	0.47
5	Girl school	0.68
6	Al-khader center	0.51
7	Al-khader club	0.48
8	Al-khader gate	0.33
9	Al-khader 60 street	0.39
10	Arab bank	0.49
11	Average	0.49

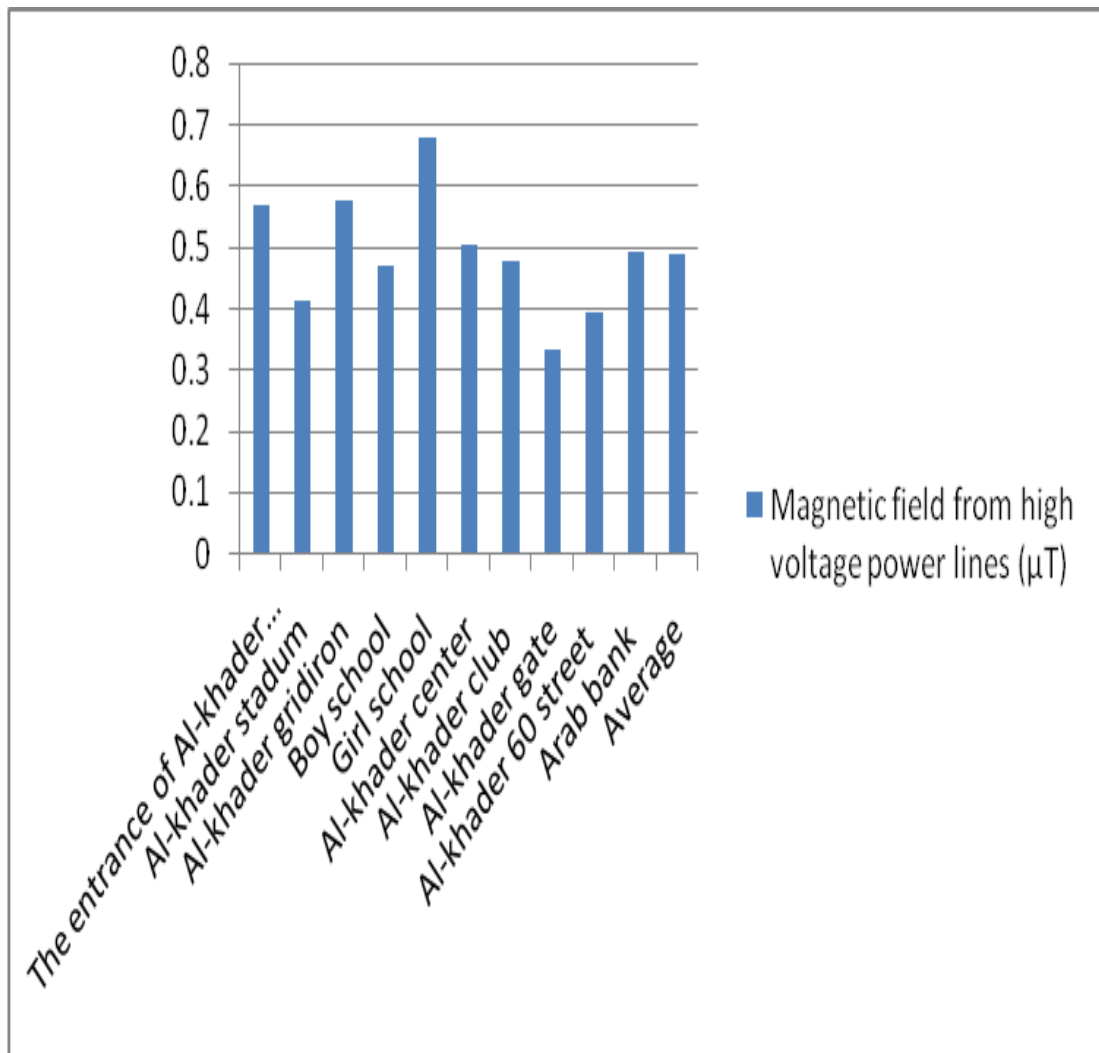


Figure 4.9: Present the magnetic field from high voltage power lines in Al-khader village

Table 4.10: Magnetic field from electric transformers and electric cabinet in Al-khader village

No	location	Magnetic field form electric transformers (μT)	Magnetic field from electric cabinet (μT)
1	The entrance of Al-khader village	4.20	31.24
2	Al-khader gridiron	4.50	54.94
3	Al-khader center	1.42	12.69
4	Al-khader gate	3.567	23.69
5	Al-khader 60 street	4.01	28.14
6	Arab bank	3.01	23.35
7	Boy school	4.42	33.22
8	The entrance of Al-khader village	5.56	21.32
9	average	3.84	28.57

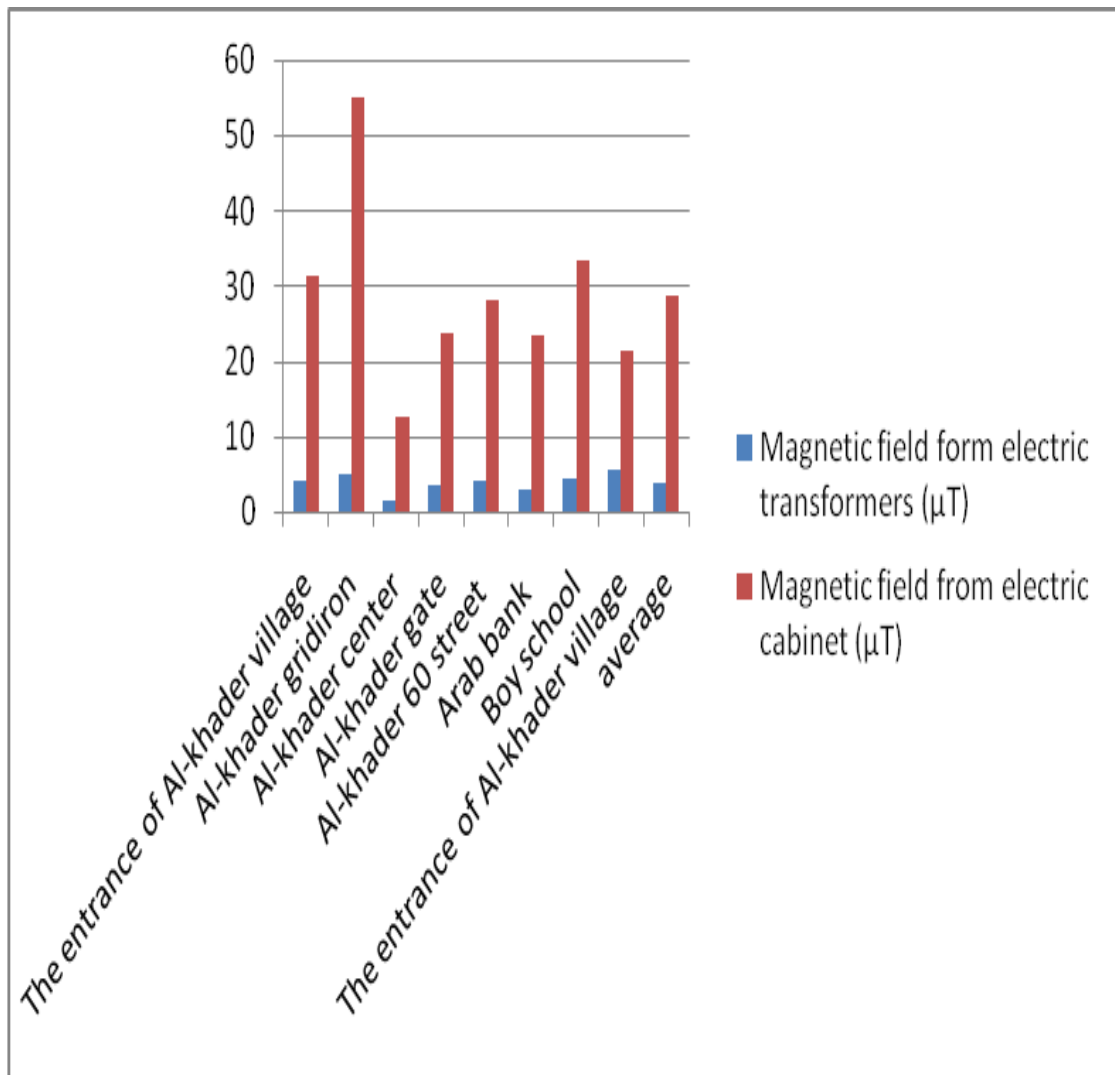


Figure 4.10: Present the magnetic field from electric transformers and electric cabinet in Al-khader village

4.1.6 Magnetic field in Battir village

The measurements were performed at 10 separate locations in Battir village most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.11 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Battir village

Table 4.12 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Battir village

Figure 4.11 present the magnetic field from high voltage power lines

Figure 4.12 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 3 in table 4.11 ($1.24 \mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 2 in table 4.12 ($4.54\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 2 in table 4.12 ($36.94\mu\text{T}$) this value above the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.11: Magnetic field from high voltage power lines in Battir village

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The entrance of Battir village	0.45
2	Alrahman mosque	0.46
3	Fatema mosque	1.24
4	Boy school	0.44
5	Girl school	0.34
6	Battir village center	0.45
7	Battir park	0.35
8	Old Battir	0.31
9	Center of Battir village	0.61
10	Khaled super market	0.51
11	Average	0.52

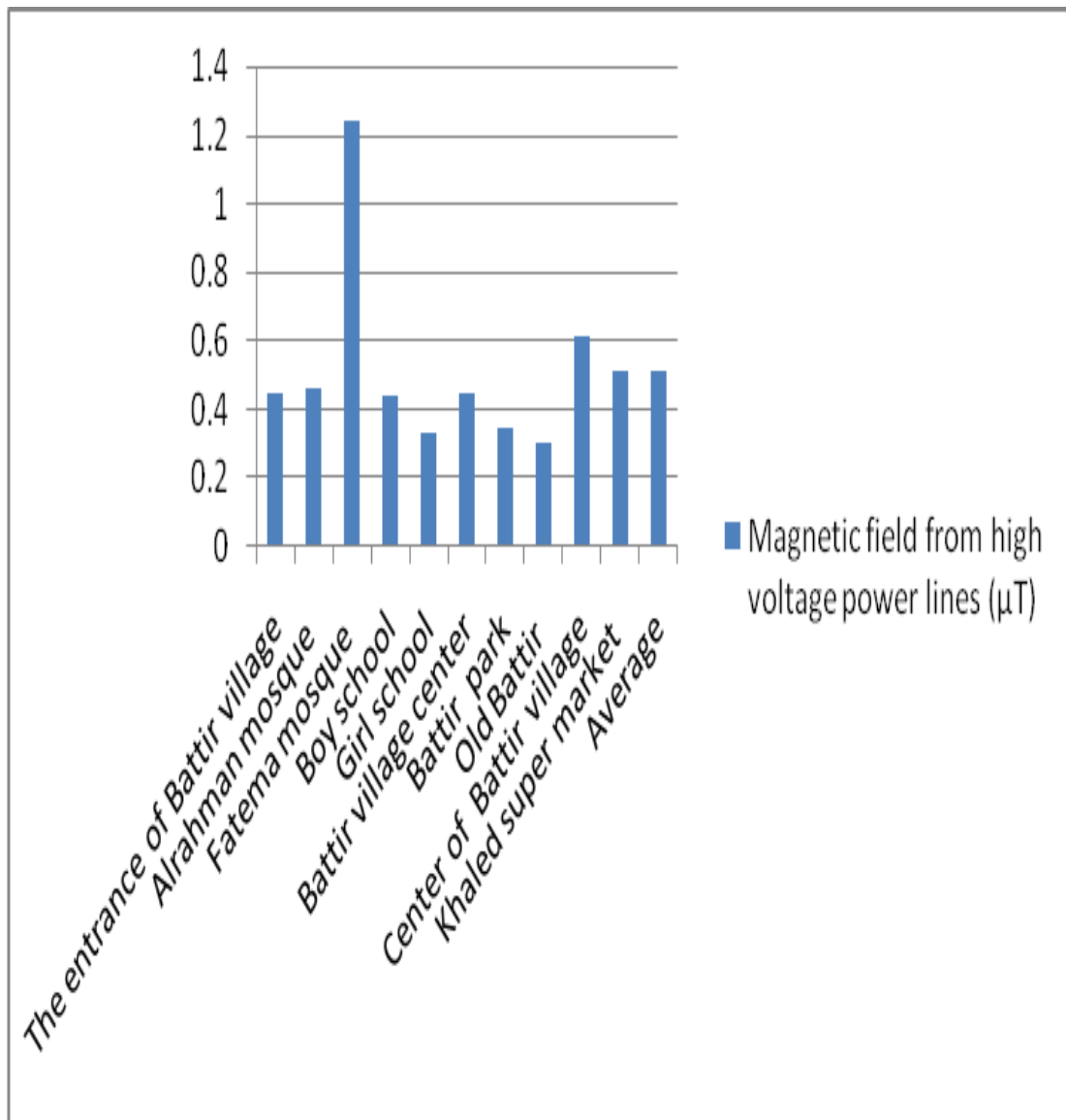


Figure 4.11: Present the magnetic field from high voltage power lines in Battir village

Table 4.12: Magnetic field from electric transformers and electric cabinet in Battir Village

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	The entrance of Battir village	2.58	19.60
2	Alrahman mosque	4.54	36.94
3	Fatema mosque	1.91	24.99
4	Battir village center	3.43	23.03
5	Center of Battir village	4.16	26.27
6	Old Battir	3.03	19.34
7	Battir park	1.20	13.42
8	average	2.98	23.37

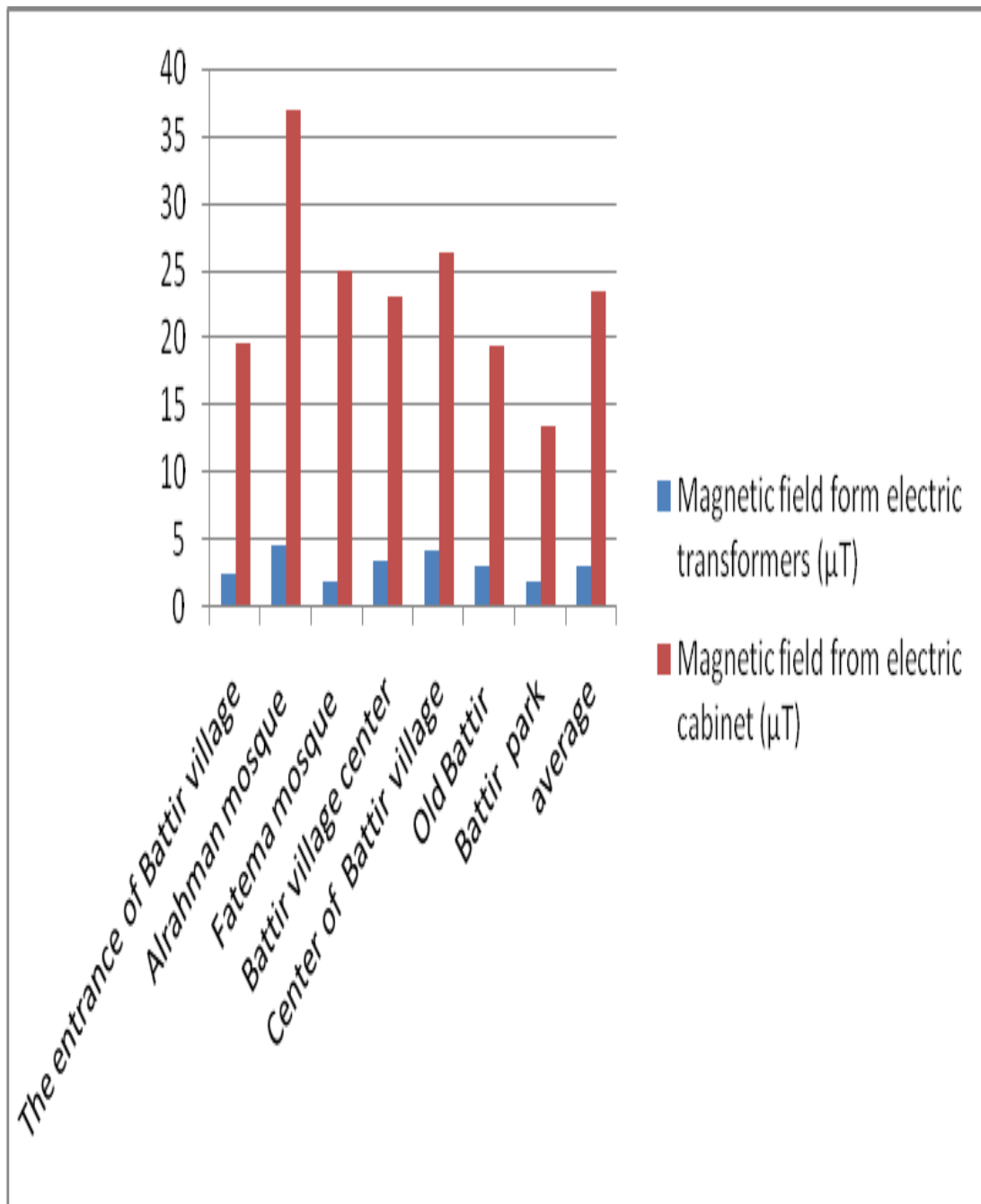


Figure 4.12: Present the magnetic field from electric transformers and electric cabinet in Battir village

4.1.7 Magnetic field in Bet gala village

The measurements were performed at 10 separate locations in Bet gala village most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.13 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Bet gala village

Table 4.14 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Bet gala village

Figure 4.13 present the magnetic field from high voltage power lines

Figure 4.14 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 5 in table 4.13 ($0.81 \mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 7 in table 4.14 ($4.03\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 7 in table 4.14 ($36.45\mu\text{T}$) this value above the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.13: Magnetic field from high voltage power lines in Bet gala village

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	Top of the Bet gala village	0.31
2	Barbara resturent	0.27
3	Kaabar resturent	0.71
4	tarasnta school	0.40
5	The center of Bet gala village	0.81
6	Fuel station	0.44
7	Bet gala gridiron	0.40
8	Alshekh sweets	0.71
9	Pharmaceutical company	0.45
10	Grace salon	0.43
11	Average	0.49

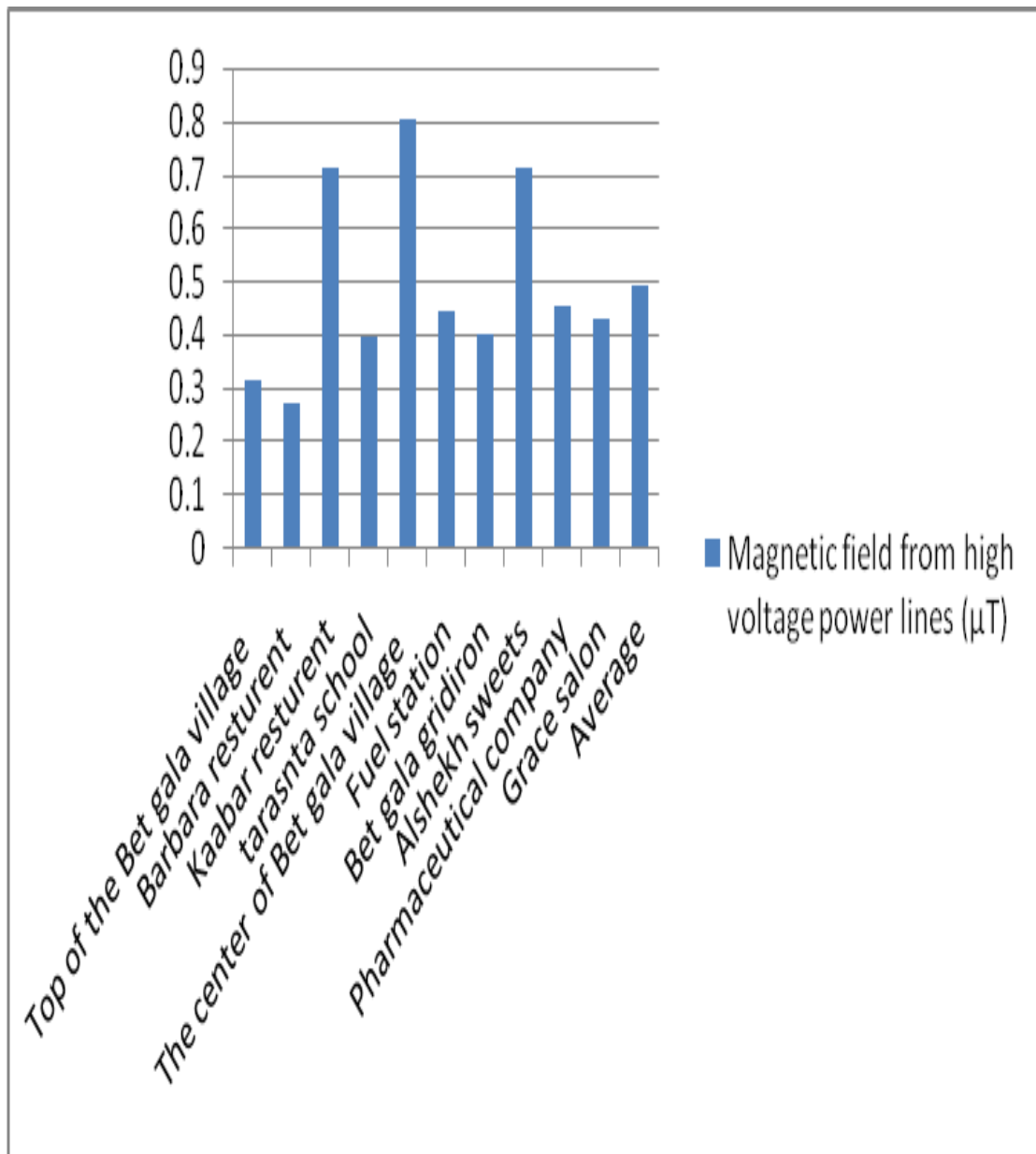


Figure 4.13: Present the magnetic field from high voltage power lines in Bet gala village

Table 4.14: Magnetic field from electric transformers and electric cabinet in Bet gala village

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	Top of the Bet gala village	2.82	23.03
2	Barbara resturent	3.64	31.33
3	Kaabar resturent	2.66	13.46
4	tarasnta school	3.75	18.38
5	The center of Bet gala village	2.73	22.46
6	Fuel station	3.71	25.62
7	Bet gala gridiron	4.03	36.45
8	Alshekh sweets	3.22	17.46
9	Pharmaceutical company	4.02	23.02
10	Grace salon	2.30	32.35
11	Average	3.29	24.3

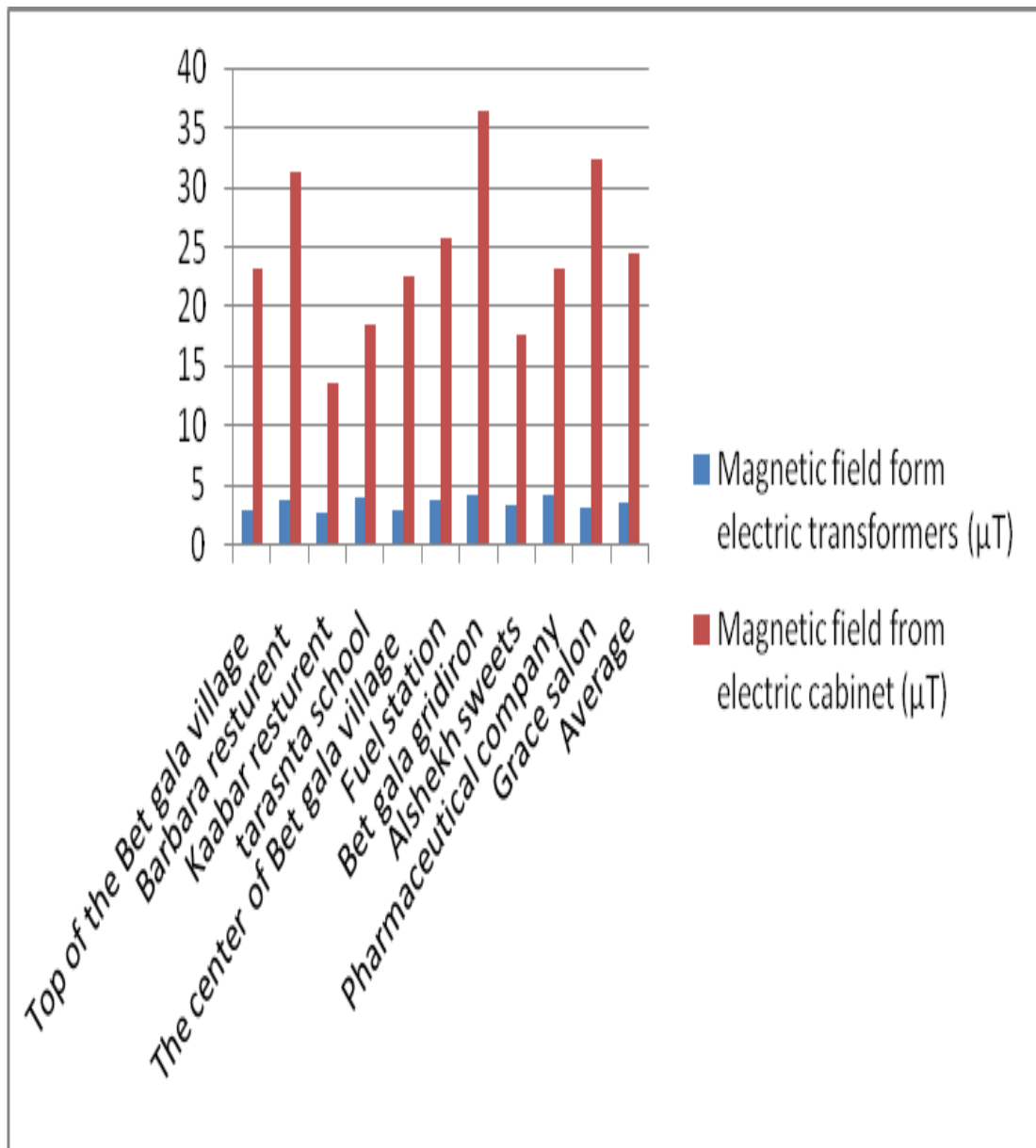


Figure 4.14: Present the magnetic field from electric transformers and electric cabinet in Bet gala village

4.1.8 Magnetic field in Aida camp

The measurements were performed at 10 separate locations in Aida camp most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.15 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Aida camp

Table 4.16 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Aida camp

Figure 4.15 present the magnetic field from high voltage power lines

Figure 4.16 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location 7 in table 4.15 ($0.69 \mu\text{T}$) this value below the limit recommended by ICNRP for general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric transformer were found at location 10 in table 4.16 ($8.42\mu\text{T}$) this value below the limit recommended by ICNIRP for general public ($100\mu\text{T}$) and above the limit recommended by IARCE ($0.4\mu\text{T}$)

The maximum value of magnetic field from electric cabinet were found at location 7 in table 4.16 ($71.45\mu\text{T}$) this value above the limit recommended by ICNIRP for the general public ($100\mu\text{T}$) and this value above the limit recommended by IARCE ($0.4\mu\text{T}$)

Table 4.15: Magnetic field from high voltage power lines in Aida camp

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	Aida camp gate	0.42
2	The main street near alquds super market	0.39
3	Boy school	0.33
4	Girl school	0.50
5	Cooperative society	0.50
6	Lagee center	0.60
7	The center of Aidacamp	0.69
8	Gsan kanafane center	0.59
9	Aida stadium	0.49
10	Albandk station	0.51
11	Average	0.50

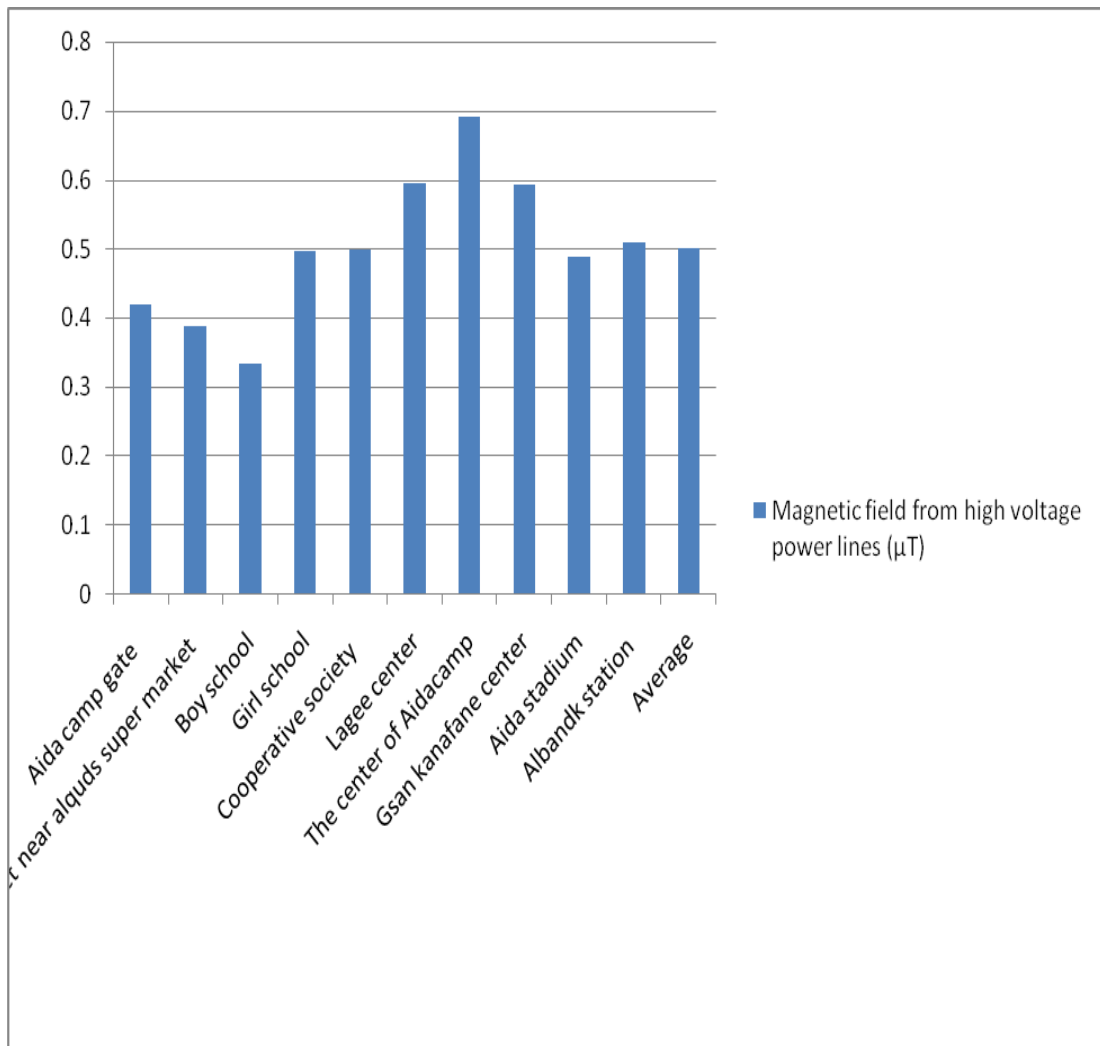


Figure 4.15: Present the magnetic field from high voltage power lines in Bet gala village

Table 4.16: Magnetic field from electric transformers and electric cabinet in Aida camp

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	Aida camp gate	6.67	23.46
2	Boy school	6.61	32.07
3	Girl school	3.40	24.44
4	Cooperative society	7.77	39.22
5	The center of Aidacamp	4.55	71.45
6	Aida stadium	6.01	52.42
7	Albandk station	8.42	31.25
8	Average	6.20	39.19

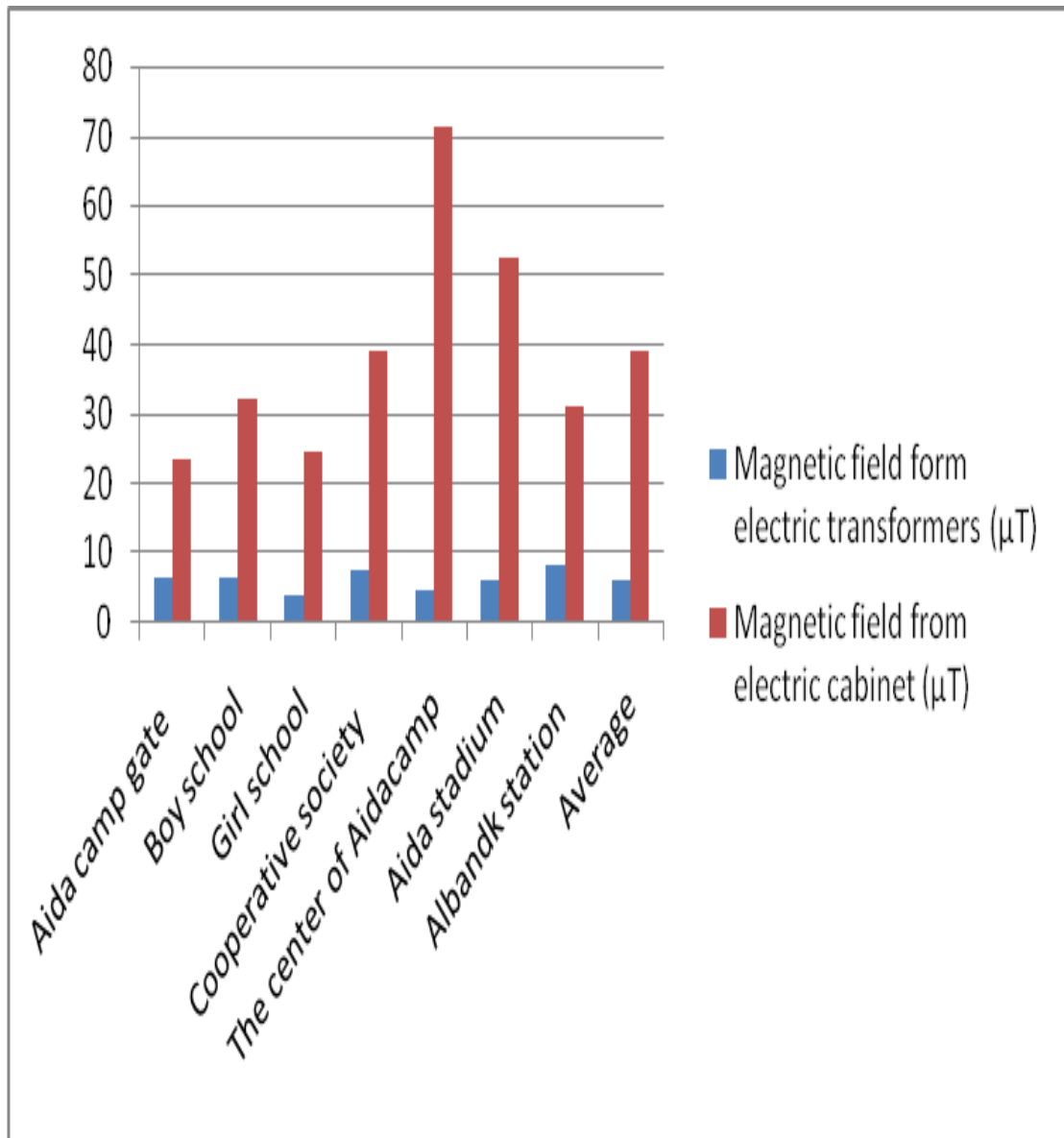


Figure 4.16: Present the magnetic field from electric transformers and electric cabinet in Bet gala village

4.1.9 Magnetic field in Aza camp

The measurements were performed at 10 separate locations in Aza camp most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.17 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Aza camp

Table 4.18 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Aza camp

Figure 4.17 present the magnetic field from high voltage power lines

Figure 4.18 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location3 in table 4.17 (0.62 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric transformer were found at location 5 in table 4.18 (7.12 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric cabinet were found at location 2 in table 4.18 (33.36 μT) this value above the limit recommended by ICNIRP for the general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

Table 4.17: Magnetic field from high voltage power lines in Aza camp

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	The entrance to Aza camp	0.52
2	Abed alrhman mosque	0.46
3	The center of the camp	0.62
4	The center of the camp	0.61
5	Near Auto 2000 market	0.60
6	Near Palestine bank	0.55
7	Hazem super market	0.42
8	Near alqese bekery	0.41
9	Aza coffe	0.40
10	Aza club	0.43
11	Average	0.50

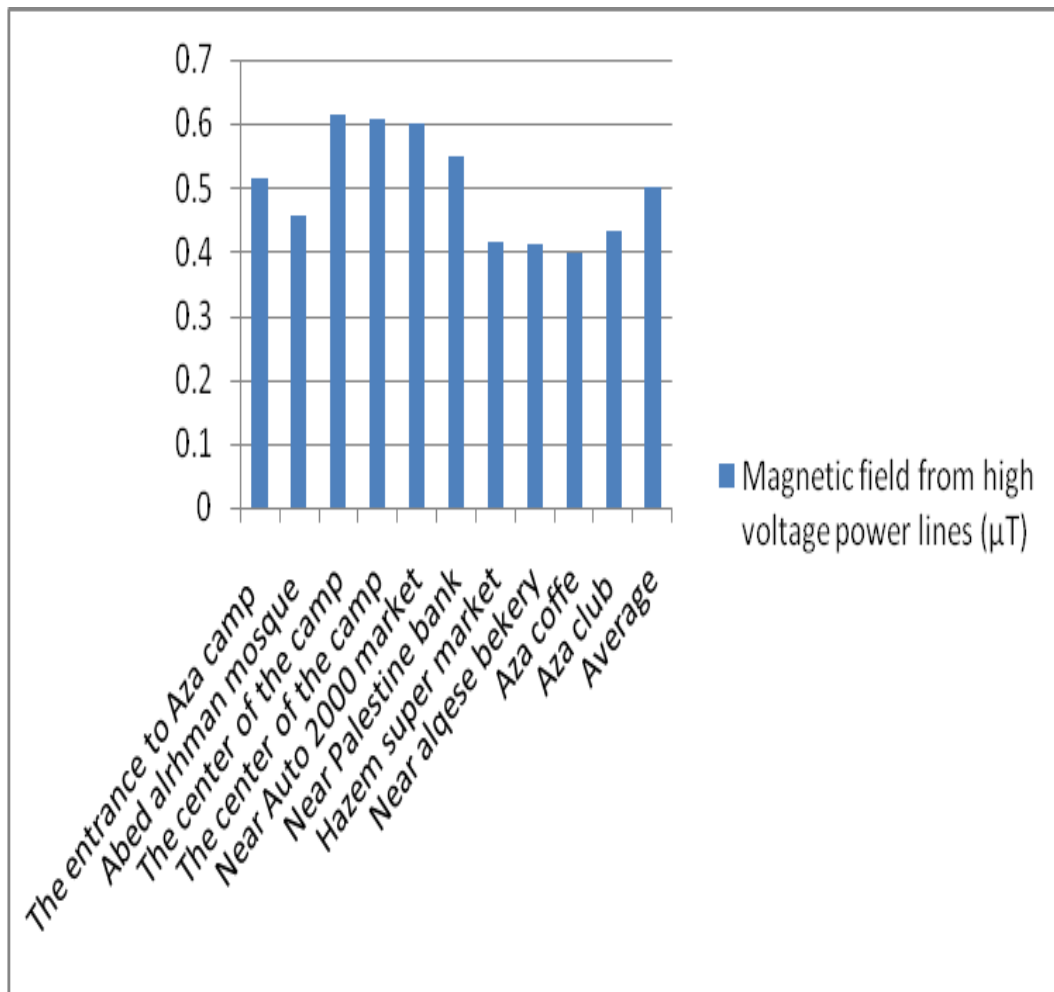


Figure 4.17: Present the magnetic field from high voltage power lines in Aza camp

Table 4.18: Magnetic field from electric transformers and electric cabinet in Aza camp

No	location	Magnetic field form electric transformers (μT)	Magnetic field from electric cabinet (μT)
1	The entrance to Aza camp	3.68	23.15
2	Abed alrhman mosque	4.53	33.36
3	Aza club	2.99	26.45
4	Near Auto 2000 market	7.12	28.46
5	Average	4.58	27.86

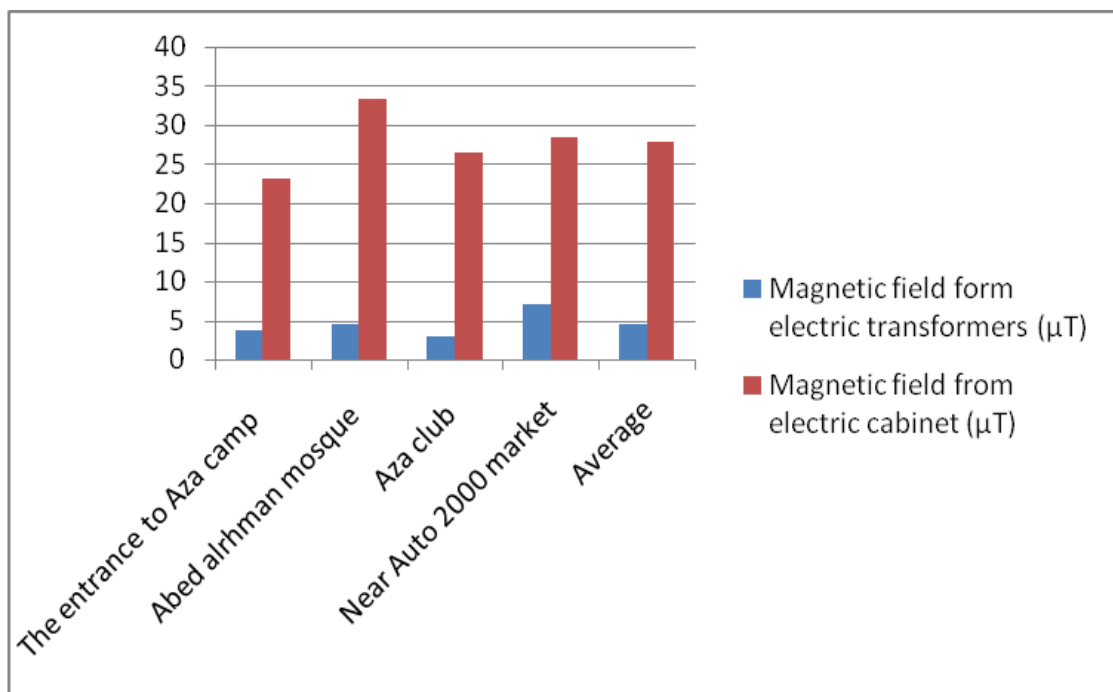


Figure 4.18: Present the magnetic field from electric transformers and electric cabinet in Aza camp

4.1.10 Magnetic field in Bet sahor

The measurements were performed at 10 separate locations in Bet sahor most measurements were taken at a high of approximately 1m above ground level as well as the measurement antennas were directed in three dimensions in order to obtain the maximum strength of measured

Table 4.19 lists the result of magnetic field from high voltage power lines, 10 locations were taken at Bet sahor

Table 4.20 lists the result of magnetic field from electric transformers and electric cabinet; eight locations were taken in Bet sahor

Figure 4.19 present the magnetic field from high voltage power lines

Figure 4.20 present the magnetic field from electric transformers and electric cabinet

The maximum value of magnetic field from high voltage power lines were found at location3 in table 4.19 (0.66 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric transformer were found at location 6 in table 4.20 (7.59 μT) this value below the limit recommended by ICNIRP for general public (100 μT) and above the limit recommended by IARCE (0.4 μT)

The maximum value of magnetic field from electric cabinet were found at location 2 in table 4.20 (41.33 μT) this value above the limit recommended by ICNIRP for the general public (100 μT) and this value above the limit recommended by IARCE (0.4 μT)

Table 4.19: Magnetic field from high voltage power lines in Bet sahor

No	Location	Magnetic field strength level from high voltage power lines (μT)
1	ymca	0.44
2	Hamza mosque	0.34
3	Hidi fashin	0.66
4	Ctrwen company	0.57
5	Toyota garage	0.48
6	Alsos fuil station	0.52
7	Primery school	0.41
8	Almgara restaurant	0.63
9	Bet sahor park	0.42
10	The center to the bet sahor	0.40
11	Average	0.49

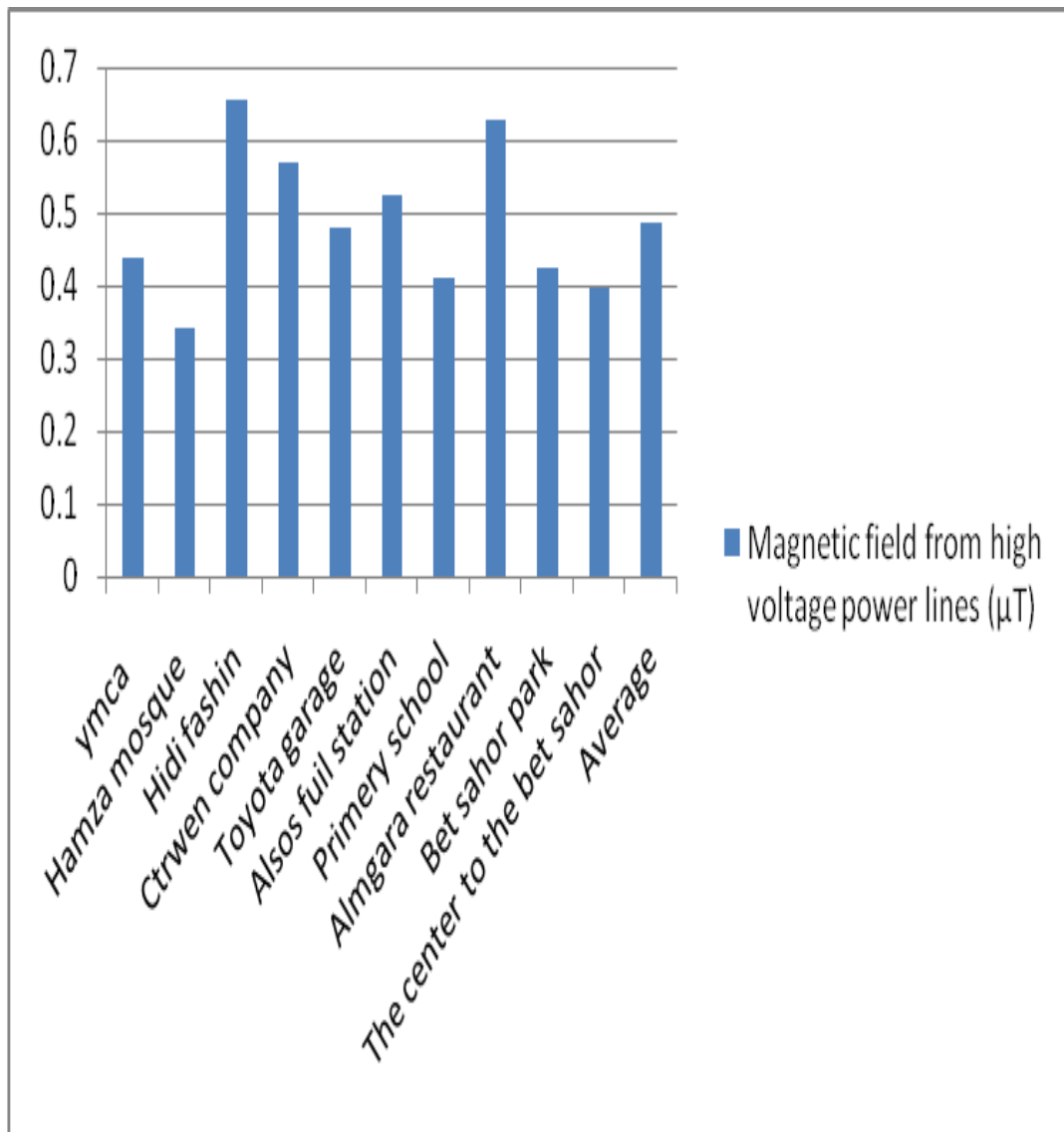


Figure 4.19: Present the magnetic field from high voltage power lines in Bet sahor

Table 4.20: Magnetic field from electric transformers and electric cabinet in Bet sahor

No	Location	Magnetic field strength level form electric transformers (μT)	Magnetic field strength level from electric cabinet (μT)
1	ymca	4.22	21.33
2	Hamza mosque	2.47	19.22
3	Hidi fashin	3.22	26.30
4	Ctrwen company	2.55	18.57
5	Toyota garage	4.66	36.42
6	Alsos fuil station	7.59	41.33
7	Primery school	6.62	30.05
8	Almgara restaurant	4.23	28.31
9	Bet sahor park	3.43	22.46
10	Average	4.33	27.11

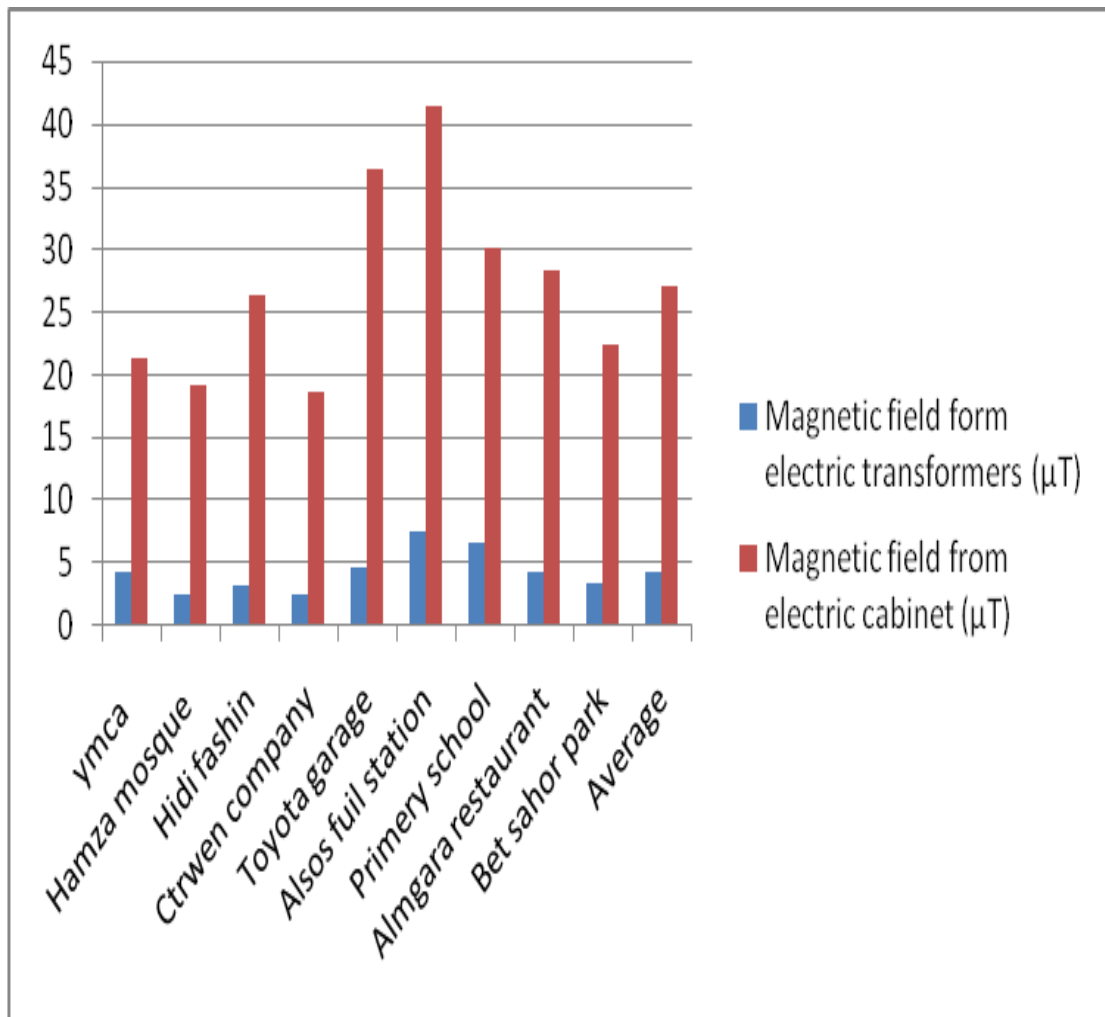


Figure 4.20: Present the magnetic field from electric transformers and electric cabinet in Aza camp

4.2 Conclusion

The magnetic field levels from high voltage power lines, electric transformer and cabinet are found in Bethlehem District. The average magnetic field from high voltage power lines is $0.60 \mu\text{T}$, this value below the limits recommended by ICNIRP.

The average magnetic fields levels from electric transformer are $3.81 \mu\text{T}$, this value is below the limit recommended by ICNIRP.

The average magnetic fields levels from electric cabinet are $28.38 \mu\text{T}$, this value below is the limit recommended by ICNIRP.

The maximum value of the magnetic field levels from high voltage power lines are ($2,77\mu\text{T}$), was found in Artas village, this value is below the limit recommended by ICNIRP.

The maximum value of the magnetic field levels from electric transformers are ($8,42\mu\text{T}$), was found in Aida Camp, this value is below the limit recommended by ICNIRP.

The maximum value of the magnetic field from electric cabinet are ($123\mu\text{T}$), was found in Dheisheh Camp, this value is above the limit recommended by ICNIRP.

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المؤينة، بينما بلغت القيمة القصوى للمجال المغناطيسي الناتج من المحولات الكهربائية ($8 \mu T$) وهذه القيمة أقل من (100 مايكرو تسلا) الحد الأعلى المسموح به حسب توجيهات اللجنة الدولية للوقاية من الإشعاعات غير المؤينة، بينما بلغت القيمة القصوى للمجال المغناطيسي من خزائن الكهرباء المرافقة للمحولات الكهربائية ($123 \mu T$) وهذه القيمة أعلى من (100 مايكرو تسلا) الحد الأعلى المسموح به حسب توجيهات اللجنة الدولية للوقاية من الإشعاعات غير المؤينة.

مستويات المجال المغناطيسي من خطوط الضغط العالي في محافظة بيت لحم

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إشراف الدكتور: عدنان اللحام

الملخص

أثبتت بعض الدراسات أن هناك علاقة بين المساكن المنشئه بالقرب من خطوط الضغط العالي وصحة الناس، وبسبب الحاجة الهائلة للكهرباء في حياتنا الحديثة أنشئت قرى تحت خطوط الضغط العالي. تهدف هذه الدراسة إلى قياس مستويات المجال المغناطيسي الناتج من خطوط الضغط العالي والمحولات الكهربائية وخزائن الكهرباء المرافقة للمحولات في 176 منطقة في محافظة بيت لحم، 100 موقع لخطوط الضغط العالي 76 موقع للمحولات وخزائن الكهرباء. هذه المواقع تشمل مراكز المدن ومناطق الإكتظاظ السكاني والمناطق الريفية. تم قياس المجال المغناطيسي على ارتفاع 1 متر عن سطح الأرض باستخدام جهاز NF 5030 ثلاثي الأبعاد الذي يستخدم لقياس المجال المغناطيسي في المجال من 0 Hz إلى 300 Hz وكان الوسط الحسابي للمجال المغناطيسي من خطوط الضغط العالي تساوي (0.6 μ T)، وكان الوسط الحسابي للمجال المغناطيسي الناتج من المحولات الكهربائية يساوي (4 μ T)، وكان الوسط الحسابي للمجال المغناطيسي الناتج من الخزائن الكهربائية المرافقة للمحولات الكهربائية يساوي (28 μ T) وهذه القيم أقل من (100 مايكرو تسلا) الحد الأعلى المسموح به للجمهور حسب توصيات اللجنة الدولية للوقاية من الإشعاعات الغير مؤينة. كانت القيمة القصوى للمجال المغناطيسي من خطوط الضغط العالي تساوي (3 μ T) وهذه القيمة أقل من (100 مايكرو تسلا) الحد الأعلى المسموح به حسب توجيهات اللجنة الدولية للوقاية من الإشعاعات غير