SCRUTINY & REVIEW
TELECOMMUNICATION MASTS
DRAFT REPORT - JUNE 2006

SEFTON MBC
LOCAL PEOPLE
LOCAL CHOICE

Telecommunications Masts and Health

1 INTRODUCTION

1.1 This Report follows an investigation into possible health risks associated with living in close proximity to a telephone mast and relevant equipment.

1.2 The investigation undertaken by the Health Scrutiny and Review Working Group prior to May 2006.

1.3 The Groups programme of inquiry will include:

a) identifying the views/concerns of Sefton Residents in respect of mobile phone technology;
b) review current statistics, literature, and background research relevant to telephone masts and base stations;
c) identify locations of telecommunication masts and base stations;

d) an understanding of current and future technology.

2 BACKGROUND

2.1 In accordance with Rule 27 of the Council and Committee Procedure Rules, a petition was presented to the Sefton Scrutiny and Review Committee (Health) on the 22nd February 2005 on behalf of residents raising concerns on possible health risks from living in close proximity to telephone masts and associated equipment.

2.2 Mr M.Bigley, on behalf of petitioners, advised of a recent resident's survey undertaken in the Marshside area of Southport in North Sefton which had raised concerns on possible health risks.

2.3 It was requested, and supported by the petition, that the Committee review the health concerns raised by the residents living in close proximity to a telephone mast and within the borough of Sefton.

2.4 Noting cross party support from members, and at the request of the petitioners, it was agreed unanimously that the review would include the whole of Sefton.

2.5 With the support of the full Committee a Working Group was agreed. They would address issues relevant to health and not undertake any investigation involving planning legislation,

2.6 Members were to be made aware of residents health concerns through interviews, questionnaires, e-mails, letters, research and public meetings.

2.7 With an estimated 50 million mobile phones and 40,000 base stations in the U.K. and together with the introduction of new technology, it was known these figures would increase as would the perception of health risks.

2.8 It was recognised that the use of mobile phones had risen from 2 5 million in 2000 to the current figure of 50 million to date.

3 PROGRAMME OF ENQUIRY

3.1 Working Group
Cllr Brenda Porter lead member
Cllr John Dodd
Cllr Paul Larkin
Cllr Anne Ibbs
Cllr Barry Griffiths

The Working Group believes the concerns of residents, support from other Councillors across the borough, and their positions on Sefton Council Health Committee fully justify their efforts in researching this topic.

3.2 Meetings

22nd	February	2005
15th	March	2005
29th	March	2005
15th	April	2005
14th	June	2005
15th	September	2005
16th	November	2005
6th	December	2005
23rd	January	2006
2nd	February	2006
3rd	February	2006

3.3 In addition to planned meetings the Working Group read reports, current and previous research, e-mails, letters, relevant literature and attended public meetings as observers.

4 CONSULTATION

4.1 A consultation process took place between March 2005 to April 2006 seeking views, opinions and information from a wide range of stake holders including:

Residents
Health Partners
Other Authorities
Members of Parliament
Relevant Professionals/Interested Parties

4.2 It is recognised and reported that Sefton has a high percentage of senior members of pressure groups within the authority's boundaries.

4.3 Witnesses

Mr & Mrs Andrews, Sefton Residents
Dr Brian Austin PhD, C.Eng, FIEE
Mrs Beverley Bush, Sefton Resident and SRAM Member
Mr John Carwadine, T-Mobile
Ms Hannah Chellaswamy, Director of Public Health, Southport & Formby PCT
Dr Mike Clark, Health Protection Agency
Mr J.Curd, Sefton Resident
Ms Nicola Davies, Council Liaison Manager, Mobile Operators Association
Mr Brian Egerton, Mast Voice UK
Mr Chris Gainey, 3
Ms R.Green, Sefton Resident
Mr & Mrs Harrison, Sefton Residents
Dr Gerard Hyland, (Warwick University, Dept of Physics)
Dr Richard Jarvis, Consultant in Health Protection, Cheshire & Merseyside
Ms Debi Jones, Sefton Resident (Now Sefton Councillor)
Mr & Mrs Jones, Sefton Resident
Mr Stephen Keigher, Orange
Ms Denise Keal, University of Essex.
Ms Anne Macracken, O2
Mr Ray McConnell, OFCOM, Mobile & Broadband Team
Mr Bill Milburn, Sefton MBC, Environmental Protection Director.
Mrs Eileen O'Connor, EM Radiation Research Trust
Mr Alasdair & Mrs Jean Philips, Powerwatch.org.uk
Dr John Pugh, MP
Mr John Riley, Sefton Resident
Mrs B.Rimmer, Sefton Resident
Mr Arthur Roberts, Resident & PPIF Member
Mr & Mrs Robinson, Sefton Residents
Mr Sam Schofield, Vodafone
Mrs Anne Silk, F.F.D.O.,F.A.D.O (Hons.), F.R.S.A
Mr Brian Spooner, 3
Mr W.G.Williams, Sefton Resident & SRAM Member
Mr & Mrs Wilson, Sefton Residents
Mrs P.Woolaston, Sefton Resident

4.4 Contact through letters, e-mails, telephone calls and public meetings have brought us in contact with over 150 people in addition to the list above, providing us with additional information to support the review.

5 GENERAL INFORMATION

5.1 One of the main pieces of literature when dealing with this issue was the Stewart Report.

What is the Stewart Report?

Commissioned in 1999 by Tessa Jowel MP and published in 2000. She requested the NRPB (National Radiological Protection Board) to set up an Independent Expert Working Group (IEWG) to assess the possible health risks from mobile phones. The Group, chaired by Prof Sir William Stewart FRS, FRSE, the Chairman of Tayside University Hospital NHS Trust Dundee. His team conducted a rigorous assessment of existing research and published its findings in May 2000 offering advice and recommendations.

The Stewart Report may be found on
www.legmp.org.uk/report/text.htm

- An updated report was published on 11th January 2005. It stated that in the absence of new scientific evidence the original recommendations on limiting the use of mobile phones by children remains appropriate as a precautionary measure.
- It acknowledges that uncertainties remain and advocates a continued precautionary approach.
- Acknowledges "gaps in knowledge" justify precautionary approach.

5.2 Question: What is IEGMP?
Answer: Independent Expert Group on Mobile Phones.
Also known as the Stewart Group.

5.3 Question: What did the IEGMP conclude?
Answer: The balance of current evidence indicated there is no general risk to health of people living near base stations, on the basis that exposures are expected to be small fractions of guidelines. Overall the Stewart Report recommended a precautionary approach until more research is completed.

5.4 Question: What is a Cellular Base Station?
Answer: They transmit and receive signals from mobile phones or other types of mobile radio. Each base station provides coverage for a given area, termed cell.

Base stations can be found a few hundred metres apart in major cities or several kilometres apart in rural areas.

A base station is not necessarily a mast.

A mast is a free standing structure that supports the antennas.

A base station might equally consist of an antenna and equipment cabin attached to a pre-existing building or structure.

5.5 Question: What is Ofcom?
Answer: Office of Communications (Ofcom) is the independent regulator and competition authority for the UK communications industries, responsible for the management of the civil radio spectrum in the UK.

5.6 Question: What is Ofcom's involvement with the Stewart Report?
Answer: They will audit mobile phone base stations as recommended in the Stewart Report to ensure that exposure guidelines are not exceeded.

5.7 Professor Challis, the Chairman of the Stewart Committee, having replaced Sir William Stewart has indicated that it can never be said "there is no risk" just take measures to reduce the risks.

6 ISSUES IDENTIFIED

6.1 General level of concern across the whole borough in respect of perceived health risks from mobile phone technology.

6.2 Low level of public knowledge on mobile phone technology, and public concern that future generations of communication technology, and sophisticated services, will increase fears over the impact on health.

6.3 Concern that value of properties will fall if living near a telephone mast.

6.4 Anger that government legislation does not address health factor.

6.5 Considerable amount of contradictory or misquoted data.

6.6 Lack of procedure for long term monitoring.

6.7 Recognised vulnerability of residents with a perceived fear of living in close proximity to a telecommunication mast and associated equipment.

6.8 Although there is widespread concern throughout the country on health risks if living near masts and equipment, there is no recognised medical acknowledgement in NHS.

6.9 Concern of many residents to report their symptoms for fear of being considered neurotic.

6.10 Vast differences of opinion between relevant professional bodies and individuals.

6.11 Although recommending masts and relevant equipment safe, further research is being urged throughout the world to address "gaps in knowledge".

6.12 Many residents at combined interviews with other residents provided working group with matching examples of a range of symptoms they considered to be the result of living near a mast. Residents unknown to one another shared symptoms that were consistent.

6.13 Many residents reported that although acknowledging symptoms as with all illness, can be accounted for other reasons, raised a concern that on leaving the area, symptoms disappeared.

7 CONCLUSIONS

7.1 It was never the intention of the working group to either prove or disprove medical or scientific facts relating to telecommunications masts and associated equipment, just present the facts after concluding our investigation.

7.2 We have looked at evidence in relation to possible health risks if living in close proximity to a telephone mast and relevant equipment.

7.3 The topic of telephone masts and mobile phone technology is an issue that generated extreme views none more so that the telecommunications industry versus campaign groups.

7.4 We are conscious of the importance of mobile phones and the technology that is changing day by day. It is for this reason that government and business has to address the concerns raised by the public who although using their equipment want to be reassured that the health risks, if any, are reduced as much as is possible.

7.5 Almost every piece of research into the impact on health of mobile phone technology was either supported or discounted by each side.

7.6 The polarised views coupled with the volume of information either from formally published research, government reports, health papers or just routine evidence from local residents made the working groups task difficult.

7.7 Where possible the group reviewed the findings of the original research papers and incorporated interviews and information provided by residents when questioning industry representatives and expert witnesses who came to Sefton to be interviewed.

7.8 The Working Group are aware that many other residents wished to speak to us after our investigation had officially closed. We would advise that we are conscious of their concerns and although their evidence could not be used in this report, we had been advised of the circumstances from other sources, and this information has been taken into account.

7.9 Having considered all the information we have a number of conclusions that we have reached.

a) While gathering all the evidence/information from residents it became obvious they were genuinely fearful for the future and possible health risks from telecommunication masts and base stations.

b) It was recognised that while current evidence supports that telephone masts have no known health risks it was noted that long term monitoring is a necessity to support this decision.

c) It was recognised that although telecommunication technology was being regarded as safe within the industry and amongst many professionals, it was with concern that the opinions of the professionals varied considerably and on-going calls for further research was being echoed all over the world.

d) Telecommunication technology is important throughout the world and will not go away. It is important that all health risks or possible health issues are addressed with some speed, recognising the concerns of many on the possible long-term health issues for our children.

8 RECOMMENDATIONS

The Working Group having considered all the evidence wish to put forward the following recommendations.

R1 That the precautionary principal be adopted as recommended in the Stewart Report and that all measures be taken to reduce the risk of exposure at all times.

R2 Engage in further dialogue with mobile phone operators, health partners and local authority to insure best practise, in the interests of local residents, and providing information relevant to health concerns.

R3 Lobby MP's to revisit Private Members Bill, the Town and Country Planning (Telecommunication, Statutory Nuisance, Health and Precautionary Principle) Bill 2006.

R4 Lobby MP's to secure formal statement of action taken to support recommendations in the Stewart Report.

R5 Utilise existing local authority powers to provide "Mast Sharing" between telecommunications service providers, discouraging where possible the erection of multiple mast clusters.

R6 To receive details of level of funding and research programmes funded from Government and Telecommunications Industry. Receive specifically those focussed on research into the impact on health arising from, and topic of, electromagnetic sensitivity.

R7 Request the submission of a certificate defining the extent of the "beam of greatest intensity" for telecommunications developments – further defining excessive EMF emissions as statutory nuisance, whereby the operator responsible may be prosecuted by the public.

R8 In line with the precautionary approach, an independent view be sought as to an agreed "safe distance" between telecommunication masts and residential properties, schools, children's nurseries and hospitals.

R9 Lobby MPs for greater rights for the removal of pre-existing telecommunication developments that are on, or close to, educational, medical premises and residential properties

Together with my colleagues on the working group, I would like to thank all those who took the time to assist us in our investigations.

I would like to thank my colleagues,

Councillors John Dodd
Councillor Paul Larkin
Councillor Anne Ibbs
Councillor Barry Griffiths

for their support and commitment in enabling us to bring forward this report. A special thanks also to Patrick Sebastian for his work and support throughout this review.

Councillor Brenda Porter

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FURTHER BACKGROUND INFORMATION

Scrutiny Review – Telecommunication Masts & Health

At the meeting of Sefton MBC Scrutiny & Review (Health Overview) Committee of the 22nd February 2005, Members proposed a review into the topic of the possible impact on health of residents living in close proximity to telecommunication masts.

A consultation process took place from Mar 2005 to April 2006 seeking views and opinions from a wide range of stakeholders on the matter of mobile telecommunication masts, a topic of relevance and interest to residents, local authorities and health service providers.

The Scrutiny Review aimed at providing Elected Members with a detailed understanding and knowledge of the issue and technology involved. Through interviews with residents and professionals, the Working Group would also gain a better appreciation into the concerns and fears surrounding the question of telecommunication masts and possible impact on health.

In addition to the recommendations contained within the report, it is hoped that additional information also enclosed may be used to inform readers on the variety of information (and opinion) widely available on this topic.

Petition in respect of Mobile Telecommunication Masts

In accordance with Rule No.27 of the Council and Committee Procedure Rules, a petition was received in respect of health concerns of residents living close to mobile telephone masts. Petitioner Mr M.Bigley informed the Committee of a recent residents survey undertaken in the Marshside area of Sefton, and reported a selection of statistics arising.

The petitioner reported that residents had raised concerns over quality of live, the impact on health, and well being of those living in close proximity to the telecommunications mast in Seacroft Crescent. It was requested that the Committee review the health concerns of residents that live close to mobile phone masts within the borough of Sefton.

Members asked a number of questions of the petitioner and debated the formation of a working group to investigate the matter, noting cross-party support from Members, and the request from petitioners that the review should include the whole of the Sefton MBC area.

Practical concerns with regard to planning issues, support resources and significant volume of research available were also discussed.

Questions / Terms of Reference

- An understanding of current and proposed future technology
- Identification of telecommunication mast base station locations
- An understanding of Sefton residents views in respect of mobile phone technology

Method of Inquiry

- Gathering of topic related literature, background documentation and research, both in hard copy and electronic format.
- Obtain oral and written evidence from health partners and relevant key personnel within communications industry and scientific community.
- Obtain oral and written evidence from residents of the borough.
- Provide information and raise public awareness of the Scrutiny Review into Telecommunication Masts via the Media, Health Partners, and the Council's Website.

The nominated Members of the Scrutiny & Review Health Overview Committee met as a Working Group on 11 separate occasions. In addition Members of the Working Group also visited various sites within the borough to meet with local residents to discuss their concerns. Questionnaires were also distributed by elected members in a number of residential areas across the borough.

At formal meetings held at Southport Town Hall, a number of key witnesses were interviewed to obtain evidence, and to assist the Working Group in the formulation of its conclusions and recommendations.

Additional face to face meetings with Local Residents took place during the course of the review

Supporting Information

During the process of this review, the Committee has gathered a substantial amount of information and data. This has been invaluable in helping the Working Group form its conclusions and recommendations. Key supporting information is available on CD upon request, from Patrick Sebastian, Scrutiny Support Officer, (telephone 0151 934 2176).

INTERVIEWS

Residents Interviews

Resident in the same property (Seacroft Crescent) 25years. Mast erected 10 years ago. Had difficulty sleeping, insomnia, prescribed medication by GP – also concern over “addictive” tablets. Had requested removal of local mast. Fatigue & poor concentration.

Resident - As above, had tried alternative treatments to alleviate sleeping problems – Hypnotherapy and Reiki (a system of natural healing - physical, mental, emotional & spiritual - that evolved in Japan). It was reported, and this confirmed by family member that symptoms alleviate when away from home (holidays, etc).

Resident (Chesterfield Road) Reported similar experience, waking regularly at 1:30am, suffering from a skin condition, and dizziness which had worsened in the past 6 months. An Ainsdale resident of 27 years, living in Chesterfield Road. On medication, thought that skin condition could be stress related. Not aware that electromagnetic sensitivity could produce same symptoms.

Resident (Seacroft Crescent) Advised those present of TV programme, including interview with a local resident..

Resident (Burnley Road) Reported suffering from Sleepless nights, and Migraines. Informed those present that he had suffered from migraines prior to erection of mast, but the condition had become worse in the last 7-8 years. He now suffered from continual headaches and dizziness, and was under medication from his GP. He acknowledged that individuals could be made ill through worry, and stress, but had informally established a link with his health deterioration and the erection of a mast near his property 10 years ago.

Resident further explained that he and his wife felt “unable” to utilise there garden / outside space as a result of fears to their health arising from the mast. He noted that the mast had Tetra and other additions / upgrades without notification to local residents.

Resident (Burnley Road) Identified that planning matters (not under the remit of this working group) were “grey area” in respect of Telecommunication Masts.

Resident (Burnley Road) Questioned the “cummulative” effect of transmitter power.

Resident (Burnley Road) Identified her own fatigue and similar symptoms experienced to others who had already presented. Noting that these had worsened in recent years.

Residents (Burnley Road) felt that the telecommunications industry, and equipment should undergo rigorous testing, and health and safety inspections

to identify if there was any link to the symptoms experienced and health and safety matters.

Resident (Burnley Road) Reported that sleep, or the lack of it, was the major issue in his experience – leading to fatigue etc. He had lived near a mast 10 years with noticeable upgrades occurring in the past 2 years. Add-ons, and upgrades to Tetra and 3G capacity.

Resident (Burnley Road) Reported that her own condition had led to her passing out on occasion, also suffering form muscular, skeletal and mental issues due to peripheral nerve damage – identified by health professionals. She identified that hypersensitivity to electrical / magnetic fields was a “long term, permanent condition”. Resident also provided evidence of the impact on house values as a result of the proximity to masts.

Councillor Porter – Informed those present that the Working Group were not looking at issues of planning, property values, etc, and that their focus was purely health matters.

Resident (Burnley Road) Explained that her own condition, “peripheral neuropathy”, similar to MS, had been confirmed by a neurologist. She also had heart flutters, and was under a heart specialist. Both of whom could not 100% state that these conditions were brought on by electro-sensitivity, but held a strong belief that the conditions could be aggravated by it. She stated that her sister suffered similarly. Resident (Burnley Road) confirmed that it was difficult to prove medically - identifying anecdotal evidence of symptoms of a third party.

It was noted that Resident also lived close to a railway line, and question arose as to general electro-sensitivity issues.

Resident (Burnley Road) Reported that he had worked in the electrical industry for a number of years as a sub-station engineer, and the rail network was a 750 volt dc system, and therefore a completely different frequency to mobile technology. It had also been around for excess of 60 years – with no recorded health impact.

Councillor Larkin – explained that these questions had to be asked to ensure a balanced investigation and make it clear that as much scientific evidence as possible was taken into account.

Resident (Seacroft Crescent) stated that the majority of these problems had arisen in the past 10 years (in line with increased development of phone networks, and usage), and were not necessarily an electrical problem, but one of “frequency”.

Resident (Dawlish Drive) Reported that, to his knowledge, not everyone was hypersensitive to electric/magnetic fields/frequencies.

Resident (Burnley Road) explained the additional equipment installed on her local mast – Tetra, and the audible “buzz” that eminated. She informed the

meeting that her particular sensitivity identified busy times for transmissions, and noted that Thursdays, Fridays and Weekends were particulary so.

Councillor Porter informed those present that she had received enquiries from residents of a similar nature, had contacted phone companies, and the audible buzz had been reduced as a result.

Resident (Chesterfield Road) asked Members if there was any liaison with GPs on this issue.

Councillor Porter explained that Doctors (as do the public) have differing views on the matter, but at present there was no obligation to record this sort of data. But residents had it in their power to ensure that GPs were made aware of the concerns, and individuals thoughts on the links between symptoms suffered and concerns over local telecommunication masts.

Resident (Seacroft Crescent) Informed the meeting that he had experienced nose bleeds along with some of the symptoms mentioned by others earlier in the meeting.

Resident (Seacroft Crescent) Detailed symptoms of disturbed sleep, morning headaches, and dizziness and headaches during waking hours. Re-iterated her husbands nose bleeds and detailed daughter (aged 31) experience of ear problems/buzzing. Mrs R also confirmed audible buzzing from local mast.

Resident (Salcombe Drive) informed the meeting of the press interest generated a few months ago, and the reporting of her own symptoms – tachycardia - heart rate irregularities. In her case, she had not associated her own health issues with the mast, or suffered noticeable symptoms until the mast was upgraded. Upon reading up on the matter – noticed possible explanation of sleep pattern disruptions as a result of beam radiation affecting melatonin levels in the brain.

Resident (Salcombe Drive) stated her property is approximately 150 metres from a mast,

Resident (Dawlish Drive) explained that enquiries with operators had resulted in “frequency adjustments”, and that the mast in question was (according to them) within “normal limits”

Private interviews with residents conducted by Councillors Porter and Dodd, but which are sensitive and therefore not recorded in print, highlighted residents concerns in respect of telecommunication masts and cancer.

Telephone interviews highlighted similar concerns.

Health Professionals

Dr Richard Jarvis, Consultant in Health Protection, Cheshire & Merseyside, provided an introduction to Members of his career experience to date. Members were appraised of his role specialising in issues of public health for the CMSHA region, and on a wider geographical basis as a member of the board of directors of the British Medical Association (BMA), and Health Protection Agency (HPA) dealing with Air Pollution and Ionising Radiation. The HPA was effective 1st April 2005, the "arms-length" body assuming the role of the NRPB in respect of issues such as telecommunications masts. The Agency, as did the NRPB, comprises Primary Care Trusts, Doctors of Research, and is an independent, publicly funded body.

With 4-5 years experience of supporting the 2 Sefton Primary Care Trusts and Directors of Public Health, as an "expert", Members were grateful to Dr Jarvis for his early input into their review.

It was noted that although not unique in its experience of public interest in the matter of telecommunications masts, Sefton was, however, unusual in the number of senior members of pressure groups who reside within the authority boundary.

Dr Jarvis explained in great detail some of the issues that they would be facing in their Investigations, and pointed out that there was currently little or no evidence, of a robust nature, that would suggest that mobile phones have an adverse impact on health. However, there may be, and this may be proven by the investigation, that there may be an "indirect health effect" produced as a result of the physical impact of telecommunications masts (whether switched on or not).

It must be noted at this stage that there are (worldwide) in the region of 1bn mobile phone users, who to date have shown no measurable effect on their health of the use of such devices.

Issues of "generalisation", probability of risk, reflex studies, non-scientific research, "reasonable doubt", and lifestyle factors will be matters that the Working Group will have to address as the review progresses.

A further update from Dr Jarvis published in the Health Protection Agency North West - Quarterly Health Protection Bulletin - Jan - Mar 2006 provides the most recent published views of the organisation.

"Some groups of the general population claim to suffer symptoms when exposed to electromagnetic radiation from sources such as mains wiring and mobile phone equipment. Several terms have sprung up to describe this condition, but the most commonly encountered are Electromagnetic Hypersensitivity (EHS) and Electromagnetic Sensitivity (ES).

Symptoms
EHS was first reported in the early 1980s as burning or tingling sensations, particularly of the face among people working with Visual Display Units

(VDUs). In the later 1980s a wider set of symptoms including headaches, dizziness, nausea, fatigue, concentration problems, palpitations and pain became apparent.

Today symptoms reported come from a very wide range. Most are minor and common in the general population, do not necessarily indicate underlying illness, and are not normally associated with a particular exposure. The most common symptom groups reported occupationally or by self-help groups are fatigue and poor-concentration type headaches, and skin symptoms. Sufferers themselves tend to attribute a much wider range of symptoms to EHS. In Scandinavian populations, facial symptoms predominate and there is some indication that there may be a progression of localised symptoms to more generalised symptoms. Populations in other European countries report predominantly more general symptoms. What is clear is that in certain individuals these symptoms can interact to cause a physically and socially debilitating condition.

Exposures
Initial reports of EHS linked symptoms to exposure to a small range of specific sources, in particular to VDU use and this remains the case in Scandinavia. In other countries the range of attributed sources has widened considerably to include a wide variety of natural, domestic, occupational or industrial sources at a wide variety of wavelengths from ultra-low frequency (mains electricity) through radio waves, microwaves and infra-red to visible light.

Particular attention is currently being focused by UK pressure groups on microwave radiation from mobile phone equipment. The majority of the published evidence relates to exposure to mains frequency radiation from domestic wiring and appliances.

Source pathway receptor relationship
Some groups report symptoms related to a specific exposure, while others claim responses to a variety of sources. There does not appear to be any typical time period between exposure and symptom onset, and while there are claims that certain individuals can detect the presence of an electromagnetic field (i.e. whether the equipment is switched on or off), this has not been confirmed by properly conducted provocation studies. There does not appear to be any good biomarkers for the condition.

Prevalence
Predictably, given the poor evidence base, estimates of prevalence vary from <1% in the general population to 35% in occupational VDU operators. Most of the available studies make estimates in the range of 1-3%. Women seem slightly more likely to suffer than men, and there are suggestions of slight excesses in age groups over 40 years and in groups with higher educational achievement, though both of these may relate to there being more studies of workers with VDUs.

Management
Management is focussed around prevention, early identification, treatment and avoidance. Prevention involves improving and adhering to emission

standards, by developing an understanding and improving design, manufacturing and installation of equipment. Early identification can be achieved by improving public understanding, prompt investigation of symptoms to exclude other causes and investigation of environmental and psychosocial risk factors (as and when they become better described).

Attempts have been made to treat the condition. Of those tried there has been some success with cognitive behavioural therapies and with symptomatic treatments. Each of these approaches has been shown to have beneficial effects in more than 50% of those treated.

Avoidance by changing location or by installing shielding is often advocated by self-help groups and pressure groups but has not been shown to be successful in the majority of cases.

Application to mobile phone equipment
Virtually all of the published evidence is based on exposure to mains frequency electromagnetic radiation, so there is little scientific background to claims that mobile phone or WiFi (wireless fidelity) equipment is responsible. There is also little biological plausibility that high frequency electromagnetic radiation would have similar effects to low frequency sources, based on the known (and varying) physiological effects of various frequencies on the body. For example, visible light excites rods and cones in the eye whereas infra red radiation excites thermo-receptors in the skin, and microwaves and lower frequencies do not excite nerve cells at all. It is therefore unjustified to claim that EHS can be caused by mobile phone equipment without the evidence base to back up the claim."

Summary

- EHS is a diffuse collection of symptoms claimed to be caused by exposure to electromagnetic fields.
- The main symptoms relate to skin sensation and neuro-cognitive function.
- Sufferers claim various exposures as the cause but the evidence base is related only to mains frequency exposures.
- Prevalence is probably in the order of 1-3% of the general population.
- Possible management strategies for GPs include symptomatic treatment and cognitive behavioural therapy.
- There is little evidence of effectiveness of avoidance strategies.
- It is currently doubtful that these conclusions can be generalised to exposures from mobile phones or WiFi signals.

Industry Representatives

As part of their review, the Working Group called upon representatives from the Telecommunication Service Providers to give evidence on the public exposure guidelines, and technology in respect of telecommunication network 'base stations', providing, where possible, information relevant to health issues. By virtue of the interest in the topic, a number of Sefton Councillors, not members of the working group, also attended the meeting.

Guest Speakers:

Nicola Davies	Council Liaison Manager, Mobile Operators Association
John Carwadine	T Mobile
Chris Gainey	3
Stephen Keigher	Orange
Anne Macracken	O2
Sam Schofield	Vodafone
Brian Spooner	3

Ms Nicola Davies, Council Liaison Manager, Mobile Operators Association (MOA), presented information to those present on Customer Demand, How the Networks Operate, Developing the Networks, the Industry's 10 Commitments and Best Practice. Hard copies of the presentation were provided. In addition further factual literature in the form of MOA leaflets, DoH handouts, and WHO / GSM Europe factsheets, were also provided.

Ms Davies informed Members of increased subscriber demand, change in patterns of use, demands upon the network and network providers, and conditions placed upon network providers as part of Government licenses.

Ms Davies provided an in depth introduction to the changes in technology i.e. 2nd and 3rd generation services, industry approach to upgrading of equipment, request process (liaison with local authorities both within and outside of the planning process) for new sites, community participation, and the Mobile Operators commitment to the Health Concerns of the Community at large.

Historical information in respect of Health Issues contained within the Stewart Report, recommendations, current research (jointly funded by the Industry and Government), and independent review bodies (AGNIR and NRPB were also covered.

Following the presentation, Lead Member, Councillor Porter, explained that non-members of the Working Group would be given the opportunity to ask questions, but given time constraints, the Working Group questions would be given priority. (n.b. Due to the detailed presentation from Ms Davies, all Members had the opportunity to put their questions).

Q&A

The following notes record, in abbreviated form, questions and responses.

Councillor Porter – Are the guidelines under review?
ND – This question best directed at the NRPB,
Councillor Porter – Who agreed the guidelines and levels?
ND – Independent scientists from the UK and International Community, Emissions levels monitored by the Radio Communications Agency. Spot Checks on Emissions. Note: the majority of developed nation's levels match the international guidelines.

Councillor Porter – When were the guideline levels agreed/set?
ND – Adopted by the EU in 1999 and by operators in the UK 2000 following publication of the Stewart Report.
JC – Actual levels are many times below agreed guidelines – eg at 100 metres recorded figures may be as much as 20,000 times lower.

Councillor Larkin – Has there been research into size of masts and relative power? Impact of Mast Sharing? Would there be strength in the argument for more, lower powered masts? Are there opportunities for Mobile Phone Operators to "put something back into the community"?
AM – Mobile Phone Operators involved in a number of initiatives (Radio Merseyside / Recycling of Old Handsets / Cash giving to Charitable Trusts/ Sponsoring of Horticultural Planting – Parish Councils)
SS – There is an argument to support a greater number of smaller base stations. However, all stations are required to meet ICNRP guideline levels, and smaller stations do not necessarily mean lower power, or lower exposures.
ND – Prof. Barton produced a report for Manchester City Council on ways to reduce concentration of emissions leves. . Government Guidelines on the sharing of mast structure, and location issues can cause public concern.
JC – Handsets generate the power.

Councillor Dodd – Can Mobile technology be routed to satellites as opposed to Mast Structures?
SS – Matter of receiving vs transmitting. Much higher power required.
JC – Volume of traffic prohibitive – Not enough satellites to cope with volumes.
BS – Government set coverage targets (80% coverage 3G by 2007)
ND – When the Government awarded the operators licenses to operate 3G networks they were set coverage targets and financial penalties may be applied if targets are not met

Councillor Porter – Prof. Challis has taken over from Stewart, "cannot give assurance as to safe levels"?
ND – Based upon available research, guidelines appear appropriate.

Councillor Porter – Are concerns recognised? Operators/Scientists may have got it wrong, how can you reassure public?
JC – There is criticism in the Press when reporting risk, quoted research is not always replicated under peer review, and can be taken out of context.

Operators work to research and guidelines set by the WHO and ICNRP. Prime Minister has recently instructed the Chief Medical Officer to discuss reporting of health issues with the Press.
BS – Mobile Phone Operators work to approximately 26 scientific research programmes.
JC – No hard evidence to prove or disprove press “theories”.

Councillor Griffiths – Stewart is quoted as saying “No phones for his Grandchildren”
ND – Referring to Handsets, this review concerns Masts.

Councillor Griffiths – Mobile Phone Operators target Children for Profit, Create demand…
AM – Operators not permitted to market to under 16’s, Not permitted to contract to under 16’s.

Councillor Griffiths – Is it correct that Insurance Companies will not provide cover to Telecom Provider employees? Is this an indication of safety?
JC, AM, SS – Not heard of this.
SS – Point to note 20,000 emergency calls made per day on the Vodafone Network, 1 in 4 mountain rescue responses as a result of mobile technology, safety issue could be considered a “red herring”.

Councillor Larkin – Health scares have happened before with the introduction of new technology eg Microwaves, TV. There’s more “risk” to health from unemployment. Kids want to use phones. Maybe focus should be on the provision of better information.
JC – Difficulty faced by all operators when providing information – “They would say that wouldn’t they”. The technology is “old science”, “new form”.
First mobile calls were made 20 years ago, and research continues.

Councillor Porter – MOA was established in 2003. How is it funded?
ND – It is trade organisation funded by the industry.

Councillor Sumner – Matter of PR. Cllrs come under pressure from residents. Better understanding / perceptions would make life easier.
BS/CG/AM – Operators have set up drop in centres and school visits and are working to the consultation guidance set out in the Office of the Deputy Prime Ministers ‘Code of Best Practice on Network Development.’.
ND – Operators automatically write to schools when siting masts in vicinity.
SK – On the matter of community liaison, Orange currently in discussions with Manchester – reviewing policies, and Wirral.

Councillor Dodd – Are Operators duty bound to apply for planning permission when siting masts eg Town Centre/Petrol Stations?
CG – (ex Town Planner) Dependant on planning law, and existing structures.

Councillor Porter – Do you have example of consultation you have undertaken?
JC – Operators regularly consult with local communities. For example, when proposing a site on a council/housing association owned residential tower

block the operators may hold Meetings with residents of tower blocks, and siting funds may be fed back into the block to the benefit of tenants, not the authority/housing trust.

Councillor Mann – Limit of 125 calls per tower was mentioned, can Operators not just add equipment to masts to accommodate increased demands.
ND – This is done at present. Only when capacity is reached will Operators search for new sites. Limited by technology at present.

Councillor Shaw – Explanation of the "inverse square law" identifying that handsets provide the "risk" vs base stations. Power outputs higher in rural areas where mast sites are fewer. The irony that more masts may mean less risk?
AM – Manchester Inquiry appears to show this – copy will be provided.
JC – Suggest approach to Laurie Challis.
ND – Dr Clarke, NRPB, will also be useful contact.

Councillor Platt – Hearing presentation, and previous answers re site sharing, what is the effect on emission figures?
SS – There are higher levels, but they remain with the ICNIRP guidelines. However, it is the duty of the last operator to place equipment to provide certificate and compliance to guidelines (ICNRP) for the whole site.

Councillor Griffiths – Are you aware of studies in respect of grazing animals?
ND – refer to Dr Clarke.
JC – refer to John Molder website Q&A
http://radlab.nl/radsafe/archives/9907/msg00488.html

Councillor Ibbs – Tetra Masts – Are they ICNRP compliant, or come under different guidelines.
ND – Higher frequency / Similar-Same power / ICNRP compliant. Tetra base stations are for use by emergency services and the company rolling out the system – Mm02 Airwave are not members of the MOA.

Councillor Griffiths – There are cases when existing masts are upgraded without consultation, or opportunity for objection….

Councillor Porter – How important is consultation with local residents? How and why would Operators invoke emergency powers to erect masts?
SS – Examples of where emergency powers can be invoked are; where notice to quit served on existing site, or in the case of building/structure collapse. In each example of finite time. Note: "fall back option"

Councillor Porter – Health concerns – sensitivity to the issue. Lamp Post Notices not the best method of raising public awareness.
JC – Planning department process.
AM – Process can be tailored to the individual community. Forums have been a useful form of opening dialogue. Example of Manchester Telecom Forum – meeting every 6mths, Cabinet Member, Reps from Planning Dept, Reps from Housing Dept. Would welcome similar in Sefton.

Councillor Platt – How far can Handsets transmit?
ND – Dependant upon landscape. Cases reported up to 10 miles.

Councillor Mann – Do the changes to technology (3G) impact on power levels?
ND – 3g base stations comply fully with ICNIRP guidelines. There is impact on capacity i.e. volumes per base station.

Ms Davies offered that should Members have any further questions, or requests for information, the MOA would be pleased to assist.

Independent Expert – Dr Brian Austin

A meeting of the Working Group was scheduled to allow Members to question Dr Brian Austin, BSc(Eng), MSc(Eng) and PhD over technical interpretation of some of the data previously reported to this working group.

Dr Austin retired last year as a Senior Lecturer from the Department of Electrical Engineering and Electronics at the University of Liverpool, and holds degrees of BSc(Eng), MSc(Eng) and PhD. He is also a Chartered Engineer and a Fellow of the Institution of Electrical Engineers (London).

His research interests throughout a 35 year career (of which ten were in industry as an electronics engineer) centred mainly on radio systems with a particular emphasis on applied electromagnetics - the science/art of producing electromagnetic radiation for various purposes from antennas (aerials) of various geometrical shapes as well as the propagation of that energy through space ("air waves" as referred to in the media).

Prior to his attending the Town Hall, Dr Austin provided a paper to Members entitled “the mythology of the mobile phone mast” (see Appendix 2), further copies of which were circulated at the meeting.

Dr Austin informed members of his background in technical engineering, and informed the group on the basic principles of “line of sight” transmission distances, and the impact on mobile phone signals produced by the urban environment vs clear uninterrupted signals experienced (for example) in more rural areas.

Councillors Dodd and Ibbs raised the question of satellite technology, and the possible use of this form of technology as a substitute for the existing method of mobile phone transmissions.

Dr Austin explained the principle of satellite technology, and the problems associated with delay of signals due to the vast distances involved (time lag of approximately 1 second), supporting satellite technology when things go wrong, and capacity implications. Dr Austin then informed members on the principles of the current system of voice and data transmissions using 3G and “Cells”. Members were interested to note that the telecommunication masts

were essentially points of access to the existing landline cable network, and very rarely connected to satellite networks – even on international calls, specifically because of the “time lag” issues associated with satellite technology.

Members heard further explanation of the distances involved when connecting a handheld phone set to the mast and the impact on signals in built up areas, and how handsets identify themselves to the network on outgoing transmissions, and vice versa with incoming calls.

Councillor Porter enquired as to the introduction of cell network transmitters in street light standards, a point that Dr Austin confirmed was already taking place, identifying the network “macro cells”, “micro cells” and even smaller lower power “pico cells”. Conventional mobile telephone networks the cells generally span 3 to 25km, currently adequate for the density of handsets in most city, town and rural locations.

Dr Austin informed members of the levels of power involved in respect of the transmitter mast and individual handsets, identifying the impact of “signal drop off” with distance, and the position in the radio spectrum of mobile telecommunication devices.

Dr Austin detailed the difference between “Ionised” and “non-Ionising” radiation, and the biological effect (or not) resulting from the different types of radiation. Namely that the uncontrolled growth of cells arising from the impact of exposure to “positive state” electrons or “ionised” electrons, to be found in for example in nuclear radiation or x-rays.

Members were informed that in all verified research tests done to date, there was no evidence to prove that radio frequency radiation (those used by radio, TV, and mobile phone technology) was carcinogenic.

Councillor Griffiths enquired as to the possible effect of long term exposure to such “radio waves”, for example when sleeping in relative close proximity to a transmission mast. Dr Austin explained that there would be no cumulative effect.

Dr Austin further informed members that there were 3 types of radiation – thermal, Optical and Radio. Put in context Dr Austin and members agreed that there was a much more “measurable” biological effect arising from Solar Radiation (Thermal) in the form of sunburn/heatstroke/skin cancers.

Councillor Porter and Councillor Griffiths questioned Dr Austin on his views over the Stewart Report, and the precautionary principle/views contained within. Dr Austin explained that there had been criticism levelled at the report because of this particular statement.

In further discussion on “measurable effects” Dr Austin explained the process by which scientific research had to be verified by peers before it was acknowledged as truthful in the wider community. Which in turn gave rise to problems of unsubstantiated evidence being headlined in press articles –

even when the scientific community had requested the inclusion of the caveats “not peer reviewed”.

Councillor Porter enquired if the scientific knowledge available at the present time could guarantee that electro-magnetic fields were not dangerous to health, citing personal knowledge of similar such statements with reference to Asbestos in the past.

Dr Austin provided an example (many more exist) of a current industry test on the biological impact of thermal radiation utilising the organ in the body most sensitive to heat – the eye – where resultant heat results in the formation of cataracts.

The “Thermal Effect” is represented by the Specific Absorption Rate (SAR). The absorption of RFR energy is measured by the quantity specific absorption rate (SAR) in units of Watts per Kilogram (W/kg). It is defined as - the rate at which RF energy is absorbed per unit mass of a biological body. An SAR of 0.4 W/kg would take 10 days to melt a kilogram of ice. All mobile phones now have SAR figures reported.

Members noted that parallel research was being undertaken by industry and the independent scientific community into power line and sub-station radiation. At present there is still no scientific link to such topics and ill health.

Councillor Dodd questioned Dr Austin on the matter of TETRA communication technology. Members heard that this technology was purely a different frequency/wavelength on the electro-magnetic spectrum. Another example of “non-ionising” radiation, and therefore according to previous argument – “safe”.

Dr Austin further informed the group of the measurable effect of “thermal” radiation, and the body’s capacity to dissipate heat to handle vigorous exercise for example, and the effect of thermal overload – heat stroke.

Members discussed the difficulties associated with identifying specific cause of health problems (particularly from telecommunication masts) when there were arguments for the handset and its proximity to the body when in use, could be seen as having a higher impact. Dr Austin explained that exposure to TV transmitter signals, radio signals, microwaves, taxi radio transmitters, speed camera radar signals, etc all appear to add fuel to possible public paranoia, but in each case have been in existence for many years with no scientific measurable effect.

Members also discussed the placebo effect, and impact that telecommunication masts have had in the past on residential communities, even when not switched on. Stress being shown to play a major part in this example, <u>and</u> have a measurable effect on health.

Independent Expert – Dr Mike Clark

A meeting of the Working Group held on the 3 February 2006 enabled Members to question Dr Mike Clark of the Health Protection Agency (HPA).

Dr Clark represents the HPA at its Centre for Radiation, Chemical and Environmental Hazards – Radiation Protection Division (formerly the National Radiological Protection Board).

Dr Clark presented members with a detailed explanation of the workings of mobile phone technology, information on the electromagnetic spectrum and the work of ICNIRP and the HPA, and the Independent Expert Group on Mobile Phones (the Stewart Report 2000).

Dr Clark summarised the current views and main conclusions on the health effects of mobile phone technology, namely: Exposure to RF radiation below guidelines does not cause adverse effects to the general population. Noting that:

- Some evidence suggests biological effects may occur at exposures below guidelines.
- Biological effects do not necessarily result in health effects.

Gaps in knowledge justify a precautionary approach until more detailed and robust information is available. There may be possible indirect effects on well-being (i.e. Stress), and people should be dissuaded from using either hand-held or hands-free phones whilst driving.

Members also heard that epidemiological evidence currently does not suggest that RF exposure causes cancer, with:

- Biological evidence suggesting that RF fields do not cause mutation, or initiate or promote tumours.
- Mobile Phones have not been in use long enough to allow comprehensive assessment of impact on Health.
- Cannot exclude possibility of association between mobile phone use and risk of cancer.

Health effects from Radiofrequency electromagnetic fields

Conclusions of AGNIR in 2003:

Research published since the Stewart Report does not give cause for concern.

No evidence of health effects at exposures below guidelines.

Published research has limitations because of short periods of use.

Dr Clark presented a summary of other reports (by country) specific to mobile phones and health, in line with the Working Groups review topic. They are as follows:-

UK	BMA 2001, 2004; AGNIR 2001; IEE 2002, 2004; MHRA 2004; NRPB 2004
Holland	HCN 2000, 2001, 2002, 2004a,b
France	Zmirou 2001; Senate 2002; ART 2002; AFSEE 2003a,b
Sweden	SSI 2002, 2003
Swiss	BUWAL 2003
USA	GAO 2001; NCRP 2003
Canada	Krewski 2001a,b
International	CSTEE 2001; ICNIRP 2004; WHO 2004; COST-281; EMF-NET

Dr Clark summarised the main conclusions and further questions arising from the reports on mobile phones and health. Which include, the view that adverse effects remain unproven, although subtle biological effects were possible. **More research necessary, and a precautionary approach is advocated**, and the continued paradox of “exposure versus concern”.

Questions that remain – Are children more sensitive? And do pulsed fields have special effects?

Dr Clark summarised the most recent conclusions of the NRPB (December 2004) as follows:

- Development in use of mobile phones has not been associated with clearly established health effects.
- Lack of hard information showing that mobile phones systems are damaging to health.
- Nevertheless, widespread use of mobile phones is recent and technology continues to develop.
- Some data which suggest that RF fields can interfere with biological systems.
- Not yet been possible to carry out long-term epidemiological studies.
- Members of the public, including children can vary in susceptibility.
- A precautionary approach to the use of mobile phone technologies should continue to be adopted.

EM Radiation Research Trust Representative – Mrs Eileen O'Connor

The Working Group heard evidence in the form of a presentation.
"Microwave Communication. Does it pose a health risk ?"

Extracts reproduced below:

Do you know?
Q. What safety levels the industry use?
A. NONE. - They only follow guidelines known as I.C.N.I.R.P

ICNIRP Guidelines only protect your body from cooking. We all know before heating takes place, many biological changes have already happened. ICNIRP only cover short term exposure.

They are only guidelines, they are not law. No one knows the safe levels of radiation.

Different countries use different guidelines

TORONTO - CANADA	6 UNITS
RUSSIA	10 UNITS
POLAND	100 UNITS
US RESEARCH BASE	100 UNITS
INTERNATIONAL COMMISSION	450 UNITS
NRPB FOR BRITAIN (HPA) (Recently adopted)	450 UNITS

Recent EU-funded project, undertaken by twelve institutions from seven European countries, published its Final Report in November 2004.
Known as The REFLEX Project.
Researchers discovered, damage to DNA - both single-strand and double-strand breaks after exposing human, rat and mouse cells to GSM mobile phone systems levels of radiation within the ICNIRP guidelines.

Did you know?
In October 2002 a team of German physicians, after seeing a dramatic rise in severe and chronic diseases, set up the Freiburger Appeal for action to be taken. It has subsequently been endorsed by over 6500 practitioners.

In Britain a group of 30 doctors from Crosby in Liverpool have started a similar campaign.

Finland: Helsinki Appeal 2005
Calls on the European Parliament to act promptly for the adoption of new safety standards in the European Union. Doctors and researchers, feel concern about the Precautionary Principle not being applied to electromagnetic fields. <u>They want ICNIRP to be rejected.</u>

Irish Doctors Environmental Association believe that a sub-group of the population are sensitive to electro-magnetic radiation.

Sweden now medically recognise that some people are electro-sensitive to this form of radiation . They now have a medical register of 285,000 people and California has 700,000. If the same % applies to the UK, we will have over 2 million people affected.

Did you know?
A recent German study (Nov 2004) conducted over 10 years by a team of medical doctors, has discovered a threefold increase in cancer up to 400m from a mast after five years exposure. Compared to people living further away.

A study Kaplan Medical Centre, Israel (April 2004) has discovered a fourfold increase in cancer within 350m after long term exposure to a phone mast and a TENFOLD increase specifically in women.

Five other mobile phone mast studies have found significant health effects such as headaches, dizziness, depression, fatigue, sleep disorder, difficulty in concentration and cardiovascular problems.

- Santini et all (Paris) 2002
- Netherlands Ministries of Economic Affairs (TNO)
- The microwave syndrome – Further Aspect of a Spanish Study – Oberfeld Gerd, International Conference in Kos, Greece 2004
- Dr Oberfeld, Salzburg May 2005 – brainwaves changed significantly measured by EEG, group of people exposed 80 metres from a mast.
- Bamberg, Germany Evaluation of 356 people – DECT, telephones and masts versus level of power flux density. April 2005

<presentation extracts end>

Mrs O'Connor commented on recent announcements in the media concerning the link/non-link between mobile telecommunications and brain tumours. Mrs O'Connor informed Members of the alleged omission of 49% of data due to mortality and other statistical reasoning – stating that the research had found effects, but these facts had not been quoted in the media.

Mrs O'Connor further informed Members on ICNIRP guidelines, and a future meeting she would be attending on the 2nd March where these and other relevant issues were to be discussed. Sir William Stewart would be in attendance. Concerns were also expressed concerning the "economy driven" nature of the mobile phone industry, lack of risk assessment, or investigation into "safe frequencies"

Councillor Porter questioned Mrs O'Connor re the guidelines.

It was noted that the guidelines were not measured, or set, in respect of long-term exposure.

Mrs O'Connor reported further concerns that as a result of recent press coverage (dismissing the link between mobile phones and brain tumours)

people were almost encouraged to use handsets more than at present. Mrs O'Connor also reported that SAR guidance on individual handsets was included inside the packaging of mobile phones at the point of sale, and information.

Mrs O'Connor suggested that some form of screening unit(s) would be a valuable tool in assessing the issue of electro-magnetic sensitivity (EMS), and no guidance was available to GP's in respect of diagnosis of EMS.

The group discussed evidence of the level of mobile phone usage in many areas, noting that there was an indication that due to the transient nature of areas of with high concentrations of rental properties, and the increase in sales of pay as you go mobile phones, it could be argued that such areas would experience higher concentration and levels of transmission. – note: correlation to health impact may be difficult to prove in such areas due to transient nature of population.

Recent conversation between Scrutiny Support and the University of Essex was reported to the group. Essex University 2 year project – original findings due June 2006, now delayed until Dec 2006, as a result of additional funding allowing more detailed research/analysis to be carried out.

Mrs O'Connor reported that the Essex study was flawed in one respect, by the fact that "over sensitive" individuals were being dropped from the study, if their symptoms caused distress as a result of the testing, therefore ruling them out of the final study data reporting. However, interim findings in the case of one individual case had resulted in re-housing prior to the final report being made public.

Councillor Larkin questioned if anyone present had experience of the secretive nature of public health data, or if the witnesses were aware that the DoH had such data. Councillor Porter and Mrs O'Connor believed that it was likely that there were differences between the data collection between public health bodies, and no central database existed as a result.

Councillor Porter noted that there was now almost an acceptance that mobile technology was so widely available, and so embedded in today's lifestyles that a large number of public telephone booths were now being removed from the street scene.

Mrs O'Connor suggested that interim actions that could be taken should include:

- Taller masts – to reduce the levels of radiation experienced at ground level to acceptable levels.
- Reduction of guideline / permitted levels of exposure to "Saltzburg" levels.
- Research into "safe" technology alternatives.

Discussion continued in respect of the balance of signal strength over distance, the cost of screening, and suggestion that grants to cover costs could benefit individuals who suffer from the effects of EMS, and live in close

proximity to telecommunication masts. The example of noise pollution, and stress levels supporting the grant case in respect of double/triple glazing for those living close to, or under the flight path of, an airport.

It was noted by all that power levels from handsets were identified as more damaging to health due to the proximity to the body, but also not “constant”, as in the case of masts – element of “choice”. Note also – EMS sufferers pick up on even the lowest transmission levels.

NATIONAL / INTERNATIONAL PICTURE

The Stewart Report

What was the Stewart Report?
The report was commissioned in March 1999 by Tessa Jowell MP, who was then Minister for Public Health. She asked the NRPB (National Radiological Protection Board) to set up an independent expert working group to assess the possible health risks from mobile phones.

The group was chaired by Professor Sir William Stewart, FRS, FRSE; the Chairman of Tayside University Hospitals NHS Trust, Dundee. His team conducted a rigorous assessment of existing research and published its findings in May 2000, offering advice and recommendations.

The Stewart Report may be found at :-
http://www.IEGMP.org.uk/report/text.htm

Has this advice been updated?
On 11 January 2005 Sir William Stewart published an update to his May 2000 report into mobile phones and health. The update stated that, in the absence of new scientific evidence, his original recommendation on limiting the use of mobile phones by children remains appropriate as a precautionary measure.

It acknowledges that uncertainties remain and advocates a continued precautionary approach to their use. A view supported by the Working Group.

The Government has also published its own health advice and information. Mobile Phones and Health guidance may be found via :-
http://www.dh.gov.uk/PublicationsAndStatistics

It concluded that base stations should comply with the radiation guidelines of the International Commission on Non-Ionising Radiation Protection (ICNIRP).

Even so the Stewart Report confirmed that it was not possible to say that exposure to RF radiation, even at levels below national guidelines, would be totally without potential adverse health effects, and that the gaps in knowledge were sufficient to justify a precautionary approach.

The Government's advice to local authorities is that where a proposed installation falls within these guidelines, it should not be necessary to consider further the health effects.

The key scientific body - Health Protection Agency (HPA) ex National Radiological Protection Board (NRPB) says that exposures from mobile phone base stations are usually small fractions of international guidelines, typically less than 0.01% at most locations accessible to the public. Surveys also show that radio and TV transmitters can produce exposures that are comparable with those from mobile phone base stations.

International Guidelines

International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines and Risk Assessment

Electromagnetic field levels vary with frequency in a complex way. Listing every value in every standard and at every frequency would be difficult to understand. The table below is a summary of the exposure guidelines for the three areas that have become the focus of public concern: electricity in the home, mobile phone base stations and microwave ovens. These guidelines were last updated in April 1998.

Summary of the ICNIRP exposure guidelines

	European power frequency		Mobile phone base station frequency		Microwave oven frequency
Frequency	50 Hz Electric field (V/m)	50 Hz Magnetic field (μT)	900 MHz Power density (W/m^2)	1.8 GHz Power density (W/m^2)	2.45 GHz Power density (W/m^2)
Public exposure limits	5 000	100	4.5	9	10
Occupational exposure limits	10 000	500	22.5	45	

ICNIRP, EMF guidelines, Health Physics 74, 494-522 (1998)

The old NRPB guidelines included a precautionary reduction factor of 10 whilst the ICNIRP public guidelines include a precautionary factor of 50. They are only based on heating, acute neurological effects such as uncontrolled twitching, and electric shock. Neither of the guidelines is intended to protect from cancer promotion or from any of the other adverse health effects that some studies have associated with prolonged low level microwave exposure, (but for which evidence is inconsistent).

International guidelines for microwave exposure at 900MHz

Country	**$\mu W/cm^2$**
International Commission on Non-ionising Radiation (ICNIRP)	450
Australia & New Zealand	200
Italy	16
Poland	10
Toronto Health Board, Canada	6
Switzerland	4
Russia	2
Salzburg Resolution (2002: 19 scientists, 9 countries)	0.1

(For comparison only. TETRA operates around 300-450MHz.) UK now uses ICNIRP guidelines.

It should be noted that in practice Telecommunication Masts transmit signals enabling effective network communications at levels far below the ICNIRP public exposure limits.

Base Station Locations (UK)

It was identified during the early stages of review that members of the public and Councillors would find it beneficial if mast base stations could be easily located and individual site operators identified. Working Group Members believed that by better access to data on all matters in respect of mobile phone technology, residents would be better informed on the facts regarding telecommunication transmissions in their area (search by postcode).

The Office of Communications (Ofcom) 'Sitefinder' Mobile Phone Base Station Database is a national database of mobile phone base stations and their emissions, and provides just such information. The website address for this easy to use information source is:- http://www.sitefinder.radio.gov.uk/

Ofcom is not responsible for planning or health issues relating to mobile phone base stations and masts, however the site also holds information on details of the appropriate contacts within Government and general enquiries relating to these issues.

The data is owned by the network operators who, on a voluntary basis, supply Ofcom with updates periodically. Please note therefore that some more recently commissioned sites may not appear on Sitefinder, and Ofcom cannot accept liability for any inaccuracies or omissions in the data thus provided.

An example of location information, Southport Town Hall postcode PR8 1DA, is shown below. Each blue triangle denoting a specific base station site. This view also provides a high level summary of the type of technology. Further detail is then accessed by clicking specific “triangle” sites (see figure 5)..

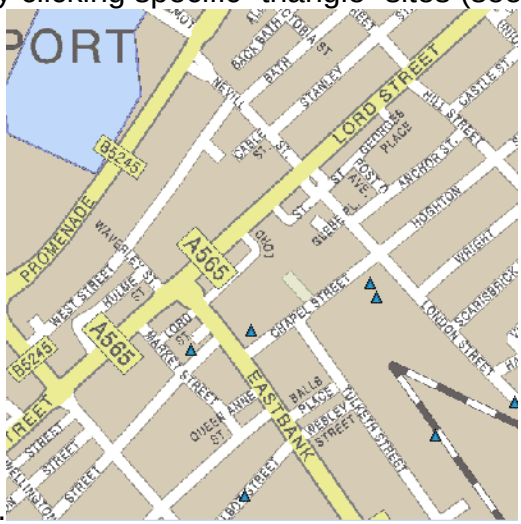


Figure 5.

Base stations displayed in this square:

Single operator GSM technology	5
Single operator UMTS technology	1
Single operator TETRA technology	0
Shared base stations (more than one operator or more than one technology)	1

The "Precautionary Principle"

Further to the Stewart Report 2000 and subsequent recommendations supporting the precautionary principle, additional research reports published since then continue to highlight "gaps" in research into the topic of the impact of radiofrequency exposure on health. In particular the gathering of substantive data over the long term. A prime example being that of the monitoring body itself :-

Epidemeology of Health Effects of Radiofrequency Exposure – ICNIRP Standing Committee on Epidemeology – Environmental Medicine – Review December 2004.

Summarises its report as follows:-

"However, because the RF research questions are not driven by a specific biophysical hypothesis but rather by a general concern that there are unknown or misunderstood effects of RFs, studies on other health effects may be equally justified. Examples are eye diseases, neurodegenerative diseases, and cognitive function. Given the increase in new mobile phone technologies, it is essential to follow various possible health effects from the very beginning and for long periods, because such effects may be detected only after a long duration, because of the prolonged latency period of many chronic diseases. Thus, research is needed to address long-term exposure, as well as diseases other than those included in the ongoing case–control studies. Another gap in the research is children. No study population to date has included children, with the exception of studies of people living near radio and TV antennas. Children are increasingly heavy users of mobile phones. They may be particularly susceptible to harmful effects (although there is no evidence of this), and they are likely to accumulate many years of exposure during their lives."

Further reason to support the Working Groups recommendation to maintain the "precautionary principle" as recommended in the Stewart Report 2000.

Current Research and Ongoing Studies

Expert Studies

Since the publication of the Stewart Report in May 2000, there have been several other studies conducted internationally into the effects of mobile phone use on health:

Institute of Cancer Research study

In August 2005 a study by the Institute of Cancer Research in London found that using a mobile phone for up to ten years does not increase the risk of cancer. The study, which assessed the risk of acoustic neuroma (a benign tumour in the nerve between the brain and the ear), suggested that there was no substantial risk in the first decade after starting mobile phone use. The study also found no association of risk with the number of calls made or the length of time spent using a mobile phone. There was also no association shown with the use of either analogue or digital handsets.

However, as widespread mobile phone use is a relatively recent phenomenon, the scientists said that an increase in risk after longer term use or after a longer lag period could not be ruled out.

Reflex study

In December 2004 a European Union funded research study, called the Reflex study, found that radiowaves from mobile phones could permanently alter DNA in human and animal cells. After being exposed to electromagnetic fields, the cells showed a significant increase in DNA damage which could not always be repaired by the cell. Such mutations have been cited as possible causes of cancer.

The research did not go on to look at whether these cellular changes were linked to disease. The UK National Radiological Protection Board reportedly advised people not to be worried by the study's findings. It is understood that the report failed to show any direct evidence of harm to human health from mobile phones. The scientists that published the study said more work was needed to see the actual effect of mobile phones on health.

Karolinska Institute study

In August 2004, scientists from the Karolinska Institute in Stockholm reported on a study looking at the power levels of mobile phones used in different areas, which found that those used in rural areas are likely to use higher power levels to ensure a good signal. This is because mobile phones adapt their output to the conditions around them so in rural areas, where base stations are relatively sparse, the output power level is higher than in more densely populated parts.

University of Szeged study

In June 2004, scientists from the University of Szeged in Hungary presented research to the European Society of Human Reproduction and Embryology (ESHRE) suggesting that carrying a mobile phone may have an adverse effect on male fertility. The report's findings were however questioned by other experts who suggested that further research needed to be carried out into any possible link between mobile phones and fertility.

Advisory Group on Non-Ionising Radiation

In January 2004 the Government's Advisory Group on Non-Ionising Radiation published a review of the evidence on the health effects of mobile phones, which has been published since the Stewart Report.

This review found that the existing evidence does not support cancer causation from radiofrequency exposure, in particular from mobile phone use. This backs up the findings of the Stewart Report, which concluded that 'the balance of evidence does not suggest that emissions from mobile phones and base stations put the health of the UK population at risk.' [Foreword]

However, the Advisory Group acknowledged that as mobile phones have been in use for a relatively short time, continued research is needed as there is still a possibility that there could be health effects from exposure to

radiofrequency transmissions below guideline levels. The report may be found along with other relevant research papers at:-
http://www.hpa.org.uk/radiation/publications

French Environmental Health Safety Agency
In April 2003 the French Environmental Health Safety Agency (AFSSE) released a report prepared for the French Parliament and Government. The report did not find that there was any evidence of a health risk from the use of mobile phones and/or living near a base station, although it recommended adopting the precautionary principle.

Norwegian Radiation Protection Authority
The Norwegian Radiation Protection Authority (NRPA) published a report concluding that studies of the population in recent years do not suggest there is any link between the use of mobile phones or human proximity to base stations and health risks.

Lund University
In February 2003 scientists at Lund University in Sweden carried out a study on rats, looking at the effects of their exposure to mobile phone radiation. The study suggested that such exposure could destroy cells in areas of the brain important for memory, movement and learning and could conceivably lead to the early onset of illnesses such as Alzheimer's disease, although as yet there is no evidence of a similar effect in humans.

World Health Organisation – See Appendix 1 to this report
The World Health Organisation (WHO) is also in the process of carrying out research into possible health and environmental effects of exposure to electromagnetic fields.

In the meantime the WHO states that “None of the recent reviews have concluded that exposure to the radio frequency (RF) fields from mobile phones or their base stations causes any adverse health consequences.

“However there are gaps in knowledge that have been identified for further research to better assess health risks. It will take about 3-4 years for the required RF research to be completed, evaluated and to publish the final results of any health risks.”

[WHO Fact Sheet No. 193, revised June 2000]

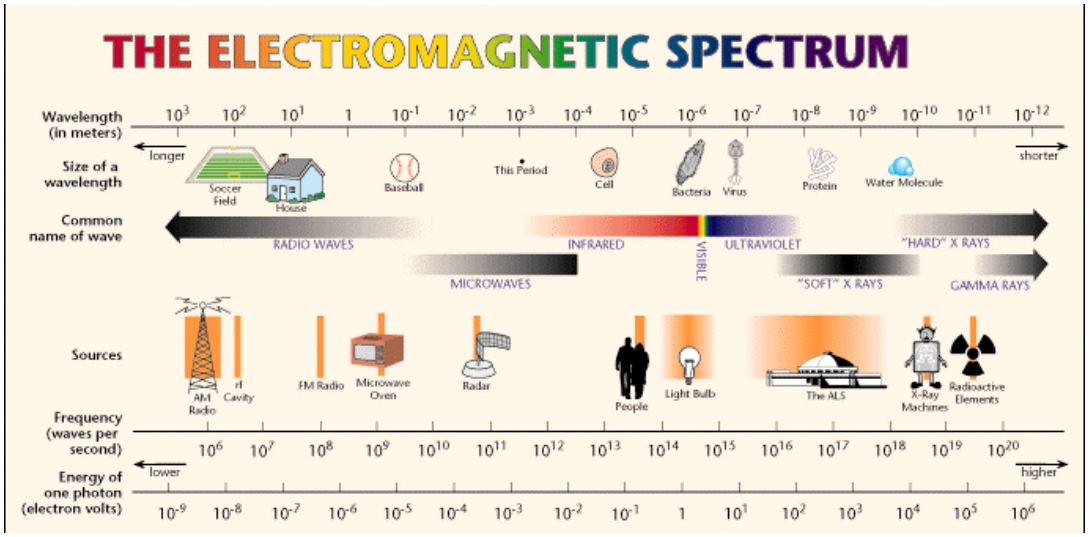
Radio Frequency research continues…

MOBILE TELECOMMUNICATION – WHAT IS IT ? HOW DOES IT WORK?

The Science

Radiowaves, x-rays and light are all forms of electromagnetic radiation, which are known collectively as the electromagnetic spectrum. They vary in frequency (Hz) and hence the amount of energy they carry – the higher the frequency, the higher the energy (see figure 1).

Figure 1. The Electromagnetic Spectrum



Mobile phone systems operate within the radiofrequency (RF) section (30kHz-300GHz) of the electromagnetic spectrum. Analogue phones operate at 450MHz and 900MHz, digital phones (GSM) at 900MHz or 1800MHz, and third generation phones (3G) to be launched in a few years, at approximately 2000MHz (2GHz).

The phone systems depend on RF communication between handsets and fixed base stations. In engineering terms, “base station” describes the electronic equipment contained in the plant room at the base of the mast. However, this term is frequently used to refer to the complete installation comprising base station, mast and antenna (see figure 2).

Mobile phones and base stations: the basics

Figure 2. Base Stations.

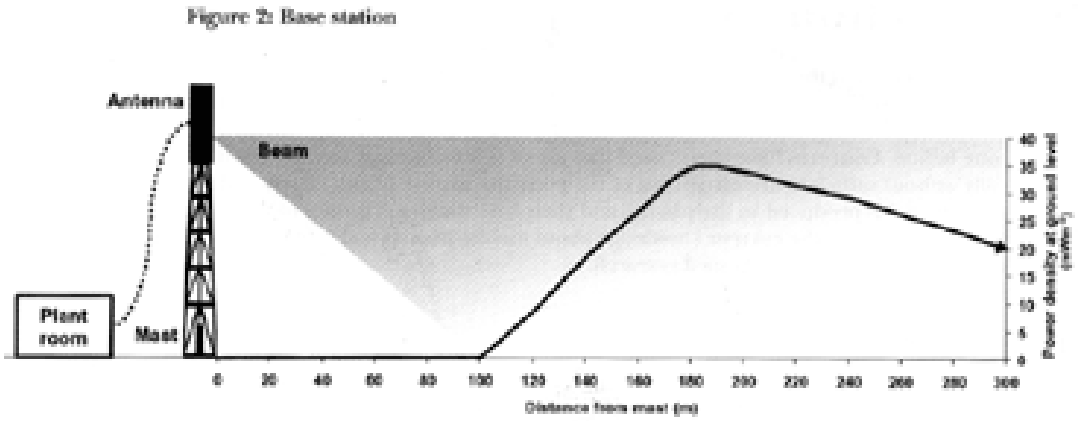


Figure 2 also shows the degree of exposure, in terms of power density, at ground level with increasing distance from a typical GSM900 antenna, where the top of the beam is situated 15m from ground level.

In this example, the main beam is tilted downwards so that the lower edge of the beam touches the ground at a distance of 100m from the mast. Power density increases from 100m to a maximum of 35 mWm-2 at a distance of 180m from the mast, after which it decreases with greater distance.

There may be a small amount of exposure between 10-100m due to other radiating elements on the antenna, but this is unlikely to exceed 17 mWm-2.
Each base station covers phone use in a specific area or ‘cell’, as great as 10km in rural areas, or as small as 0.2-0.5km in towns where demand is greatest. As the wavelengths at 900MHz are twice as long as those at 1800MHz, they are better at reaching the shielded regions behind obstructions as a result of diffraction (bending).

So in order to obtain identical coverage, fewer base stations are needed at 900MHz than 1800MHz. On receipt of a call, the base station closest to the handset will transmit and receive the RF signal. As the user moves, this signal may be transferred to a nearer base station in order to maintain an optimum user signal at the lowest possible power output.

Other forms of mobile communication that operate using a similar system of a handset and a base station include cordless telephones (analogue, operating at 914-960MHz, and the new digital DECT system, operating at 1.88-1.9GHz), and portable radio systems.

A new cellular radio system, TETRA, is increasing in use across Europe. It operates at either 400MHz or 900MHz, and is designed for use in closed groups, particularly the emergency services. Little research has been conducted into its possible adverse health effects, and therefore this research is necessary.

At high intensities RF radiation has heating properties that can be detrimental to health (thermal effects). For this reason guidelines are in place to limit the intensity of the radiation. The use of RF radiation in daily life is not new, however, and figure 1 shows other technologies that operate at this frequency. Electromagnetic radiations of many kinds occur in nature, although at very much lower intensities than most man-made fields. Indeed, daylight, produced by the Sun, is such a radiation. There are other sources of light in nature; glow-worms and certain fish can produce dim light for instance and radioactive substances glow in the dark too.

Electrons vibrating backwards and forwards 50 times every second in a wire connected to the mains produce a similar disturbance in space, except, that in this case, the 'ripples' are the lines of force of the EMF. As with pond ripples, the field weakens as it moves out from the conductor, (fig,3) In the case of EMFs there are two types of 'ripples', the electrical and magnetic parts of the field and they radiate at right angles to both each other and to the conductor carrying the current. (see figure 3).

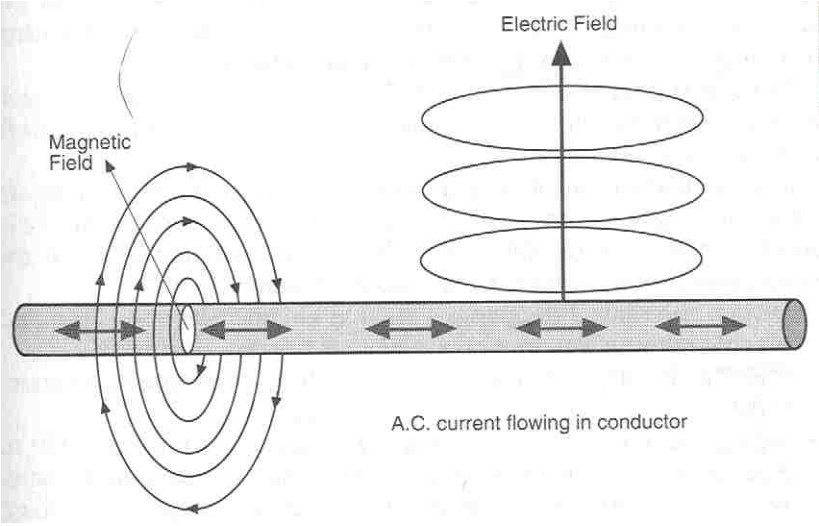


Figure 3.

Visible light lies within a narrow band from 4 x 1014 to 7.7 x 10'4Hz and every colour in the spectrum has its own specific frequency. Light (which we can see) and infra-red (which is' felt as warmth) are the only parts of the electromagnetic spectrum for which we have specific sense organs. This is what makes all other electromagnetic radiations both rather mysterious and, in many cases, so potentially dangerous.

Probably the most important fact about light in this context is that even though it is a natural EMF it can be unpleasant or even dangerous in excess. Stay out too long in strong sunlight – result sunburn. Do it too often, and there is a risk of skin cancer. Similarly, excessive exposure to infrared can be harmful. The Sun produces other EMFs in the radio-frequency range — sun-spots can interfere with radio and television reception.

With reference to the chart of different electromagnetic frequencies (fig.4), we see that light is somewhere in the middle, with mains electricity at one end and ionising radiation at the other. Working up from the lowest frequencies, we have the following: (see figure 4)

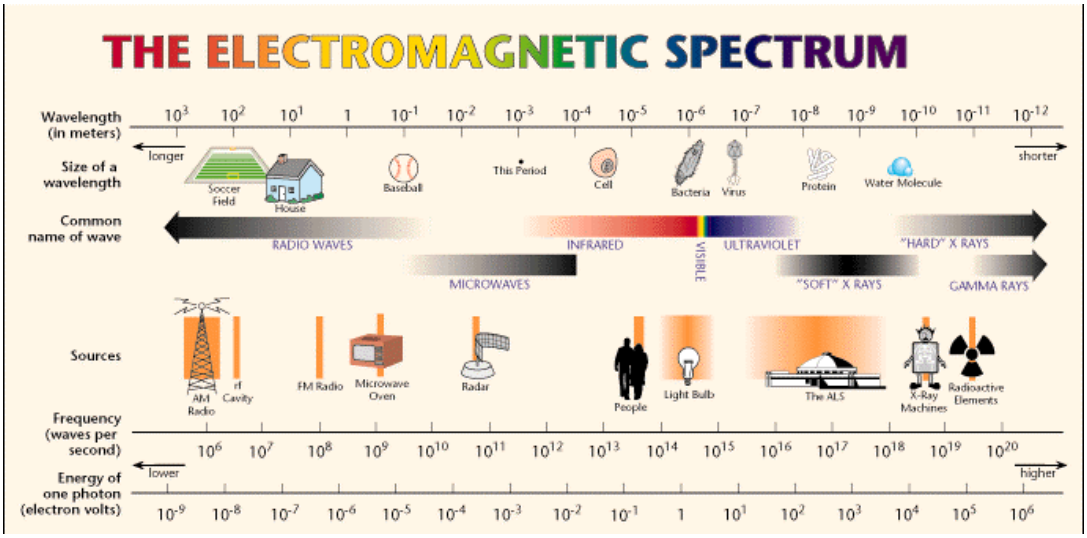


Figure 4.

- Certain specialised frequencies such as electric fences - I Hz; and electric railways in some countries (not Britain) - 16 2/3 z.
- Mains electricity - 50Hz (or 60Hz in U.S.A. and some other countries).
- Radio, television and radar - a very wide band from 3 x 10^4 to 3 x 10^{l2}Hz. At the upper end of this range are so-called microwaves, used for communications (telecommunications, military, etc.) as well as microwave ovens.
- Infra-red radiation - from 3 x 10^{11} to 3 x 10^{l4}Hz.
- Visible light - a narrow band from 4 x 1014 to 7.7 x 10l4Hz.
- Ultra-violet radiation from 7.7 x 10^{14} to 3 x 10^{17}Hz.
- Ionising radiations (neutrons, alpha-, beta-, gamma- and X-rays) - up to 3 x 10^{22}Hz

This is a good point to clarify the matter of ionising and non-ionising radiation. (See also reference later in the text and Appendix 2 of this report) As you can see from the outline above and from the chart, what are called ionising radiations occur at the high end of the spectrum. There is no controversy about the hazards which these represent — their name means that they will ionise or change the molecular structure of tissue exposed to them. This is what makes them so dangerous.

We are concerned here only with the lower frequency, non-ionising waves. But the fact that they do not directly affect molecular structure in the way that a gamma-ray or an X-ray will does not necessarily mean that they pose no threat to living organisms and in particular to human beings.

Shielding and Safe Distances

There are two possible ways to avoid electromagnetic radiations: try to move far enough from the source so that the field has weakened to an acceptable level; or find some way of shielding ourselves. When talking about shielding we must distinguish between the two main types of electromagnetic radiation.

Electrical Fields are produced whenever there is a voltage in a conductor (voltage is the 'pressure' that pushes the electric current around a circuit). These fields will be present even if there is no current flowing. There is no need for anything to be connected to the circuit. Electrical fields will be absorbed by any material that conducts electricity - walls, people, trees - and so it is fairly easy to shield against them.

Magnetic Fields, on the other hand, are produced only when current flows (that is, when the circuit is switched on, just as water flows in a pipe when a tap is opened). These fields pass almost unhindered through people, the ground and many building materials, although concrete and steelwork in buildings will reduce them to some degree. Mains frequency magnetic fields are particularly persistent. Even aluminium sheeting half an inch (12mm.) thick will only be partially effective. **As a result, shielding against them is extremely difficult and often, for all practical purposes, impossible. The relatively small shielding effects of common construction material is illustrated in the table below.**

	Permeability (%) for	
	Electrical fields	Magnetic fields
Wire mesh (1 mm) - 3 cm pitch	0.5	65
Wire mesh (irnrn) - 0.3 cm pitch	0.I	10
Iron sheet (Zmrn)	0.I	50
Copper foil (0.2mm)	0.1	90
Reinforced concrete (60 cm)	0.1	0.-l
All the above are for 50 Hz fields		

Both electrical and magnetic fields become weaker with distance. For instance, there are very strong fields immediately under a high voltage power line, but they fall away steadily as you move away. It has been suggested that the UK should follow the practice of some other countries and establish a clear zone (which can be 100 yards [91metres] or more) on either side of power lines within which building houses is banned. In America or Russia the debate is whether existing zones are wide enough, whereas in the U.K. there are no regulations at all and power lines often run directly over inhabited areas.

There is no easy answer to the problem as fields from strong sources can persist over amazing distances; for instance, in Germany the characteristic 16 2AHz waves of the railway system have been detected in the earth 10 miles (16 km) from the nearest line (the operating voltage in this case is up to 110kV, which is far less than most power distribution lines). It is necessary to move fully 3A of a mile (1.2km) from a 500KV overhead power line before field strengths fall off to 'background' levels, and higher voltages than this are increasingly used around the world.

However, it is not only high voltages that have historically raised concerns. Many people worry about their house being too near a power line, few think about the wiring in their houses. A simple calculation will show that wiring in your home may produce an EMF as strong as that from a overhead power pylon at the end of the garden. **In other words, being close to a weak source can have as much effect as being further away from a strong one. In either case the effective frequency is the same, which is probably the most important characteristic.** The results of exposure may be different in the two cases, but it seems likely that both may cause health problems.

The argument is exactly the same for the comparison of Telecommunication Mast output and Mobile Phone Handsets.

Key messages

Mobile Phones	***Base Stations***
Radiate powers up to around ¼ watt.	Radiate powers up to around 100 watts.
Held with their antenna around 2 cm from the user's head.	Antennas are typically tens of metres away from the general public.
Mostly expose the tissues of the head nearest to the phone's antenna.	Exposure is more even over the body but at a very much lower level than with a phone.
Localised exposure is measured as the Specific Absorption Rate (SAR) of energy in the head.	The power density of the radio waves incident on the body is a good measure of whole-body exposure.
Guidelines advise localised SAR should not exceed 2 watts per kilogram when averaged over any 10 grams of tissue and any 6 minute period.	Guidelines advise reference levels of either 4.5 or 9 watts per square metre depending on the frequency band.
All phones sold in the UK have to be tested to ensure they produce SARs below the above figure.	In addition to their obligations under UK safety law, the Network operators have voluntarily agreed to comply with lower international guidelines.
SAR values for specific phone models can be found through the MMF website and range up to around 1.5 watts per kilogram.	Typical exposures at locations accessible to the public are thousands of times lower than guidelines.

Industry Advice

Is there a possible health risk associated with mobile phones?

Mobile phones are basically sophisticated two-way radios that receive and transmit radio waves to and from base stations.

Radio waves are known, in the jargon, as microwave radiation or electromagnetic energy (EME) or electromagnetic fields (EMF). EME occurs in natural light and other commonplace household objects such as light bulbs and televisions - and we are exposed to it all the time. EME is part of the natural world. However, some scientists suspect that over-exposure to radio waves, or EME/EMF, may be harmful.

The crux of this review is based upon public concerns over this matter and the conflicting information available that neither, conclusively proves, or disproves the case.

Are mobile phones safe for children?

Despite a plethora of contradictory professional reports, the current consensus based on peer reviewed data concurs with the precautionary view published in the Stewart Report 2000 that:

"If there are currently unrecognised adverse health effects from the use of mobile phones, children may be more vulnerable because of their developing nervous system, the greater absorption of energy in the tissues of the head, and the longer lifetime of exposure. In line with our precautionary approach, we believe that the widespread use of mobile phones by children for non-essential calls should be discouraged. We also recommend that the mobile phone industry should refrain from the promoting the use of mobile phones by children".

[Stewart Report - para 6.90]

If they are to be used by children, and in support of this precautionary principle, and the recommendation of 'responsible' use of mobile phones, mobile phone companies have advised younger users to:

- keep calls short;
- send an SMS instead.

Unfortunately, "popular youth culture" does not always follow this advice.

What safety standards exist to make sure mobile phones are safe?
Mobile phones are designed and manufactured not to exceed the limits for exposure to radio frequency (RF) recommended by international guidelines (ICNIRP). These limits are part of comprehensive guidelines and establish permitted levels of RF energy for the general population. They were adopted in the UK following a recommendation in the Stewart Report. The guidelines were developed by independent scientific organisations through periodic and thorough evaluation of scientific studies. The limits include a substantial safety margin designed to assure the safety of all persons, regardless of age and health. Further information is contained in this report.

The exposure standard for mobile phones employs a unit of measurement known as the Specific Absorption Rate, or SAR. The SAR limit stated in the international guidelines is 2.0 W/kg. Tests for SAR are conducted using standard operating positions with the phone transmitting at its highest certified power level in all tested frequency bands. Although the SAR is determined at the highest certified power level, the actual SAR level of the phone while operating can be well below the maximum value. This is because phones ares designed to operate at multiple power levels so as to use only the minimum power required to reach the network. In general, the closer you are to a base station, the lower the power output of the phone.

To check SAR values phone owners may contact the mobile phone manufacturer, or visit the website of the Mobile Manufacturers Forum at http://www.mmfai.org/public/, the trade association representing the handset manufacturers.

While there may be differences between the SAR levels of various phones and at various positions, a lower SAR value does not mean that a phone is safer.

The SAR limit for mobile phones used by the public is 2.0 watts/kilogram (W/kg) averaged over ten grams of body tissue. The guidelines are said to incorporate a substantial margin of safety to give additional protection for the public and to account for any variations in measurements.

HEALTH CONCERNS

Fatigue, Stress or Electro-Magnetic Sensitivity?

The focus of the review, as a result of public petition, focused on health concerns. During the questioning of residents, through face to face and telephone interview, and written correspondence received, the Working Group independently established a consistent “set of symptoms” experienced by local residents.

The symptoms, primarily fatigue, can be linked to stress, and this view has been expressed by some medical professionals as the probable cause of illness in the case of residents living in close proximity to telecommunication masts.

Recent research however, suggests that there is growing evidence that certain individuals may be susceptible to electromagnetic fields, and may experience physical symptoms as a result. It is this view that has gathered substantial support during the course of this review, and has been acknowledged by the Health Protection Agency in their report published October 2005.

However, even if the condition “electro-magnetic sensitivity” is supported - what evidence is there that the symptoms experienced by local residents can be directly linked to telecommunication masts, and are not the result of sensitivity to electro-magnetic fields from other sources in their homes, workplace or the general environment?

Other factors could include:

- Age / Weight
- General Health / Pre existing Medical Conditions
- Family Health History / Undiagnosed Conditions
- Lifestyle
- Psychological causes
- Length of time in current property
- Exposure to other possible sources at a previous residence

Fatigue

Fatigue is a symptom, rather than a specific disease or disorder. People who are fatigued feel tired all the time - in both body and mind. Estimates vary, but it is thought that between three and 10 per cent of patients visit their doctors because of fatigue.

A person suffering from fatigue has slowed reflexes and reduced function in daily life. Excessive tiredness is also a known risk factor in motor vehicle and workplace accidents. Always see your doctor for diagnosis if suffering from chronic tiredness - that is, fatigue persisting over a long period of time.

Symptoms

Fatigue can cause a vast range of other physical, mental and emotional symptoms including:

Chronic Tiredness or Sleepiness	Muscle Weakness	Impaired Hand to Eye co-ordination	Problems with Short Term Memory
Headache	Slowed Reflexes and Responses	Appetite Loss	Poor Concentration
Dizziness	Impaired Decision Making and Judgement	Reduced Immune System Function	Hallucinations
Sore or Aching Muscles	Moodiness, and Irritability	Blurry Vision	Low Motivation

A range of causes

The wide range of causes that can trigger fatigue include:

- Undiagnosed medical conditions
- Unhealthy lifestyle choices
- Workplace issues
- Emotional concerns and stress
- Fatigue can be caused by a number of factors working in combination

Medical causes

Many diseases and disorders can trigger fatigue, including:

The Flu	Myalgic Encephalopathy (Chronic Fatigue Syndrome)	Chronic pain	Heart problems
Glandular Fever	Hypothyroidism	Coeliac disease	HIV
Anaemia	Hepatitis	Addison's disease	Cancer
Sleep Disorders, such as Sleep Apnoea	Tuberculosis	Parkinson's disease	Side-effects of certain medications

Lifestyle related causes
Common lifestyle choices that can cause fatigue include:

Lack of sleep - adults need about eight hours of sleep per night. Because of work, family, social commitments and other reasons, some people 'burn the candle at both ends' and try to get by on fewer hours of sleep. New parents are commonly sleep deprived, since babies wake often for food or comfort.

Too much sleep - adults sleeping more than 11 hours per day can lead to excessive daytime sleepiness.

Alcohol and drugs - alcohol is a depressant drug that slows the nervous system and disturbs normal sleep patterns. Other drugs, such as cigarettes and caffeine, stimulate the nervous system and make insomnia more likely.

Sleep disturbances - disturbed sleep may occur for a number of reasons, for example, noisy neighbours, young children who wake in the night, a snoring partner, or an uncomfortable sleeping environment such as a stuffy bedroom.

Lack of regular exercise and sedentary behaviour - physical activity is known to improve fitness, health and wellbeing, reduce stress, and boost energy levels. It also helps you sleep. Regular exercise is also an effective treatment for anxiety and depression.

Poor diet - low kilojoule diets, low carbohydrate diets or high energy foods that are nutritionally poor don't provide the body with enough fuel or nutrients to function at its best. Quick fix foods, such as chocolate bars or caffeinated drinks, only offer a temporary energy boost that quickly wears off and worsens fatigue.

Individual factors - events that impact on the individual can cause fatigue. These may include personal illness or injury, illnesses or injuries in the family, too many commitments (for example, working two jobs) or financial problems.

Workplace related causes
Common workplace issues that can cause fatigue include:

Shift work - the human body is designed to sleep during the night. This pattern is set by a small part of the brain known as the circadian clock. A shift worker confuses their circadian clock by working when their body is programmed to be asleep. Sleeping during the day is usually difficult, because the person's brain chemicals (neurotransmitters) are naturally set to 'wakefulness' mode.

Poor workplace practices - can add to a person's level of fatigue. These may include long work hours, hard physical labour, irregular working hours (such as rotating shifts), stressful work environment (such as excessive noise or temperature extremes), boredom, working alone with little or no interaction with others, or fixed concentration on a repetitive task.

Workplace stress - can be caused by a wide range of factors including job dissatisfaction, heavy workload, conflicts with bosses or colleagues, bullying, constant change, or threats to job security.

Burnout - can be described as striving too hard in one area of life while neglecting everything else. 'Workaholics', for example, put all their energies into their career, which puts their family life, social life and personal interests out of balance.

Unemployment - financial pressures, feelings of failure or guilt, and the emotional exhaustion of prolonged job hunting can lead to stress, anxiety, depression and fatigue.

Psychological causes
Studies suggest that psychological factors are present in at least 50 per cent of fatigue cases. These may include:

Depression - this illness is characterised by severe and prolonged feelings of sadness, dejection and hopelessness. People who are depressed commonly experience chronic tiredness.

Anxiety and stress - a person who is chronically anxious or stressed keeps their body in overdrive. The constant flooding of adrenaline exhausts the body, and fatigue sets in.

Grief - losing a loved one causes a wide range of emotions including shock, guilt, depression, despair and loneliness.

Diagnosis can be difficult
Since fatigue can present a vast range of symptoms and be caused by many different factors working in combination, diagnosis can be difficult. Your doctor may diagnose fatigue using a number of tests including:

- Medical history - recent events such as childbirth, medication, surgery or bereavement may contribute to fatigue.

- Physical examination - to check for signs of illness or disease. The doctor may also ask detailed questions about diet, lifestyle and life events.

- Tests - this may include blood tests, urine tests, x-rays and other investigations. The idea is to rule out any physical causes, such as anaemia, infection or hormonal problems.

Sleep disruption
Theories linking sleep disruption and EMF tend to focus on the impact of melatonin production. Both human and animal circadian rhythms are driven by the day/night cycle and are synchronized with natural geomagnetic electromagnetic fields. The major control gland over this natural cycle is the pineal gland which secretes the neurohormone melatonin. During the day, light falling on the eye's retina produces signals which are biochemically amplified to stimulate the pineal gland to reduce its melatonin output. At night the absence of light with sleep stimulates the pineal gland to produce melatonin.

The circadian production of melatonin is also thought to control important processes in the eyes, including restoration of rods (for night vision) at the end of the night, and renewal of cones (for colour vision) at the end of the day.

One theory, which appears to be gathering support, is founded on the belief that man made EMF's may affect the pineal gland, and that the pineal gland may 'sense' EMF's as light. Therefore reducing melatonin production, impacting on an individual’s sleep pattern, leading to fatigue.

Things to remember
Fatigue can be caused by a number of factors working in combination, such as medical conditions, unhealthy lifestyle choices, workplace problems and stress.

Is there a link between masts/base stations, and symptoms of ill health?
In the course of the review, Members of the Working Group had the opportunity to interview residents from different locations in the borough of Sefton.

Independently, they provided the Working Group with matching examples of a range of symptoms as mentioned above. Surprisingly, it should be noted that in many of the interviews with residents, telecommunication masts were not initially identified or blamed as the cause of the onset of ill health.

But the question remains:

If the condition “electro-magnetic sensitivity” is supported - what evidence is there that the symptoms experienced by local residents can be directly linked to telecommunication masts, and are not the result of sensitivity to electro-magnetic fields from other sources in their homes, workplace or the general environment?

The Working Group believes that as a result of its review into public concerns over the impact on health from telecommunication masts, their research into the topic has highlighted areas where guideline limits are perhaps, too lenient.

APPENDIX 1

WORLD HEALTH ORGANISATION

GUIDANCE ON ELECTROMAGNETIC FIELDS

The World Health Organization is the United Nations specialized agency for health. It was established on 7 April 1948. WHO's objective, as set out in its Constitution, is the attainment by all peoples of the highest possible level of health. Health is defined in WHO's Constitution as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

WHO is governed by 192 Member States through the World Health Assembly. The Health Assembly is composed of representatives from WHO's Member States. The main tasks of the World Health Assembly are to approve the WHO programme and the budget for the following biennium and to decide major policy questions.

What are electromagnetic fields?

Definitions and sources

Electric fields are created by differences in voltage: the higher the voltage, the stronger will be the resultant field. Magnetic fields are created when electric current flows: the greater the current, the stronger the magnetic field. An electric field will exist even when there is no current flowing. If current does flow, the strength of the magnetic field will vary with power consumption but the electric field strength will be constant.

(Extract from Electromagnetic fields published by the WHO Regional Office for Europe in 1999 (Local authorities, health and environment briefing pamphlet series; 32).

Natural sources of electromagnetic fields

Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms. The earth's magnetic field causes a compass needle to orient in a North-South direction and is used by birds and fish for navigation.

Human-made sources of electromagnetic fields
Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radiowaves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations.

The basics of wavelength and frequency
What makes the various forms of electromagnetic fields so different?
One of the main characteristics which defines an electromagnetic field (EMF) is its frequency or its corresponding wavelength. Fields of different frequencies interact with the body in different ways. One can imagine electromagnetic waves as series of very regular waves that travel at an enormous speed, the speed of light. The frequency simply describes the number of oscillations or cycles per second, while the term wavelength describes the distance between one wave and the next. Hence wavelength and frequency are inseparably intertwined: the higher the frequency the shorter the wavelength.

A simple analogy should help to illustrate the concept: Tie a long rope to a door handle and keep hold of the free end. Moving it up and then down slowly will generate a single big wave; more rapid motion will generate a whole series of small waves. The length of the rope remains constant, therefore, the more waves you generate (higher frequency) the smaller will be the distance between them (shorter wavelength).

What is the difference between non-ionizing electromagnetic fields and ionising radiation?
Wavelength and frequency determine another important characteristic of electromagnetic fields: Electromagnetic waves are carried by particles called quanta. Quanta of higher frequency (shorter wavelength) waves carry more energy than lower frequency (longer wavelength) fields. Some electromagnetic waves carry so much energy per quantum that they have the ability to break bonds between molecules. In the electromagnetic spectrum, gamma rays given off by radioactive materials, cosmic rays and X-rays carry this property and are called 'ionizing radiation'. Fields whose quanta are insufficient to break molecular bonds are called 'non-ionizing radiation'. Man-made sources of electromagnetic fields that form a major part of industrialized life - electricity, microwaves and radiofrequency fields – are found at the relatively long wavelength and low frequency end of the electromagnetic spectrum and their quanta are unable to break chemical bonds.

Electromagnetic fields at low frequencies
Electric fields exist whenever a positive or negative electrical charge is present. They exert forces on other charges within the field. The strength of the electric field is measured in volts per metre (V/m). Any electrical wire that is charged will produce an associated electric field. This field exists even

when there is no current flowing. The higher the voltage, the stronger the electric field at a given distance from the wire.

Electric fields are strongest close to a charge or charged conductor, and their strength rapidly diminishes with distance from it. Conductors such as metal shield them very effectively. Other materials, such as building materials and trees, provide some shielding capability. Therefore, the electric fields from power lines outside the house are reduced by walls, buildings, and trees. When power lines are buried in the ground, the electric fields at the surface are hardly detectable.

Magnetic fields arise from the motion of electric charges. The strength of the magnetic field is measured in amperes per meter (A/m); more commonly in electromagnetic field research, scientists specify a related quantity, the flux density (in microtesla, μT) instead. In contrast to electric fields, a magnetic field is only produced once a device is switched on and current flows. The higher the current, the greater the strength of the magnetic field.

Like electric fields, magnetic fields are strongest close to their origin and rapidly decrease at greater distances from the source. Magnetic fields are not blocked by common materials such as the walls of buildings.

Electric fields / Magnetic fields

1. Electric fields arise from voltage.
2. Their strength is measured in Volts per metre (V/m)
3. An electric field can be present even when a device is switched off.
4. Field strength decreases with distance from the source.
5. Most building materials shield electric fields to some extent.
1. Magnetic fields arise from current flows.
2. Their strength is measured in amperes per meter (A/m). Commonly, EMF investigators use a related measure, flux density (in microtesla (μT) or millitesla (mT) instead.
3. Magnetic fields exist as soon as a device is switched on and current flows.
4. Field strength decreases with distance from the source.
5. Magnetic fields are not attenuated by most materials.

Electric fields

Plugging a wire into an outlet creates electric fields in the air surrounding the appliance. The higher the voltage the stronger the field produced. Since the voltage can exist even when no current is flowing, the appliance does not have to be turned on for an electric field to exist in the room surrounding it.

Magnetic fields

Magnetic fields are created only when the electric current flows. Magnetic fields and electric fields then exist together in the room environment. The greater the current the stronger the magnetic field. High voltages are used for the transmission and distribution of electricity whereas relatively low voltages are used in the home. The voltages used by power transmission equipment

vary little from day to day, currents through a transmission line vary with power consumption.

Electric fields around the wire to an appliance only cease to exist when the appliance is unplugged or switched off at the wall. They will still exist around the cable behind the wall.

How do static fields differ from time-varying fields?
A static field does not vary over time. A direct current (DC) is an electric current flowing in one direction only. In any battery-powered appliance the current flows from the battery to the appliance and then back to the battery. It will create a static magnetic field. The earth's magnetic field is also a static field. So is the magnetic field around a bar magnet which can be visualized by observing the pattern that is formed when iron filings are sprinkled around it.

In contrast, time-varying electromagnetic fields are produced by alternating currents (AC). Alternating currents reverse their direction at regular intervals. In most European countries electricity changes direction with a frequency of 50 cycles per second or 50 Hertz. Equally, the associated electromagnetic field changes its orientation 50 times every second. North American electricity has a frequency of 60 Hertz.

What are the main sources of low, intermediate and high frequency fields?
The time-varying electromagnetic fields produced by electrical appliances are an example of extremely low frequency (ELF) fields. ELF fields generally have frequencies up to 300 Hz. Other technologies produce intermediate frequency (IF) fields with frequencies from 300 Hz to 10 MHz and radiofrequency (RF) fields with frequencies of 10 MHz to 300 GHz. The effects of electromagnetic fields on the human body depend not only on their field level but on their frequency and energy. Our electricity power supply and all appliances using electricity are the main sources of ELF fields; computer screens, anti-theft devices and security systems are the main sources of IF fields; and radio, television, radar and cellular telephone antennas, and microwave ovens are the main sources of RF fields. These fields induce currents within the human body, which if sufficient can produce a range of effects such as heating and electrical shock, depending on their amplitude and frequency range. (However, to produce such effects, the fields outside the body would have to be very strong, far stronger than present in normal environments.)

Electromagnetic fields at high frequencies
Mobile telephones, television and radio transmitters and radar produce RF fields. These fields are used to transmit information over long distances and form the basis of telecommunications as well as radio and television broadcasting all over the world. Microwaves are RF fields at high frequencies in the GHz range. In microwaves ovens, we use them to quickly heat food.

At radio frequencies, electric and magnetic fields are closely interrelated and we typically measure their levels as power densities in watts per square metre (W/m2).

Key points

- The electromagnetic spectrum encompasses both natural and human-made sources of electromagnetic fields.
- Frequency and wavelength characterise an electromagnetic field. In an electromagnetic wave, these two characteristics are directly related to each other: the higher the frequency the shorter the wavelength.
- Ionizing radiation such as X-ray and gamma-rays consists of photons which carry sufficient energy to break molecular bonds. Photons of electromagnetic waves at power and radio frequencies have much lower energy that do not have this ability.
- Electric fields exist whenever charge is present and are measured in volts per metre (V/m). Magnetic fields arise from current flow. Their flux densities are measured in microtesla (μT) or millitesla (mT).
- At radio and microwave frequencies, electric and magnetic fields are considered together as the two components of an electromagnetic wave. Power density, measured in watts per square metre (W/m2), describes the intensity of these fields.
- Low frequency and high frequency electromagnetic waves affect the human body in different ways.
- Electrical power supplies and appliances are the most common sources of low frequency electric and magnetic fields in our living environment. Everyday sources of radiofrequency electromagnetic fields are telecommunications, broadcasting antennas and microwave ovens.

Summary of health effects

What happens when you are exposed to electromagnetic fields?

Exposure to electromagnetic fields is not a new phenomenon. However, during the 20th century, environmental exposure to man-made electromagnetic fields has been steadily increasing as growing electricity demand, ever-advancing technologies and changes in social behaviour have created more and more artificial sources. Everyone is exposed to a complex mix of weak electric and magnetic fields, both at home and at work, from the generation and transmission of electricity, domestic appliances and industrial equipment, to telecommunications and broadcasting.

Tiny electrical currents exist in the human body due to the chemical reactions that occur as part of the normal bodily functions, even in the absence of external electric fields. For example, nerves relay signals by transmitting electric impulses. Most biochemical reactions from digestion to brain activities go along with the rearrangement of charged particles. Even the heart is electrically active - an activity that your doctor can trace with the help of an electrocardiogram.

Low-frequency electric fields influence the human body just as they influence any other material made up of charged particles. When electric fields act on conductive materials, they influence the distribution of electric charges at their surface. They cause current to flow through the body to the ground.

Low-frequency magnetic fields induce circulating currents within the human body. The strength of these currents depends on the intensity of the outside magnetic field. If sufficiently large, these currents could cause stimulation of nerves and muscles or affect other biological processes.

Both electric and magnetic fields induce voltages and currents in the body but even directly beneath a high voltage transmission line, the induced currents are very small compared to thresholds for producing shock and other electrical effects.

Heating is the main biological effect of the electromagnetic fields of radiofrequency fields. In microwave ovens this fact is employed to warm up food. The levels of radiofrequency fields to which people are normally exposed are very much lower than those needed to produce significant heating. The heating effect of radiowaves forms the underlying basis for current guidelines. Scientists are also investigating the possibility that effects below the threshold level for body heating occur as a result of long-term exposure. To date, no adverse health effects from low level, long-term exposure to radiofrequency or power frequency fields have been confirmed, but scientists are actively continuing to research this area.

Biological effects or health effects? What is a health hazard?
Biological effects are measurable responses to a stimulus or to a change in the environment. These changes are not necessarily harmful to your health. For example, listening to music, reading a book, eating an apple or playing tennis will produce a range of biological effects. Nevertheless, none of these activities is expected to cause health effects.

The body has sophisticated mechanisms to adjust to the many and varied influences we encounter in our environment. Ongoing change forms a normal part of our lives. But, of course, the body does not possess adequate compensation mechanisms for all biological effects. Changes that are irreversible and stress the system for long periods of time may constitute a health hazard.

An adverse health effect causes detectable impairment of the health of the exposed individual or of his or her offspring; a biological effect, on the other hand, may or may not result in an adverse health effect.

It is not disputed that electromagnetic fields above certain levels can trigger biological effects. Experiments with healthy volunteers indicate that short-term exposure at the levels present in the environment or in the home do not cause any apparent detrimental effects. Exposures to higher levels that might be harmful are restricted by national and international guidelines. The current debate is centred on whether long-term low level exposure can evoke biological responses and influence people's well being.

Widespread concerns for health
A look at the news headlines of recent years allows some insight into the various areas of public concern. Over the course of the past decade, numerous electromagnetic field sources have become the focus of health

concerns, including power lines, microwave ovens, computer and TV screens, security devices, radars and most recently mobile phones and their base stations.

The International EMF Project
In response to growing public health concerns over possible health effects from exposure to an ever increasing number and diversity of electromagnetic field sources, in 1996 the World Health Organization (WHO) launched a large, multidisciplinary research effort. The International EMF Project brings together current knowledge and available resources of key international and national agencies and scientific institutions.

Conclusions from scientific research
In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research.

Effects on general health
Some members of the public have attributed a diffuse collection of symptoms to low levels of exposure to electromagnetic fields at home. Reported symptoms include headaches, anxiety, suicide and depression, nausea, fatigue and loss of libido. To date, scientific evidence does not support a link between these symptoms and exposure to electromagnetic fields. At least some of these health problems may be caused by noise or other factors in the environment, or by anxiety related to the presence of new technologies.

Effects on pregnancy outcome
Many different sources and exposures to electromagnetic fields in the living and working environment, including computer screens, water beds and electric blankets, radiofrequency welding machines, diathermy equipment and radar, have been evaluated by the WHO and other organizations. The overall weight of evidence shows that exposure to fields at typical environmental levels does not increase the risk of any adverse outcome such as spontaneous abortions, malformations, low birth weight, and congenital diseases. There have been occasional reports of associations between health problems and presumed exposure to electromagnetic fields, such as reports of prematurity and low birth weight in children of workers in the electronics industry, but these have not been regarded by the scientific community as being necessarily caused by the field exposures (as opposed to factors such as exposure to solvents).

Cataracts
General eye irritation and cataracts have sometimes been reported in workers exposed to high levels of radiofrequency and microwave radiation, but animal studies do not support the idea that such forms of eye damage can be

produced at levels that are not thermally hazardous. There is no evidence that these effects occur at levels experienced by the general public.

Electromagnetic fields and cancer
Despite many studies, the evidence for any effect remains highly controversial. However, it is clear that if electromagnetic fields do have an effect on cancer, then any increase in risk will be extremely small. The results to date contain many inconsistencies, but no large increases in risk have been found for any cancer in children or adults.

A number of epidemiological studies suggest small increases in risk of childhood leukemia with exposure to low frequency magnetic fields in the home. However, scientists have not generally concluded that these results indicate a cause-effect relation between exposure to the fields and disease (as opposed to artifacts in the study or effects unrelated to field exposure). In part, this conclusion has been reached because animal and laboratory studies fail to demonstrate any reproducible effects that are consistent with the hypothesis that fields cause or promote cancer. Large-scale studies are currently underway in several countries and may help resolve these issues.

Electromagnetic hypersensitivity and depression
Some individuals report "hypersensitivity" to electric or magnetic fields. They ask whether aches and pains, headaches, depression, lethargy, sleeping disorders, and even convulsions and epileptic seizures could be associated with electromagnetic field exposure.

There is little scientific evidence to support the idea of electromagnetic hypersensitivity. Recent Scandinavian studies found that individuals do not show consistent reactions under properly controlled conditions of electromagnetic field exposure. Nor is there any accepted biological mechanism to explain hypersensitivity. Research on this subject is difficult because many other subjective responses may be involved, apart from direct effects of fields themselves. More studies are continuing on the subject.

The focus of current and future research
Much effort is currently being directed towards the study of electromagnetic fields in relation to cancer. Studies in search for possible carcinogenic (cancer-producing) effects of power frequency fields is continuing, although at a reduced level compared to that of the late 1990's.

The long-term health effects of mobile telephone use is another topic of much current research. No obvious adverse effect of exposure to low level radiofrequency fields has been discovered. However, given public concerns regarding the safety of cellular telephones, further research aims to determine whether any less obvious effects might occur at very low exposure levels.

Key points

- A wide range of environmental influences causes biological effects. 'Biological effect' does not equal 'health hazard'. Special research is needed to identify and measure health hazards.
- At low frequencies, external electric and magnetic fields induce small circulating currents within the body. In virtually all ordinary environments, the levels of induced currents inside the body are too small to produce obvious effects.
- The main effect of radiofrequency electromagnetic fields is heating of body tissues.
- There is no doubt that short-term exposure to very high levels of electromagnetic fields can be harmful to health. Current public concern focuses on possible long-term health effects caused by exposure to electromagnetic fields at levels below those required to trigger acute biological responses.
- WHO's International EMF Project was launched to provide scientifically sound and objective answers to public concerns about possible hazards of low level electromagnetic fields.
- Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health.
- The focus of international research is the investigation of possible links between cancer and electromagnetic fields, at power line and radiofrequencies.

Progress in research

If electromagnetic fields constitute a health hazard, there will be consequences in all industrialized countries. The public demands concrete answers to the ever more pressing question, whether everyday electromagnetic fields cause adverse health effects. The media often seem to have definitive answers. However, one should judge these reports with caution and take into account that the primary interest of the media is not education. A journalist may select and report a story driven by a range of non-technical reasons: journalists compete with one another for time and space and different journals and newspapers compete for circulation numbers. Novel sensational headlines that are relevant to as many people as possible aid them in achieving these goals - bad news is not only the big news, it is often the only news we hear. The large number of studies which suggest that electromagnetic fields are harmless receive little if any coverage. Science cannot provide a guarantee of absolute safety yet but the development of research is reassuring overall.

Different types of studies are needed

A mix of studies in different research areas is essential for the evaluation of a potential adverse health effect of electromagnetic fields. Different types of studies investigate distinct aspects of the problem. Laboratory studies on cells aim to elucidate the fundamental underlying mechanisms that link electromagnetic field exposure to biological effects. They try to identify mechanisms based on molecular or cellular changes that are brought about by the electromagnetic field - such a change would provide clues to how a

physical force is converted into a biological action within the body. In these studies, single cells or tissues are removed from their normal living environment which may inactivate possible compensation mechanisms.

Another type of study, involving animals, is more closely related to real life situations. These studies provide evidence that is more directly relevant to establishing safe exposure levels in humans and often employ several different field levels to investigate dose-response relationships.

Epidemiological studies or human health studies are another direct source of information on long-term effects of exposure. These studies investigate the cause and distribution of diseases in real life situations, in communities and occupational groups. Researchers try to establish if there is a statistical association between exposure to electromagnetic fields and the incidence of a specific disease or adverse health effect. However, epidemiological studies are costly. More importantly, they involve measurements on very complex human populations and are difficult to control sufficiently well to detect small effects. For these reasons, scientists evaluate all relevant evidence when deciding about potential health hazards, including epidemiology, animal, and cellular studies.

Interpretation of epidemiological studies

Epidemiological studies alone typically cannot establish a clear cause and effect relationship, mainly because they detect only statistical associations between exposure and disease, which may or may not be caused by the exposure. Imagine a hypothetical study showing a link between electromagnetic field exposure in electrical workers of the company "X-Electricity" and an increased risk of cancer. Even if a statistical association is observed, it could also be due to incomplete data on other factors in the workplace. For example, electrical workers may have been exposed to chemical solvents with the potential to cause cancer. Moreover, an observed statistical association may be due only to statistical effects, or the study itself may have suffered from some problem with its design.

Therefore, finding an association between some agent and a specific disease does not necessarily mean that the agent caused the disease. Establishing causality requires that an investigator consider many factors. The case for a cause-and-effect link is strengthened if there is a consistent and strong association between exposure and effect, a clear dose-response relationship, a credible biological explanation, support provided by relevant animal studies, and above all consistency between studies. These factors have generally been absent in studies involving electromagnetic fields and cancer. This is one of the strongest reasons why scientists have generally been reluctant to conclude that weak electromagnetic fields have health effects.

Difficulties in ruling out the possibility of very small risks

"The absence of evidence of detrimental effects does not seem to suffice in modern society. The evidence of their absence is demanded more and more instead". (Barnabas Kunsch, Austrian Research Centre Seibersdorf) "There is no convincing evidence for an adverse health effect of electromagnetic fields" or "A cause-effect link between electromagnetic fields and cancer has not

been confirmed" are typical of the conclusions that have been reached by expert committees that have examined the issue. This sounds as if science wanted to avoid giving an answer. Then why should research continue if scientists have already shown that there is no effect?

The answer is simple: Human health studies are very good at identifying large effects, such as a connection between smoking and cancer. Unfortunately, they are less able to distinguish a small effect from no effect at all. If electromagnetic fields at typical environmental levels were strong carcinogens, then it would have been easy to have shown that by now. By contrast, if low level electromagnetic fields are a weak carcinogen, or even a strong carcinogen to a small group of people in the larger population, that would be far more difficult to demonstrate. In fact, even if a large study shows no association we can never be entirely sure that there is no relationship. The absence of an effect could mean that there really is none. But just as well it could mean that the effect is simply undetectable with our method of measurement. Therefore, negative results are generally less convincing than strong positive ones.

The most difficult situation of all, which unfortunately has developed with epidemiology studies involving electromagnetic fields, is a collection of studies with weak positive results, which however are inconsistent among each other. In that situation, scientists themselves are likely to be divided about the significance of the data. However, for the reasons explained above, most scientists and clinicians agree that any health effects of low level electromagnetic fields, if they exist at all, are likely to be very small compared to other health risks that people face in everyday life.

What's in the future?

The main aim of WHO's International EMF Project is to initiate and co-ordinate research worldwide to produce a well-founded response to public concerns. This evaluation will integrate results from cellular, animal and human health studies to allow as comprehensive a health risk assessment as possible. A holistic assessment of a variety of relevant and reliable studies will provide the most reliable answer possible about the adverse health effects, if any exist, of long term exposure to weak electromagnetic fields.

One way to illustrate the necessity of evidence from different types of experiments is a crossword. To be able to read the given crossword's solution with absolute CERTAINTY nine questions must be answered. Assuming we can only answer three of these, we might be able to guess the solution. However, the three given letters may also be part of a very different word. Every additional answer will increase our own confidence. In fact, science will probably never be able to answer all questions, but the more solid evidence we collect the better will be our guess at the solution.

Key points

- Laboratory studies on cells aim to determine if there is a mechanism by which electromagnetic field exposure could cause harmful biological effects. Animal studies are essential for establishing effects in higher organisms whose physiology resembles that of humans to a degree. Epidemiological studies look for statistical associations between field exposure and the incidence of specific adverse health outcomes in humans.
- Finding a statistical association between some agent and a specific disease does not mean that the agent caused the disease.
- The absence of health effects could mean that there really are none; however, it could also signify that an existing effect is undetectable with present methods.
- Results of diverse studies (cellular, animal, and epidemiology) must be considered together before drawing conclusions about possible health risks of a suspected environmental hazard. Consistent evidence from these very different types of studies increases the degree of certainty about a true effect

Typical exposure levels at home and in the environment

Electromagnetic fields at home

Background electromagnetic field levels from electricity transmission and distribution facilities.

Electricity is transmitted over long distances via high voltage power lines. Transformers reduce these high voltages for local distribution to homes and businesses. Electricity transmission and distribution facilities and residential wiring and appliances account for the background level of power frequency electric and magnetic fields in the home. In homes not located near power lines this background field may be up to about 0.2 µT. Directly beneath power lines the fields are much stronger. Magnetic flux densities at ground level can range up to several µT. Electric field levels underneath power lines can be as high as 10 kV/m. However, the fields (both electric and magnetic) drop off with distance from the lines. At 50 m to 100 m distance the fields are normally at levels that are found in areas away from high voltage power lines. In addition, house walls substantially reduce the electric field levels from those found at similar locations outside the house.

Electric appliances in the household

The strongest power frequency electric fields that are ordinarily encountered in the environment exist beneath high voltage transmission lines. In contrast, the strongest magnetic fields at power frequency are normally found very close to motors and other electrical appliances, as well as in specialized equipment such as magnetic resonance scanners used for medical imaging.

Typical electric field strengths measured near household appliances at a distance of 30 cm (**Guideline limit value** = **5000)**

Electric appliance	**Electric field strength (V/m)**
Stereo receiver	180
Iron	120
Refrigerator	120
Mixer	100
Toaster	80
Hair dryer	80
Colour TV	60
Coffee machine	60
Vacuum cleaner	50
Electric oven	8
Light bulb	5

(From: Federal Office for Radiation Safety, Germany 1999)

Many people are surprised when they become aware of the variety of magnetic field levels found near various appliances. The field strength does not depend on how large, complex, powerful or noisy the device is. Furthermore, even between apparently similar devices, the strength of the magnetic field may vary a lot. For example, while some hair dryers are surrounded by a very strong field, others hardly produce any magnetic field at all. These differences in magnetic field strength are related to product design. The following table shows typical values for a number of electrical devices commonly found in homes and workplaces. The measurements were taken in Germany and all of the appliances operate on electricity at a frequency of 50 Hz. It should be noted that the actual exposure levels vary considerably depending on the model of appliance and distance from it.

Typical magnetic field strength of household appliances at various distances

Electric appliance	3 cm distance (µT)	30 cm distance (µT)	1 m distance (µT)
Hair dryer	**6 – 2000**	0.01 – 7	0.01 – 0.03
Electric shaver	**15 – 1500**	0.08 – 9	0.01 – 0.03
Vacuum cleaner	200 – 800	**2 – 20**	0.13 – 2
Fluorescent light	40 – 400	**0.5 – 2**	0.02 – 0.25
Microwave oven	73 – 200	**4 – 8**	0.25 – 0.6
Portable radio	16 – 56	**1**	< 0.01
Electric oven	1 – 50	**0.15 – 0.5**	0.01 – 0.04
Washing machine	0.8 – 50	**0.15 – 3**	0.01 – 0.15
Iron	8 – 30	**0.12 – 0.3**	0.01 – 0.03
Dishwasher	3.5 – 20	**0.6 – 3**	0.07 – 0.3
Computer	0.5 – 30	< **0.01**	
Refrigerator	0.5 – 1.7	**0.01 – 0.25**	<0.01
Colour TV	2.5 – 50	0.04 – 2	**0.01 – 0.15**

With most household appliances the magnetic field strength at a distance of 30 cm is well below the guideline limit for the general public of 100 µT.
(Source: Federal Office for Radiation Safety, Germany 1999) Normal operating distance is given in **bold**)

The table illustrates two main points: First, the magnetic field strength around all appliances rapidly decreases the further you get away from them. Secondly, most household appliances are not operated very close to the body. At a distance of 30 cm the magnetic fields surrounding most household appliances are more than 100 times lower than the given guideline limit of 100 µT at 50 Hz (83 µT at 60 Hz) for the general public.

Television sets and computer screens
Computer screens and television sets work on similar principles. Both produce static electric fields and alternating electric and magnetic fields at various frequencies. However, screens with liquid crystal displays used in some laptop computers and desktop units do not give rise to significant electric and magnetic fields. Modern computers have conductive screens which reduce the static field from the screen to a level similar to that of the normal background in the home or workplace. At the position of operators (30 to 50 cm from the screen), alternating magnetic fields are typically below 0.7 µT in flux density (at power frequencies). Alternating electric field strengths at operator positions range from below 1 V/m up to 10 V/m.

Microwave ovens
Domestic microwave ovens operate at very high power levels. However, effective shielding reduces leakage outside the ovens to almost non-detectable levels. Furthermore microwave leakage falls very rapidly with increasing distance from the oven. Many countries have manufacturing standards that specify maximum leakage levels for new ovens; an oven that meets the manufacturing standards will not present any hazard to the consumer.

Portable telephones
Portable telephones operate at much lower intensities than mobile phones. This is because they are employed very close to their home base station, and so do not need strong fields to transmit over long distances. As a consequence, the radiofrequency fields that surround these devices are negligible.

Electromagnetic fields in the environment

Radar
Radars are used for navigation, weather forecasting, and military applications, as well as a variety of other functions. They emit pulsed microwave signals. The peak power in the pulse can be high even though the average power may be low. Many radars rotate or move up and down; this reduces the mean power density to which the public is exposed in the vicinity of radars. Even high power, non-rotating military radars limit exposures to below guideline levels at locations of public access.

Security systems
Anti-theft systems in shops use tags that are detected by electrical coils at the exits. When a purchase is made the tags are removed or permanently deactivated. The electromagnetic fields from the coils do not generally exceed

exposure guideline levels. Access control systems work in the same way with the tag incorporated into a key ring or identity card. Library security systems use tags that can be deactivated when a book is borrowed and reactivated when it is returned. Metal detectors and airport security systems set up a strong magnetic field of up to 100 μT that is disturbed by the presence of a metal object. Close to the frame of the detector, magnetic field strengths may approach and occasionally exceed guideline levels. However, this does not constitute a health hazard, as will be discussed in the section on guidelines. (see Are exposures above the guidelines harmful?)

Electric trains and trams

Long-distance trains have one or more engine cars that are separate from the passenger cars. Thus passenger exposure comes mainly from the electricity supply to the train. Magnetic fields in the passenger cars of long-distance trains can be several hundred μT near the floor, with lower values (tens of μT) elsewhere in the compartment. Electric field strengths may reach 300 V/m. People living in the vicinity of railway lines may encounter magnetic fields from the overhead supply which, depending on the country, may be comparable to the fields produced by high-voltage power lines.

Motors and traction equipment of trains and trams are normally located underneath the floors of passenger cars. At floor level, magnetic field intensities may amount to tens of μT in regions of the floor just above the motor. The fields fall off quickly with distance from the floor, and exposure of the upper bodies of passengers is much lower.

TV and radio

When choosing a radio station on your stereo at home, have you ever wondered what the familiar abbreviations AM and FM stand for? Radio signals are described as amplitude-modulated (AM) or frequency-modulated (FM) depending on the way in which they carry information. AM radio signals can be used for broadcasting over very long distances whereas FM waves cover more localized areas but can give a better sound quality.

AM radio signals are transmitted via large arrays of antennas, which can be tens of metres high, on sites which are off-limits to the public. Exposures very close to antennas and feed cables can be high, but these would affect maintenance workers rather than the general public.

TV and FM radio antennas are much smaller than AM radio antennas and are mounted in arrays at the top of high towers. The towers themselves serve only as supporting structures. As exposures near the foot of these towers are below guideline limits, public access to these areas may be possible. Small local TV and radio antennas are sometimes mounted on the top of buildings; if this is the case it may be necessary to control access to the roof.

Mobile phones and their base stations

Mobile phones allow people to be within reach at all times. These low-power radiowave devices transmit and receive signals from a network of fixed low power base stations. Each base station provides coverage to a given area. Depending on the number of calls being handled, base stations may be from

only a few hundred metres apart in major cities to several kilometres apart in rural areas.

Mobile phone base stations are usually mounted on the tops of buildings or on towers at heights of between 15 and 50 metres. The levels of transmissions from any particular base station are variable and depend on the number of calls and the callers' distance from the base station. Antennas emit a very narrow beam of radiowaves which spreads out almost parallel to the ground. Therefore, radiofrequency fields at ground level and in regions normally accessible to the public are many times below hazard levels. Guidelines would only be exceeded if a person were to approach to within a metre or two directly in front of the antennas. Until mobile phones became widely used, members of the public were mainly exposed to radiofrequency emissions from radio and TV stations. Even today, the phone towers themselves add little to our total exposure, as signal strengths in places of public access are normally similar to or lower than those from distant radio and TV stations.

However, the user of a mobile phone is exposed to radiofrequency fields much higher than those found in the general environment. Mobile phones are operated very close to the head. Therefore, rather than looking at the heating effect across the whole body, the distribution of absorbed energy in the head of the user must be determined. From sophisticated computer modelling and measurements using models of heads, it appears that the energy absorbed from a mobile phone is not in excess of current guidelines.

Concerns about other so-called non-thermal effects arising from exposure to mobile phone frequencies have also been raised. These include suggestions of subtle effects on cells that could have an effect on cancer development. Effects on electrically excitable tissues that may influence the function of the brain and nervous tissue have also been hypothesized. However, the overall evidence available to date does not suggest that the use of mobile phones has any detrimental effect on human health.

Magnetic fields in everyday life: are they really that high?

In recent years, national authorities in different countries have conducted many measurements to investigate electromagnetic field levels in the living environment. None of these surveys has concluded that field levels could bring about adverse health effects.

The Federal Office for Radiation Safety in Germany recently measured the daily exposure to magnetic fields of about 2000 individuals across a range of occupations and public exposures. All of them were equipped with personal dosimeters for 24 hours. The measured exposure varied widely but gave an average daily exposure of 0.10 µT. This value is a thousand times lower that the standard limit of 100 µT for the public and 200 times lower than the 500 µT exposure limit for workers. Furthermore, the exposure of people living in the centres of cities showed that there are no drastic differences in exposure between life in rural areas and life in the city. Even the exposure of people living in the vicinity of high voltage power lines differs very little from the average exposure in the population.

Key points

- Background electromagnetic field levels in the home are mainly caused by the transmission and distribution facilities for electricity or by electrical appliances.
- Electrical appliances differ greatly in the strength of fields they generate. Both electric and magnetic field levels decrease rapidly with distance from the appliances. In any event, fields surrounding household appliances usually are far below guideline limits.
- At operator positions the electric and magnetic fields of television sets and computer screens are hundreds of thousands times below guideline levels.
- Microwave ovens meeting the standards are not hazardous to health.
- As long as close public access to radar facilities, broadcasting antennas and mobile phone base stations is restricted, exposure guideline limits for radiofrequency fields will not be exceeded.
- The user of a mobile phone encounters field levels that are much higher than any levels in the normal living environment. However, even these increased levels do not appear to generate harmful effects.
- Many surveys have demonstrated that exposure to electromagnetic field levels in the living environment is extremely low.

Current standards

Standards are set to protect our health and are well known for many food additives, for concentrations of chemicals in water or air pollutants. Similarly, field standards exist to limit overexposure to electromagnetic field levels present in our environment.

Who decides on guidelines?

Countries set their own national standards for exposure to electromagnetic fields. However, the majority of these national standards draw on the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). This non-governmental organization, formally recognized by WHO, evaluates scientific results from all over the world. Based on an in-depth review of the literature, ICNIRP produces guidelines recommending limits on exposure. These guidelines are reviewed periodically and updated if necessary.

Electromagnetic field levels vary with frequency in a complex way. Listing every value in every standard and at every frequency would be difficult to understand. The table below is a summary of the exposure guidelines for the three areas that have become the focus of public concern: electricity in the home, mobile phone base stations and microwave ovens. These guidelines were last updated in April 1998.

Summary of the ICNIRP exposure guidelines

	European power frequency		Mobile phone base station frequency		Microwave oven frequency
Frequency	50 Hz Electric field (V/m)	50 Hz Magnetic field (μT)	900 MHz Power density (W/m^2)	1.8 GHz Power density (W/m^2)	2.45 GHz Power density (W/m^2)
Public exposure limits	5 000	100	4.5	9	10
Occupational exposure limits	10 000	500	22.5	45	

ICNIRP, EMF guidelines, Health Physics 74, 494-522 (1998)

The exposure guidelines may differ by a factor of more than 100 between some former Soviet countries and Western countries. With the globalization of trade and the rapid introduction of telecommunications worldwide there is a need for universal standards. As many countries from the former Soviet Union are now considering new standards, the WHO has recently launched an initiative to harmonize exposure guidelines worldwide. Future standards will be based on the results of the WHO's International Electromagnetic Field Project.

What are guidelines based on?

An important point to make is that a guideline limit is not a precise delineation between safety and hazard. There is no one level above which exposures become hazardous to health; instead, the potential risk to human health gradually increases with higher exposure levels. Guidelines indicate that, below a given threshold, electromagnetic field exposure is safe according to scientific knowledge. However, it does not automatically follow that, above the given limit, exposure is harmful.

Nevertheless, to be able to set limits on exposure, scientific studies need to identify the threshold level at which first health effects become apparent. As humans cannot be used for experiments, guidelines critically rely on animal studies. Subtle behavioural changes in animals at low levels often precede more drastic changes in health at higher levels. Abnormal behaviour is a very sensitive indicator of a biological response and has been selected as the lowest observable adverse health effect. Guidelines recommend the prevention of electromagnetic field exposure levels, at which behavioural changes become noticeable.

This threshold level for behaviour is not equal to the guideline limit. ICNIRP applies a safety factor of 10 to derive occupational exposure limits, and a factor of 50 to obtain the guideline value for the general public. Therefore, for example, in the radiofrequency and microwave frequency ranges, the maximum levels you might experience in the environment or in your home are at least 50 times lower than the threshold level at which first behavioural changes in animals become apparent.

Why is the safety factor for occupational exposure guidelines lower than for the general public?

The occupationally exposed population consists of adults who generally experience known electromagnetic field conditions. These workers are trained to be aware of potential risk and to take appropriate precautions. By contrast, the general public consists of individuals of all ages and of varying health status. In many cases, these are unaware of their exposure to EMF.

Moreover, individual members of the public cannot be expected to take precautions to minimize or avoid exposure. These are the underlying considerations for more stringent exposure restrictions for the general public than for the occupationally exposed population.

As we have seen earlier, low frequency electromagnetic fields induce currents in the human body (see What happens when you are exposed to electromagnetic fields?). But various biochemical reactions within the body itself generate currents as well. The cells or tissues will not be able to detect any induced currents below this background level. Therefore, at low frequencies, exposure guidelines ensure that the level of currents induced by an electromagnetic fields is below that of natural body currents.

The main effect of radiofrequency energy is the heating of tissue. Consequently, exposure guidelines for radiofrequency fields and microwaves are set to prevent health effects caused by localized or whole-body heating (see What happens when you are exposed to electromagnetic fields?). Compliance with the guidelines will ensure that heating effects are sufficiently small not to be harmful.

What guidelines cannot account for...

At present, speculations about potential long-term health effects cannot form the basis for the issuing of guidelines or standards. Adding up the results of all scientific studies, the overall weight of evidence does not indicate that electromagnetic fields cause long-term health effects such as cancer. National and international bodies set and update standards on the basis of the latest scientific knowledge to protect against known health effects.

Guidelines are set for the average population and cannot directly address the requirements of a minority of potentially more sensitive people. Air pollution guidelines, for example, are not based on the special needs of asthmatics. Similarly, electromagnetic field guidelines are not designed to protect people from interference with implanted medical electronic devices such as heart pacemakers. Instead, advice about exposure situations to be avoided should be sought from the manufacturers and from the clinician implanting the device.

What are typical maximum exposure levels at home and in the environment?

Some practical information will help you to relate to the international guideline values given above. In the following table you will find the most common sources of electromagnetic fields. All values are maximum levels of public

exposure – your own exposure is likely to be much lower. For a closer look at field levels around individual electrical appliances, please see the section Typical exposure levels at home and in the environment.

Source	Typical maximum public exposure	
	Electric field (V/m)	Magnetic flux density (μT)
Natural fields	200	70 (Earth's magnetic field)
Mains power (in homes not close to power lines)	100	0.2
Mains power (beneath large power lines)	10 000	20
Electric trains and trams	300	50
TV and computer screens (at operator position)	10	0.7

	Typical maximum public exposure (W/m^2)
TV and radio transmitters	0.1
Mobile phone base stations	0.1
Radars	0.2
Microwave ovens	0.5

Source: WHO Regional Office for Europe

How are guidelines put into practice and who checks on them?
The responsibility to investigate fields around power lines, mobile phone base stations or any other sources accessible to the general public lies with government agencies and local authorities. They must ensure that compliance with guidelines is maintained.

With electronic devices, the manufacturer is responsible for complying with the standard limits. However, as we have seen above, the nature of most devices ensures that the emitted fields are well below the cut-off values. Furthermore, many consumer associations carry out tests on a regular basis. In case of any particular concern or worry, contact the manufacturer directly or enquire with your local public health authority.

Are exposures above the guidelines harmful?
It is perfectly safe to eat a pot of strawberry jam up to the expiration date – but if you consume the jam any later the manufacturer cannot guarantee good food quality. Nevertheless, even a few weeks or months after the expiration date, it will usually be safe to eat the jam. Similarly, electromagnetic field guidelines ensure that, within the given exposure limit, no known adverse health effects will occur. A large safety factor is applied to the level known to cause a health consequence. Therefore, even if you experienced field strengths several times higher than the given limit value, your exposure would still be within this safety margin.

In everyday situations, most people do not experience electromagnetic fields that exceed the guideline limits.

Typical exposures are far below these values. However, there are occasions where a person's exposure may, for a short period, approach or even exceed the guidelines. According to ICNIRP, radiofrequency and microwave exposures should be averaged over time to address cumulative effects. The guidelines specify a time-averaging period of six minutes and short-term exposures above the limits are acceptable.

In contrast, exposure to low frequency electric and magnetic fields is not time-averaged in the guidelines. To make things even more complicated, another factor called coupling comes into play. Coupling refers to the interaction between the electric and magnetic fields and the exposed body. This depends on the size and shape of the body, the type of tissue and the orientation of the body relative to the field. Guidelines must be conservative: ICNIRP always assumes maximum coupling of the field to the exposed individual. Thus the guideline limits provide maximum protection. For example, even though the magnetic field values for hairdryers and electric shavers appear to exceed the recommended values, extremely weak coupling between the field and the head prevents the induction of electrical currents that could exceed guideline limits.

Key points

- ICNIRP issues guidelines on the basis of the current scientific knowledge. Most countries draw on these international guidelines for their own national standards.
- Standards for low frequency electromagnetic fields ensure that induced electric currents are below the normal level of background currents within the body. Standards for radiofrequency and microwaves prevent health effects caused by localized or whole body heating.
- Guidelines do not protect against potential interference with electromedical devices.
- Maximum exposure levels in everyday life are typically far below guideline limits.
- Due to a large safety factor, exposure above the guideline limits is not necessarily harmful to health. Furthermore time-averaging for high frequency fields and the assumption of maximum coupling for low frequency fields introduce an additional safety margin.

Precautionary approaches

With more and more research data available, it has become increasingly unlikely that exposure to electromagnetic fields constitutes a serious health hazard, nevertheless, some uncertainty remains. The original scientific discussion about the interpretation of controversial results has shifted to become a societal as well as political issue.

The public debate over electromagnetic fields focuses on the potential detriments of electromagnetic fields but often ignores the benefits associated with electromagnetic field technology. Without electricity, society would come to a standstill. Similarly, broadcasting and telecommunications have become a simple fact of modern life. An analysis of the balance between cost and potential hazards is essential.

Protection of public health
International guidelines and national safety standards for electromagnetic fields are developed on the basis of the current scientific knowledge to ensure that the fields humans encounter are not harmful to health. To compensate uncertainties in knowledge (due, for example, to experimental errors, extrapolation from animals to humans, or statistical uncertainty), large safety factors are incorporated into the exposure limits. The guidelines are regularly reviewed and updated if necessary. It has been suggested that taking additional precautions to cope with remaining uncertainties may be a useful policy to adopt while science improves knowledge on health consequences.

However, the type and extent of the cautionary policy chosen critically depends on the strength of evidence for a health risk and the scale and nature of the potential consequences. The cautionary response should be proportional to the potential risk. For more information, see the WHO Backgrounder on Cautionary Policies.

Several policies promoting caution have been developed to address concerns about public, occupational and environmental health and safety issues connected with chemical and physical agents.

What should be done while research continues?
One of the objectives of the International EMF Project is to help national authorities weigh the benefits of using electromagnetic field technologies against the possibility that a health risk might be discovered. Furthermore, the WHO will issue recommendations on protective measures, if they may be needed. It will take some years for the required research to be completed, evaluated and published. In the meantime, the World Health Organization has issued a series of recommendations:

- Strict adherence to existing national or international safety standards: such standards, based on current knowledge, are developed to protect everyone in the population with a large safety factor.
- Simple protective measures: barriers around strong electromagnetic field sources help preclude unauthorized access to areas where exposure limits may be exceeded.
- Consultation with local authorities and the public in siting new power lines or mobile phone base stations: siting decisions are often required to take into account aesthetics and public sensitivities. Open communication during the planning stages can help create public understanding and greater acceptance of a new facility.
- Communication: an effective system of health information and communication among scientists, governments, industry and the public can help raise general awareness of programmes dealing with exposure to electromagnetic fields and reduce any mistrust and fears.

APPENDIX 2

The Mythology of the Mobile Phone Mast

An issue of concern to many members of the public is the effect that radiation from so-called mobile phone masts may have on the health of those exposed to it, especially when these objects happen to be positioned close to schools and other public amenities.

Since the subject falls within the ambit of those who have studied Maxwell's Equations and the propagation of the electromagnetic (EM) waves, it is important that you have a grasp of the fundamental issues involved so that you can correct the often erroneous and frequently alarming statements that appear in the media and in conversation. To do so with conviction, however, requires that some of the terminology - so often misused - is itself well-understood and appropriately used. I'll therefore point out some of the most often misused, and even abused, terms in what follows. We'll then examine the issues from a scientific and engineering point of view and, hopefully, dispel some of the mythology that surrounds this subject.

Radiation

Probably the most misunderstood and yet most important word in this context is *radiation.* Radiation, whenever it occurs, is immediately assumed by many within the public-at-large to mean *radioactivity*. This is both inaccurate and imprecise and its frequent misuse certainly explains why there is such public concern about any structure, especially a "mobile phone mast", which emits "radiation".

Radiation, in the context we'll be using the term here, has two specific forms: it is either *ionising* or *non-ionising*. They differ only in their energy content though both are electromagnetic and hence can be completely described by means of Maxwell's Equations. However they also differ substantially in their frequency range.

Since energy is related to frequency by the simple (though profound) relationship $\mathrm{E} = h\nu$, where $h = 6.63\times10^{-34}\ J.s$ is Planck's constant and ν is the symbol for frequency in the form used by quantum physicists, it is obvious that the higher the frequency of a system the higher its energy. If the energy produced or radiated by some source is sufficient to break an atomic or molecular bond by removing electrons we say that the atom or molecule has been *ionised* and the radiation responsible is therefore *ionising* radiation with energy measured in units of electron-volts (eV). The energy required to ionise biological materials is about 10 eV, which can be expressed in the more familiar units of Joules (J) as follows:

$$E = 1eV = 1.6\times10^{-19}\,J = h\nu = 6.63\times10^{-34}\nu\ .$$

The frequency of a source that'll yield 10 eV of energy therefore follows directly and we find that in this case $\nu = 2.4\times10^{15}\ Hz.$ Since the radio

frequency spectrum is orders of magnitude lower than this (extending up to a maximum of (typ.) 300 GHz or $3\times10^{11}Hz$) it is impossible for any radio or microwave frequency signal - no matter how powerful - to cause ionisation. Therefore all radio and microwave sources are said to be *non-ionising.* By contrast, X-rays, which have a typical wavelength of $15\times10^{-12}m$ or a frequency of $2\times10^{19}Hz$, have energy of $8.3\times10^{4}eV$ and so are highly ionising and can be dangerous if applied incorrectly, as is well known.

It is this confusion, or simply ignorance, of the difference between ionising and non-ionising radiation that causes much of the concern in the public mind about radiation in all its many forms. One should realise that the radiation from the sun in the form of heat and light is absolutely vital for our existence on Earth and yet that "radiation" is never questioned except when it causes sunburn! Its intensity is about 800 -1000 W/m^2 on a clear day.

The radiation from any form of radio, television or radar transmitting antenna, being non-ionising, cannot cause damage to human tissue by any radioactive process. However, the energy contained within the Poynting vector ($\vec{S}=\vec{E}\times\vec{H}$) can certainly be transferred to biological materials where it will be dissipated as heat and that, in itself, can be dangerous if the resulting temperature rise exceeds the limits of the body's own thermoregulatory system or the safe temperature limits of some organ or cell. Internationally agreed guidelines therefore exist to control the amount of non-ionising radiation to which human beings may be exposed during the normal course of their daily lives. In the UK these limits are set by the National Radiological Protection Board (NRPB).

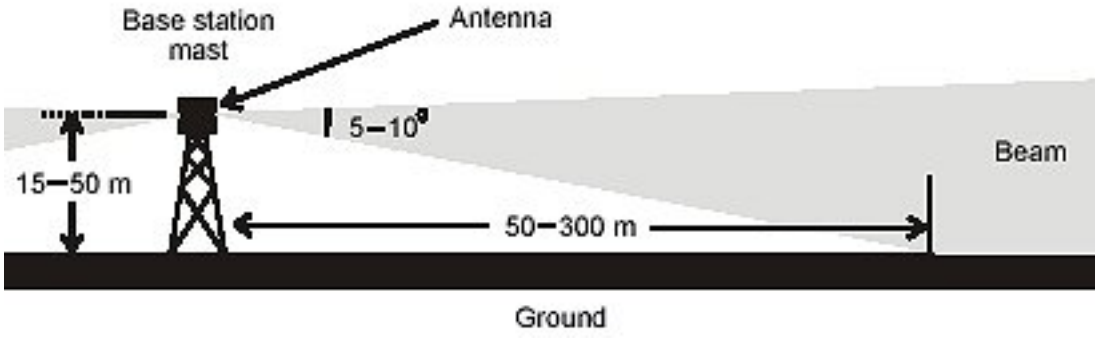
Mobile Phone Systems

Because of their sheer ubiquity, mobile phones have attracted considerable media attention from the point of view of their possible danger to human health and none more so than the "mobile phone mast". Now that we have dispelled the myth that their radiated energy may in some way be radioactive we are in a position to concentrate on the likely thermal and other effects that it may cause within nearby human tissue or organs. Before doing so, however, it is most important to understand how a mobile phone system functions from the point of view of the interaction between the base-stations and the mobile units, either handheld or (less-commonly these days) mounted within motor vehicles.

Mobile phone networks work on the basis of hexagonal cells and, indeed, they are actually called *cellphones* in most parts of the world other than the UK for that reason. Each cell is served by a base station situated roughly at its centre that communicates with all the mobile handsets within its line-of-sight (LOS). These cells vary in size, depending upon the local terrain, from a maximum of about 35 km between base stations to as little as a few tens of metres in so-called micro- and picocells within buildings or other highly complex structures. When a mobile phone moves from one cell to another the first base station automatically "hands over" the communication to the base station in the adjacent cell and so the process continues across the complete coverage area – presently about 99% of mainland UK. The base station

antennas are usually mounted high above nearby obstacles such as buildings, trees etc, in order to maximise their coverage. The structure upon which these antennas are mounted is therefore either a latticework tower or simply just a mast or pole typically 10 to 30m in height. In itself it is nothing more than a support that holds aloft the antenna that radiates and receives radio signals from all other radio devices in the network. It is important to make clear that the mast itself produces no radiation; it is only the antenna or array of antennas, at least 10m above the ground, that radiate.

As shown in the diagram below, the major lobe produced by the antenna (Poynting's vector, in fact!) is canted downwards at a fairly shallow angle so that the EM fields reach ground level anywhere between about 50 and 200m from the mast or tower. Both closer to its base of the mast and further away from the area of maximum illumination the field strengths are reduced but they are not zero.



Radiated power density

It is a simple matter to calculate the power density at ground level from an antenna on top of the mast or tower from a knowledge of the base station transmitter output power and the antenna gain. The actual power density is regulated by the licence issued to the mobile phone operator and is quoted in terms of the "equivalent isotropically radiated power" (EIRP), which is the product of transmitter power, P_t, and the antenna gain, G_t. A figure of 60W is typical of the transmitter power in most installations (though it could be considerably less in both micro- and picocells). The antenna gain is again site-dependent, but 17 dB_i is typical. From these figures the radiated power density at a distance of 50m along the ground from an antenna atop a 10m mast is:

$$S = \frac{G_t P_t}{4\pi r^2} = \frac{50 \times 60}{4\pi \times 51^2} \approx 92 mW/m^2$$

[note that the slant range is 51m whereas the ground range is 50m].

This yields an electric field strength of $E = \sqrt{S\,Z_0} = \sqrt{92 \times 10^{-3} \times 377} = 5.9\ V/m$ and a magnetic field strength of $H = \frac{E}{Z_0} = \frac{5.8}{377} = 15.6\,mA/m.$

On their own these figures probably mean little but they should be compared with the power density and field strengths produced by the mobile phone when held in its usual operating position just a few cm from the user's head.

Mobile phone characteristics

The mobile phone transmitter (within the handset) produces 2W at the 900 MHz mobile phone band or 1W at 1800 MHz. The antenna is a simple monopole, normal-mode helical or other electrically short device whose gain will typically be low (typ. 0 - 2dB$_i$), due to the inefficiency of such devices. However, the power density within the user's head is determined predominantly by the short distance between the antenna and the head and by the dielectric properties of the head itself. A simple calculation, using the same approach as used above, shows that the power density at a distance of 2cm from the mobile phone is about 5000 times or 37 dB greater than the maximum value at ground level from the base station antenna. In reality, the fields are not plane waves so close to the antenna and therefore the power density cannot be so simply calculated, however the order of magnitude of the answer is about right.

It should now be obvious that the radiation from the base station antenna (or the "mobile phone mast" as the media has it) is much lower at the closest point at ground level, where any user might find himself relative to the antenna above, than it is from the mobile phone pressed up against his ear. If there is cause for concern then it is the mobile phone that should be feared and not its base stations. **These masts and towers may be eyesores to some, and blots on the landscape to many, but they are not a source of harmful rays that will cause damage to the population at large.**

Conclusion

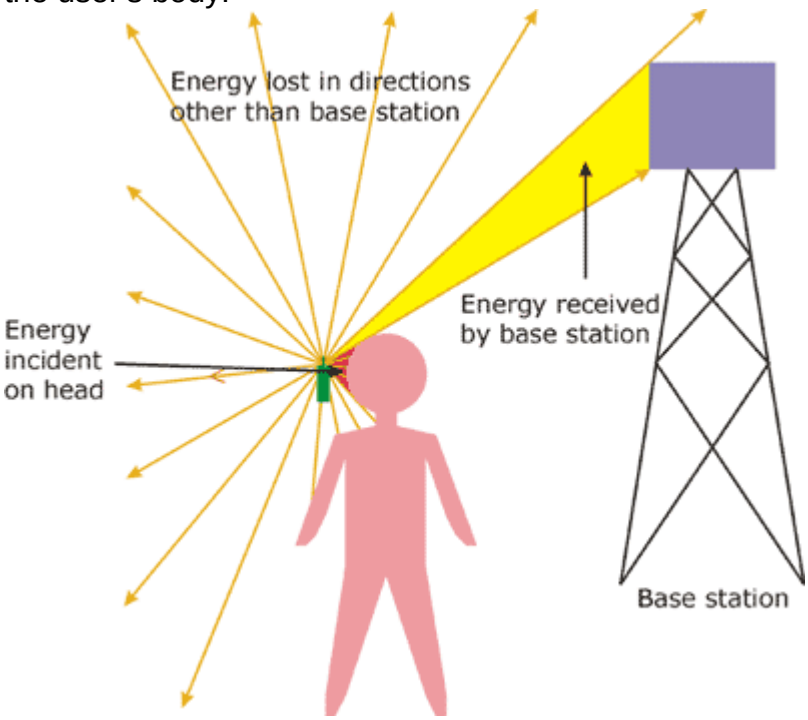
We may therefore conclude – and should ensure that we communicate this to the faithful at large – that electromagnetic radiation from mobile phone base station antennas can never be more dangerous to people in their vicinity than is the radiation emitted from the mobile phone handsets which are used in their tens of millions across the planet.

APPENDIX 3

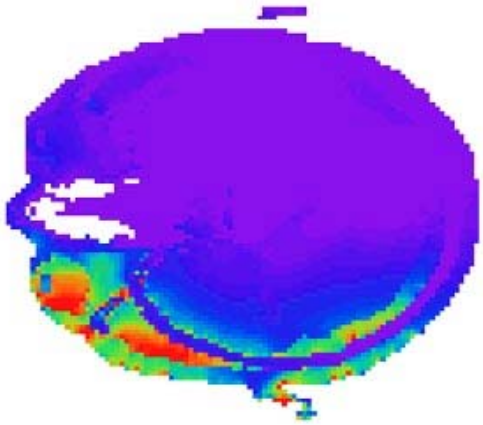
HEALTH PROTECTION AGENCY INFORMATION

Mobile Telephony and Health - Exposures from Mobile Phones

Mobile phones are designed to transmit radio waves in all directions because base stations could be in any direction with respect to phone users. This means that a proportion of the radio waves they produce is directed towards the user's body.



The radio waves are mainly radiated from the antenna of a mobile phone, although leakage onto the phone body shell does occur. The antenna is sometimes visible as a projection on the top surface of the phone, although some phones have conformal antennas mounted inside their main plastic case. The radio waves that are directed towards the head of the phone user penetrate into the body tissues for a few cm and tend to be absorbed. In being absorbed, they give up their energy to the body tissues and this adds to the energy being produced by the body's metabolism.



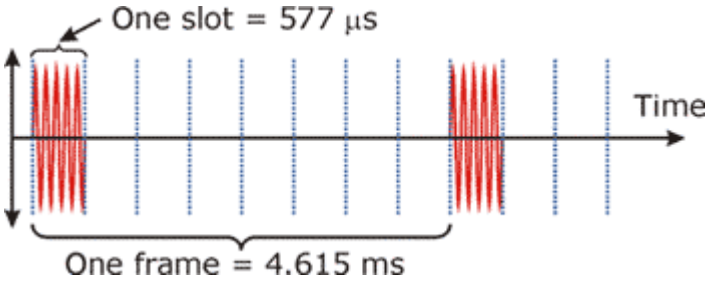
Up to a point, the body is able to accommodate extra energy being absorbed in its tissues, but beyond this point, temperature rises or thermoregulatory

responses can occur. Protection guidelines advise restrictions on energy absorption in tissues designed to ensure that such effects are small enough not to pose a hazard.

Calculations have shown that the maximum temperature rise produced in the head due to absorption of energy in the radio waves from a mobile phone is around 0.1ºC. Although the IEGMP did not identify any adverse effects on health at this level of exposure, there is no comparable situation where large numbers of people are exposed. It is for this reason that research related to exposure to RF from mobile phones is currently being carried out.

Mobile Phone SARs

The quantity that is used to describe absorption of radio waves in the head is the Specific Absorption Rate (SAR) of the energy. ICNIRP has advised that this should not exceed 2 W kg^{-1} (watts per kilogram) when averaged over any 10 gram of contiguous tissue and over any 6 minute period in the head. This advice has been accepted by the mobile phone industry and all phones sold in the UK should produce a SAR below this level.



Until recently, there was no clear consensus over the best way to measure the SAR produced by a mobile phone. Consequently, results reported in one laboratory were not necessarily comparable with results reported in another laboratory. In July 2001, the European Committee for Electrotechnical Standardisation (CENELEC) published a technical standard detailing how to make SAR measurements and industry is now publishing SAR values for phones.

The Mobile Manufacturers Forum has produced a note explaining industry's approach to the reporting of SAR values, which can be obtained via manufacturer's websites through which consumers can find the SAR values for their phones. There are many sites on the Internet that give information about how SAR is measured.

Maximum Output Powers from Phones

The output powers of phones are set in the relevant technical standards to ensure that mobile phones will work when they are used with any network. The *peak output powers* of GSM phones operating at 900 MHz and 1800 MHz are 2 W (watts) and 1 W respectively.

GSM mobile phones transmit their radio signals as 217 *bursts* of information every second. There is one burst every 4.6 ms (thousandth of a second) and

each burst is 577 µs (millionths of a second) in duration. This means that, on average, they transmit for 1/8 of the time and their *average output power* is 8 times less than their peak output power.

Exposure guidelines, such as those published by ICNIRP, require exposures to be averaged over 6 minutes for comparison with their basic restrictions and it is more relevant to consider the average output power than the peak output power from phones. In this respect, GSM phones transmitting at 900 MHz and 1800 MHz have maximum time-averaged output powers of 0.25 W and 0.125 W respectively.

Exposure during Normal Use

There are several reasons why the SAR derived from a technical standard methodology represents a pessimistic estimate of the SAR typically received during a call. The SAR values quoted for mobile phones assume that a mobile phone is transmitting at its maximum possible power for a period of 6 minutes.

A key feature of mobile phone technology is that a mobile phone does not operate with a fixed output power level when a call is made. The maximum power output from a GSM mobile phone is around 2 W peak, but this can reduce in a sequence of 15 steps down to around 2 mW during calls, a power reduction factor of 1000.

The power level that a mobile phone operates at during a call depends on the quality of the radio link to the base station. If the link is good, a low output power level will be used, whereas if the link is poor, a higher output level will be used. A typical situation where a good link to a base station would occur is outdoors at a location where there is a clear view of the base station antennas. Poorer links would be obtained if a mobile phone is used indoors, or at a location where there are physical obstructions such as buildings or hills between the phone and the base station.

SAR is proportional to output power. So, if a mobile phone has a good link to the base station and reduces its output power by a factor of 1000 from the maximum, the SAR in the head would also be reduced by a factor of 1000.
In order to compare SAR with the ICNIRP basic restriction, it is first necessary to average SAR over a period of 6 minutes. For example, a 3 minute call during which the SAR was 1 W kg^{-1} followed by no use of the phone for the next 3 minutes, the 6 minute averaged SAR would be 0.5 W kg^{-1}. This would be the correct figure to compare with the 2 W kg^{-1} ICNIRP basic restriction.

Factors affecting Exposure

It is not possible to show that reducing an exposure within the ICNIRP guidelines gives any specific health benefit. Nevertheless, IEGMP felt that people buying mobile phones should have the information to enable them to choose to reduce their exposure if they so wished. The issues identified by IEGMP to aid personal choice included information on mobile phone SAR

assessments, the use of approved hands-free kits, and the number and duration of calls made.

Phone SAR
The value of SAR is obtained using an approved compliance testing procedure under constant high power and as such is the only practical option for comparison at the point of sale. In practice the measured SAR will not be the same as that to the user as the phone's power output may be on average much lower in normal use. If the phone is receiving a strong signal from a particular base station, it will require less power to communicate. This will reduce SAR in proportion to the reduction in the phone's output power.

Distance from Head
The antenna is the main source of the radio waves that produce SAR in the body. Moving the phone away from the head, for example by using a hands free kit, will reduce the localised SAR in the head but may increase the localised SAR in other parts of the body.

Frequency of use and call duration
Using a mobile phone less will give rise to lower exposure

Health Protection Agency

November 2005

CHESHIRE & MERSEYSIDE HEALTH PROTECTION NEWSLETTER ADVICE TO GPs

THE HEALTH EFFECTS OF MOBILE PHONE TECHNOLOGY

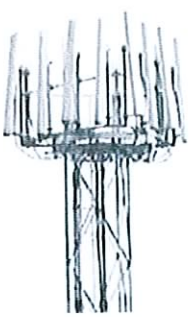
OVERVIEW

The mobile phone industry is one which has advanced dramatically in recent times, in keeping with the increasing popularity of mobile communications. Concerns have been raised in recent years, about the relative lack of understanding of the potential adverse health effects of the electromagnetic fields produced by both the phones and their base stations. These concerns have persisted despite no clear evidence of them causing adverse health implications.

ELECTROMAGNETIC RADIATION

Mobile phones operate within the radiofrequency section 30kHZ-300kHZ of the electromagnetic spectrum, which is a form a electromagnetic radiation. Other sources include MRI scanners, power lines, domestic appliances, microwave ovens, radar and lasers, all at varying frequencies, and hence carrying different amounts of energy.

BASE STATIONS



The phone systems depend on radiofrequency communication between handsets and fixed base stations. The UK network is made up of 3 main types of base stations, macrocells, microcells and picocells. Macrocells provide the main framework and tend to be the more highly conspicuous type of masts. Microcells are used in areas of high demand to infill the network and prevent lost calls. These tend to be mounted at street level typically on the external walls of buildings, often disguised as building features. Picocells also infill the network, but inside buildings or other enclosed areas to improve signal strength. Each base station covers phone use in a specific area called a cell which may vary in size from 0.2 to 10 km. As users move between cells, the signal is transferred to a nearer base station to maintain an optimum signal at the lowest power output.

RADIOWAVE EXPOSURE

Are there any exposure limits?

Public exposure to radio waves from both handsets and base stations fall below international exposure limit standards. These guidelines set out the basic restrictions on the amount of energy that can be safely absorbed by a given mass of body tissue, and are called SAR (Specific Absorption Rate). SAR value information is now available on all mobile phones marketed in the UK, enabling the public to make comparisons between products.

How much more radiation does a base station emit?

The source of much public anxiety tends to be the base stations, as they can be conspicuous modern structures that are cropping up all over the place and because of their high-tech appearance are deemed hazardous. In reality, the actual power transmission is similar to that of an ordinary mobile phone. The masts typically communicate with multiple mobile phones at the same time so in effect the actual total power output is about 50 times that of a phone, but because the mast is so much farther away, the amount of radiation transmitted is significantly less. They are also causing concern by being placed on buildings such as schools and hospitals. In fact, maximum exposure at ground level actually occurs between 50 & 300m from the base station. There is very little exposure closer than this due to the angle at which the radio wave beam is directed towards the ground.

Is there anything that can be done to reduce exposure?

- Pick a handset with a low SAR value.
- Reduce the duration & frequency of calls.
- Using a hands-free device can reduce exposure to the head by 50%. This may however increase exposure to other parts of the body.
- Encourage children to text rather than voice call.

HEALTH EFFECTS

Does mobile phone technology cause cancer?

- The weight of scientific evidence does not suggest that mobile technologies operating within international health and safety guidelines cause adverse health effects.[1]
- The NRPB summary of a number of recent reports produced by national and international bodies, acknowledges that 'exposure to low level radiofrequency fields may cause subtle biological effects on cells, animals or humans, but the possibility of exposure causing adverse health effects remains unproven.'[1]
- Use of handsets has been associated with localised heating of tissue, including brain, but there is no research evidence to suggest harm.

Are those living near base stations at risk?

- Reports such as the Stewart Report stress that very low level exposures, typical of base stations, are extremely unlikely to cause any effects on biophysical grounds and that there is no general risk to the public living near to base stations.[2]
- There is concern that despite the lack of evidence implicating base stations to be harmful, there may be other indirect effects on well-being such as anxiety about possible effects, or possibly a reduction in the value of property.
- To allay public concerns about the levels of exposure, the Stewart Report recommended that there should be an independent, random, ongoing audit of base stations.[2] This began in 2001 and details of location and operating characteristics of stations throughout the UK can be found on the website www.sitefinder.radio.gov.uk.

- **Electromagnetic Hypersensitivity** is a syndrome so far only accepted in Sweden at present, and relates to a group of the population exposed to radio waves who have reported a variety of symptoms including dizziness, fatigue, headache, irregular heart beat, nausea, vertigo, and loss of memory and concentration. Evidence is inconclusive and research ongoing into this phenomenon in the UK.

Are there any proven hazards associated with mobile phone technology?

- Using handsets whilst driving increases the risk of road traffic accident by approximately 4 times, and there is still an association of increased risk despite using hands-free kits. Using a handset whilst driving is now illegal. Pedestrians are also more likely to be involved in an RTA through distraction.
- Mobile phones have become a popular target of street crime through people using their handsets whilst walking through urban areas.

ELECTRONIC EQUIPMENT

Is it safe to use mobile phones in hospitals & airplanes?

Mobile phones have been known to interfere with electronic equipment in hospitals and on aircraft when used in close proximity to unshielded equipment. Most healthcare and aviation authorities therefore have a complete ban on mobile phone use. There is no evidence to suggest that base stations cause interference with hospital equipment.

Pacemaker interference?

Radio waves from mobile phones do not interfere with pacemakers and implantable defibrillators, except for some analogue and flip-top handsets that contain magnets. Patients with such devices are advised not to carry their handset over the implantation site.

GUIDANCE

What recommendations have been made?

The current advice is to use a precautionary approach in the absence of explicit scientific data, which includes:

- ICNIRP guidelines are to be adopted for the public in the UK rather than NRPB guidelines, reducing exposure levels fivefold.[3]
- Discouragement of the widespread use of mobile phones by children for non-essential calls.
- Increased controls over mast siting including: marked exclusion zones, school site limitations, and planning permission (implemented in Scotland & Northern Ireland). Current UK legislation requires permission only for masts over 15m in height.

FURTHER RESEARCH

The use of mobile phone technologies is still fairly recent and technologies are continuing to develop at a pace which is outstripping analyses of any potential impact on health. Therefore it has not been possible to carry out the necessary long-term epidemiological studies to provide the most direct information on any long-term health effects. What has been established from the research already completed is the direction in which research needs to go in the future to be useful. All the main professional organisations have called for ongoing research to be conducted, particularly in the following areas:

- An international cohort study of mobile phone users aimed at pooling and sharing experimental design, findings and expertise internationally.
- Effects on radiofrequency exposure on children.
- Investigation of public concerns about mobile phone technology.
- Electromagnetic hypersensitivity and its possible impact on health, including well-being.
- Studies of radiofrequency effects on direct and established measures of human brain function and investigations of possible mechanisms involved.

The UK department of health has established a multimillion pound programme of research to contribute towards the worldwide effort, conducted largely according to the WHO agenda of further research (www.who.int/peh-emf).

KEY MESSAGES

1) Adverse health effects of mobile phone technology remains unlikely but unproven.
2) Do **NOT** 'drive and talk'.
   Try **NOT** to 'walk and talk'.
3) Radiation exposure to an individual is greater from using a mobile phone than from surrounding base stations.
4) Research is ongoing.
5) Health related advice will continue to be provided based on the best available evidence.
6) The benefits of mobile phone technology currently supersede any reservations.

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IF YOU HAVE ANY TOPICS FOR FUTURE ISSUES PLEASE LET US KNOW

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Glossary

The descriptions below are intended to help the reader understand the text; they are not necessarily definitive scientific terms, for which the reader is advised to consult specialist sources.

Words in bold are defined separately.

Analogue	The original cellular technology used in the transmission of speech by Vodafone and Cellnet since 1985, operating as an analogue system at 900 MHz. Typically accessed by high powered phones installed in cars.
AM	Amplitude modulation.
Action potential	Voltage produced across a nerve cell membrane by a stimulus. It arises from the entry of sodium ions across the cell membrane, which results in membrane depolarisation.
Antenna	Device designed to radiate or receive electromagnetic energy.
APC	Adaptive Power Control. System used to control mobile phones and base stations in order to ensure that the radiated power does not exceed the minimum consistent with high quality communication. The system effectively operates to reduce average radiated powers.
Base station	Facility providing transmission and reception for radio systems. For macrocells, the infrastructure comprises either roof- or mast-mounted antennas and an equipment cabinet or container. For smaller microcells and picocells, the antennas and other equipment may be housed in a single unit.
Case–control study	An investigation into the extent to which a group of persons with a specific disease (the cases) and comparable people who do not have the disease (the controls) differ with respect to exposure to putative risk factors.
CDMA	Code Division Multiple Access. System that encodes signals to a number of users, so that all of these users can simultaneously use a single, wide frequency band. Each user's handset decodes the information for that user, but cannot access information for any other user.
Cell and Cellular	A cell in the context of mobile phone technology is the area of geographical coverage from a radio base station. "Cellular" describes such systems, but is often used to distinguish the original analogue systems from the later digital **PCN** systems, although the latter themselves have cells.
Chromosomes	Rod-shaped bodies found in the **nucleus** of cells in the body. They contain the genes or hereditary material. Human beings possess 23 pairs.
Cohort study	An investigation into the extent to which a group of individuals (the cohort) about whom certain exposure information is collected, and the ascertainment of the occurrence of diseases at later times. For each individual, information on prior exposures can be related to subsequent disease experience.

CJD	Creutzfeldt-Jakob disease.
Confidence interval (CI)	An interval calculated from data when making inferences about an unknown parameter. In hypothetical repetitions of the study, the interval will include the parameter in question on a specified percentage of occasions (for example, 95% for a 95% confidence interval).
CW	Continuous wave.
Decibel (dB)	A measure of the increase or decrease in power at two points expressed in logarithmic form. Gain = 10 $\log_{10}(P_2/P_1)$.
DECT	Digital Enhanced Cordless Telecommunications.
Digital	Technology introduced in the 1990s as a method of transmitting speech and data. Offers increased security, and technical advantages with low powered phones.
DNA	Deoxyribonucleic acid. The compound that controls the structure and function of cells and is the material of inheritance.
DTX	Discontinuous transmission. System regulating mobile phones to ensure that transmission occurs only during speech. The system has the effect of reducing the time of exposure to approximately half (assuming an equal conversation).
EEG	Electroencephalogram. Measurement of changing voltages associated with brain activity.
EIRP	Equivalent isotropically radiated power. This is the power that would have to be emitted in *all directions* to produce a particular intensity and so takes account of the transmitter power plus the characteristics of the antenna.
Electric field	Produces a force on a charged object. Measured in units of volts per metre.
Electromagnetic fields	The electric and magnetic fields associated with electromagnetic radiation.
Electromagnetic radiation	A wave of electric and magnetic energy that travels or *radiates* from a source.
EMF	Electromagnetic field.
ERP	"Evoked" or "Event-related" potential.
FDD	Frequency division duplex.
Frequency	The number of complete cycles of an electromagnetic wave in a second. Measured in units of **hertz (Hz)**.
Genes	Biological units of heredity. They are arranged along the length of **chromosomes**.
Gene expression	The realisation of genetic information encoded in **genes** to produce functional protein or **RNA**.
GSM	Global System for Mobile Communications or *Groupe Spéciale Mobile*. The international, pan-European operating standard for the new generation of digital cellular mobile communications. Enables mobile phones to be used across national boundaries. PCN operators work to the same standard but at different frequency allocations.
Hertz (Hz)	Unit of frequency. One cycle per second.

IMT - 2000	International Mobile Telecommunications - 2000. International name for **UMTS**.
Infrared radiation	**Electromagnetic radiation** capable of producing the sensation of heat and found between visible radiation and **radiofrequency radiation** in the electromagnetic spectrum.
Intensity	The power crossing unit area normal to the direction of wave propagation. Measured in units of watts per square metre (W/m^2). See also **power density**.
Ion	Electrically charged atom or group of atoms.
Ion channel (gate)	Protein that allows the passage of ions across a membrane, down a concentration gradient.
Ion pump	A protein pump that moves ions across a membrane against a concentration gradient.
Magnetic field B	Produces a force on a charged object moving at an angle to it. Measured in tesla (T). See also **magnetic flux density**.
Magnetic flux density	Produces a force on a charged object moving at an angle to it. Measured in tesla (T). See also **magnetic field B**.
Magnetite	Naturally occurring oxide of iron with magnetic properties
Microwave	Electromagnetic radiation of ultra high frequencies between 1 GHz and 300 GHz.
Molecule	Smallest portion of a substance that can exist by itself and retain the properties of the substance.
Mutation	Chemical change in the DNA in the nucleus of a cell. Mutations in sperm or egg cells, or their precursors, may lead to inherited effects in children. Mutations in body cells may lead to effects in the individual.
Neuron(e)	Nerve cell. Basic unit of the nervous system, specialised for the transmission of electrical impulses.
Nucleus	The controlling centre of higher cells. Contains the important material **DNA**.
Order of magnitude	Quantity given to the nearest power of ten. A factor of ten or so.
OFTEL	Office of Telecommunications.
PCN	Personal Communications Network. A mobile system principally directed towards the hand portable, domestic user market and operating with **digital** technology at 1.8 GHz. The two main UK operators are One 2 One and Orange.
Power density	The power crossing unit area normal to the direction of wave propagation. Measured in units of watts per square metre (W/m^2). See also **intensity**.
Radiofrequency radiation	Electromagnetic radiation used for telecommunications and found in the electromagnetic spectrum at longer wavelengths than **infrared radiation**.
Relative risk	The ratio of the disease rate in the group under study to that in a comparison group, with adjustment for confounding factors such as age, if necessary.
RF	**Radiofrequency radiation**.

Risk	The probability or likelihood of injury, harm or damage occurring.
RNA	Ribonucleic acid.
SAR	**Specific energy absorption rate.**
Significance level	The probability of obtaining a result at least as extreme as that observed in the absence of a raised risk. A result that would arise less than 1 in 20 times in the absence of an underlying effect is often referred to a being "statistically significant".
Specific energy absorption rate	The rate at which energy is absorbed by unit mass of tissue in an electromagnetic field. Measured in units of watts per kilogram (W/kg).
Third Generation	The next evolution of mobile phone technology, based on **UMTS** and expected to result in widespread use of video phones and access to multimedia information.
TDD	Time Division Duplex.
TDMA	Time division multiple access. System that divides each frequency band into a number of time slots, each allocated to a single user. Allows several users to operate on the same frequency at the same time.
TETRA	Terrestrial enhanced trunk radio system.
Transcription	The synthesis of **RNA** from **DNA**.
UMTS	Universal Mobile Telecommunications System.
Wavelength	Distance between two successive points of a periodic wave in the direction of propagation, in which the oscillation has the same phase. Measured in units of metres.

Quantities and units used to characterise electromagnetic radiation

Quantity	Unit	Symbol
Frequency	hertz	Hz
Wavelength	metre	m
Electric field strength	volt per metre	V/m
Magnetic field strength*	ampere per metre	A/m
Magnetic field, B/Magnetic flux density*	tesla	T
Intensity/Power density	watt per square metre	W/m^2
Specific energy absorption rate (SAR)	watt per kilogram	W/kg

*A magnetic field strength of 1 A/m is equivalent to a magnetic field of $4\pi\ 10^{-7}$ T in non-magnetic media