ESTABLISHING A DIALOGUE ON RISKS FROM ELECTROMAGNETIC FIELDS

WORLD HEALTH ORGANIZATION

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ESTABLISHING A DIALOGUE ON RISKS FROM ELECTROMAGNETIC FIELDS

RADIATION AND ENVIRONMENTAL HEALTH
DEPARTMENT OF PROTECTION OF THE HUMAN ENVIRONMENT
WORLD HEALTH ORGANIZATION
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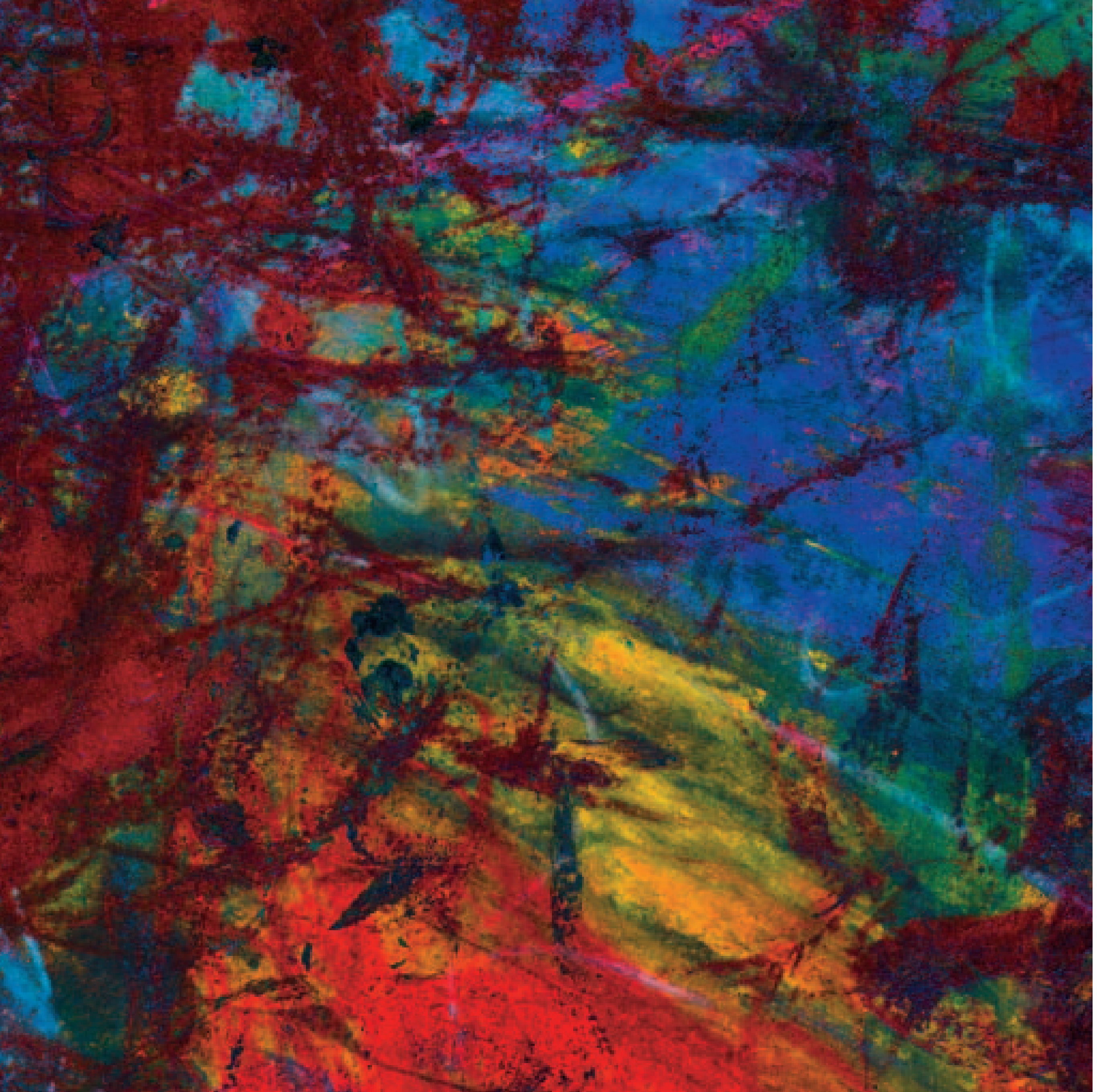

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FOREWORD

Public concern over the possible health effects from electromagnetic fields (EMF) has led to the preparation of this handbook. Potential risks of EMF exposure from facilities such as power lines or mobile phone base stations present a difficult set of challenges for decision-makers. The *challenges* include determining if there is a hazard from EMF exposure and what the potential health impact is, i.e. risk assessment; recognizing the reasons why the public may be concerned, i.e. risk perception; and implementing policies that protect public health and respond to public concerns, i.e. risk management. Responding to these challenges requires the involvement of individuals or organizations with the right set of *competencies*, combining relevant scientific expertise, strong communication skills and good judgement in the management and regulatory areas. This will be true in any *context*, be it local, regional or even national or global.

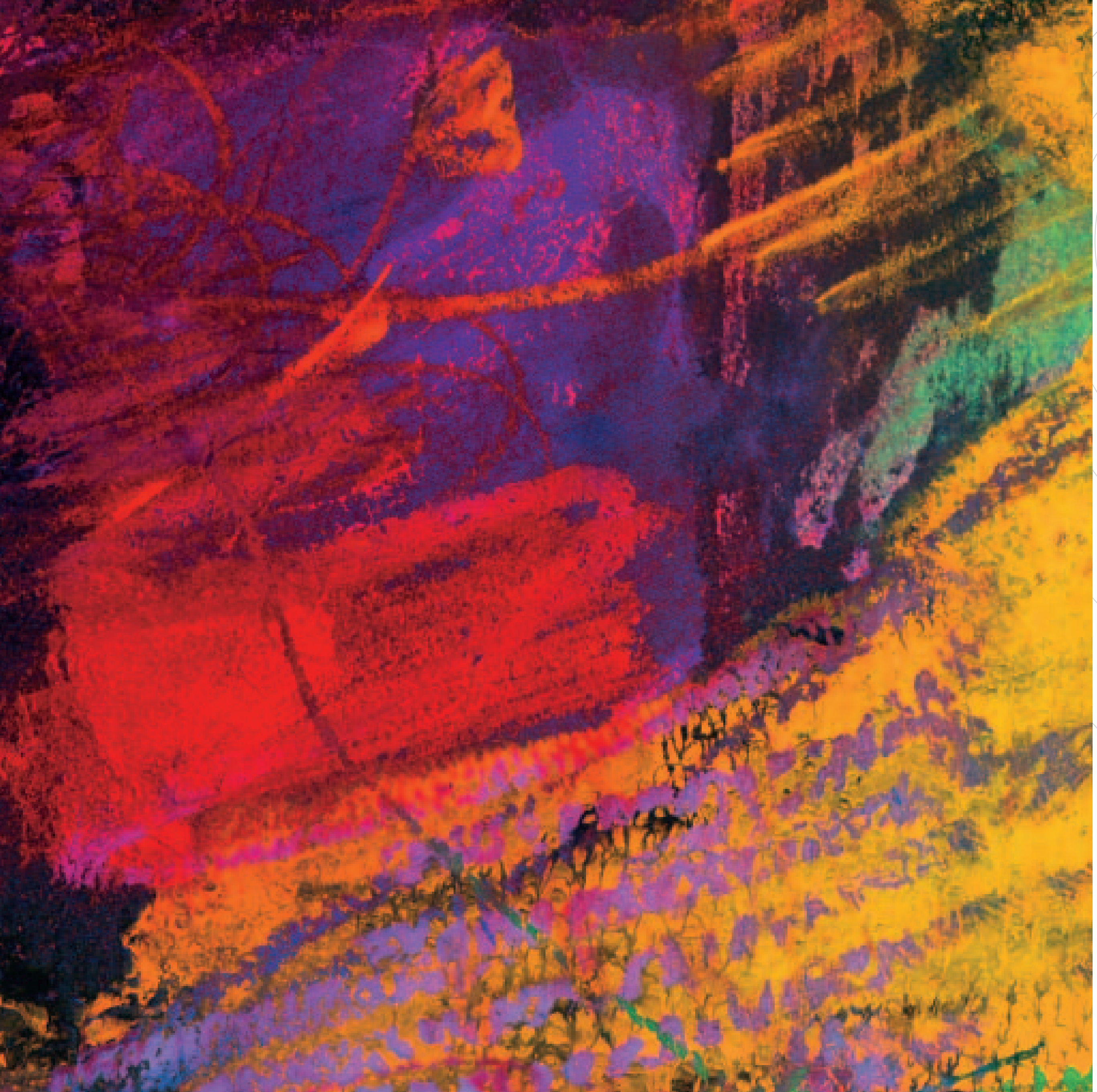
WHY A DIALOGUE?

Many governmental and private organizations have learned a fundamental, albeit sometimes painful, lesson; that it is dangerous to assume that impacted communities do not want, or are incapable of meaningful input to decisions about siting new EMF facilities or approving new technologies prior to their use. It is therefore crucial to establish a dialogue between all individuals and groups impacted by such issues. The ingredients for effective dialogue include consultation with stakeholders, acknowledgement of scientific uncertainty, consideration of alternatives, and a fair and transparent decision-making process. Failure to do these things can result in loss of trust and flawed decision-making as well as project delays and increased costs.

WHO NEEDS THIS HANDBOOK?

This handbook is intended to support decision-makers faced with a combination of public controversy, scientific uncertainty, and the need to operate existing facilities and/or the requirement to site new facilities appropriately. Its goal is to improve the decision-making process by reducing misunderstandings and improving trust through better dialogue. Community dialogue, if implemented successfully, helps to establish a decision-making process that is open, consistent, fair and predictable. It can also help achieve the timely approval of new facilities while protecting the health and safety of the community.

It is expected that many other public officials, private groups and non-governmental organizations will also find this information useful. This guide may assist the general public when interacting with government agencies that regulate environmental health, and with companies whose facilities may be sources of concern. References and suggestions for further reading are provided for those who seek more information.



1

ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH
THE PRESENT EVIDENCE

Electromagnetic fields (EMF) occur in nature and thus have always been present on earth. However, during the twentieth century, environmental exposure to man-made sources of EMF steadily increased due to electricity demand, ever-advancing wireless technologies and changes in work practices and social behaviour. Everyone is exposed to a complex mix of electric and magnetic fields at many different frequencies, at home and at work.

Potential health effects of man-made EMF have been a topic of scientific interest since the late 1800s, and have received particular attention during the last 30 years. EMF can be broadly divided into *static* and *low-frequency* electric and magnetic fields, where the common sources include power lines, household electrical appliances and computers, and *high-frequency* or radiofrequency fields, for which the main sources are radar, radio and television broadcast facilities, mobile telephones and their base stations, induction heaters and anti-theft devices.

Unlike ionizing radiation (such as gamma rays given off by radioactive materials, cosmic rays and X-rays) found in the upper part of the electromagnetic spectrum, EMF are much too weak to break the bonds that hold molecules in cells together and, therefore, cannot produce ionization. This is why EMF are

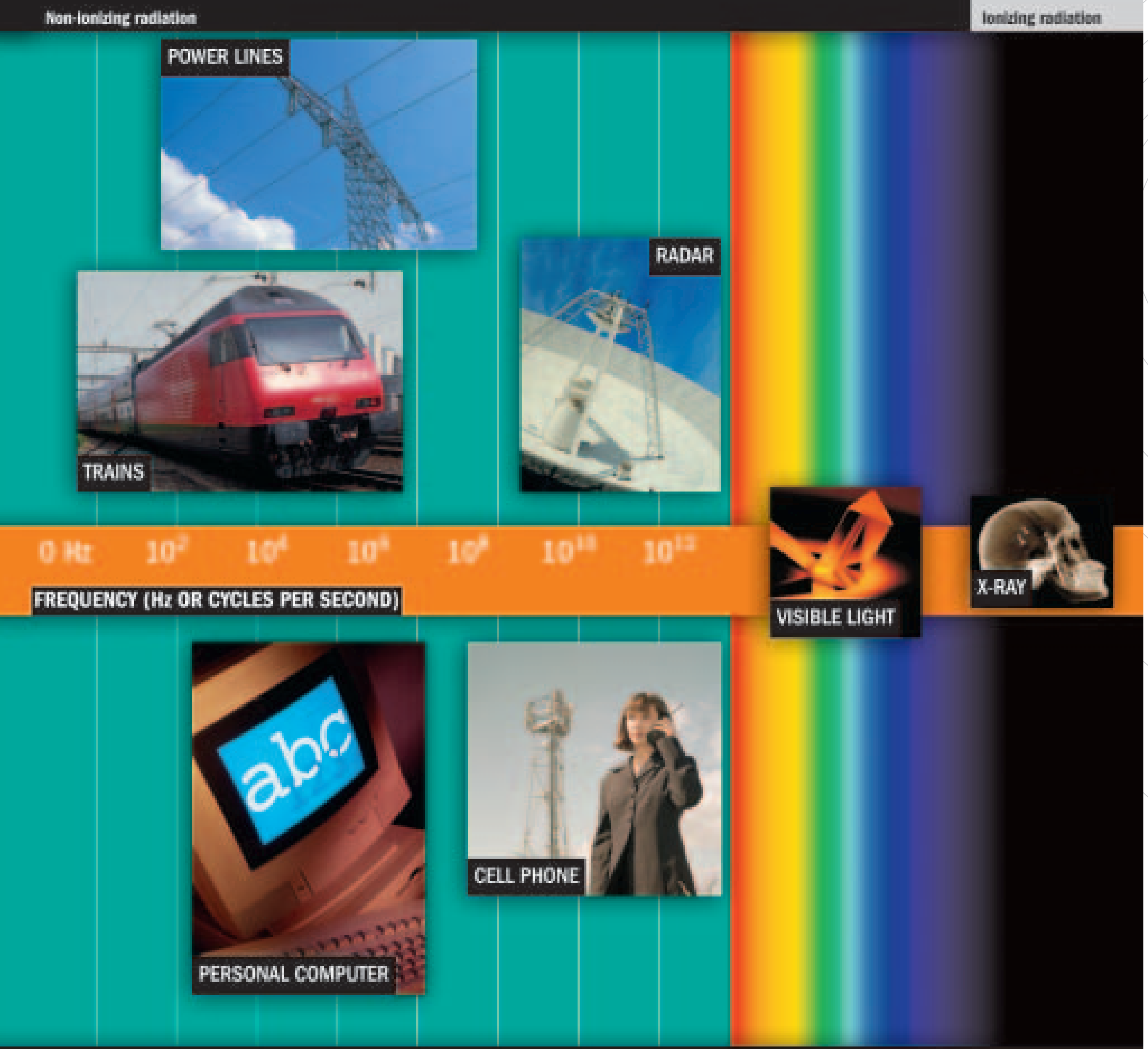


FIGURE 1. THE ELECTROMAGNETIC SPECTRUM

called 'non-ionizing radiations' (NIR). *Figure 1* displays the relative position of NIR in the wider electromagnetic spectrum. Infrared, visible, ultraviolet and ionizing radiation will not be considered further in this handbook.

WHAT HAPPENS WHEN YOU ARE EXPOSED TO ELECTROMAGNETIC FIELDS?

Electrical currents exist naturally in the human body and are an essential part of normal bodily functions. All nerves relay their signals by transmitting electric impulses. Most biochemical reactions, from those associated with digestion to those involved in brain activity, involve electrical processes.

The effects of *external* exposure to EMF on the human body and its cells depend mainly on the EMF *frequency* and *magnitude* or strength. The frequency simply describes the number of oscillations or cycles per second. At low frequencies, EMF passes through the body while at radio frequencies the fields are partially absorbed and penetrate only a short depth into the tissue.

Low-frequency electric fields influence the distribution of electric charges at the surface of conducting tissues and cause electric current to flow in the body (Fig. 2A). *Low-frequency magnetic fields* induce circulating currents within the human body (Fig. 2B). The strength of these induced currents depends on the intensity of the outside magnetic field and the size of the loop through which the current flows. When sufficiently large, these currents can cause stimulation of nerves and muscles.

At *radiofrequencies* (RF), the fields only penetrate a short distance into the body. The energy of these fields is absorbed and transformed into the movement of molecules. Friction between rapidly moving molecules results in a temperature rise. This effect is used in domestic applications such as warming up food in microwave ovens, and in many industrial applications such as plastic welding or metal heating. The levels of RF fields to which people are normally exposed in our living environment are much lower than those needed to produce significant heating.

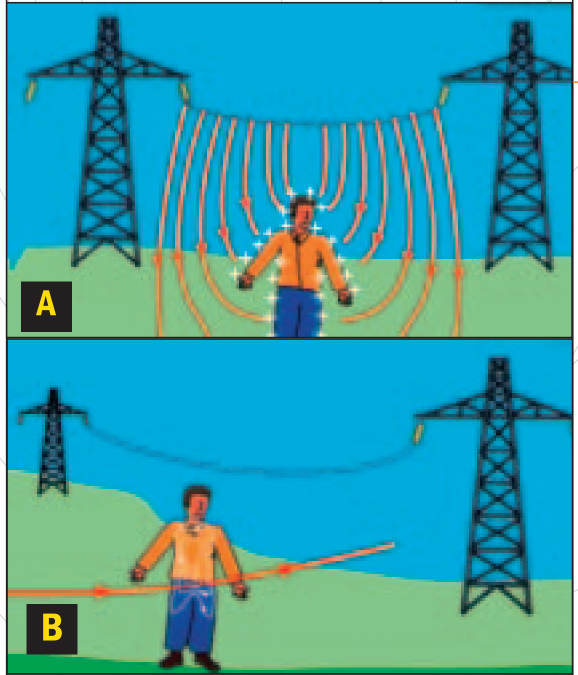


FIGURE 2. **A Electric fields do not penetrate the body significantly but they do build up a charge on its surface, while B exposure to magnetic fields causes circulating currents to flow in the body.**

BIOLOGICAL EFFECTS AND HEALTH EFFECTS

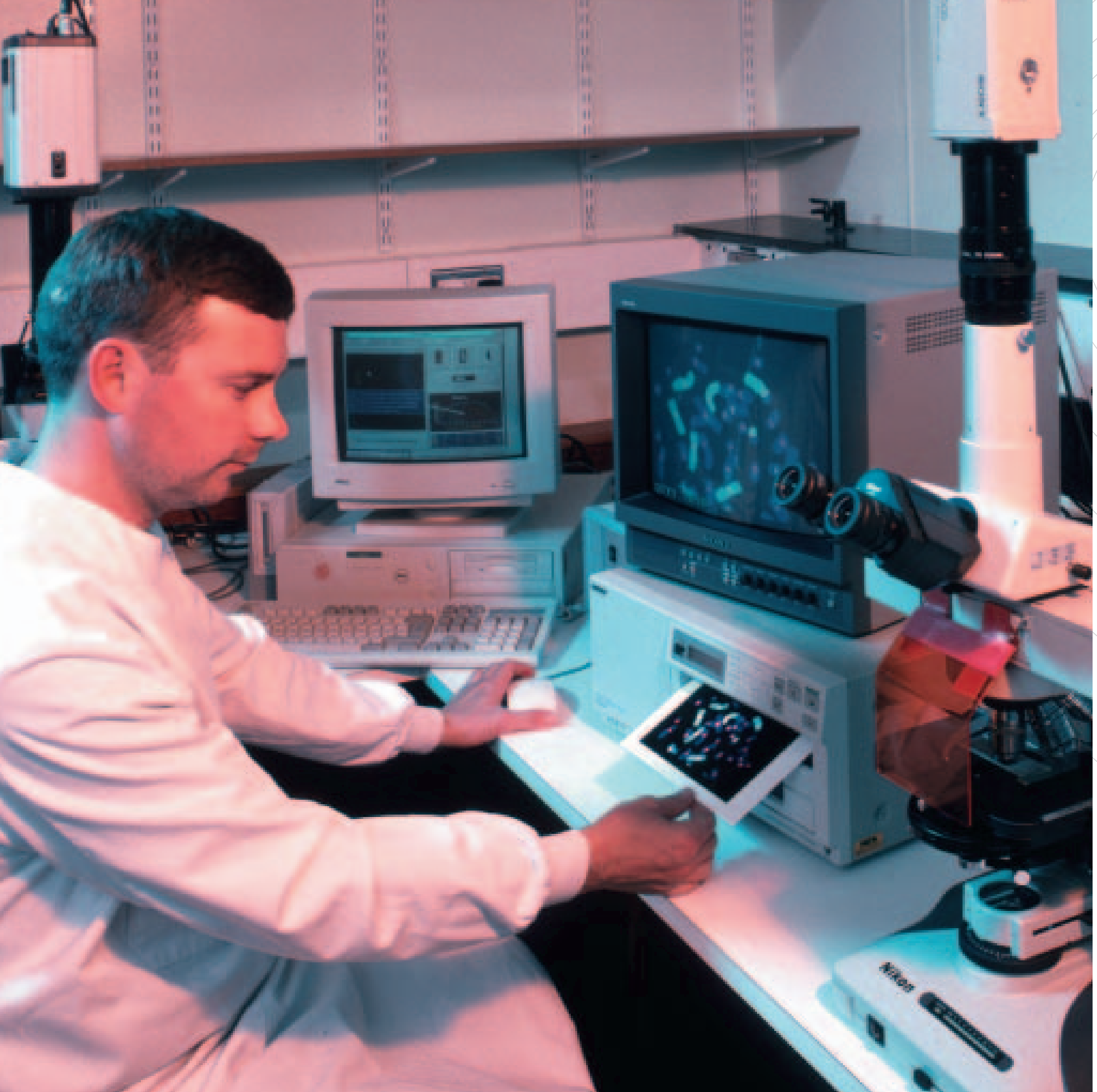
Biological effects are measurable responses of organisms or cells to a stimulus or to a change in the environment. Such responses, e.g. increased heart rate after drinking coffee or falling asleep in a stuffy room, are not necessarily harmful to health. Reacting to changes in the environment is a normal part of life. However, the body might not possess adequate compensation mechanisms to mitigate all environmental changes or stresses. Prolonged environmental exposure, even if minor, may constitute a health hazard if it results in stress. In humans, an adverse *health effect* results from a biological effect that causes detectable impairment in the health or well-being of exposed individuals.

Complying with exposure limits recommended in national and international guidelines helps to control risks from exposures to EMFs that may be harmful to human health. The present debate is centred on whether long-term, low level exposure below the exposure limits can cause adverse health effects or influence people's well being.

CONCLUSIONS FROM SCIENTIFIC RESEARCH

LOW-FREQUENCY FIELDS

Scientific knowledge about the health effects of EMF is substantial and is based on a large number of epidemiological, animal and in-vitro studies. Many health outcomes ranging from reproductive defects to cardiovascular and neurodegenerative diseases have been examined, but the most consistent evidence to date concerns childhood leukemia. In 2001, an expert scientific working group of WHO's International Agency for Research on Cancer (IARC) reviewed studies related to the carcinogenicity *of static and extemely low frequency (ELF) electric and magnetic fields*. Using the standard IARC classification that weighs human, animal and laboratory evidence, ELF magnetic fields were classified as *possibly carcinogenic to humans* based on epidemiological studies of childhood leukaemia. An example of a well-known agent classified in the same category is coffee, which may increase risk of kidney cancer, while at the same time be protective against bowel cancer. "Possibly carcinogenic to humans" is a classification used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals. Evidence for all other cancers in children and adults, as well as other types of exposures (i.e. static fields and ELF electric fields) was considered inadequate to classify either due to insufficient or inconsistent scientific information. While the classification of ELF



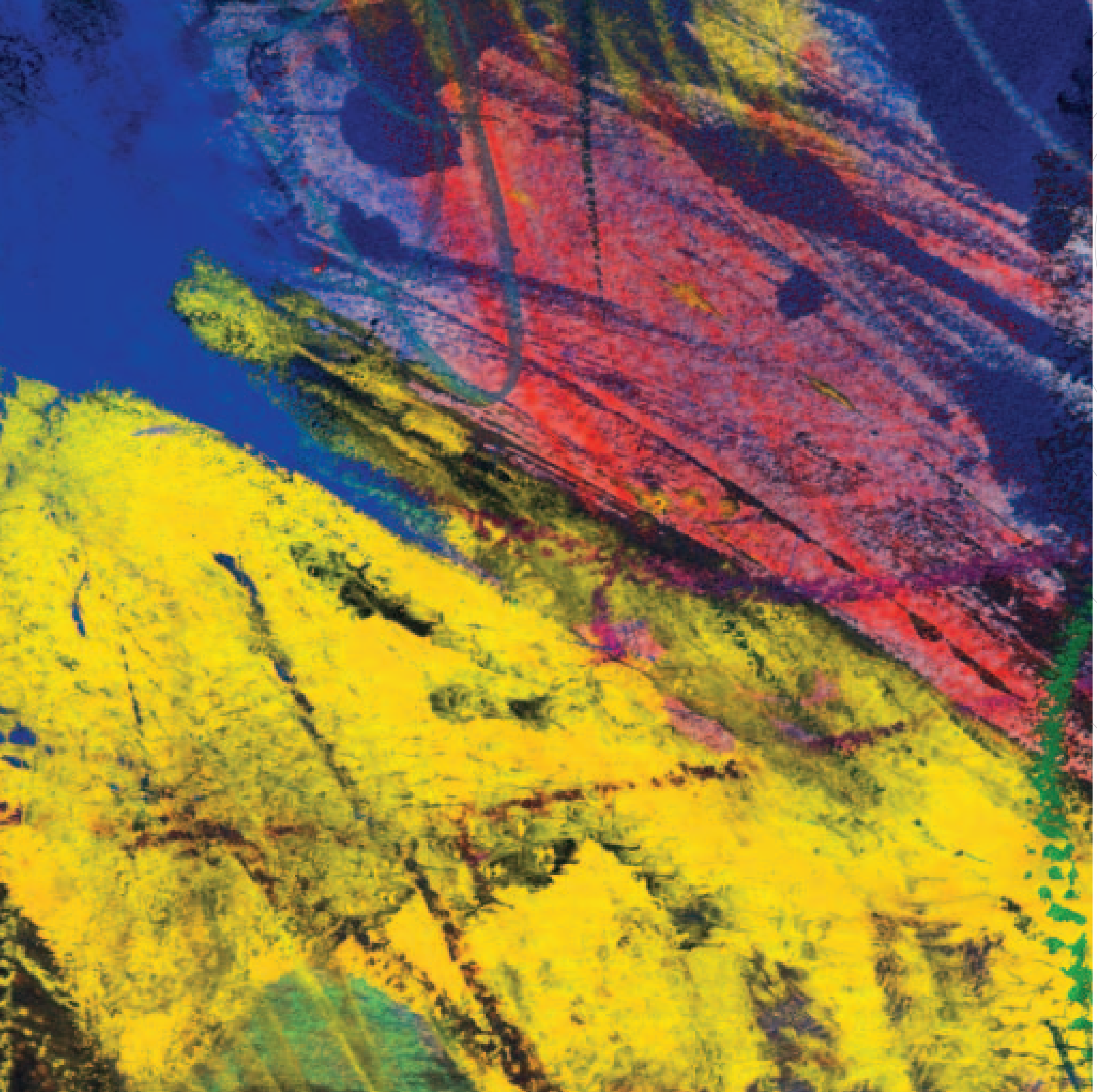
magnetic fields as possibly carcinogenic to humans has been made by IARC, it remains possible that there are other explanations for the observed association between exposure to ELF magnetic fields and childhood leukaemia.

HIGH-FREQUENCY FIELDS

Concerning radiofrequency fields, the balance of evidence to date suggests that exposure to low level *RF* fields (such as those emitted by mobile phones and their base stations) does not cause adverse health effects. Some scientists have reported minor effects of mobile phone use, including changes in brain activity, reaction times, and sleep patterns. In so far as these effects have been confirmed, they appear to lie within the normal bounds of human variation.

Presently, research efforts are concentrated on whether *long-term, low level* RF exposure, even at levels too low to cause significant temperature elevation, can cause adverse health effects. Several recent epidemiological studies of mobile phone users found no convincing evidence of increased brain cancer risk. However, the technology is too recent to rule out possible long-term effects. Mobile phone handsets and base stations present quite different exposure situations. RF exposure is far higher for mobile phone users than for those living near cellular base stations. Apart from infrequent signals used to maintain links with nearby base stations, handsets transmit RF energy only while a call is being made. However, base stations are continuously transmitting signals, although the levels to which the public are exposed are extremely small, even if they live nearby.

Given the widespread use of technology, the degree of scientific uncertainty, and the levels of public apprehension, rigorous scientific studies and clear communication with the public are needed.



2

EMF RISK COMMUNICATION
DEALING WITH PUBLIC PERCEPTION

Modern technology offers powerful tools to stimulate a whole range of benefits for society, in addition to economic development. However, technological progress in the broadest sense has always been associated with hazards and risks, both perceived and real. Industrial, commercial and household applications of EMF are no exception. Around the start of the twentieth century people were worried about the possible health effects of light bulbs and the fields emanating from the wires on poles connecting land-based telephone systems. No adverse health effects appeared, and these technologies were gradually accepted as part of normal lifestyle. Understanding and adjusting to newly introduced technologies depends partly on how the new technology is presented and how its risks and benefits are interpreted by an ever more wary public.

Throughout the world, some members of the general public have indicated concern that exposure to EMF from such sources as high voltage power lines, radar, mobile telephones and their base stations could lead to adverse health consequences, especially in children. As a result, the construction of new power lines and mobile telephone networks has met with considerable opposition in some

countries. Public worry about new technologies often stems from unfamiliarity and a sense of danger from forces that they cannot sense.

Recent history has shown that lack of knowledge about health consequences of technological advances may not be the sole reason for social opposition to innovations. Disregard for differences in risk perception that are not adequately reflected in communication among scientists, governments, industry and the public, is also to blame. It is for this reason that *risk perception* and *risk communication* are major aspects of the EMF issue.

This section aims to provide governments, industry and members of the public with a framework to establish and maintain effective communication about EMF associated health risks.

DEFINING RISK

In trying to understand people's perception of risk, it is important to distinguish between a health hazard and a health risk. A *hazard* can be an object or a set of circumstances that could potentially harm a person's health. *Risk* is the likelihood, or probability, that a person will be harmed by a particular hazard.

HAZARD AND RISK

- Driving a car is a potential *health hazard*. Driving a car fast presents a *risk*. The higher the speed, the more risk is associated with the driving.
- Every activity has an associated risk. It is possible to diminish risks by avoiding specific activities, but one cannot abolish risk entirely. In the real world, *there is no such thing as a zero risk*.

MULTIPLE DETERMINANTS OF THE EMF RISK ISSUE

Scientists assess health risk by weighing and critically evaluating all of the available scientific evidence to develop a sound *risk assessment* (see *Box*, page 13). The public may perform its own

FIGURE 3. EVALUATING, INTERPRETING AND REGULATING RISKS ASSOCIATED WITH EMF

assessment of risk by an entirely different process, often not based on quantifiable information. Ultimately this perceived risk could take on an importance as great as a measurable risk in determining commercial investment and government policy.

BASICS OF RISK ASSESSMENT

Risk assessment is an organized process used to describe and estimate the likelihood of adverse health outcomes from environmental exposures to an agent. The four steps in the process are:

1. **Hazard identification**: the identification of a potentially hazardous agent or exposure situation (e.g., a particular substance or energy source)
2. **Dose-response assessment**: the estimation of the relationship between dose or exposure to the agent or situation and the incidence and/or severity of an effect
3. **Exposure assessment**: the assessment of the extent of exposure or potential exposure in actual situations
4. **Risk characterization:** the synthesis and summary of information about a potentially hazardous situation in a form useful to decision-makers and stakeholders.

The factors that shape *risk perception* of individuals include basic societal and personal values (e.g. traditions, customs) as well as previous experience with technological projects (e.g. dams, power plants). These factors may explain local concerns, possible biases or hidden agendas or assumptions. Careful attention to the social dimensions of any project allows policy makers and managers to make informed decisions as part of a thorough *risk management* programme. Ultimately, risk management must take into account both measured and perceived risk to be effective (Figure 3).

The identification of problems and the scientific risk assessment of those problems are key steps to defining a successful risk management programme. To respond to that assessment, such a programme should incorporate actions and strategies, e.g. finding options, making decisions, implementing

RANGE OF RISK MANAGEMENT OPTIONS

DECISION TO TAKE NO FORMAL ACTION is an appropriate response in cases where the risk is considered very small, or the evidence is insufficient to support formal actions. This response is often combined with watchful waiting, i.e. monitoring the results of research and measurements and the decisions being made by standard-setters, regulators, and others.

COMMUNICATION PROGRAMMES can be used to help people understand the issues, become involved in the process and make their own choices about what to do.

RESEARCH fills gaps in our knowledge, helps to identify problems, and allows for a better assessment of risk in the future.

CAUTIONARY APPROACHES are policies and actions that individuals, organizations or governments take to minimize or avoid future potential health or environmental impacts. These may include voluntary self-regulation to avoid or reduce exposure, if easily achievable.

REGULATIONS are formal steps taken by government to limit both the occurrence and consequences of potentially risky events. Standards with limits may be imposed with methods to show compliance or they may state objectives to be achieved without being prescriptive.

LIMITING EXPOSURE or banning the source of exposure altogether are options to be used when the degree of certainty of harm is high. The degree of certainty and the severity of harm are two important factors in deciding the type of actions to be taken.

TECHNICAL OPTIONS should be used to reduce risk (or perceived risk). These may include the consideration of burying power lines, or site sharing for mobile phone base stations.

MITIGATION involves making physical changes in the system to reduce exposure and, ultimately, risk. Mitigation may mean redesigning the system, installing shielding or introducing protective equipment.

COMPENSATION is sometimes offered in response to higher exposures in a workplace or environment. People may be willing to accept something of value in exchange for accepting increased exposure.

those decisions, and evaluating the process. These components are not independent, nor do they occur in a predetermined order. Rather, each element is driven by the urgency of the need for a decision, and the availability of information and resources. While there is a range of risk management options (see *Box*, page 14), emphasis in this handbook is placed on the second option, namely communication programmes.

HOW IS RISK PERCEIVED?

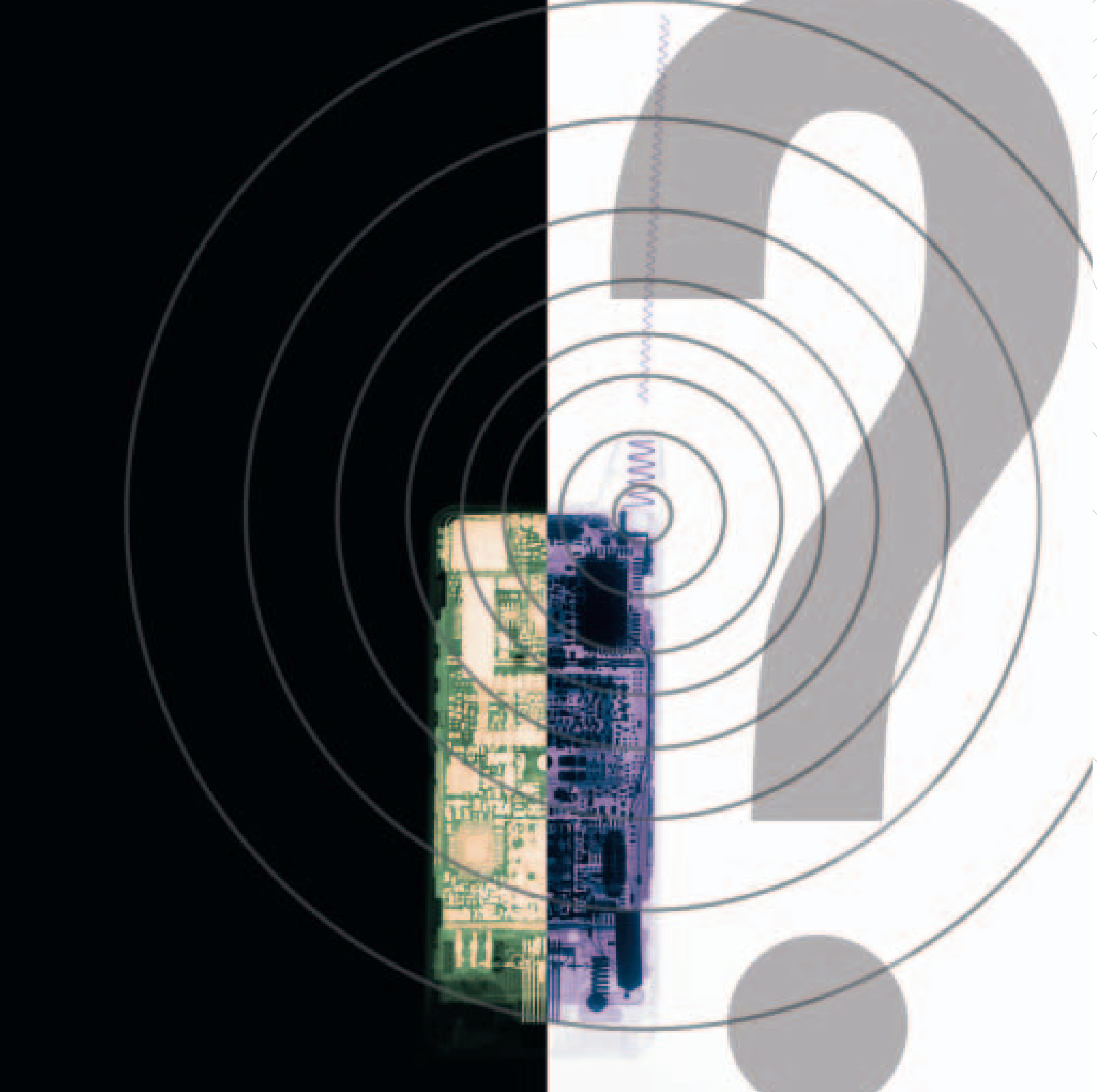
Many factors influence a person's decision to take or reject a risk. People perceive risks as negligible, acceptable, tolerable, or unacceptable, in comparison to perceived benefits. These perceptions depend on personal factors, external factors as well as the nature of the risk. *Personal factors* include age, sex, and cultural or educational backgrounds. Some people, for example, find the risks associated with taking street drugs as acceptable. On the other hand, many people do not. Inherent acceptability in personal risk-taking is the ability to control it.

However, there are situations where individuals may feel that they do not have control. This is especially true when it comes to exposure to EMF where the fields are invisible, the risk is not easily quantifiable, and the degree of exposure is beyond immediate control. This is further exacerbated when individuals do not perceive direct benefit from exposure. In this context, public response will depend on the perception of that risk based on *external factors*. These include available scientific information, the media and other forms of information dissemination, the economic situation of the individual and community, opinion movements, and the structure of the regulatory process and political decision-making in the community (Figure 4).

FIGURE 4. FACTORS AFFECTING PERCEPTION OF ENVIRONMENTAL RISKS

The *nature of the risk* can also lead to different perceptions. The greater the number of factors adding to the public's perception of risk, the greater the potential for concern. Surveys have found that the following pairs of characteristics of a situation generally affect risk perception.

- **FAMILIAR VS. UNFAMILIAR TECHNOLOGY.** Familiarity with a given technology or a situation helps reduce the level of the perceived risk. The perceived risk increases when the technology or situation, such as EMF, is new, unfamiliar, or hard-to-comprehend. Perception about the level of risk can be significantly increased if there is an incomplete scientific understanding about potential health effects from a particular situation or technology.
- **PERSONAL CONTROL VS. LACK OF CONTROL OVER A SITUATION.** If people do not have any say about installation of power lines and mobile telephone base stations, especially near their homes, schools or play areas, they tend to perceive the risk from such EMF facilities as being high.
- **VOLUNTARY VS. INVOLUNTARY EXPOSURE.** People feel much less at risk when the choice is theirs. Those who do not use mobile telephones may perceive the risk as *high* from the relatively low RF fields emitted from mobile telephone base stations. However, mobile telephone users generally perceive as *low* the risk from the much more intense RF fields from their voluntarily chosen handsets.
- **DREADED VS. NOT DREADED OUTCOME.** Some diseases and health conditions, such as cancer, or severe and lingering pain and disability, are more feared than others. Thus, even a small possibility of cancer, especially in children, from a potential hazard such as EMF exposure receives significant public attention.



- **DIRECT VS. INDIRECT BENEFITS.** If people are exposed to RF fields from mobile telephone base stations, but do not have a mobile telephone, or if they are exposed to the electric and magnetic fields from a high voltage transmission line that does not provide power to their community, they may not perceive any direct benefit from the installation and are less likely to accept the associated risk.
- **FAIR VS. UNFAIR EXPOSURE.** Issues of social justice may be raised because of unfair EMF exposure. For example, if facilities were installed in poor neighbourhoods for economic reasons (e.g. cheaper land), the local community would unfairly bear the potential risks.

Reducing perceived risk involves countering the factors associated with personal risk. Communities feel they have a right to know what is proposed and planned with respect to the construction of EMF sources that, in their opinion, might affect their health. They want to have some control and be part of the decision-making process. Unless an effective system of public information and communication among scientists, governments, the industry and the public is established, new EMF technologies will be mistrusted and feared.

THE NEED FOR RISK COMMUNICATION

Today, communication with the public about environmental risks from technology plays an important role. According to the U.S. National Research Council, risk communication is "an interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risks, that express concerns, opinions, or reactions to risk messages or to legal and

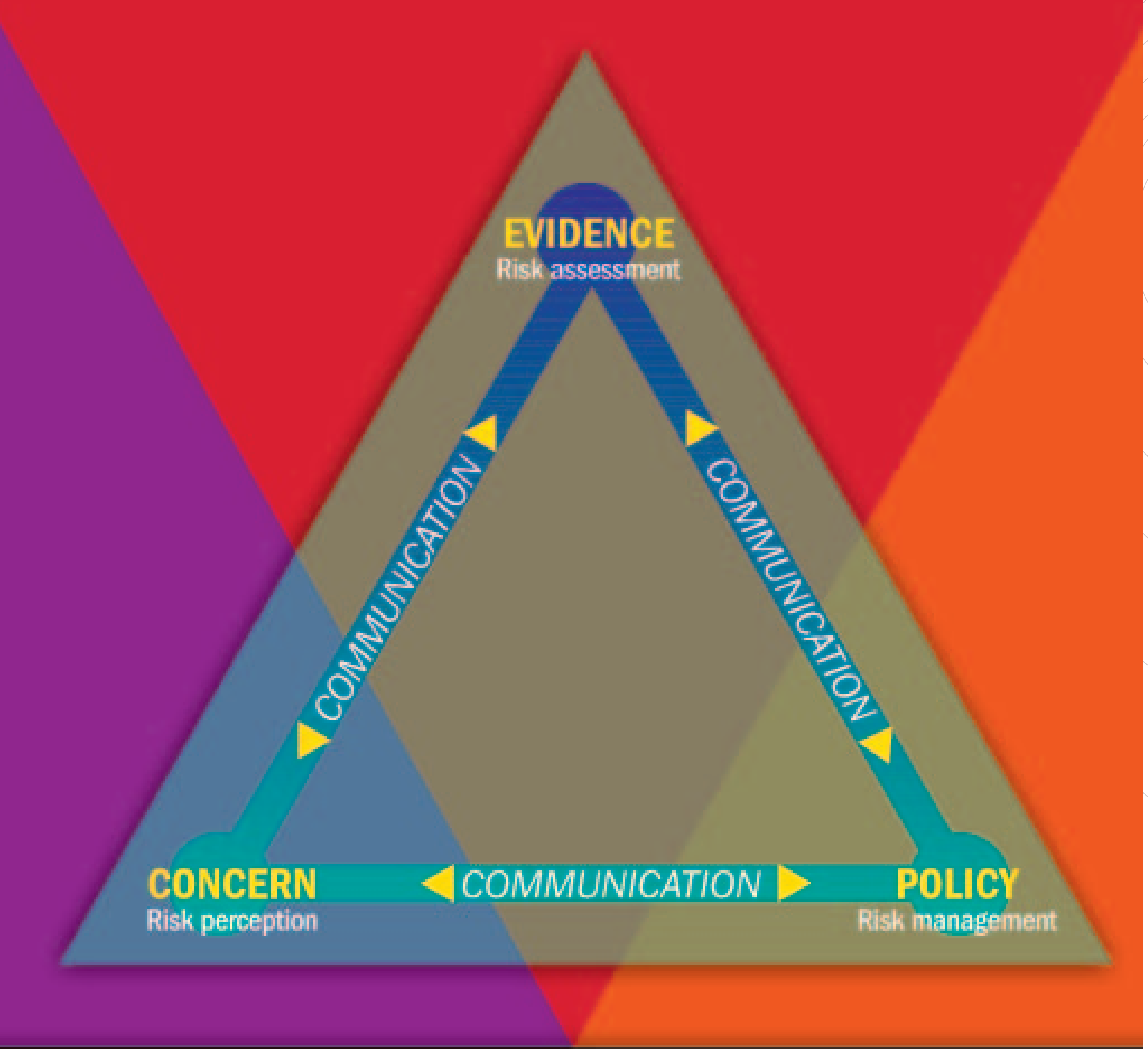


FIGURE 5. CHANNELS OF COMMUNICATION

institutional arrangements for risk management". Risk communication is therefore not only a presentation of the scientific calculation of risk, but also a forum for discussion on broader issues of ethical and moral concern.

Environmental issues that involve uncertainty as to health risks require supportable decisions. To that end, scientists must communicate scientific *evidence* clearly; government agencies must inform people about safety regulations and *policy* measures; and *concerned* citizens must decide to what extent they are willing to accept such risk. In this process, it is important that communication between these stakeholders be done clearly and effectively (Figure 5).

Danger: mobile phones can 'cook' your brain

by Jonathan Leake

HEAVY users of mobile phones may be damaging more than just their image. Research reveals that as much as 70% of the microwave radiation they emit is absorbed by the head, prompting fears that the phones may be a health risk.

The findings come as the European commission prepares to publish the first recom-

Three unpublished studies by leading academics — one British and two American — appear to confirm safety concerns. According to the findings, energy absorbed by the head when using a phone cre-

has more than 5m mobile phone users. While the industry insists that emissions are too low to be hazardous, tomorrow sees the launch of a new nickel and steel fibre phone cover, which the makers claim blocks up to 90% of emissions that would otherwise enter the user's body.

MANAGING EMF RISK COMMUNICATION

As the public becomes increasingly aware of environmental health issues, there has been concurrently a decreasing sense of trust in public officials, technical and scientific experts, and industrial managers, especially in large private and public businesses. Also, many sections of the public believe that the pace of scientific and technological change is too fast for governments to manage. Moreover, in politically open societies, people are ready to act and are able to become involved. Individuals, community-based organizations, and non-governmental organizations are willing to intervene with action to direct decisions or to disrupt activities if they are excluded from the decision process. Such a societal trend has increased the need for effective communication between all stakeholders.

A successful approach to planning and evaluating risk communication should consider all aspects and parties involved. This section provides an introduction to communication on the EMF issue through the four-step process described in the following pages.

KEY QUESTIONS

- When should you enter into a dialogue?
- Is there sufficient planning time?
- Can you quickly research who and what influences community opinions?
- When do you include the stakeholders? When do you plan the process, set the goals and outline the options? When are decisions made?

There is often significant public anxiety over particular sources of EMF, such as transmission lines and mobile phone base stations. This anxiety can lead to strong objections to the siting of such facilities. When community opposition builds, it is often because the communication process was not started early enough to ensure public trust and understanding.

Successful communication about a project requires planning and skill. It is important to anticipate information needs: know what to share and when to share it.

Establishing a dialogue as early as possible provides several benefits. First, the public will see the communicator as acting in a responsible manner and demonstrating concern about the issue. Avoiding delays in providing information and discussion will also dispel controversy, and decrease the likelihood of having to rectify misinformation and misunderstandings. One should take clues from the stakeholders, and use what is learned to improve communication planning and implementation. Initiating risk communication proves that one is trying to build a relationship with stakeholders, and that, in itself, can be almost as important as what is communicated.

The communication process passes through different stages. At the beginning of the dialogue, there is a need to provide *information* and knowledge. This will increase awareness, and sometimes concern, on the part of the different stakeholders. At this stage, it will become important to continue communication, through an open *dialogue*, with all parties involved before setting policies. When it comes to planning a new project, for example, building a power line or installing a mobile phone base station, the industry should start immediate communication with regional and local authorities as well as interested stakeholders (landowners, concerned citizens, environmental groups).

MANAGING A TIME-SENSITIVE ISSUE

Public health and environmental health issues have a dynamic life; they evolve with time. The life cycle of an issue illustrates how social pressure on decision-makers develops with time (Figure 6). During the early stages of the life cycle, when the problem is dormant or just emerging, public pressure is at a minimum. While the problem may not yet be on the research agenda, there can still be ample time to research and *analyse* potential risks. As the problem bursts into current public awareness, often brought into the forefront by a triggering event (e.g. due to media attention, organized activist intervention, the Internet, or simple word of mouth), it is important to take *action* in the form of

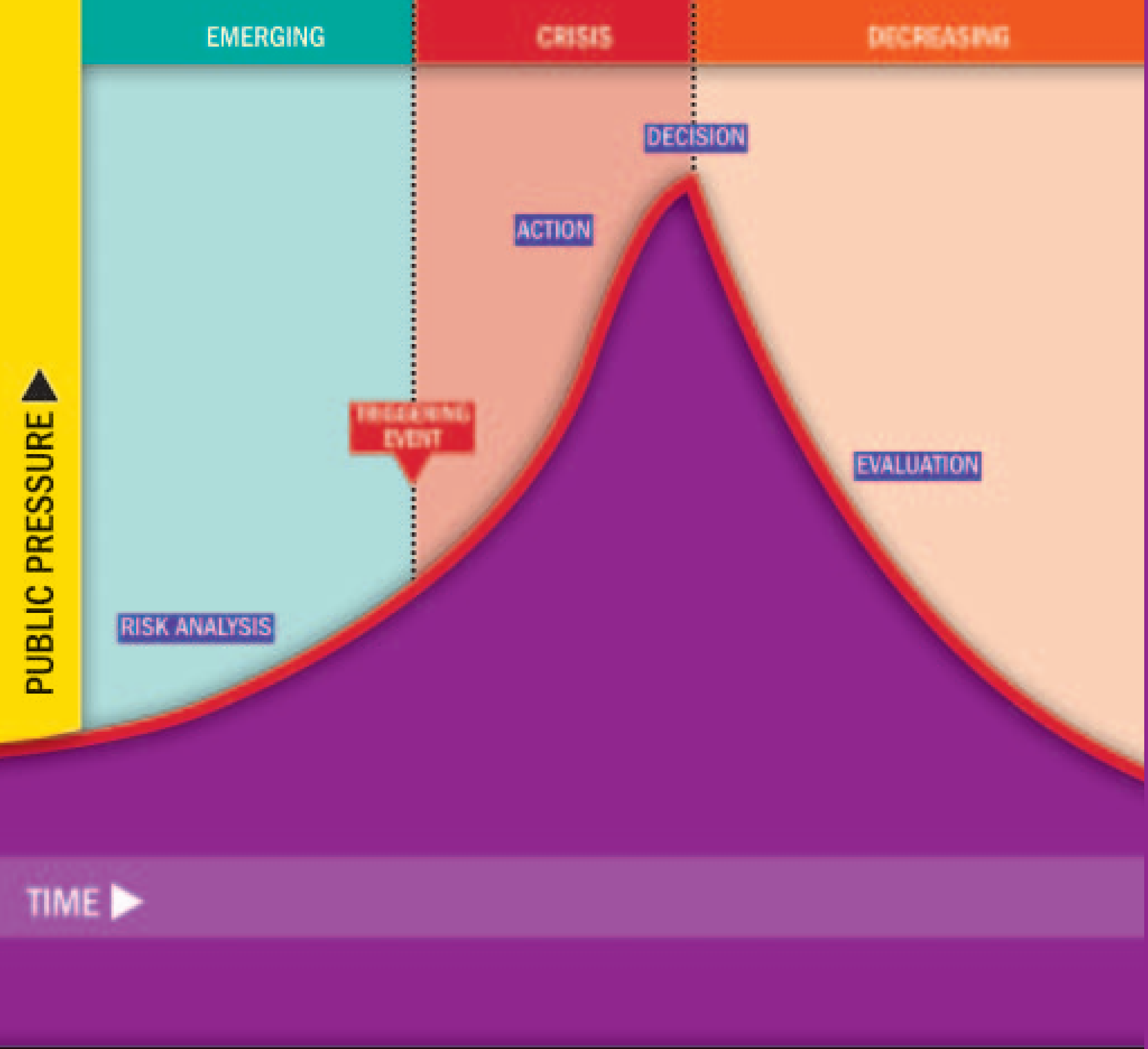


FIGURE 6. THE RISK PERCEPTION LIFE CYCLE
(adapted from *Evaluating Response Options*, Judy Larkin,
Proceedings of the International Seminar on EMF Risk Perception and Communication, WHO 1999)

WHEN TO COMMUNICATE

communication with the public. As the problem reaches crisis proportions, a *decision* must be taken but a hurried outcome can leave all sides dissatisfied. As the problem begins to diminish in importance on the public agenda, time should be made for a follow-up *evaluation* of the issue and decisions made. The transition between different phases within the life cycle of an issue is dependent upon the levels of awareness and pressure from various stakeholders (Figure 6).

The earlier balanced information is introduced, the more able the decision-makers will be to prevent the issue reaching the crisis stage. It is indeed much easier to help people form opinions than to change opinions. Once there is a crisis, it is increasingly difficult to conduct effective risk communication and to achieve successful outcomes from the decision-making process since there is less time to consider options and to engage stakeholders in dialogue. Because topics that can generate controversy

SOME DRIVING FORCES OF THE LIFE CYCLE

- Lack of trust
- Perception of a “villain” in the story (e.g., industry)
- Misinformation
- Belief that the majority is treating the minority “unfairly”
- Media coverage
- Intervention of activist groups and other highly motivated interest groups
- Emotional dynamics in the public

WHEN TO COMMUNICATE

become even more critical in periods of elections and other political events, it is advisable to prepare strategies and have options at hand for action.

ADAPTING TO A DYNAMIC PROCESS

Throughout the life cycle of the issue, the communication strategy will need to be tailored to the groups or individuals concerned on an ad-hoc basis, and may take a variety of forms to be most effective. The means of communication and actions should be appropriately modified, as new information becomes available. An opportunity to influence the life cycle can arise from the timely publication of scientific results. While international scientific bodies have to respond publicly to recent scientific discoveries in an unbiased manner, decision-makers can prove to the stakeholders that their concerns are taken seriously by adopting a similar strategy. Indeed, *risk surveillance* is a key component to ensure proper risk management, as continuing information is essential for monitoring and providing feedback to the ongoing risk management process.

WITH WHOM TO COMMUNICATE

KEY QUESTIONS

- Who will be most interested in this issue?
- What is known about the interests, fears, concerns, attitudes and motivation of the stakeholders?
- What authorities are responsible for determining and implementing policy?
- Are there organizations with whom to form effective partnerships?
- Who can provide advice or scientific expertise?

Developing effective communication about risk depends upon identifying the key stakeholders, those who have the strongest interest or who can play the greatest role toward developing understanding and consensus among the relevant constituency.

Identifying these stakeholders and recognizing their role often requires a substantial investment in time and energy. Failure to make this investment may compromise the effectiveness of the message.

IDENTIFYING THE STAKEHOLDERS

It is crucial to have a good understanding of the "playing field" and in particular the key "players" or stakeholders in the EMF issue. Depending on the particular situation, the communicator may need to consider several, if not all, of the stakeholders (Figure 7). Each of these groups needs to be included in the communication process and will become, in turn, the instigator or the recipient of the communication. The roles of some of the key stakeholders are discussed below.

The *scientific community* is an important stakeholder as it provides technical information, and is therefore assumed to be independent and apolitical. Scientists can help the public understand the benefits and risks of EMF, and help regulators evaluate risk management options and

FIGURE 7. THE KEY STAKEHOLDERS IN THE EMF ISSUE

WITH WHOM TO COMMUNICATE

assess the consequences of different decisions. They have the important role of explaining available scientific information in a way that helps people understand what is known, where more information is needed, what the main sources of uncertainty are, and when better information will become available. In this role, they can also try to anticipate and put boundaries on expectations of the future.

The *industry*, such as electricity companies and telecommunications providers as well as manufacturers, is a key player and is often seen as the risk producer as much as the service provider. Deregulation of these industries in many countries has increased the number of companies (and, in some cases, the number of EMF sources as companies compete for coverage). In a number of countries, industry players, especially electrical utilities, have taken a proactive and positive approach to managing risks and have emphasized open communication of information to the public. However, profit motive ultimately causes the public to have misgivings about their messages.

Government officials at the national, regional and local levels have social as well as economic responsibilities. Because they act in a political environment, the general public does not always trust them. In particular, regulators have a crucial role as they devise standards and guidelines. To that end, they need detailed and complete information from the major stakeholders to decide on policy measures regarding protection from EMF exposure. They have to consider any

WITH WHOM TO COMMUNICATE

new sound scientific evidence, which would suggest the need to revise the existing exposure measures, while being sensitive to society's demands and constraints.

The *general public,* now better educated and better informed on technology-related issues than ever before, may be the single greatest determinant to the success or failure of a proposed technology project. This is especially true in democratic and highly industrialized societies. Public sentiment often makes itself heard through highly vocal *associations* or other special interest groups that usually have good access to the media.

The *media* plays an essential role in mass communications, politics and decision-making in most democratic societies.

Media coverage—newspapers, radio, television and now the Internet—has a major impact on the way an environmental risk is perceived and ultimately on the success of the decision-making process. The media can be an effective tool to increase problem awareness, to broadcast information through clear messages, and to increase individual participation. However, it can be equally effective at disseminating incorrect information, thereby reducing trust and support of the decision-making process. This is especially true of the Internet, since there is no quality control. The professionalism of presentation does not necessarily reflect in the quality of content. Individuals have to establish in their own minds how much they trust a particular source, which is not an easy decision for a layperson to take.

WHAT TO COMMUNICATE

KEY QUESTIONS

- Do the stakeholders have access to sufficient and impartial information about the technology?
- Is the message intelligible or does it contain a large amount of complex information?
- Are the messages of all key stakeholders being heard? i.e. is there an effective means for providing feedback?

Identification of public concerns and potential problems is critical for strategic and pro-active approaches. Once stakeholders become aware of an issue, they will raise questions based on their perceptions and evaluations of the risk. Therefore, the dissemination of information should be done in a way that is sensitive to these preconceived notions, or else the decision-makers risk offending and alienating the stakeholders.

The strategy and rationale to pursue will depend on the audience. The public will also dictate which questions can be expected. To convince the audience, appropriate and credible arguments that appeal not only to reason, but also to emotion and social bonds should be advanced. Different types of arguments are described in Figure 8.

COMMUNICATING THE SCIENCE

Scientists communicate technical results derived from research through publications of different scientific value (the highest being peer review publications), expert reviews and risk assessments. Through this process, the results of scientific investigation can be incorporated into the development and implementation of policy

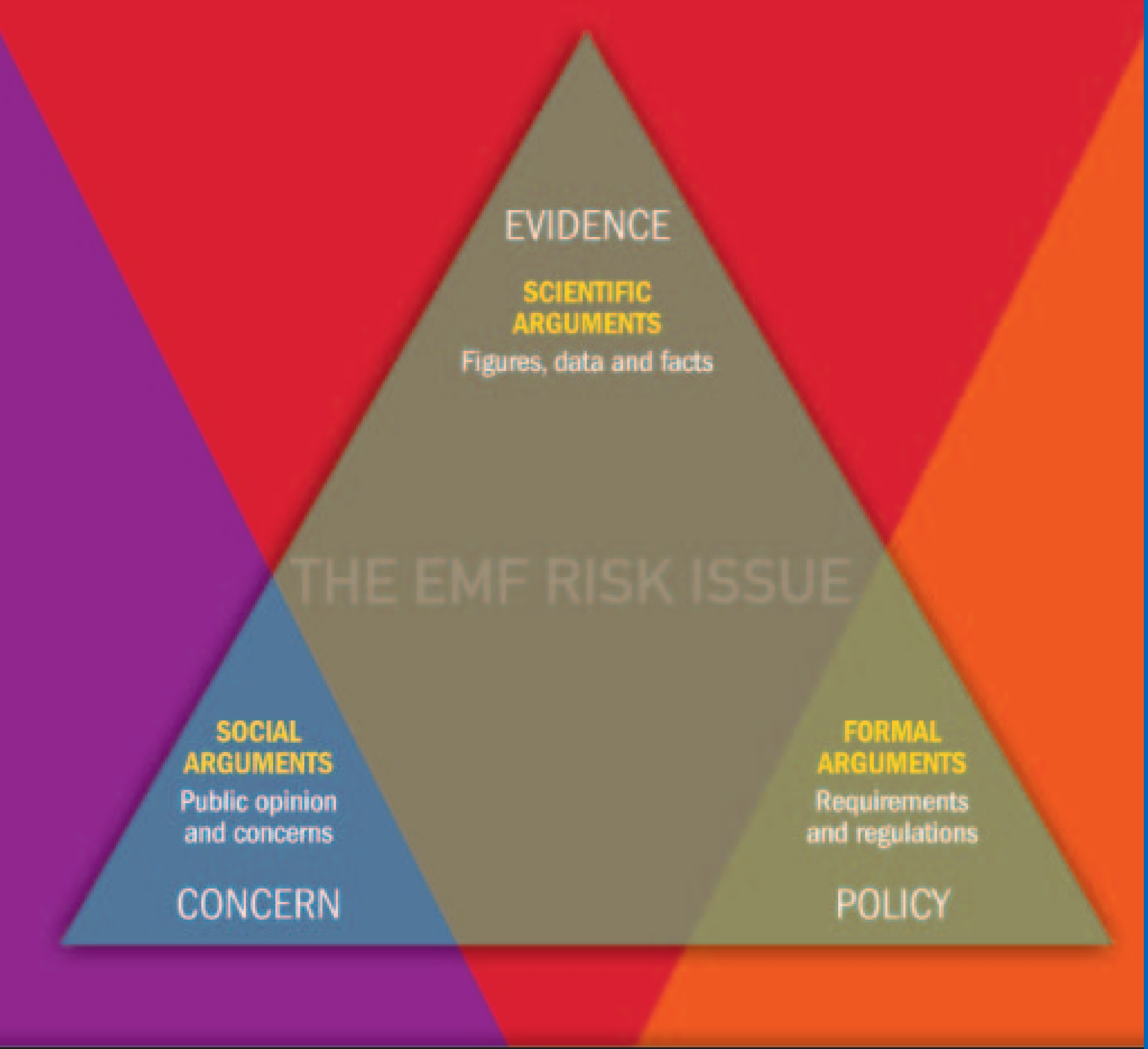


FIGURE 8. THE COMPONENTS OF THE MESSAGE

WHAT TO COMMUNICATE

guidance and standards. Continuous monitoring and review of technical findings is important to ensure that any residual uncertainties are addressed and minimized in the medium to long term, and to provide reassurance to the public.

However, while scientific information has proven to be valuable in making public health decisions, it is not error-free. The contributions of scientists can fail for several reasons. For example, the available information may be presented in a way that is not useful to the decision-makers (either because it is too complex or oversimplified) and leads to incorrect conclusions or decisions (possibly because of the uncertainty inherent in the data or problems in communicating), or is erroneous.

■ SIMPLIFYING THE MESSAGE

Technical experts are faced with the challenge of providing information that is comprehensible by the public at large. This entails simplifying the message. If not, the media will take on this task with the danger of miss-communicating the information. This is especially true of EMF, as most people have a very diffuse picture of electromagnetism, perceiving these invisible and pervasive waves as potentially harmful.

■ EXPLAINING SCIENTIFIC UNCERTAINTY

When it comes to risk assessment, the available information for decision-making is based on science. However, scientific evaluation of the biological responses from environmental exposures rarely leads to unanimous conclusions. Epidemiological studies are prone to bias, and the validity of extrapolation from animal studies to humans is often questionable. The "weight-of-evidence" determines the degree to which available results support or refute a given hypothesis. For estimates of small risks in complex areas of science and of society, no single study can provide a definitive answer. Strengths and weaknesses of each study should be evaluated and results of each study should be interpreted as to how it alters the "weight-of-evidence". Uncertainty is therefore inherent in the process and should be an integral part of planning any risk management or communication task. Indeed, the public commonly interprets uncertainties in scientific knowledge on EMF health effects as a declaration of the existence of real risks.

PRESENTING ALL THE EVIDENCE

The public will often base its preconceptions on publicised scientific results that have shown a possible association to a health effect. It is important for the scientist to present *all* of

SOME RULES OF THUMB TO POPULARISE TECHNICAL INFORMATION

- Determine and classify the key messages that you want to pass on, i.e. define your information goals
- Make sure you understand the information needs of your audience
- Explain concepts in simple language, and if needed, clarify the technical vocabulary used in press releases by experts, e.g. IARC classification of potential carcinogens into different categories depending on the scientific evidence ("is carcinogenic", "probably carcinogenic" and "possibly carcinogenic").
- Avoid oversimplifying, as you may seem to be ill informed or hiding the truth.
- Acknowledge that you are simplifying and provide references to supporting documents.

WHAT TO COMMUNICATE

the available evidence when disseminating scientific information even if research is showing opposing results. Only then can scientists be seen to be truly independent. Scientific reasoning can always be used to argue against a particular finding.

UNDERSTANDING THE AUDIENCE

It is important to discern what type of information the public wants and to address that need head on, acknowledging when necessary that the science is incomplete. Restricting communication to those issues about which there is scientific certainty may leave the public, and sometimes policy makers, with the feeling that their information needs are not being met. Understanding the motivations of the stakeholders will help to fine-tune the message. For example, a resident facing the possibility of construction of a nearby power line may be worried by unforeseen depressed property values or the impact on landscape or environmental damage, while a potential home buyer in the vicinity of an existing power line may be mostly worried about health.

DISTORTING SCIENTIFIC INFORMATION

Science is a powerful tool and has earned its credibility by being predictive. However, its usefulness depends on the quality of the data, which is related to the quality and credibility of the scientists. It is important to verify the knowledge and integrity of so-called "experts", who may look and sound extremely convincing but hold unorthodox views that the media feel justified in airing "in the interests of balance". In fact giving weight to these unorthodox views can disproportionately influence public opinion. For the public, often the best sources of information are from panels of independent experts who periodically provide summaries of the current state of knowledge.

PUTTING THE EMF RISK IN PERSPECTIVE

Even though the current scientific evidence does not indicate that health risks from EMF are high, the public remains concerned about facilities that produce EMF. This discrepancy in viewpoint is mostly based on differing approaches to risk issues on the part of the experts and the general public. On one hand, the experts will have to evaluate the scientific evidence of the risk (risk assessment) using objective and well-defined criteria. Their findings will then be used to draft

TIPS TO BUILD EFFECTIVE RISK COMMUNICATION STRATEGIES

- Do research to answer these questions:
  - What are the sources of information?
  - What are the key journals or magazines?
  - What are the relevant websites?
  - Are there other similar issues you could learn from?
  - Who can explain the scientific research to lay people?
- Make yourself available in both formal and informal settings to improve the communication. Private meetings can destroy trust if access is not balanced among all stakeholders.
- Acknowledge uncertainty, describe why it exists, and place it in a context of what is already known.
- Acknowledge that risk communication skills are important for all levels of the decision-making organization, from inception to project management.
- Avoid unnecessary conflict, but understand that a personal or policy decision is by nature a dichotomy; e.g., a person will decide to buy or not to buy a home near a power line.
- Recognise that even if you communicate well, you may not reach an agreement.
- Remember that in most societies, even though it may take a long time, communities ultimately decide what is an acceptable risk, not governmental agencies or corporations.

responses in the form of decisions and actions through public policies. On the other hand, the general public evaluates the risk incurred by EMF technologies at the individual level (risk perception). The differences in approach are further detailed in the Box below. Quantifying risk is of limited utility in communications with the general public who may not possess a technical background.

DIFFERENCES IN RISK EVALUATION AMONG STAKEHOLDERS

EXPERT EVALUATION (RISK ASSESSMENT)	LAYPERSON' S EVALUATION (RISK PERCEPTION)
Scientific approach to quantify risk	Intuitive approach to quantify risk
Uses probabilistic concepts (deals in averages, distributions,...)	Uses local, situation-specific information or anecdotal evidence
Depends on technical information transmitted through well-defined channels (scientific studies)	Depends on information from multiple channels (media, general considerations and impressions)
Product of scientific teams	Individual process
Importance given to objective scientific facts	Importance of emotions and subjective perceptions
Focused on benefits versus costs of technology	Focused on safety
Seeks to validate information	Seeks to deal with individual circumstances and preferences

COMPARISON: A TOOL FOR COMMUNICATION

Risk comparison should be used to raise awareness and be educational in a neutral way. It is an advanced tool that requires careful planning and experience. While a comparison puts facts into an understandable context, be careful not to use it to gain acceptance or trust. Inappropriate use of risk comparison may lower the effectiveness of your communication and even damage your credibility in the short-term.

NOTE: *Never compare voluntary exposure (such as smoking or driving) to involuntary exposure. For a mother with three children who has to live close to a mobile phone base station, the risk she is taking is not voluntary. If you were to compare her exposure to EMF with her choice to drive on the freeway at 140 km/h, you may offend her.*

- Take into account the social and cultural characteristics of the audience and make your comparison relevant to what they know
- Do not use comparisons in situations where trust is low
- Make sure that your comparisons do not trivialise peoples' fears or questions
- Do not use comparisons to convince a person about the correctness of a position
- Remember that a comparison of exposure data is less emotional than a comparison of risks
- Be aware that the manner in which you present risks may affect how you are perceived
- Use a pre-test to learn if the comparisons you plan to use cause the response you hope to elicit
- Acknowledge that the comparison in itself does not dispose of the issue
- Recognise that if your comparison creates more questions than it answers, you need to find another example
- Be prepared for others to use comparisons to emotionalise or to dramatise

EXAMPLE : *To illustrate the power level of an EMF emission source,*

- Show emission data before and after a similar facility went into operation
- Compare with guidelines limits, but acknowledge that people concerns might be about levels well below the guidelines

WHAT TO COMMUNICATE

When quantitative information is used, it may be most useful when compared with readily understood quantities. This has been used effectively to explain the risk associated with commercial air travel by comparing it with familiar activities such as driving, or to explain the risk of radiation exposure from routine diagnostic X-rays by comparing the exposure to that coming from natural background radiation. However, care has to be taken when using risk comparison (see Box, page 40). It is indeed important to quantify different risks to health in a comparable framework, particularly for setting policy agendas and research priorities.

EXPLAINING POLICY MEASURES

The type of measures that a government takes gives a strong message as to where the regulators stand vis-à-vis the risks associated with the EMF health issue. Regulatory agencies have the responsibility to prepare and disseminate information about policy measures implemented at the local and national level. At the local level, it is important that authorities have at least a minimum knowledge of the EMF issue to answer questions from the public or be ready to direct requests to appropriate sources of information. At the national level, dissemination has been implemented very effectively in several countries through WHO fact sheets or similar simple information pamphlets, often available on the World Wide Web.

When discussing policy measures with the public, the communicator should be ready to explain what the guidelines on exposure limits cover (e.g. frequencies, reduction

WHAT TO COMMUNICATE

factors,...) and how they were established, i.e. what scientific facts were used, what assumptions were made, what administrative resources are needed to implement them, and what mechanisms are in place to ensure compliance by product manufacturers (e.g. mobile phones) or utilities providers (e.g. electricity or telecommunications supplier).

It is also of interest to let the public know if there are procedures and timetables for updating the guidelines as scientific research advances. Indeed, decision-makers often rely on preliminary results or insufficient data, and their decisions should be reviewed as soon as an assessment is completed.

EXPLAINING EXPOSURE LIMITS TO THE PUBLIC

Using EMF exposure limits as a formal policy argument requires good scientific understanding on the part of the decision maker and the communicator. It is important to stress to the public that:

- The determination of field levels at a certain location is a key element that will determine whether there is a risk or not.

  If possible, it is useful to show data from field measurement surveys at selected sites and compare them with numerical calculations and with accepted exposure guidelines.

- The field strength is dependent on distance from the EMF source, and normally decreases rapidly away from it.

  In order to ensure human safety, fences, barriers or other protective measures are used for some facilities to preclude unauthorised access to areas where exposure limits may be exceeded.

- Often, but not in all standards, the exposure limits are lower for the general public than for workers.

HOW TO COMMUNICATE

KEY QUESTIONS

- What type of participation tool do you choose to address your audience?
- Where, when and under what circumstances does the discussion take place?
- What tone prevails?
- How formally is the situation handled?

Effective risk communication relies not only on the content of the message, but also the context. In other words, the way that something is said is as important as what is said. Stakeholders will receive information at various stages of the issue. This will come from a wide range of sources with differing perspectives. This diversity influences how stakeholders perceive risks and what they would like to see happen.

SETTING THE TONE

When dealing with an emotive issue such as the potential health risk from EMF, one of the most important communications skills is the ability to build and sustain a relationship of trust with the other parties involved in the process. To that end, one will need to create a non-threatening atmosphere and set the tone for a candid, respectful and supportive approach to resolving issues. Such behaviour should ideally be embraced by all stakeholders.

HOW TO WORK WITH DISTRUST

To a large extent, communities with concerns about involuntary exposure to EMF are likely to be distrustful of official views and sources of information. Considerable effort may then be required to encourage stakeholders to suspend that distrust. As acknowledged in the Phillips Report for the UK Government on the BSE crisis, "to establish credibility it is necessary to generate trust – Trust can only be generated by openness – Openness requires recognition of uncertainty, where it exists."

Decision-makers need to ensure that all individuals involved in communicating with the public are kept up to date with developments in the debate and are prepared to discuss, rather than dismiss, public fears.

Some of the necessary components of communication under conditions of distrust are:

- Acknowledge the lack of trust
- Recognize uncertainty, where it exists

BUILDING EFFECTIVE COMMUNICATION SKILLS

INSPIRE TRUST

- Be competent
- Be calm and respectful
- Be honest and open
- Show your human side, personalise
- Use clear language, and be careful not to sound or be condescending
- Explain the consequences of the assumptions used
- Demonstrate your own values

BE ATTENTIVE

- Choose your words carefully
- Watch emotions, yours and those of your audience
- Be an attentive listener
- Be attentive to body language

MAINTAIN AN OPEN DIALOGUE

- Seek input from all
- Share information
- Provide means for frequent communication, e.g. publication of findings on the Web with opportunity to comment

HOW TO COMMUNICATE

- Point out what is different this time (e.g. disclosure of information, earlier involvement of stakeholders, clear goals and roles, etc.)
- Ask what would help to dispel distrust
- Be patient—it takes time to earn trust
- Never hold a closed meeting
- Admit when you honestly do not know the answer to a question
- Be accountable in ways the stakeholders value

SELECTING TOOLS AND TECHNIQUES

Members of a community where construction of a new facility is proposed will want to be a part of the decision-making process. To that end, it is important to structure a process that involves the stakeholders in a meaningful way and to seek out and facilitate their involvement when addressing this decision. The process usually will be carried in three stages: planning, implementation and evaluation.

The first stage is crucial, because stimulating public interest and involvement can be counter-productive if the communicator is not fully prepared for the public's participation, questions and concerns. In the second stage, when it is time to engage the public, the communicator will have to choose the setting to discuss the issue with them. The choice will depend on the type, number and interest of the stakeholders. In the last stage, it will be important to evaluate the outcome of the process, take follow-up actions, arrange for documentation of what was said and what agreements were reached, and share these summaries with those who participated.

Individual queries may be handled on an ad-hoc basis through, for example, phone or email. Communication with groups of stakeholders requires more planning. For a *small group of stakeholders*, it may be feasible to involve them in sessions devoted to changing undesirable aspects of the project. One could encourage creativity, but always be up front about the limits for change and how the suggestions will be used to influence the final decision. Proponents will have clear views about the extent to which they have room to manoeuvre.

It may be useful to employ individuals from local community organizations to take advantage of existing networks and enhance credibility, but one has to make sure that the individual is qualified, and to establish his or her role, responsibilities and limitations at the start. It is important to identify the stakeholder group that represents the opposition and determine what they specifically want. On major issues it may be possible to use advisory committees to build consensus on specific project decisions to encourage compromise, provide structure, and focus on solving problems that have been identified. Consensus building techniques include the Delphi process, nominal group process, and public value assessment (see Glossary).

HOW TO COMMUNICATE

KEY STEPS TO ENGAGING STAKEHOLDERS

1. PLANNING

- Design the programme: Define or anticipate the role of the public and other stakeholders and tailor the programme to enhance stakeholders' involvement.
- Seek comments on the programme plan: Test your proposed programme internally and externally to ensure that it will work as intended.
- Prepare for implementation: Obtain the necessary resources, choose and train your personnel, develop contingencies, assess your strengths and weaknesses, explain the programme internally, find and work with appropriate community partners, develop a communications plan, and prepare the most critical materials.
- Be prepared for managing requests for information and involvement as they arise.
- Co-ordinate within your organization: Even small inconsistencies give an impression of internal confusion and ineptness. The goal is to avoid giving mixed messages. Do all you can to keep the same staff in place throughout the process: They become more proficient and more trusted in the community over time.

2. IMPLEMENTING

- Implement the stakeholder involvement programme: Act on your plan. Use the tools and techniques appropriate to the community and the issue.
- Provide information that meets your stakeholders' needs: Determine what they want to know now and anticipate what they will need to know in the future. Develop a list of problems, issues and needs, with responses to each. Address, where possible, specific concerns of different individuals or groups.
- Cooperate with other organizations: Co-ordinate messages, while openly acknowledging any differences. Mixed messages confuse and create distrust.
- Enlist the help of others who have community credibility: Local groups or residents (e.g., local researchers, medical doctors) that have credibility can be helpful to the outsider, but they cannot substitute for a forthright approach and extensive community involvement.

3. EVALUATING

- Use feedback from stakeholders for continuous evaluation: As you implement the programme, listen carefully to what others are telling you and follow-up with action.
- Evaluate the success of the programme: If stakeholders are not informally telling you how your process is working and what would improve it, formally ask their advice with a questionnaire or other method. Ask again at the end of the process so their ideas can assist you to design and implement the next steps.

HOW TO COMMUNICATE

For a *large group of stakeholders*, one could circulate response sheets to gain information on public concern and preferences. It may also be useful to conduct surveys, questionnaires and polls via mail and Internet to sample the

EXAMPLES OF ALTERNATIVES

PASSIVE ENGAGEMENT TECHNIQUES

- Printed materials (fact sheets, brochures, reports)
- Websites and list servers
- Newspaper advertisement, insertions or solicited stories
- Press releases
- Radio or television reporter interviews

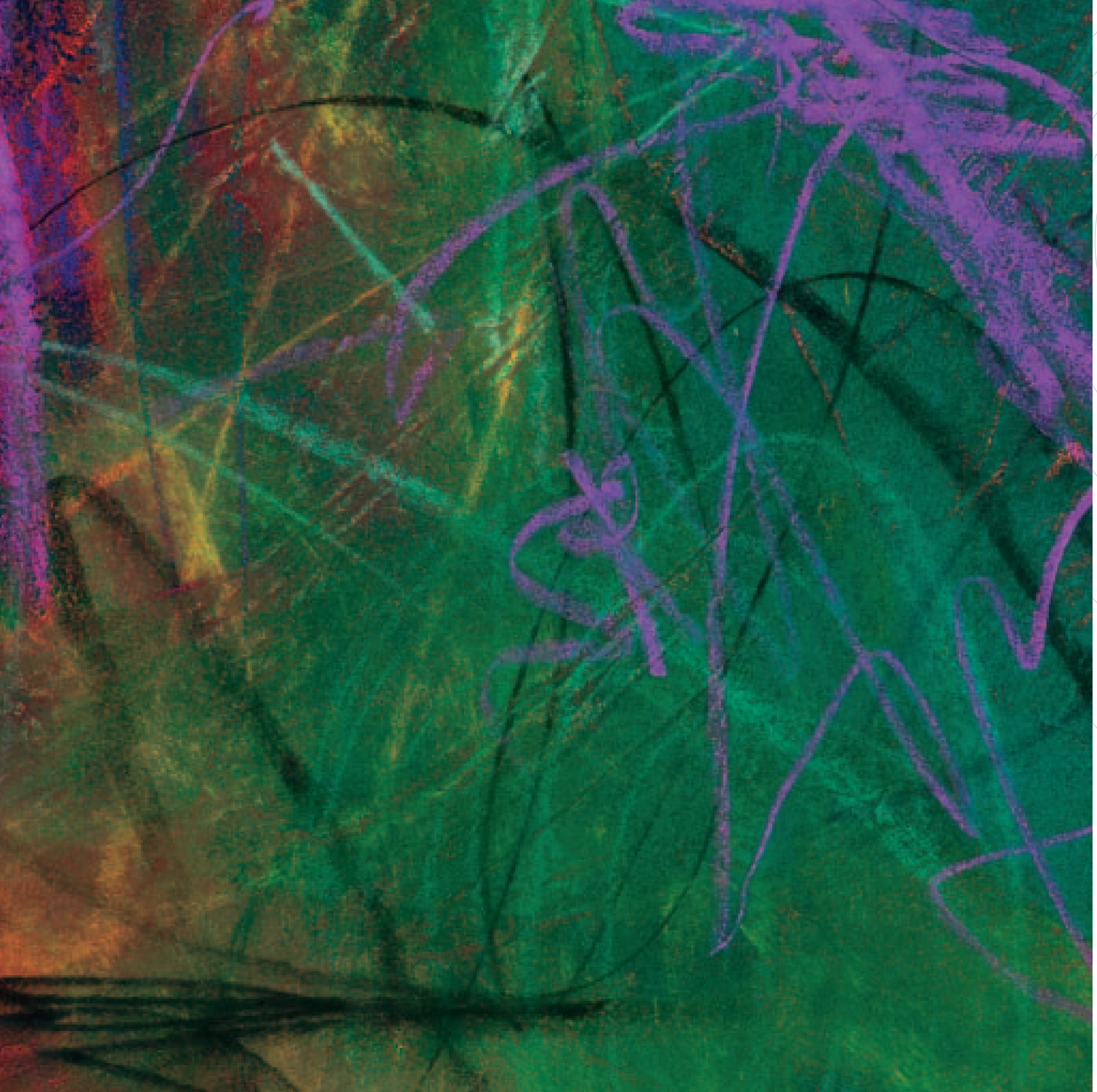
ACTIVE ENGAGEMENT TECHNIQUES

- Talk to people about the process
  - Hold "open houses" e.g., with posters
  - Do radio or television "phone-in" dialogue
  - Use third-party networks (do briefings at community group meetings)
  - Provide a staffed information hotline or "drop-in" centre
  - Arrange for tours of successful similar projects
  - Sponsor telephone, internet or mail surveys
  - Respond to personal enquiries
- Conduct small meetings
  - Stakeholder sessions
  - Focus groups
  - Citizen advisory councils
- Conduct large meetings
  - Public hearings
  - Professionally facilitated meetings

HOW TO COMMUNICATE

population for attitudes towards specific aspects of the project. Surveys and polls done on the Internet will provide useful information, but may not represent a statistically valid sample. They will only be that part of the group that uses the Internet. A much more efficient method of performing surveys, albeit much more expensive, is to use a trained professional or a specialized polling organization.

There are many ways to provide for the exchange of information. Different methods will be appropriate for different stakeholders at different times. If stakeholders are engaged early in the process, more passive (one-way) forms of engagement may be the appropriate place to start. If the issue is in a crisis stage, an active form of dialogue that will quickly define and help solve the perceived problems is a better choice. Stakeholders will be involved to varying degrees. Some may sit quietly through a meeting, while others will be quite vocal. Some may come to only one meeting, while others will never miss one. Some may choose to communicate through written correspondence or by posting information on the Internet. Each level of participation is valuable and requires an appropriate response.



3

EMF EXPOSURE GUIDELINES AND POLICIES
THE PRESENT SITUATION

WHO DECIDES ON GUIDELINES?

Countries set their own national standards for exposure to electromagnetic fields. However, the majority of national standards are based 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. ICNIRP produces guidelines recommending limits of exposure, which are reviewed periodically and updated as necessary.

WHAT ARE GUIDELINES BASED ON?

ICNIRP guidelines developed for EMF exposure cover the non-ionizing radiation frequency range from 0 to 300 GHz. They are based on comprehensive reviews of all the published peer-reviewed literature. Exposure limits are based on effects related to *short-term* acute exposure rather than *long-term* exposure, because the available scientific information on the long-term low level effects of exposure to EMF fields is considered to be insufficient to establish quantitative limits.

Using short-term acute effects, international guidelines use the approximate exposure level, or *threshold level*, that could potentially lead to

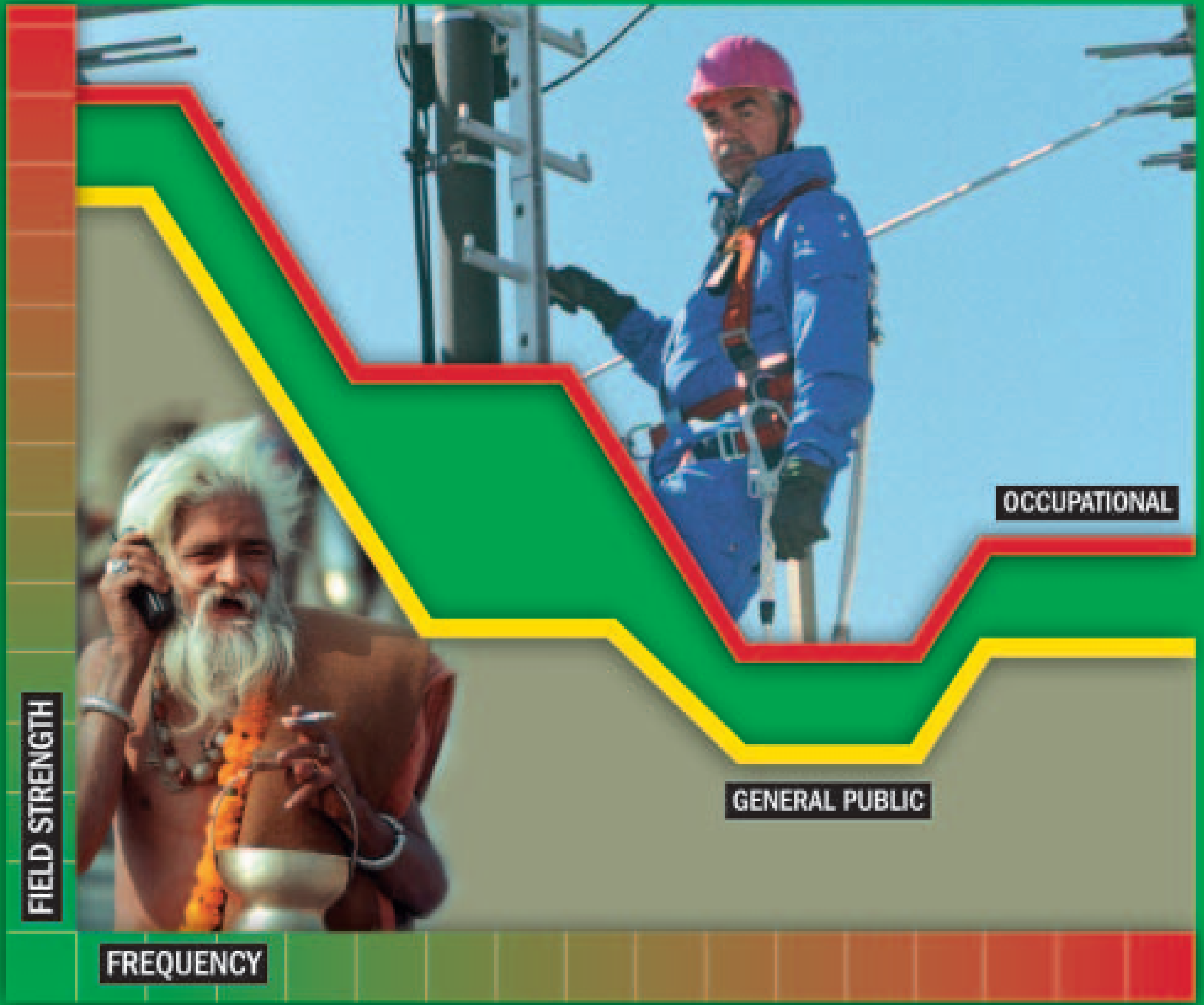


FIGURE 9. ICNIRP GUIDELINES FOR OCCUPATIONAL AND GENERAL PUBLIC EXPOSURE LIMITS

adverse biological effects. To allow for uncertainties in science, this lowest threshold level is reduced further to derive limit values for human exposure. For example, ICNIRP uses a reduction factor of 10 to derive occupational limits for workers and a factor of about 50 to arrive at exposure limits for the general public. The limits vary with frequency, and are therefore different for low frequency fields, e.g. power lines, and high frequency fields, e.g. mobile phones (Figure 9).

WHY IS A HIGHER REDUCTION FACTOR APPLIED FOR GENERAL PUBLIC EXPOSURE GUIDELINES?

The occupationally exposed population consists of adult workers who are generally aware of electromagnetic fields and their effects. 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 who, in many cases, are unaware of their exposure to EMF. In addition, workers are typically exposed only during the working day (usually 8 hours per day) while the general public can be exposed for up to 24 hours per day. These are the underlying considerations that lead to more stringent exposure restrictions for the general public than for the occupationally exposed population (Figure 9).

PRESENT EXPOSURE GUIDELINES

- In general, standards for low frequency electromagnetic fields are set to avoid adverse health effects due to induced electric currents within the body, while standards for radiofrequency fields prevent health effects caused by localised or whole body heating
- Maximum exposure levels in everyday life are typically below guideline limits
- Exposure guidelines are not intended to protect against electromagnetic interference (EMI) with electromedical devices. New industry standards are being developed to avoid such interference

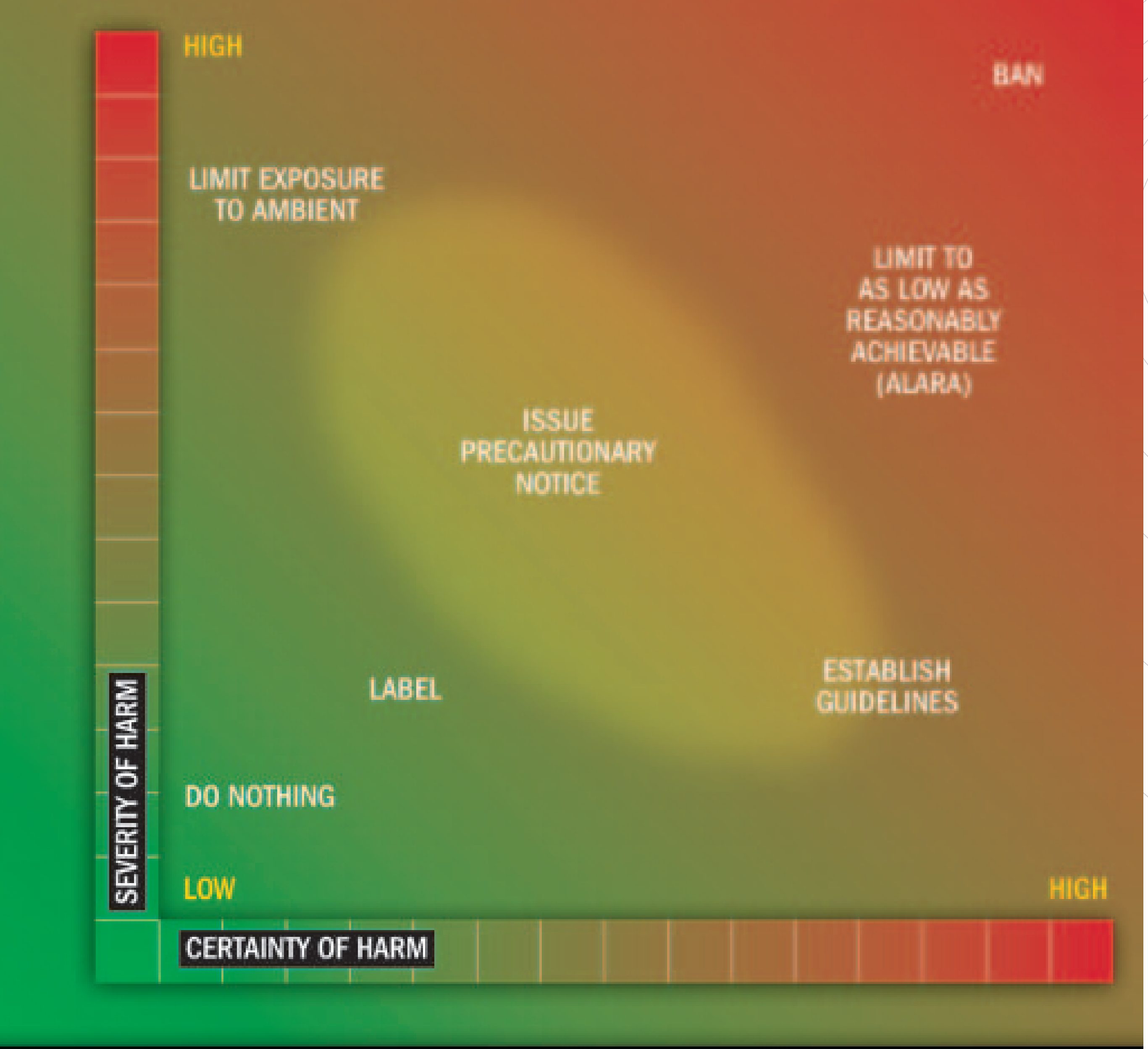


FIGURE 10. RANGE OF ACTIONS UNDER UNCERTAINTY
(adapted from *The precautionary principle and EMF: implementation and evaluation*, Kheifets L. et al., *Journal of Risk Research* 4(2), 113-125, 2001).

PRECAUTIONARY APPROACHES AND THE PRECAUTIONARY PRINCIPLE

Throughout the world there has been a growing movement inside and outside of government to adopt "precautionary approaches" for management of health risks in the face of scientific uncertainty. The range of actions taken depends on the severity of harm and the degree of uncertainty surrounding the issue. When the harm associated with a risk is small and its occurrence uncertain, it makes sense to do little, if anything. Conversely, when the potential harm is great and there is little uncertainty about its occurrence, significant action, such as a ban, is called for (Figure 10).

The *Precautionary Principle* is usually applied when there is a high degree of scientific uncertainty and there is a need to take action for a potentially serious risk without awaiting the results of more scientific research. It was defined in the Treaty of Maastricht as "taking prudent action when there is sufficient scientific evidence (but not necessarily absolute proof) that inaction could lead to harm and where action can be justified on reasonable judgements of cost-effectiveness". There have been many different interpretations and applications of the precautionary principle. In 2000 the European Commission defined several rules for the application of this principle (see Box, page 56), including cost-benefit analyses.

SCIENCE-BASED AND PRECAUTIONARY APPROACHES FOR EMF

Science-based evaluations of the potential hazards from EMF exposure form the basis of risk assessment and are also an essential part of an appropriate public policy response. The recommendations of ICNIRP guidelines follow rigorous scientific reviews of relevant published scientific papers including those in

THE PRECAUTIONARY PRINCIPLE
EUROPEAN COMMISSION (2000)

Where action is deemed necessary, measures based on the precautionary principle should be:

- *proportional* to the chosen level of protection,
- *non-discriminatory* in their application,
- *consistent* with similar measures already taken,
- *based on an examination of the potential benefits and costs* of action or lack of action (including where appropriate and feasible, an economic cost/benefit analysis),
- *subject of review*, in the light of new scientific data, and
- *capable of assigning responsibility for producing the scientific evidence* necessary for a more comprehensive risk assessment.

the fields of medicine, epidemiology, biology and dosimetry. Science-based judgements on exposure levels that will prevent identified adverse health effects are then made. Here, caution is exercised both in respect of the magnitude of reduction factors (based on uncertainties in the scientific data and on possible differences in susceptibility of certain groups) and in the conservative assumptions made about the efficiency with which EMFs interact with people.

Precautionary approaches, such as the Precautionary Principle, address additional uncertainties as to possible but unproven adverse health effects. Such risk management policies provide an opportunity to take incremental steps with respect to emerging issues. They should include cost-benefit considerations and should be seen as an addition to, and not as a substitute for, science-based approaches in assisting decision-makers to develop public policy.

In the context of the EMF issue, some national and local governments have adopted "*prudent avoidance*", a variant of the precautionary principle, as a policy option. It was originally used for ELF fields and is described as using simple, easily achievable, low to modest (prudent) cost measures to reduce individual or public EMF exposure, even in the absence of certainty that the measures would reduce risk.

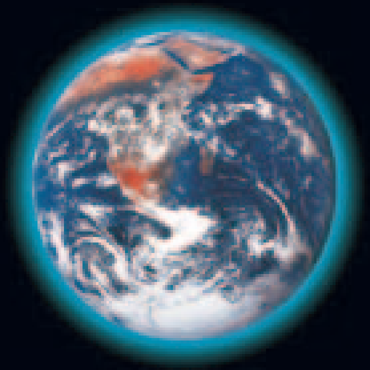
The explicit recognition that a risk may not exist is a key element of precautionary approaches. If the scientific community concludes that there is no risk from EMF exposure or that the possibility of a risk is too speculative, then the appropriate response to public concern should be an effective education programme. If a risk for EMF were to be established, it would then be appropriate to rely on the scientific community to recommend specific protective measures using established public health risk assessment/risk management criteria. If large uncertainties remain, then more research will be needed.

If regulatory authorities react to public pressure by introducing precautionary limits in addition to the already existing science-based limits, they should be aware that this undermines the credibility of the science and the exposure limits.

WHAT IS THE WORLD HEALTH ORGANIZATION DOING?

In response to growing public concern over possible adverse health effects from exposure to a rising number and diversity of EMF sources, the World Health Organization (WHO) launched the *International EMF Project* in 1996. All health risk assessments will be completed by 2006.

The International EMF Project brings together current knowledge and available resources of key international and national agencies and scientific institutions in order to assess health and environmental effects of exposure to static and time varying electric and magnetic fields in the frequency range 0 -



KEY OBJECTIVES
WHO INTERNATIONAL EMF PROJECT

1. Provide a coordinated international response to concerns about possible health effects of exposure to EMF,
2. Assess the scientific literature and makes status reports on health effects,
3. Identify gaps in knowledge needing further research to make better health risk assessments,
4. Encourage focused, high quality research programmes,
5. Incorporate research results into WHO's Environmental Health Criteria monographs where formal health risk assessments will be made of EMF exposure,
6. Facilitate the development of internationally acceptable standards for EMF exposure,
7. Provide information on the management of EMF protection programmes for national and other authorities, including monographs on EMF risk perception, communication and management, and
8. Provide advice to national authorities and others on EMF health and environmental effects and any protective measures or actions needed.

300 GHz. The Project has been designed to follow a logical progression of activities and produce a series of outputs to allow improved health risk assessments to be made and to identify any environmental impacts of EMF exposure.

The Project is administered at the World Health Organization headquarters in Geneva, since it is the only United Nations Organization with a clear mandate to investigate detrimental health effects from exposure of people to non-ionizing radiation.

WHO collaborates with 8 international agencies, over 50 national authorities, and 7 collaborating centres on non-ionizing radiation protection from major national government agencies.

Further details on the EMF Project and results achieved so far are available on the home page at: http://www.who.int/emf/.

International **EMF** *Project*

GLOSSARY

ABSORPTION In radio wave propagation, attenuation of a radio wave due to dissipation of its energy, i.e. conversion of its energy into another form, such as heat.

ACUTE Short term, immediate consequence.

ALARA A cautionary policy. "As Low As Reasonably Achievable" used to minimize risks, taking into account different factors such as costs, benefits or feasibility factors. It is only appropriate when considering a stochastic risk assumed to have no threshold. Originally used for ionizing radiation.

ASSOCIATION In epidemiology, a connection established on the basis of statistical calculations in the sense that, in individuals exhibiting a certain clinical picture, certain environmental factors appear more frequently than in individuals without that picture. The existence of an association does not constitute proof of a causal link, but may well prompt further research.

BASE STATION (mobile telephone) A base station consists of the antenna(s) emitting electromagnetic radiation in the radio frequency range, the supporting structure, the equipment cabinet and the cable structure.

BASIC RESTRICTION Health-based exposure limits that relate to certain electromagnetic phenomena that, if exceeded, may lead to health impairment in the human body. For static fields these limits are the electric and magnetic field strengths, for alternating fields up to around 10 MHz, they are the electric current that is induced in the body, and for alternating fields greater than about 100 kHz they are the conversion that takes place in the body from electromagnetic energy into heat. Between 100 kHz and 10 MHz, both the induction of currents in the body and the generation of heat are important.

CAUTIONARY APPROACH Cautionary approaches are used for management of health risks in the face of scientific uncertainty, high potential risk, and public controversy. Several different policies promoting caution have been developed to address concerns about public, occupational and environmental health issues.

CARCINOGENIC A substance or agent that causes cancer.

COST-BENEFIT ANALYSIS An economic method for assessing the costs and benefits of achieving alternative standards with different levels of health protection.

CRISIS A crucial or decisive point when conflict reaches its highest level of tension; a turning point. In the "Issue Life Cycle," the crisis stage is when the participants demand immediate action, i.e. when the dialogue stops, and the established process is no longer working.

DELPHI PROCESS A method for developing consensus, presented in two variations. The first variation includes the following steps: identify individuals who are most knowledgeable about the issue and ask them to identify others; repeat this until it is clear who people think are the experts; then, draw predictions from those experts, report the responses to them and ask if they wish to change their personal predictions; finally, repeat the process until the members choose to make no more changes. The second variation includes the following steps: use an expert panel, but ask stakeholders to name the experts they trust most; ask stakeholders to respond to questionnaires about the issue; provide their responses to the experts; and repeat the process until the experts have sufficient confidence to make decisions or propose recommendations they feel the community will accept.

DOSE-RESPONSE RELATIONSHIP The relationship between exposure, characterized by level and duration, and the incidence and/or severity of adverse effects.

DOSIMETRY The technique to determine the amount of electromagnetic energy absorbed in the body or its tissues.

EFFECT Change in the state or dynamics of a system, caused by the action of an agent.

ELECTRIC FIELD A region associated with a distribution of electric forces acting upon electric charges

ELECTROMAGNETIC COMPATIBILITY (EMC) The property of an electrical or electronic apparatus to function satisfactorily in its electromagnetic environment without introducing unacceptable interference signals to that environment.

EMF Abbreviation for Electric and Magnetic Fields or Electromagnetic Fields.

EMISSION Generally emissions are substances discharged into the air; in this handbook emissions are electromagnetic waves radiated by a source (e.g. power line or antenna).

EPIDEMIOLOGY Study of disease and health in human populations and of the factors that influence them.

EXPOSURE Concentration, amount or intensity of a particular agent that reaches a target system.

EXPOSURE LIMIT Values of specific parameters related to the strength of the electromagnetic field to which people may be maximally exposed. A difference is made between basic restrictions and reference levels.

EXTREMELY LOW FREQUENCY (ELF) Frequencies above zero and below 300 Hz.

FREQUENCY The number of complete waves or cycles per second passing a given point. The unit is hertz (1 Hz = 1 cycle per second).

HAZARD A source of possible damage or injury.

HEALTH A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

INTERMEDIATE FREQUENCY (IF) Electromagnetic fields within the frequency range 300 Hz to 10 MHz.

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER The International Agency for Research on Cancer (IARC) is a specialized agency of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control.

INTERNATIONAL COMMISSION FOR NON-IONIZING RADIATION PROTECTION The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent international scientific organization whose aims are to provide guidance and advice on the health hazards of non-ionizing radiation exposure. It is in formal relations with the World

Health Organization, the International Labor Organization and the Commission of the European Communities.

LIFE CYCLE Tracking a project or a public concern through time at all stages of its development and evolution.

LONG-TERM EFFECT Biological effect that only manifests itself a long time after exposure.

MAGNETIC FIELD A region associated with forces acting upon ferromagnetic particles or moving electric charges.

MICROWAVES Electromagnetic fields of sufficiently short wavelength for which practical use can be made of waveguide and associated cavity techniques in its transmission and reception. The term is taken to signify radiation or fields having a frequency range of 300 MHz to 300 GHz.

MOBILE TELEPHONY A means of telecommunication where at least one of the users has a mobile phone to communicate via a base station with a stationary or another mobile phone user.

NOMINAL GROUP PROCESS A moderated group dynamics technique useful for goal setting and problem identification; the group responds to a value or conflict-laden question individually writing all responses in the form of a list; each participant reads one response until all the responses (including duplicated responses indicated by a check) are visibly listed; discussion for clarification or in-depth issues discussion follows; if the goal is a prioritized list, the moderator then asks all to individually and silently rate the top three (or another agreed upon number) items listed and then repeats the response recording process; the moderator then leads the group through a discussion which results in a priorities list and may produce an action plan for implementing those items.

NON-IONIZING RADIATION Non-ionizing radiations (NIR) are electromagnetic waves that have photon energies too weak to break atomic bonds.

OCCUPATIONAL EXPOSURE All exposure to EMF experienced by individuals in the course of performing their work.

PEER REVIEW Evaluation of the accuracy or validity of technical data, observations, and interpretation by qualified experts.

PRECAUTIONARY PRINCIPLE The principle of taking measures to limit a certain activity or exposure, even when it has not been fully established that the activity or exposure constitutes a health hazard.

PROPORTIONALITY What is done to protect against risk of one agent or circumstance is about the same as has been done for other agents or circumstances of similar concern.

PRUDENT AVOIDANCE Cautionary measures that can be taken to reduce public exposure at little or modest cost; i.e., prudent refers to expenditures.

PUBLIC EXPOSURE All exposure to EMF experienced by members of the general public, excluding occupational exposure and exposure during medical procedures.

PUBLIC HEALTH The science and practice of protecting and improving the health of a community, as by preventive medicine, health education, control of communicable diseases, application of sanitary measures, and monitoring of environmental hazards.

PUBLIC VALUE ASSESSMENT Understanding how the community values something.

RADIOFREQUENCY (RF) Any frequency at which electromagnetic radiation is useful for telecommunications. Here, radiofrequency refers to the frequency range 10 MHz – 300 GHz.

REDUCTION FACTOR Size of the reduction or "safety factor" in the exposure limit that incorporates uncertainties in the data.

REFERENCE LEVELS Values for the strength of the undisturbed electric and magnetic field that are derived from the basic restrictions and which serve to establish whether the basic restrictions are being satisfied. Measuring the quantities that underlie the basic restrictions is not easy; whereas the electric and magnetic field strength is easily measured.

REGULATION A legislated set of rules, usually under an act of parliament.

RISK The probability of a specific outcome, generally adverse, given a particular set of conditions.

RISK ASSESSMENT A formal process used to describe and estimate the likelihood of adverse health outcomes from environmental exposures to an agent. The four steps are hazard identification, dose-response assessment, exposure assessment, and risk characterization.

RISK COMMUNICATION An interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risks, that express concerns, opinions, or reactions to risk messages, or to legal and institutional arrangements for risk management.

RISK MANAGEMENT The process of identifying, evaluating, selecting, and implementing actions to reduce risk to human health and to ecosystems.

RISK PERCEPTION The way that an individual or a group perceives and values a certain risk. A particular risk or hazard can have a different meaning depending on the individual and the context.

RISK SURVEILLANCE The process of monitoring and providing feedback to the ongoing risk management process with surveillance systems collecting data over time on risk factors and on health outcomes.

SHORT-TERM EFFECT Biological effect that occurs during or shortly after exposure.

SPECIFIC ABSORPTION RATE (SAR) The rate at which energy is absorbed in body tissues, in watt per kilogram (W/kg); SAR is the dosimetric measure that has been widely adopted at frequencies above about 100 kHz.

STAKEHOLDER A person or a group who has an interest in the outcome of a policy or decision, or seeks to influence the outcome.

STATIC FIELDS Electric or magnetic fields having no time variation, i.e. 0 Hz.

THERMAL EFFECTS Biological effects caused by heating.

THRESHOLD LEVEL Minimal value of the exposure parameter necessary for an effect to be first observed.

UNCERTAINTY Imperfect knowledge about the state of a system under consideration.

WEIGHT OF EVIDENCE Considerations involved in assessing and interpreting published scientific information. These include the quality of methods, ability of a study to detect adverse effects, consistency of results across studies, and biological plausibility of cause-and-effect relationships.

WORLD HEALTH ORGANIZATION The World Health Organization (WHO) is a United Nations agency with the mandate to act as the directing and coordinating authority on international health work, promoting technical co-operation, assisting Governments in strengthening health services, and working towards the prevention and control of epidemic, endemic and other diseases.

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ON ELECTROMAGNETIC FIELDS AND HEALTH IN GENERAL

The World Health Organization International EMF Project
http://www.who.int/emf

The International Commission on Non-Ionizing Radiation Protection (ICNIRP)
http://www.icnirp.org

The National Radiological Protection Board (NRPB) of the United Kingdom
http://www.nrpb.org

The NIEHS special RAPID program on electromagnetic fields
http://www.niehs.nih.gov/emfrapid

ON RISK COMMUNICATION AND MANAGEMENT IN GENERAL

The annotated bibliography on risk communication of the National Cancer Institute of the United States
http://dccps.nci.nih.gov/DECC/riskcommbib/

The Department of Health of the United Kingdom on: Communicating About Risks to Health: Pointers to Good Practice
http://www.doh.gov.uk/pointers.htm

The annotated guide on literature about risk assessment, risk management and risk communication of the Research Center Jüelich/Germany
http://www.fz-juelich.de/mut/rc/inhalt.html

The US Environmental Protection Agency on risk assessment and policy options
http://www.epa.gov/ORD/spc

A description of current national guidelines can be found on the WHO web page at
http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm

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