The Magnetic Fields of Mobile Phones
A Review of Protective Devices

Report by

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About the author

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Foreword

The past few years have seen a phenomenal rise in the number of mobile phones being used by people of all ages, accompanied by a corresponding rise in public concern over their safety. In this report, G. W. Crockford describes some of his research work with personal protective devices for mobile phones and his conclusions as to the effectiveness of these devices.

Crockford reaches the conclusion that "**Clearly, the most effective device for controlling the magnetic fields is the Mobile Protection Chip (MPC)**."

The adverse health effects generated by magnetic fields are thought to arise due to the varying flow of current through a phone, which causes the strength of the magnetic fields to vary accordingly. Consequently, most protective devices on the market are designed to remove magnetic fields. Central to the work reported by Crockford is the idea that different materials generate different magnetic fields, each requiring separate control, e.g. the magnetic field generated by iron differs from that generated by copper.

There are two approaches to the control of magnetic fields. One method of control is by means of a 'keeper', which casts a magnetic shadow or blocking field behind itself. In order to control all of the magnetic fields generated by a mobile phone, this 'keeper' would need to contain all of the elements and materials present in the phone, especially those contained in the electronic circuitry, e.g. to control a magnetic field created by silicon, one needs to incorporate silicon in the 'keeper'. The second approach to control of magnetic fields is to redirect them away from the user.

In the natural, undisturbed environment, the earth's energy fields are in balance. This balance is disturbed by man-made devices such as mobile phones, thus negatively affecting health, and any protective device must strive to restore this balance in some way.

There are a number of devices on the market designed to combat some of the emissions from mobile phones. Many of these had not been fully tested until now, thus making their standardisation very difficult. It appears that a lack of research into how the devices actually work, and how to engineer them to gain control of the magnetic fields, is the main reason for their respective deficiencies. The Crockford report has attempted to provide clear statements of how the devices work, and just how effective each one is. Crockford concludes by proposing that the principle on which the

devices work should be clearly stated and that the devices should be subjected to performance standards.

Table 1 (see page 10) from Crockford's report gives a summary of his results, based on the various elements for which the devices act as 'keepers'. Many of the devices protect against only a small number of the magnetic fields generated by the phone.

The most effective device for controlling the magnetic fields is the Mobile Protection Chip, a small device with minute fragments of natural gemstones mounted in plastic**.**

It should be noted that since Crockford completed his report, the number of gemstones in this device has increased from 8 to 9. As gemstones are derived from a wide range of elements, several of the elements in the phone can potentially be accounted for.

At the time of Crockford's study, the Mobile Protection Chip controlled the magnetic fields generated by a total of 13 elements and rebalanced the magnetic energy field, rendering it by far the most effective of the chips. Since then the elements contained in the chip have been increased to 19 in total*. The MPC also removes the diamagnetic field of the phone.

It is clear from Crockford's research that most of the devices on the market, **with the exception of the Mobile Protection Chip**, are not designed to control the majority of the emitted fields.

*The gemstones in the Mobile Protection Chip now contain the following elements: Phosphorus, Sodium, Calcium, Lithium, Magnesium, Iron, Aluminium, Boron, Silicon, Oxygen, Hydrogen, Zirconium, Chlorine, Titanium, Cadmium, Copper, Cobalt, Niobium and Tantalum.

Table of Contents

Abstract

Since 1998, a number of devices marketed to control the exposure of the user to 'deleterious' energies emanating from the ground and from electrical equipment have been studied. A theoretical basis for the 'deleterious' energies, the method of operation of the protective devices and one way by which the energies may affect people, has been developed. This is referred to as the Diamagnetic and Paramagnetic Theory of Dowsing. A synopsis of the theory is given in Annex 1.

The mechanism of operation and the performance of some personal protective devices have been reviewed.

It is concluded that although a few devices control the magnetic fields, i.e. 'deleterious energies', most achieve only partial control. It is proposed that personal protective devices for mobile phone users should be subjected to some degree of quality control so that the purchaser is aware of how the device works and of its anticipated performance.

The Magnetic Fields of Mobile Phones
A Review of Protective Devices

1. Introduction

For a number of years there has been public concern about the possibility of discomfort effects and health hazards associated with the electromagnetic radiation (EMR) and magnetic fields produced by mobile phones, electrical equipment and installations. Headlines such as 'Britain orders mobile phone health warnings' appear in the press. Statements such as 'there is too much uncertainty about the potential dangers of mobile phones for them to be classified as safe' indicate that the safety of mobile phones is of some concern. Amongst the scientific community, researchers study the exposure of people to magnetic fields, and the possible effects of these fields [1]. Oftedal *et al.* reviewed the health of mobile phone users [4] in a recently published book "Radiation at home, outdoors and in the workplace" [2]. This book covers many aspects of electric fields, magnetic fields and EMR, as regards to how they relate to biological systems. In particular, the non-thermal interactions between EMR and tissue are discussed by Persson ([2], p. 101). Three mechanisms are proposed as underlying the non-thermal effects of EMR. They are: resonant interactions, non-linear interactions, and co-operative interactions of electric and magnetic fields. In the context of magnetic fields, the non-linear interactions may be relevant. Persson suggests that the principal effects are:

- alteration of the transmembrane voltage
- alteration of the membrane conductance
- alteration and synchronisation of the firing activity in neuronal and pacemaker cells.

What appears to be happening is that a scientific or rational basis is being developed to enable investigations to be carried out into the mainly anecdotal information on ill-health associated with exposure to electromagnetic waves over the microwave frequencies (0.03 MHz to 300 GHz).

Microwaves have been referred to because they are associated with mobile phones and with the subjective health effects [4] ascribed to phone use. However, mobile phones also generate magnetic fields ([2], p. 453). The intensity of the magnetic field is inversely proportional to the cube of the distance from the source ([1], p. 649). In contrast, a square law exists for radiation emissions. This means that the intensity of

the magnetic field rises more steeply than that of EMR as the source is approached.

The sales literature associated with devices designed to protect mobile phone users from the deleterious radiation tends to be confused over EMR and magnetic fields. The following is a short review of the differences between them. According to Faraday's law, an electromotive force, EMF, is generated in an object exposed to a time-varying magnetic flux. The converse is also true. According to Ampere's law, a time-varying electric field always produces a magnetic field. This close association of electric and magnetic fields appears to lead some non-scientists to confuse EMR with the quite-separate electric and magnetic fields that may be associated with objects.

Electromagnetic waves always have an electric field perpendicular to a magnetic field and both are perpendicular to the direction in which the wave is moving. Vistness ([2], p. 115) listed the properties of electromagnetic waves which include a unique relationship between the magnitude of the electric and magnetic fields. If one is known, the other can be calculated. A wave also carries energy away from the source. Vistness pointed out that none of the above characteristics are valid for low-frequency electric and magnetic fields. Low-frequency electric and magnetic fields do not have any of the specific properties of electromagnetic waves. At low frequencies the electric and magnetic fields behave independently. Situations can arise where there is a strong electric field and a weak magnetic field, or vice versa. The electric and magnetic fields are not necessarily perpendicular to each other, neither do they remove energy from the source. Vistness showed that it is only correct to use the concept of a wave, and hence a photon, when at a distance of more than one wavelength from the source. The significance of this is illustrated by a mobile phone (900 MHz) where the wavelength used by the phone indicates that the near-field distance is 330 mm; for a FM radio transmitter (100 MHz) the distance is 3 m. When closer than these distances to the source, the electric and magnetic fields can be independent of each other. The term 'field' is used because energy is not removed from the source by either the electric or magnetic fields. When both are involved, the term 'electromagnetic fields' is used in contrast to electromagnetic waves and radiation. As Vistness ([2], p. 116) said, most who write about this area without a scientific background have yet to discover this distinction. The distinction is critical in the present context because:

a) the basis of the control technology for magnetic fields is quite different to that for the control of electromagnetic radiation, and
b) the human sensory systems only appear to respond to magnetic fields of a specific type.

The importance of this is that close to electrical appliances the electric and magnetic fields are not closely related and act independently. ‘Close to’ in this context can be many kilometres.

It is therefore possible that within and away from the near field, electrical equipment, (mobile phones included) exposes people to two elements, EMR and magnetic fields. If the two are not separated, or at least quantified, it will be difficult to ascribe subjective or health effects to either one. It appears that studies to date do not separate the EMR from the magnetic fields, although some research looks specifically at strong magnetic fields ([2], p. 371).

The study of magnetic fields is complicated by there being several forms of magnetic field, each of which has its origin in different parts of the atom or molecule, although all derive from electrons or the nucleus. There are different forms of magnetism, including diamagnetism, where the induced magnetisation is in the opposite direction to that of the applied field. All substances are diamagnetic. Paramagnetic fields are generated when the atoms and molecules have spin or orbital magnetic moments that can be aligned in the direction of the applied field. All atoms and molecules with unpaired electrons are paramagnetic (see Annex 2).

Other forms of magnetism are ferromagnetism, anti-ferromagnetism and ferrimagnetism. Magnetism is dealt with to some extent in physics and chemistry texts, some of which are listed in the references [5–8].

It appears to be a commonly held belief that the above terms only apply to the matter or substance that is giving rise to the magnetic field. The assumption is then made that all magnetic fields are the same, except in terms of strength. In dealing with magnetism, one of the important conceptual advances of the 19th century was the realisation that “whatever the cause of magnetism, the manifestation of magnetic force took place in the medium surrounding the magnet. This manifestation was the magnetic field and the energy of the magnetic system was in the field, not in the magnet” ([9], p. 98). The importance of this concept lies in that it is necessary to deal with the field, and not with the physics of the matter giving rise to the field, in order to explain magnetism. This may not be strictly correct, as an understanding of how the movement of electrons and their position in atoms, molecules and conductors may help in understanding the properties of magnetic fields but it is the properties of the fields that need to be studied. Central to the work reported here is the idea that there are differences between the fields generated by different materials; i.e. the diamagnetic fields differ from the paramagnetic fields, which differ from ferromagnetic fields. The differences between them have enabled animals, including man, to develop a sensory

system for the diamagnetic fields and another for the paramagnetic fields (Annex 1).

Whilst the association of EMR and EMF with ill-health and disease is still a matter of debate, the effects of magnetic fields on animals and people are well documented and easily demonstrated ([7], p. 210; [10]). There are specialists who train and use their magnetic sense for specific purposes, e.g. water divining [14], site surveying including archaeology, detecting ill-health, reflexology, and research [10, 11]. The magnetic sense, like the other senses, can be trained to be more acute and informed. The techniques developed by dowsers enable a considerable amount of information to be obtained from the paramagnetic and diamagnetic fields. The most obvious response to a magnetic field is the muscular reflex set off as the dowser crosses a magnetic discontinuity or gradient. It is the muscle reflex that is amplified by the device being held such as a pendulum or rods. Many dowsers are aware of the field before the rods or pendulum respond and some are extremely sensitive to fields and have no difficulty in picking up underground water and post holes using the sensation created in the body by the associated fields. There is a range of sensitivity to magnetic fields within a population. At one end of the range, many people appear to have no sensitivity to diamagnetic and paramagnetic fields. At the other end, there are individuals who can identify the magnetic anomaly left by wooden posts from around 3000 years ago. In terms of health effects, the same range of sensitivity might be expected.

In spite of the well-documented record of human sensitivity to magnetic fields, their role in health and well-being has attracted little systematic and structured scientific investigation. This is probably because the energies that the dowser responds to, and those purporting to cause discomfort and health effects, are referred to by a number of descriptions such as earth energies, negative influences, geopathic stress, the confusion between magnetic fields and electromagnetic radiation, the concept of balancing fields and radiations. However, the most important reason is probably that there has been no underlying theory of the physical forces and biological mechanisms involved. Such an underlying theory is essential if meaningful experiments are to be designed and executed. It is necessary to have an underlying theory in order to conduct such a simple process as the testing and evaluation of devices to protect mobile phone users against poorly defined emissions that have not been adequately explained. The theory used in the present study of these devices is the diamagnetic paramagnetic theory of dowsing, a synopsis of which is given in Annex 1. A full account of the theory and the experimental support for the theory will be published in 2002.

2. The Control of Emissions from a Mobile Phone

Mobile phones receive and transmit EMR at selected frequencies. This EMR is used to carry signals, which, in the case of the phone, include the voices of the users. Any interference with the EMR used by the phone for carrying speech would affect its performance and use. Because of this, a device for protecting the mobile phone user against EMR must not interfere with the incoming or transmitted carrier waves. The carrier waves used for speech transmission contain most of the radiant energy associated with the phone, and it is this EMR that is considered by one body of opinion to cause harm to the user. There are exposure standards to protect people from excess exposure to microwaves, but the present report does not consider devices for controlling EMR.

Magnetic fields are associated with all materials, the flow of electric currents and magnets, two of which are used in the phone. In the case of permanent magnets, the fields will be static. Where current flow varies, it would be reasonable to expect the associated magnetic fields to vary in strength accordingly. The adverse health effects associated with mobile phones are believed by some to be due to these magnetic fields and the frequency with which they vary.

A third field associated with the phone is that due to the electro potential gradients between it and the user. Due to the low voltage used (phones are battery powered), these are not normally considered to be of any health significance.

Of the three fields associated with the phone, the EMR field, i.e. that associated with the carrier waves, is central to the functioning of the device. The magnetic fields are associated with electron movement, permanent magnets, and the materials used in their construction. These fields are, in a sense, a by-product and, with the exception of the fields required for the functioning of the speaker and microphone, can be removed without affecting the performance of the phone. A device protecting the health of the user would therefore be expected to remove magnetic fields but not EMR.

There are devices on the market that claim to provide the phone user with some protection from the electromagnetic emissions of the phone. They apparently act as aerials that block and cast an EMR shadow towards the users head. Interference with transmission and reception is said to be minimal.

Magnetic fields fall into three main groups, according to their origin within the atom

and molecule. They are ferromagnetic, paramagnetic and diamagnetic fields. The mobile phone produces all three. There is little indication that ferromagnetic fields are detrimental to health and they are in fact used for magnetic therapy. The other two fields are believed by many people to have both good and bad health effects. People are sensitive to these two fields.

One concept in the literature associated with protective devices is that of balance. The idea appears to be that in the natural undisturbed environment, the earth's energy fields are in balance. The damage caused by man-made sources of magnetic fields is said to be due to this balance being disturbed, and the protective device helps to restore the balance in some way.

Any protective device would be expected to control either the paramagnetic or diamagnetic fields or both. These fields are characteristic of their origin, e.g. aluminium, iron and silicon each produce quite different paramagnetic fields, requiring separate controls. This is easily demonstrated by using a piece of aluminium, iron or silicon as a 'keeper' across the field. A magnetic shadow is then cast behind the 'keeper'. In order to control the paramagnetic fields from a mobile phone, the 'keeper' would have to contain all of the elements and materials present in the phone. In practice, complete coverage may not be required as some fields are likely to be weak. Importantly, the device should contain those materials present in the electronic circuitry of the phone. The power of the paramagnetic fields from these components increases greatly when the phone is switched on.

A second method of controlling paramagnetic fields is to generate an opposing diamagnetic field. The paramagnetic fields will then lie at right angles to the diamagnetic field. This control mechanism is used in devices such as the Raditech. The device is plugged into the ring mains of a house or factory and the copper wire of the electric circuitry acquires a diamagnetic field which directs the paramagnetic fields vertically. The fields therefore appear to disappear but can be detected by walking across them. The device works on the basis that there is a neutral wire attached to the diamagnetic pole of a coil or magnet. That a diamagnetic field is involved can be demonstrated by connecting the north pole of a magnet to the neutral of a 13-amp plug and then plugging it into the ring main. The connection between the magnet and the 13-amp plug can be a piece of string, which is a conductor for diamagnetic fields. Organic molecules are diamagnetic due to the electron cloud around the molecule. Long straight molecules make excellent conductors of diamagnetic fields, which can be conducted along many meters of string. There must be physical contact in order to transfer a diamagnetic field from one conductor to another. A cigarette paper, for example, in which the organic molecules are arranged randomly, will block the trans-

fer of the field. A paramagnetic field will jump such an obstacle, as will a ferromagnetic field. A simple ring of copper wire generates a sufficient diamagnetic field to change the direction of paramagnetic fields.

In summary, there are two approaches to the control of paramagnetic fields. One is to attract them to a keeper, which casts a magnetic shadow. The other is to redirect them using the rule that paramagnetic fields normally lie at right angles to a diamagnetic field. Unfortunately there are exceptions to this rule.

3. Health Effects of Magnetic Fields

There is a small industry based on the concept that magnetic fields can improve health and lead to the rapid healing of injuries. Magnetic therapy (magnotherapy) is an alternative health field in its own right. The physical basis for the therapy is the ferromagnetic fields associated with magnets. The author is unaware of any therapy based on the diamagnetic or paramagnetic field of the magnets. Magnets do have both of these fields, with the diamagnetic axis having the same axis as the ferromagnetic field.

People respond to the very weak magnetic fields associated with both the ground they are walking over and with electrical equipment. When the source is the ground, it is not unknown for people to vacate their house and only return when the ‘energies’ have been removed, controlled or suppressed in some way. There has been much research carried out to find associations between, on the one hand, disease, ill-health, and changes in the performance of psychomotor tasks and, on the other hand, the presence of sources of EMR and magnetic fields. To date, the work has raised much public concern but has made only limited progress in identifying if health hazards exist and the possible physical and biological mechanisms that are involved. The clearest evidence of weak magnetic fields having an influence on people comes from non-mainstream scientific research by amateurs. Mr W. Gawn [10] on many occasions has demonstrated in public the influence of deleterious energy (diamagnetic fields) on muscle strength. The reproducibility of dowsing responses when dowsing for underground artefacts and streams clearly demonstrates the ability of some people at least to detect weak magnetic fields. In recent work, J. Keen used a quantitative approach to investigate dowsing [12] and to characterise the strength of fields in relation to the mass of the source. In 1993, Reddish [11] published his research on the nature of the field to which dowsers respond. In the foreword to the monograph, Reddish states “I believe that any professional scientist carrying out these experiments will share my conclusion that we are dealing with a real physical force, as real as

gravity and magnetism, not some mysterious psychical effect outwith the bounds of physics, as has sometimes been supposed". It is one thing to demonstrate a physical basis for a phenomenon but quite another to link that physical basis to ill-health and disease. At present, in the view of the author, the jury appears to be out on the issue, although some would strongly contest this view.

The linkage of magnetic fields to subjective feelings and physical effects is much clearer. The whole field of dowsing and its associated health disciplines are based on this relationship. It is therefore possible, the author believes, to say that certain magnetic fields give rise to subjective feelings that people can use, e.g. for water divining, or that they would rather be without. But at present, it is not possible to say that exposure to the fields will lead directly to ill-health. Like infra sound, ultraviolet light, and many other phenomena, magnetic fields are sensed subliminally, but that does not mean that they cannot affect the exposed person either physically or psychologically. Exposure to diamagnetic and paramagnetic fields is increasing all the time. Those from base stations appear to be strong and need to be assessed but they are not the only source. Diamagnetic fields are associated with electron spin and there is the possibility of a new technology based on spinning electrons. Will it produce even more diamagnetic fields? There is clearly a need to understand:

a) the relationship between magnetic fields and the biological systems and psychological functions that may be affected by them, and
b) magnetic field control technology.

This view is perhaps supported by the Sir William Stewart report [15], which, in referring to radio frequency radiation, says that there is scientific evidence suggesting that there may be biological effects occurring at exposures below those given in the guidelines. The suggestion is made because populations are not genetically homogeneous and people vary in susceptibility to environmental hazards. Because of this, additional factors need to be taken into account in assessing possible health effects that may not lead to disease. Although referring to EMR the report would also appear to apply to magnetic fields.

4. Review of Personal Protective Devices for Mobile Phones

Synopsis of Tests

Over the past few years, the present author has been sent a number of devices designed for mobile phones which are said to provide the user with protection against deleterious radiation. The devices received included those referred to as:

Wave Shield
Raditech
Vector 100
Techno AO antenna
Bio electric Shield
Techno AO for mobile phones
Compu Shield and Phone Dome
Mini Rayonex
Safety Butterfly
MPC Chip

Not all of these devices have been fully tested but all have been assessed to some extent. The testing procedure for personal protective devices is given in Annex 3 and involves dowsing the magnetic fields emitted from the protective device and the mobile phone. The results are presented in Table 1. It should be noted that when a field is referred to as carbon, iron, etc., it is not saying that the origin of the field is carbon or iron, only that it dowses as if it is. The use of a 'witness' cannot unequivocally identify the source of the field. However, the accuracy of the technique is high.

Some devices, such as the Wave Shield, are specifically designed to protect against EMR and not magnetic fields. The Wave Shield is composed of a wire gauze of fine construction said to block EMR of the wavelength generated by mobile phones. However, the materials contained in the device should lead to the blocking of some of

Table 1. Summary of the magnetic fields controlled by devices designed to protect mobile phone users from deleterious energy emissions from the phone.

Device	C	Fe	Co	Al	Cu	Na	K	Ti	Cr	Pb	Sn	OH^-	Ni	Cd	Si	Ta
Mini Rayonex	√	√					√	√		√			√		√	
MPC	√	√	√	√	√	√		√	√	√	√		√	√	√	
Phone Dome	√	√		√											√	
Safety Butterfly	√			√	√	√										
Techno AO		√		√	√	√								√	√	
Vector 100	Diamagnetic field not sufficiently strong to control fields during a call															
Wave Shield	No effect on the magnetic fields															

C, Carbon; Fe, Iron; Co, Cobalt, Al, Aluminium; Cu, Copper, Na, Sodium; K, Potassium; Ti, Titanium; Cr, Chromium; Pb, lead; Sn, Tin; OH^-, the hydroxide ion; Ni, nickel; Cd, Cadmium; Si, Silicon; Ta, Tantalum.

the magnetic fields associated with the mobile phone. The Raditech is a large, non-personal device that, when connected to a household 13-amp ring mains, provides protection against fields generated by electrical equipment. The device works by setting up a diamagnetic field in the ring main which directs the paramagnetic fields vertically and hence away from the person. It does this very effectively. The Vector 100 appears to work on the same principle. When fixed to the mobile phone, the paramagnetic fields are directed along the axis of the phone. The Vector 100 appears to contain copper and a loop of copper wire, which, because it is diamagnetic, has the same effect on its fields when affixed to the phone. Because of the principle upon which it is based, the Vector 100 is effective in controlling the fields when the phone is not being used but it does not appear to be strong enough to control the fields when a call is made. A copper wire loop itself, however, does control the fields during a call. Only one sample of the device was assessed in carrying out the tests, so the lack of control of fields when the device is in use should be confirmed on more samples. The design of the device appears to be sound.

The Techno AO antenna is a large device intended for use on the screens of TV sets and word-processing units. It appears to be effective on such equipment, blocking the paramagnetic field emissions from iron and copper. The size of the device, which is based on two aluminium tubes containing solutions of salts, renders it unsuitable for use in mobile phones, and the Techno AO does not control the fields emanating from them. Its interest in the present context is that devices can be engineered to deal with specific problems, such as those relating to VDUs.

A Techno AO for mobile phones is available on the market. The device is said to protect from the harmful biological effects of EMR. It is “an ultra low intensity autonomous magnetic oscillator with no electronic components”. The manufacturer claims that the magnetic oscillator ensures electromagnetic biocompatibility between the mobile phone and the user. When attached to a Panasonic mobile phone, the device blocked the fields due to aluminium, copper, cadmium, iron, sodium, silicon and polythene, seven out of about 14 fields associated with the phone. The fields dowsing as if due to carbon, cobalt, hydroxide, lead, nickel, tantalum and tin were not controlled by the device.

The Compu Shield and Phone Dome are designed for computers and mobile phones, respectively. The devices appear to be based on the use of small pieces of crystals which attract magnetic fields. The results of the test are given in Table 2, in order to illustrate the test procedure. It must be emphasised that when a dowser is using a witness to identify a material, it is the field that is being identified and not the material. It is possible for a material to have a field similar or identical to that of another material

and be mistaken for it. The fields due to polythene, aluminium, iron, silicon and carbon were blocked by the Phone Dome. Those due to copper, cadmium, nickel, lead, tin, sodium, cobalt, hydroxide and, when tested for later, tantalum were not blocked by the device.

The distances at which the fields generated by the phone could be detected were measured in the 'off' and 'on' standby state. The distance changed from nearly 4 m to over 16 m. This indicates a 16-fold increase in power based on the inverse square law, but even more if the fields follow an inverse cube law. When a call was being made, there appeared to be no increase in magnetic field strength.

The Mini Rayonex is too large to be placed on a phone (55 × 95 × 20 mm) but the makers claim that it provides protection if placed in the pocket or brief case. It is unusual in that it appears to have eight paramagnetic axes. When placed next to a mobile phone, it blocked seven out of the 14 fields.

The Safety Butterfly is said to protect against electromagnetic fields. The sales literature indicates that the electromagnetic emissions from biological systems clash with EMF from artificial sources. This can alter the cell itself. The literature claims that the Safety Butterfly protects against electromagnetic waves at high frequencies. There appears to be some confusion in the sales literature between fields and waves. However, it claims to work by deflecting waves away from the user of the phone. This would need to be confirmed by an expert in EMR technology. At the wavelength used by the phone, the device is mounted in the near field of the radiation. The device is not engineered to control the magnetic fields and consequently it fails to block nine of the mobile phone fields.

The Mobile Protection Chip is a small device with minute fragments of eight natural gemstones mounted in plastic. The device is claimed to protect phone users from magnetic fields. Gemstones are derived from a range of elements and it would be expected that if eight are used, they would contain a number of the elements present in the 'chip'. This proves to be the case.

Most of the fields from the phone were blocked by the MP Chip; those that were not blocked were due to hydroxide, polythene and tantalum. Because of its method of construction, the MP Chip is the most effective device for controlling the magnetic fields. The Vector 100 controls the fields when the phone is on but not when it is being used. The technology used appears to be sound, so the failure to control the fields when the phone is being used may be due to poor quality control of the prod-

Table 2. Field Analysis of a Mobile Phone and a Phone Dome.

	Phone off	Phone on	Phone Dome	Fields from Phone Blocked by Phone Dome
Ag				
Au				
C	+	+	+	√
Fe	+	+	+	√
Co	+	+		
Al	+	+	+	√
Cu	+	+		
Ca			+	
Na	+	+		
K			(+)	
Cl				
F				
Ti				
Cr		+		
Pb	+	+		
Sn	+	+		
Zn				
OH	+	(+)		
Polythene	+	+	+	√
Nylon				
Polyester			+	
Ni	+	+		
Cd	+	+		
Si	+	+	+	√

uct. The MP Chip also removes the diamagnetic field of the phone. The Vector 100 did not appear to do this.

Paramagnetic fields are controlled by using the equivalent of a magnetic keeper. Just as a ferromagnetic field from a magnet will go through a piece of iron placed across the North and South Poles, so too will a paramagnetic field from, e.g. aluminium, be attracted to a piece of aluminium, and a copper field to a piece of copper. The ability of the so-called protective devices to control paramagnetic fields is determined quite simply by the elements present in them. In the context of a mobile phone, there are approximately 15 paramagnetic fields. All of the elements and materials producing these fields, or at least a substantial proportion of them, must be present in the protective device if protection is to be provided. The use of crystals may enhance the performance to a certain extent in that, for example, quartz attracts iron fields when there appears to be no iron in the crystal.

When first introduced to mobile phone personal protection devices, it was apparent that there was no clear statement of exactly what it was they were controlling and how. There was no performance standard against which they could be tested or judged. In this respect, the devices appeared to differ from practically every other product on the market. How could the purchaser be sure what exactly it was they were to be protected against, and that protection was achieved?

Without instruments capable of measuring diamagnetic and paramagnetic fields, the standardisation of products may at first seem impossible. However, the food and drinks industries have a similar problem with quality control. The industries solve their problems by using people specialised in tasting and smelling the products, i.e. they use a sample of the people that are going to consume the products to control the quality. The same approach could be used for mobile phone personal protective devices and other similar products. All that is required is that the device's efficacy at controlling magnetic fields is confirmed by a panel trained to assess the performance of such devices.

5. Discussion

With the exception of aerials designed for microwave emissions, the personal protective devices on the market appear to be attempting to control the magnetic field emissions of the mobile phones by attracting the fields or redirecting them. Those attracting the fields, with the exception of the MP Chip, are not designed to control the majority of the emitted fields. The result is that when placed on the phone, a

dowsing response is still obtained when crossing the paramagnetic axes. The user will therefore be exposed to a field that may give them the symptoms described in the sales literature of the devices. When considering the coverage of fields achieved, it appears that the manufacturers are not adequately aware of how the devices work and of how to engineer them to gain control of the magnetic fields.

The devices using diamagnetic fields to control the direction in which the paramagnetic field axes lie would be expected to work on most mobile phones. They do not however appear to control the diamagnetic field. If this field is not directed towards the user of the phone, then perhaps there is no need for control. The deficiency does point towards a need to know the diamagnetic axis of a phone with this type of device. The manufacturers producing aerials to control microwave radiation do not claim, as far as can be determined, that magnetic fields are also controlled. They do not explain, however, how their device works in the near field. It may be that they deal with high-frequency harmonics which are outside the near field, but this does not appear to have been explained.

The manufacturers of devices attracting magnetic fields often claim that the EMR is also controlled. They do not explain how this can be achieved by the device.

In testing and assessing protective devices for mobile phones, the most outstanding deficiency has been the lack of clear statements on how the devices work, of performance standards and how the performance of the device can be tested. The manufacturers cannot necessarily be blamed for this as the theory of dowsing is poorly developed. However, it is not necessary to have a theory of taste or smell to tell if milk is good or not. The performance of devices can quite simply be determined by placing them on a phone and testing to determine if the fields are controlled or not.

The diamagnetic–paramagnetic theory of dowsing provides a rational basis for the subjective effects associated with mobile phones, the magnetic emissions and their control. The theory is based on experiments that can be repeated. It is also based on current knowledge of physics and chemistry, and to date it has been able to explain every dowsing phenomenon that the author has investigated. The experiments have to be repeated by others and the theory validated. Importantly, at present it provides the only scientific tool for investigating the boundary between hard science and the ‘harder’ aspects of the paranormal, such as main-line dowsing and deleterious energy protective devices.

6. Conclusions

The devices on the market that are designed to control magnetic field exposure from mobile phones, and that have been investigated or assessed by the author, vary considerably in their effectiveness. It is proposed that they be subjected to performance standards, and the principle upon which they work clearly stated.

Studies of the health and subjective effects of mobile phones on users should clearly define whether the exposure of subjects is due to EMR, magnetic fields, or both. Humans have a sensory system sensitive to some types of magnetic field. Magnetic fields can possibly have a direct effect on biological systems and or an effect through the sensory system. This must be recognised in future research.

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Annex 1

A Synopsis of the Diamagnetic and Paramagnetic Theory of Dowsing

The author, on entering the field of dowsing in 1995, found that there was no theoretical basis for either the energy fields to which the dowser was responding, or the sensory system(s) that was responding to them. There appeared to be general, but by no means complete, acceptance that the energy field was magnetic in nature. This view was reviewed by Bird in his book 'The Divining Hand' [13]. In Chapter 14, Bird considered the evidence supporting the involvement of magnetic fields. He referred to the work of Harvalik in the 1960s and 1970s. Harvalik, following experimental work, concluded that there is a sixth bodily sense in humans for detecting changes in magnetic fields, and that dowsers may potentially be the world's most sensitive magnetometers ([13], p. 262). Harvalik deemed the sensor to be in the head.

It seems odd that Harvalik's work was not developed. However, the fact that dowsers would, on the one hand, not respond to quite large magnetic fields, while on the other hand would respond to other fields that were so minute that they were immeasurable by normal physical methods at the time, created confusion and doubt.

Perhaps what was not appreciated was that if a sensory system is to be developed by an organism, it would aim at the energies that contained the most relevant information for the organism. The ferromagnetic field of the planet, although very strong compared with other fields, contains little information. The sensory system might therefore be blind to the strong magnetic fields, while showing the sensitivity of the other five senses to the very low energy levels associated with diamagnetism and paramagnetism. Another factor holding back research is that it appears to be a common conception that magnetism is a homogeneous force. This is not the case, as text books and physical data on the magnetic properties of materials refer to a number of forms of magnetism. The author's main research has therefore been directed at identifying the magnetic fields to which the dowser responds and the features of the sense organs involved.

The initial important observation was made when the author was dowsing the north and south poles of a magnet at shoulder height in a glass-fronted kitchen cupboard. The north and south poles were being identified when the dowsing response disappeared. This was difficult to understand, so the author proceeded to walk back and forth, and 2–3 minutes later the dowsing response returned. On opening the cupboard

to change the magnetic pole facing the author, it was found that the magnet was no longer behind the glass and had fallen down behind the wood frame. Knowing that wood did not block ferromagnetic fields, it was clear that another form of magnetism was involved.

All of the work carried out by the author to date very clearly indicates that the dowser is not directly sensitive to ferromagnetic fields, hence his 'blindness' to strong fields. This can be demonstrated by asking a dowser to identify which pole of a magnet, placed at shoulder or head height approximately 2 m from him, is facing him. Most dowsers will:

a) identify a field as they pass the magnet;
b) identify if it is north or south based on whether the rods close or open.

If a wooden bread board or cork mats are now placed in front of the magnet, the dowser can no longer identify the field or its polarity. After a period of time, the field from the magnet will penetrate the cork or wood and the dowser can again identify it. The ferromagnetic field immediately penetrates the barrier and can be identified using a compass. The dowser is sensitive to diamagnetic fields (the weakest of the magnetic forces) and paramagnetic fields. The presence of the diamagnetic field can be demonstrated by placing a diamagnetic material between the magnet's north pole and the dowser. A diamagnetic material moves away from the applied diamagnetic field because of Lens' law, i.e. a north pole develops to face the north pole of the applied field. This means that the side of the material facing the dowser is now a south pole. As all materials are diamagnetic, a sheet of plastic, aluminium foil, or steel can be used to demonstrate the apparent change in polarity of the magnet.

The paramagnetic field of the magnet, which is at right angles to the diamagnetic field, does not have its polarity reversed by a sheet of plastic. It does however penetrate wood and cork more readily than the diamagnetic field.

The next question was whether there were one or two magnetic sensors. Because diamagnetic fields are easily blocked by mats of chaotically arranged organic fibres such as cork mats, and by wood with the grain at right angles to the field, it is possible to collimate the field from a diamagnetic magnet, such as a pure sodium chloride crystal. If the collimated beam is set up at different heights and the dowser walks through the beam, a dowsing response is only obtained when the beam is at head height. It was later found that the diamagnetic axis of a cut sapphire, which comes out of the top of the stone, could also be used to demonstrate that the sensor was in the dowser's head. Thrusting the hands into the diamagnetic beam did not produce a response.

Gawn's work [10] on muscle responses to diamagnetic fields confirms this observation. Gawn has shown that the deleterious (diamagnetic) energy does not act on the muscles directly but on a sensor in the dowser's head.

A similar experiment can also be carried out using a paramagnetic beam. More material has to be used to collimate the beam but this time a dowsing response is obtained regardless of the body part that enters the beam, apart from the head. A dowsing response is obtained if the hands are thrust into the beam. The dowsing response does not confirm that a sensory system is involved. However, if one hand is cooled below 10°C when the sensory nerves can no longer function, tested with a pin, and the hand is then inserted into the paramagnetic beam, no dowsing response is obtained. The response returns much later as the hand warms up. The same experiment can be conducted with an arterial occlusion at the wrist. As the sensory nerves in the hand fail, so the dowsing response disappears. Recovery of the dowsing response is rapid on removal of the cuff.

If there are sensory systems for diamagnetic and paramagnetic fields, then their response to the strength of a field can be assessed. One feature of the dowsing response is that it is there or it is not, i.e. it is quite good at giving a yes or no response. If the strength of a paramagnetic field, say from iron nails, is increased by increasing the number of nails, the distance from the nails at which the dowser responds increases. J. Keen [12] reported results on his studies using various materials and found that the detection distance increases with mass. If the same experiment is repeated but, instead of adding more nails, aluminium, copper and other materials are added, the detection distance does not increase, i.e. if nails detectable at 3 m are added to aluminium rods detectable at 3 m, there appears to be little, if any, change in detection distance. If the diamagnetic axes of the nails and other materials are used, there is an increase in the detection distance. The two sensory systems appear to work differently. This work on the sensory aspects of the magnetic sense is at a very early stage but it is indicating that the two systems have different biological functions. It also shows that in carrying out research into dowsing, the researcher has to be clear as to the relevant fields and the sensory system involved.

To summarise, the dowser appears to respond when cutting field lines at particular angles. There appears to be a sensor in the dowser's head responding to diamagnetic fields, the rest of the body is sensitive to paramagnetic fields. The dowser is able to sense what is called the polarity of a field, i.e. whether the field is from the north or south pole of the source. Because the dowser responds when cutting field lines at certain angles, e.g. at 90°, 45° and at a tangent, dowsing is remarkably directionally sensitive, not as good as sight but probably better than hearing and smell. Just as with the

other senses, there is a considerable element of skill in obtaining information from the dowsing sense and it also appears to be possible to focus the attention in a manner similar to the other senses. The sensitivity of the dowsing sense in terms of the energy levels to which it responds is almost certainly at the same level as that of hearing and sight.

The underlying theory for dowsing research and the procedures used by the author is that:

a) All dowsing phenomena are due to diamagnetic and paramagnetic fields.
b) Paramagnetic fields are characteristic of their source. This does not rule out different sources having the same paramagnetic field however.
c) All materials are magnetic, generating diamagnetic fields, and most generate paramagnetic fields as well.
d) The diamagnetic and paramagnetic fields developed by a material tend to oppose each other and are at right angles to each other.
e) The paramagnetic fields do not appear to interfere with one another and they retain their identity. The dowser will however 'see' some combination of fields as something else and will not be able to distinguish them as separate fields.
f) There are commonly two paramagnetic axes at right angles to each other but some rocks and man-made devices have more than two.
g) The dowsing sensory system is directionally sensitive and has a sensitivity to energy of the same order as other sense organs.
h) The detection distance of a specific field is determined by the mass of material giving rise to the field; the sensory system for paramagnetic fields does not summate different fields.
i) There appear to be separate sensory systems for the diamagnetic and paramagnetic fields. The head contains the sensor for diamagnetic fields.
j) The use of witnesses allows the dowser to focus on specific magnetic fields and identify their source. There is however an interaction between some fields, which can confuse the dowser.

It has been noted that the paramagnetic sensory system does not add different fields together. If this was true, it would indicate an extremely complex sensory system able to distinguish thousands of different fields. This is not likely to be the case and some fields are likely to be seen as the same, and together will increase the detection distance.

Annex 2

Diamagnetism and Paramagnetism

The magnetic properties of materials are due to circulating and spinning electrons within the atom and molecule.

When a magnetic field is applied to a diamagnetic material, the induced magnetism is in the opposite direction to the applied field and the material will therefore move away from the applied field. All substances have a diamagnetic contribution to their magnetic susceptibility. As atoms and molecules contain circulating and spinning electrons, the electron, as a result of the orbital and spin motions, possesses a resultant magnetic moment. In a diamagnetic atom, these contributions to the magnetic moment cancel out. In a paramagnetic atom, there is a residual resultant magnetic moment that will cause the magnetic field of the atom to line up with the applied field. However, thermal motion tends to prevent this so that paramagnetism is still a weak form of magnetism at normal temperatures.

Annex 3

Mobile Phone Test Procedure

This review of devices designed to protect the users of mobile phones from what are referred to as deleterious magnetic fields considers reports prepared over a number of years. During this time, the methods and procedures of testing have developed and changed. The following is an outline of the latest methods used by the author. It is based on the concept that a device such as a mobile phone:

a) emits paramagnetic fields characteristic of the materials used in its construction;
b) has fields that increase in power when the phone is in use;
c) has fields with magnetic axes, of which there may be several.

Experience to date indicates that there may be only one diamagnetic axis.

The Mobile Phone

With the phone switched on to receive, the first step is to identify the magnetic axes of the phone. It is recognised that this is not always easy and some axes may be close together. It may be later in the study that an axis is identified.

The second step is to use witnesses to identify the origin of the paramagnetic fields. For example, the following elements and substances could be used on each of the axes in turn.

Aluminium	Nylon
Carbon	Nickel
Calcium	Potassium
Cobalt	Polythene
Copper	Polyester
Chromium	Sodium
Cadmium	Silicon
Gold	Tantalum
Hydroxide radical	Tin
Iron	Titanium
Lead	Zinc

The procedure is to walk across the field axis. If the element of the witness, e.g. lead, is present in the phone, then it should be identifiable in one of the paramagnetic axes.

Once an element has been found to be present in an axis, the witness is placed between the phone and dowser. This prevents the lead field (in this case) from reaching the dowser. When all fields on an axis have been blocked by witnesses, the axis disappears and there is no dowsable energy left, and the next axis can be tested. The procedure is repeated for all paramagnetic axes until the composition of the phone is determined. Once this has been accomplished, witnesses for all of the materials found are placed close to the phone and the diamagnetic axis is checked. It should have disappeared. If not, it may indicate that all paramagnetic fields have not been identified.

The above procedure is made easier if information can be obtained from the manufacturer on what materials are used in the phone.

Having identified the sources of the paramagnetic fields, it is possible to determine the sources that may be electrically active by walking towards the phone using a witness and noting the distance at which a field, say for copper, is detected. This is accomplished with the phone switched on and off. For electrically active components, there should be an increase of two or three times or more in the distance at which the fields can be detected.

The Control Device

The next stage is to determine the elements and materials present in the field control device being investigated. If the device is based on crystals or has some magnetic polarity, it may be possible to identify paramagnetic and diamagnetic axes. These axes can then be used to determine the composition of the device. If not, the device is placed in a diamagnetic field to generate paramagnetic field axes. The procedure is the same as with the phone. A list of elements and materials is drawn up and compared with those in the phone. If the device is mounted on the phone, the materials it contains should block their respective fields. The fields that are not blocked can be checked for using witnesses. A poorly designed device will control few of the fields, whereas a well-designed device will control most of them.

Annex 4

Dowsing for Diamagnetic and Paramagnetic Fields

The dowser responds to a paramagnetic field when cutting it at certain angles, e.g. when walking forward normal to the field lines, when cutting them at 45°, and at a tangent. The dowser also responds when walking along the magnetic axis. A paramagnetic field can therefore be recognised when a response is obtained when cutting the magnetic axis at right angles and when walking along the axis. The rods will open in one direction, while in the other they close. The field is not easily blocked by 2–3 mm of cork and can be detected by the dowser pushing the hands and arms forward into it. The polarity of the field is not, however, changed by a sheet of plastic, aluminium or steel placed between the source and dowser. A diamagnetic field produces a response when cut at right angles but there is no response when walking along the axis towards or away from the source. When cutting the field at right angles, the polarity appears to change if a sheet of plastic, aluminium or other material is placed in front of the source. This is because the surface of the sheet facing the field adopts the same polarity as the source, and the side facing the dowser becomes the opposite pole. The dowsing response is not obtained by pushing the hands and arms into a diamagnetic field; the head has to enter in order to obtain a response. Paramagnetic fields appear to be sensitive to and are moved by diamagnetic fields. For example, the paramagnetic field from a quartz crystal is pushed to one side by the axis of a diamagnetic field from a sapphire or sodium chloride crystal. The diamagnetic axis of one field does not appear to be changed by another diamagnetic field. The above is based on present experience and does not mean that strong paramagnetic fields will be moved by much weaker diamagnetic fields.

Annex 5

Witnesses and their Use

When holding in one hand a piece of material such as iron or aluminium, the dowser appears to be blind to all paramagnetic fields apart from that, or those, of the witness being held. This phenomenon can be used to identify the paramagnetic fields from an object. Witnesses are seldom pure materials, and some care has to be exercised in their use. One suitable source of witnesses is paint pigments. Pigments may be based on one simple material, e.g. graphite, oxides of iron, titanium dioxide, or on a number of other pigments. Witnesses can be iron, tin, sulphur, copper or stainless steel, copper alloys and complex paints (see Winsor & Newton's Notes on the composition and permanence of Artist's Colours). Artists' colours make a useful series of witness as they can be painted onto pieces of stiff white paper of about 7 cm × 5 cm and labelled. Other sources of chemicals can be used, such as chemistry sets and industrial materials. It is important that the witness is not contaminated by even traces of other materials.

The witness can be used to block paramagnetic fields. For example, a piece of iron placed between the test piece, e.g. a mobile phone, and the dowser will block the paramagnetic field due to iron so that the dowser can no longer detect it. Progressively more and more fields from a source can be blocked using witnesses.

Although the mechanism by which witnesses work is as yet unknown, they are a very powerful analytical tool.