"You pick up the phone once, twice, ten times a day — or only a few times a month. But, each and every time, you're gambling that 'this time' won't be the occasion when the radiation causes irreparable damage to your brain. It only takes a seemingly small trauma at a very small location to result in tissue damage, DNA damage, or chromosome mutations."

CELLULAR TELEPHONE RUSSIAN ROULETTE

A HISTORICAL AND SCIENTIFIC PERSPECTIVE

ROBERT C. KANE

Excerpts from the book:

"[A] repeated insult or irritation to a particular biological area, such as a small region of the brain, can lead to irreparable damage. [G]iven the existence of energy absorption "hot spots" . . . each damaging exposure to radiofrequency radiation provides a new opportunity that the damage will become permanent."

"[W]e can expect that no warning of brain tissue destruction would be provided to a cellular telephone user until the damage was so extensive that the scalp, which absorbs very little energy, sensed heating."

"Every action which occurs within that individual's life during that next week will be affected by the EEG modifications resulting from the portable cellular telephone call."

"[E]arlier, researchers have consistently reported that transmitting antennas could not be operated close to the human body—the human head-without violating the safe exposure limits."

"[T]he shape of the skull, thickness of sub-cutaneous fat, muscle layering, and how an individual holds a portable cellular telephone each contributes to make the energy absorption different from one individual to another. The important common factor, however, is that all individuals will absorb a large portion of the radiation."

"Today we know that even a single exposure to low level radiofrequency radiation causes damage to the DNA makeup of brain cells."

Cellular Telephone Russian Roulette

A Historical and Scientific Perspective

Robert C. Kane

VANTAGE PRESS
New York

FIRST EDITION

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About the Author

Robert C. Kane has been actively employed in the telecommunications industry for more than thirty years . He holds a BSEE from the Midwest College of Engineering, an MSEE with an emphasis in electromagnetics from the Illinois Institute of Technology and also at the Illinois Institute of Technology, has completed the full course of study and research leading to the Ph.D. in electrical engineering with emphasis in the fields of electromagnetics and solid-state physics. As a research scientist and product design engineer, he has been directly involved with programs and projects for the design and development of portable cell phones, radio frequency mobile radios, microwave telecommunications systems, video display systems, and biological effects research.

Introduction

The EMF and radiofrequency radiation issues are receiving a great deal of attention as of late. Whenever that, attention focuses on radiation from hand-held portable transmitters it invariably includes recent research findings that support the position that there may be an increased risk of disease caused by operating these devices.

Most notably, the currently available books, and articles on the RF radiation issue give only slight consideration, if any at all, to the large body of research studies that establish the scientific foundation on which the current findings are based.

Typically, the most recent research study will be reported as a revelation to be investigated further while industry continues to treat each such study as if it were isolated in the scientific universe. By keeping the findings uncollected and the data dissembled the financially interested parties can continue business as usual. Business and usual amounts to utilizing their substantial resources to employ the various media to broadcast the industry "belief system." The "belief system" renounces or buries unfavorable scientific findings.

This monograph takes a bold step backward by providing a broad view of the scientific landscape that clearly advises us that there is danger here. The bold step back ward is a historical accounting of the research that is available, has been available for forty years or more, and

has been neglected or buried by an industry that will place its absolute need to sell products above the health and well-being of its own customers. The practice of producing such products can only be viewed as predatory.

Never in human history has there been such a practice as we now encounter with the marketing and distributing of products hostile to the human biological system by an industry with foreknowledge of those effects. Unlike the tobacco industry, which could claim ignorance for many decades after its product came into common use, the telecommunications industry has had access to this same scientific research base to which you will now be introduced.

In this work you will not find details of the most recent research findings of cancer causation or DNA damage. Those studies, each in its turn, have been well publicized and quickly forgotten as the industry "spin doctors" discounted the importance of each finding. Instead what you will find here is a commentary that presents a litany of past research studies, hundreds of research studies from the 1950s through the mid-1990s. But don't be misled. These older studies are equally alarming in their findings of radiation exposure, DNA damage, chromosome damage, tissue damage, radiation absorption, cataract formation, tumor formation, memory loss, motor skills degradation, and more. There are many more studies, hundreds that might have been added, but the point is well made by those that are cited without the need to bludgeon the reader with more than what has been presented.

Cellular Telephone Russian Roulette

1

The Foundations of Radiation Research

1

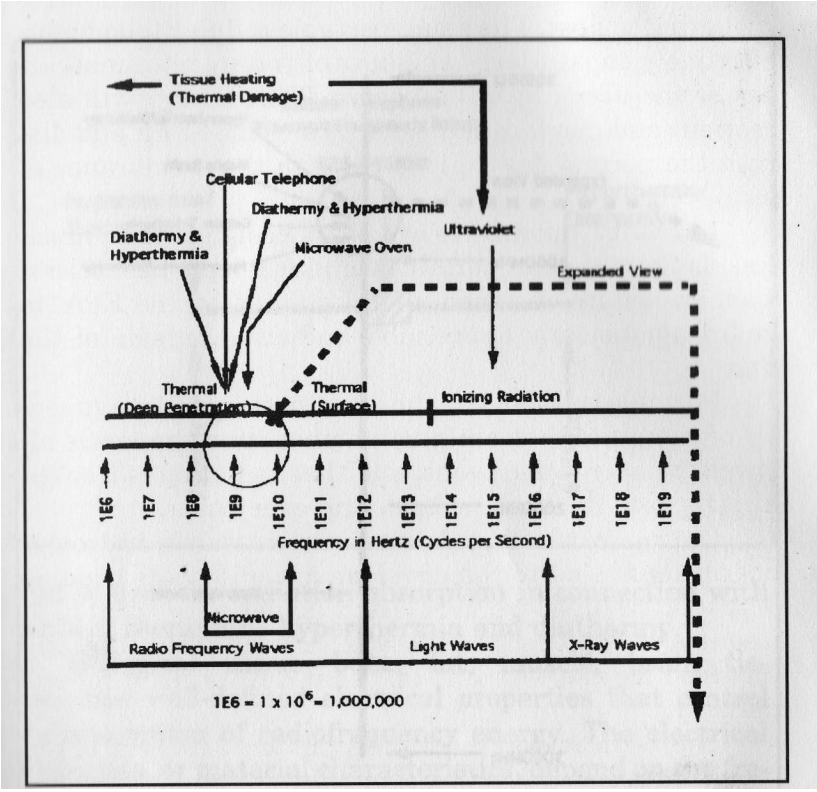
The earth and all living creatures on the land have evolved in an environment that has a low background level of radiofrequency radiation that occurs naturally.
The power density that radiates, close to the head of a user, from a portable 'cellular telephone is 2 billion times higher than that background level. More explicitly, a portable cellular telephone, held in the operating position, will provide a power density of radiofrequency radiation about 2 billion times greater than occurs naturally in the environment.

Since the portables are designed to be operated by being placed against the side of the user's head, a large part of the transmitter energy is radiated directly into that person's brain.

For communication purposes that absorbed energy is useless. But even more significant is that the absorbed energy acts within the brain to provide dangerous and damaging biological effects. One way to look at the portable cellular telephone is to visualize placing a miniature microwave oven directly against your head. The radiofrequency energy is absorbed into the head and brain and

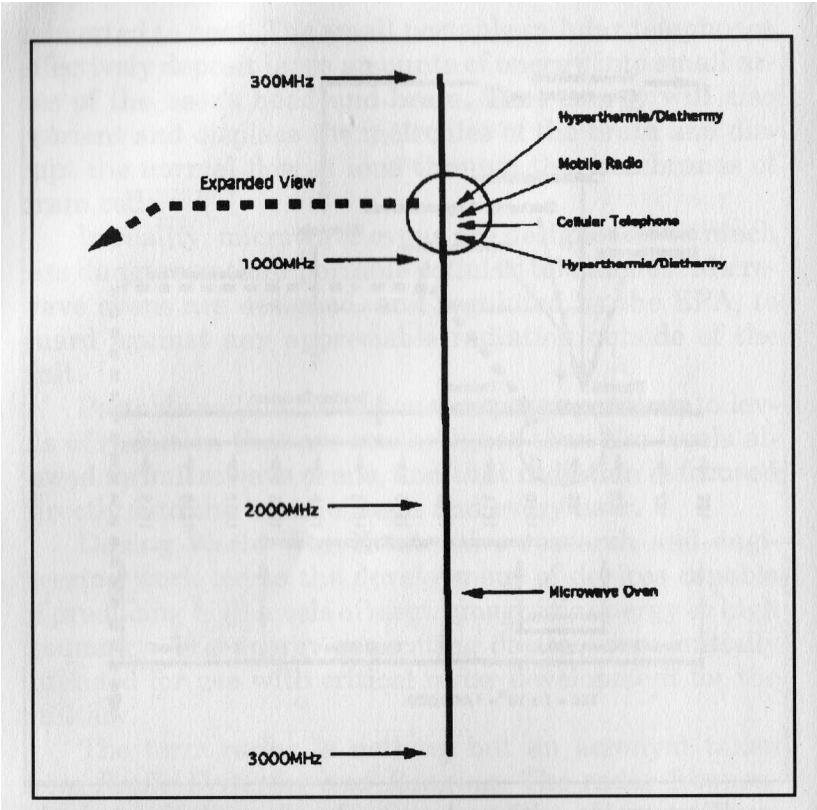
converted to heat. The small portable cellular telephones effectively deposit large amounts of energy into small areas of the user's head and brain. That energy will also reorient and displace the molecules of the brain and disrupt, the normal flow of ions through the membranes of brain cells.
In reality, microwave ovens are designed to be much less dangerous than portable cellular telephones. Microwave ovens are designed, and regulated by the EPA, to guard against any appreciable radiation outside of the unit.
Portable cellular telephones expose operators to levels of radiation that are much higher than the levels allowed for microwave ovens, and that radiation is focused directly into the brain of each and every user.
During World War II intensive research and engineering work led to the development of devices capable of producing high levels of electromagnetic energy at high frequency. The energy-generating devices were initially intended for use with critical radar development for the military.

The term radar is nothing but an acronym taken from Radio Detecting and Ranging. The radar frequencies are radio-frequencies. Some radar equipment operates in the same frequency range as does the cellular telephone, 800-900 MHz. Other radar systems operate at higher frequencies, around 2,000 MHz. In the early years of microwave ovens, they were commonly referred to as "radar ranges." There's nothing unique about radar; it's just another term for radiofrequency radiation. Along with the military applications of high-frequency energy generation for radar, research was initiated to investigate the prospects of utilizing the new energy source for medical applications.



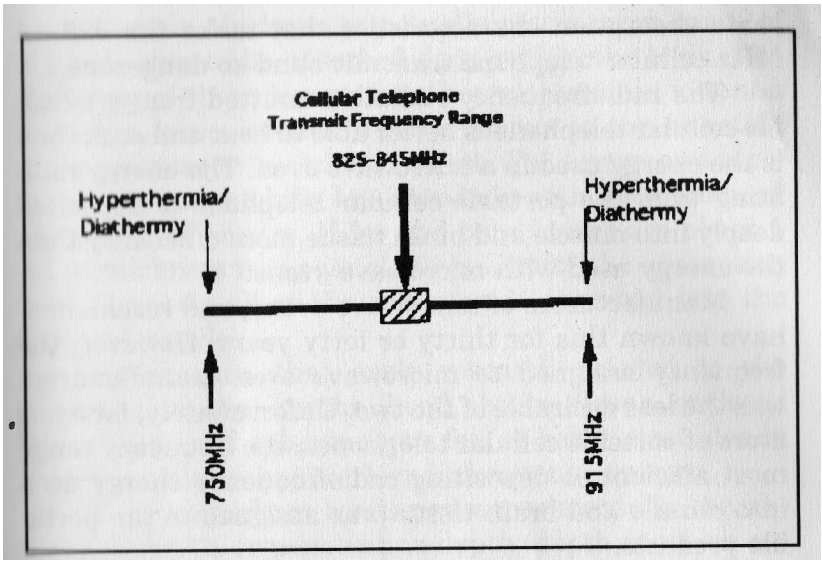
That work, although considered crude by today's standards and level of understanding, established a beginning point for research of the biological effects of radiofrequency (RF) and microwave radiation. The most significant facts learned in those early programs were that RF and microwave energy can be readily absorbed within the human body and that excessive energy absorption leads to tissue damage and death.

Considerable research has identified the radiofrequency (RF) energy that produces the most effective therapeutic results and, also, undesirable effects in people.



The frequencies from about 700 MHz to 1,000 MHz interact most efficiently with human tissue to yield the greatest energy absorption.

Notice that the frequency range of our interest, 750-950 MHz, occupies an infinitesimally small-portion of the electromagnetic spectrum. An even smaller portion of the spectrum is occupied by the portable cellular telephone transmit band, 825-45 MHz. It's a tiny sliver of the frequency spectrum in the very middle of the band



that is used for radiation absorption in connection with medical therapies—hyperthermia and diathermy.

Biological tissue — bone, fat, muscle, brain tissue - has well-defined electrical properties that control the absorption of radiofrequency energy. The electrical properties, or material characteristics, depend on the frequency of the electromagnetic energy. The properties at very low frequencies are much different from those at extremely high frequencies.

However, these material characteristics are virtually identical across the frequency range from 750 MHz to 950 MHz. That is, over the frequency range of 750 - 950 MHz the electrical properties of biological tissue do not change very much.

These energy absorption characteristics that make the 750 and 915 MHz frequencies so desirable for hyperthermia and diathermy treatments are also the very

same absorption characteristics that make the 825-45 MHz cellular telephone transmit band so dangerous. The radiofrequency radiation emitted from a portable cellular telephone is better able to heat and cook than is the energy used in a microwave oven. The energy radiating from the portable cellular telephone is deposited deeply into muscle and brain tissue more efficiently than the energy used with microwave ovens.

Manufacturers of microwave ovens, and researchers have known this for thirty or forty years. However, the frequency assigned to microwave oven manufacturers was the less desirable of the two. Unfortunately, for operators of portable cellular telephones, the frequency range most efficient at depositing radiofrequency energy deep into muscle and brain tissue was assigned to the portable products.

2

It has also been found that the electrical properties of various tissue layers may actually serve to increase the amount of radiofrequency energy absorbed within biological tissues such as muscle and brain.

Enormous variations in actually absorbed energy
. . . depend on the thickness of the subcutaneous fat layer. [1]

The subcutaneous fat layer in humans lies beneath the skin and varies in thickness from one person to the

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[1] *H. P. Schwan and G. M. Piersol, "The Absorption [of Electromagnetic Energy in Body Tissues," International Review of Physical Medicine and Rehabilitation, December 1954, pp. 371-404.*

next. Certain thicknesses actually cause much more of the radiation to be absorbed deep within the body. The thickness of these layers, together with certain antenna distances, can establish what is known in the scientific community as a "matching" effect. Fat layers and bone may serve as matching layers to help with this enhanced absorption of energy. If fat and bone layers are about 1 rm in thickness it is possible to maximize the absorption so that nearly all of the radiation is absorbed into the brain or muscle.

Significantly, that early research pointed to the structure of the human head, brain tissue enclosed within bone and subcutaneous fat, as being most ideally suited to efficiently absorb radiofrequency energy.

The researchers confirmed experimentally the absorption depth, or penetration depth (depth at which energy level has dropped to 37 percent of the surface value), for muscle and brain tissue. As energy penetrates into biological tissue some of it is absorbed and the remainder moves deeper, something like a cup of hot coffee spilled onto a stack of napkins. As you look more deeply into the stack, less of the coffee has penetrated, until finally you come to a point where all of the coffee has been absorbed into the napkins above. So, too, with absorption of radiofrequency energy; from the point of energy deposition the intensity will decrease as one observes farther into the body. However, under some conditions energy will be focused directly into deep regions of the human brain. At 825-45 MHz, the radiating frequency range for the portable, the penetration depth into brain tissue is from 2 cm to 3.8 cm.[2]

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[2] *C. Polk and E. Postow, eds., CRC Handbook of Biological Effects of electromagnetic Fields, CRC Press, (Boca Raton, FL: 1986).*

Early experiments clearly show that the radiofrequency ·energy penetrates sufficiently deep within the biological tissue, such as a human brain, to provide a mechanism to effectively heat and in some cases overheat that tissue. According to the data of H. P. Schwan and G. M. Piersol, the radiofrequency radiation mostly passes through the surface layers of skin, fat, and bone and is absorbed within the underlying deeper tissue (brain tissue or muscle).

More recent work by N. Kuster[3] , O. Gandhi[4,5], G. Lovisolo[6], V. Hombachl[7], and others proves that a substantial amount of the radiofrequency radiation is deposited into the user's brain and converted to heat. These researchers have reported that from 50 percent to more than 90 percent of the radiofrequency energy is absorbed by the user instead of being transmitted into the atmosphere.

3

A unit of measure, called the Specific Absorption Rate (SAR)[8], given in terms of Watts per Kilogram (W/Kg) or

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[3] N. Kuster, "Multiple Multipole Method for Simulating EM Problems Involving Biological Bodies," IEEE Transactions on Biomedical Engineering 40, no. 7 (July 1993), pp. 611-20.

[4] O. P. Gandhi, J. Y. Chen, and D. Wu, "Electromagnetic Absorption in the Human Head for Cellular Telephones," 16th Annual Bioelectromagnetics Society Conference, June 17, 1994, unpublished.

[5] O. P. Gandhi, "Electromagnetic Absorption in the Human Head and Neck for Cellular Telephones at 835MHz, revised," submitted to the U.S. Federal Communications Commission, August 1994.

[6] G. A. Lovisolo, "Hand-held Cellular Telephones: SAR Deposition in Phantoms," 16th Annual Bioelectromagnetics Society Conference, June 17, 1994.

[7] V. Hombach and H. Thielen, 16th Annual Bioelectromagnetics Society Conference, June 17, 1994.

[8] H. S. Ho and A. W. Guy, "Development of Dosimetry for RF and Microwave Radiation-II: Calculations of Absorbed Dose Distributions

milli—watts per gram (mW/g), provides more meaning and insight into experimental results. This measurement unit is particularly advantageous since absorption in biological bodies and specific organs is nonuniform and frequency-dependent. The SAR unit identifies the amount of power, in watts, that is absorbed in a gram of tissue.

A gram of tissue has a size of approximately a cube of one centimeter on a side or 0.4 inches on a side. Of course, a gram of tissue is not limited in shape, but for descriptive purposes it is instructive to visualize a cube.

Smaller volumes of tissue may also be considered when utilizing the SAR method, since it is a rate of depositing energy.

For example, if the energy absorbed in ten grams of tissue is measured the SAR is the average for each of the ten grams and if the energy deposited in 0.1 gram of tissue is used for the measurement the SAR is stated in terms of what the absorption would be if the rate were the same for ten of those 0.1 gram samples. The concept of SAR is a significant step forward, as it moves the discussion of safety or hazard to the place where the energy is absorbed - deep within the biological tissue. In the instance of portable cellular phones - within the brain.

Using the SAR (mW/g) lets the interested person, whether scientist, portable telephone user, or safety-conscious consumer, develop a clear visual picture of where the energy is deposited and how much is deposited. Use of the SAR, as a measure of absorbed energy, resulted in serious debate among researchers, since that meant the safety standards would need to be restated in terms of internal energy absorption in addition to power

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in Two Sizes of Muscle-Equivalent Spheres," Health Physics, 29 (August 1975): 317-24.

density at the surface. That revision took place with the 1982 modifications to the IEEE/ANSI radiation exposure standard. But the portable cellular telephones were made exempt from any safety requirements—even for the SAR modification.

Experimental data show that energy absorption (SAR) within simulated brain material, at what would be the temporal lobe of the brain, is about 2.3 mW/g for a portable cellular telephone radiating 0.6 watts.[9] If it were not for the exemption that the industry promoted, the portables would be in violation of all accepted safety standards now in existence.

In another report of radiation penetration,[10] testing performed at 900 MHz and 0.6 watts output power provided averaged SAR levels of as much as 1.9 mW/g. This averaging, performed over ten grams of tissue, indicates that the peak energy absorption at local "hot spots" within that ten-gram volume was much higher than 1.9 mW/g. The researchers estimate that 72 percent of the radiated energy was absorbed by and "burnt off in the brain." Their choice of the phrase "burnt off in the brain" is very appropriate, as that is exactly what occurs. The radiofrequency energy is converted to heat, and the resulting heat, when sufficient, cooks the brain cells. But what is the significance of 2 mW/g, 3 mW/g, or 5 mW/g of absorption? Research results clearly show that such levels, measured in laboratory animals and models of humans, yield significant temperature rises

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[9] *R. F. Cleveland and T. W. Athey, "Specific Absorption Rate (SAR) in Models of the Human Head Exposed to Hand-Held UHF Portable Radios," Bioelectromagnetics, 10, no. 2 (1989): pp. 173-86.*

[10] *G. A. Loxrisolo, et al., Hand-Held Cellular Telephones: SAR Deposition in Phantoms, 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 65.*

and all of the attendant biological effects mentioned earlier. For comparison, the IEEE/AN SI safe exposure limit is l.6 mW/g and even that level is facing strong opposition as being too high.

4

Computer analysis and measurements, which specifically considered the effects from portable antennas in close proximity to a human head, also show that about 50 percent of the radiated energy is absorbed in the head of the operator.[11] Graphic illustrations of the energy absorption profile clearly show very high absorption levels at the region of the head closest to the antenna.

The electromagnetic field exposure of a portable cellular telephone user depends on the type of antenna and its position.[12] There is a wide variety of antennas available, and each provides its own unique pattern of radiation into the head and brain. Some antennas are so efficient at directing radiation into the head and brain that they are used for diathermy and hyperthermia therapies. Depending on the type of antenna used, as much as 90 percent of the radiated energy can be absorbed within the head and brain of the user. These researchers also have reconfirmed that operation of commercially available portable cellular telephones provides for 50 percent or more of the radiated

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[11] *H J. Toftgard, et al., "Effects on Portable Antennas of the Presence of a Person," IEEE Transactions on Antennas and Propagation 41, no. 6 (June 1993): 739-46.*

[12] *V. Hombach, and H. Thielen, Investigations on Antennas for Hand-Held Telephones with Minimum EM -Field Exposure of the User, 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 12.*

energy to be absorbed in the head of the user. They obtained the results with a simple homogeneous laboratory model. The simple, single material models understate the actual absorption that would occur in a human. Even so, their SAR levels indicate exposure at more than 5 mW/g for some antennas. Had they used a more complex, multilayered model the results would have indicated significantly higher radiation absorption by the user.

That energy absorption and conversion can, and does, lead to a dangerous temperature increase.[13,14] It's a thermal issue in addition to a nonthermal issue. Some researchers now believe that nonthermal effects may be dramatically multiplied in the presence of significant tissue heating.

Most of the temperature rise associated with the energy absorption takes place in the first sixty to ninety seconds of exposure. This finding is inconsistent with the cellular telephone industry's recommendation which suggests that if users are concerned about the effects of radiation they should make short calls to reduce the hazards of operation. From what the research data indicates, the definition of a short call would need to be much less than one minute—probably less than thirty seconds. In other words, based on these research findings and the industry's warnings portable cellular telephones should not be used.

Absorption of RF energy, with the use of selective shielding, revealed that the most sensitive area for absorption is over the temporal lobe of the brain and at

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[13] *H. P. Schwan and G. M. Piersol, "The Absorption of Electromagnetic Energy in Body Tissues," International Review of Physical Medicine and Rehabilitation, June 1955, pp. 424-48.*

[14] *S. F. Cleary, "Uncertainties in the Evaluation of the Biological Effects of Microwave and Radiofrequency Radiation," Health Physics 25 (October 1973): pp. 387-404.*

frequencies from 300 to 1200 MHz.[15] This brings our attention to the issue of localized radiation absorptions and the possibility of damage to small areas in the head and brain.

> **"It should be understood that a cumulative effect is the accumulation of damage resulting from repeated exposures each of which is individually capable of producing some small degree of damage. In other words, a single exposure can result in covert thermal injury, but the incurred damage repairs itself within a sufficient time period, for example hours or days, and therefore is reversible and does not advance to a noticeable permanent, or semi-permanent state. If a second exposure or several repetitive exposures take place at time intervals shorter than that needed for repair, damage can advance to a noticeable stage."[16]**

What we learn is that a repeated insult or irritation to a particular biological area, such as a small region of the brain, can lead to irreparable damage. That is, given the existence of energy absorption "hot spots," the existence of which have been verified by numerous researchers, then each damaging exposure to radiofrequency radiation provides a new opportunity that the damage will become permanent. Part of the problem is that an exposed person would never know of the penetration and damage.

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[15] *I. J. Bahl, et al., "Microstrip Loop Radiators for Medical Applications," IEEE Transactions on Microwave Theory and Techniques MIT-30, no. 7 (July 1982) 1090-93.*

[16] *S. M. Michaelson, "Human Exposure to Nonionizing Radiant Energy—Potential Hazards and Safety Standard's," Proceedings of the IEEE, April 1972, pp. 389-421.*

Perhaps even more troublesome is that tissue damage in the body is usually followed by a process of repair or restoration. So, each damaging exposure is likely to activate the growth of new cells to replace damaged or destroyed tissue. Cells that participate in the repair process are also likely to be some of the cells that were earlier damaged.

S. M. Michaelson reported that the thermal sensation of pain is evoked when thermal sensors in the skin reach approximately 46°C. From data given in that same research report we learn that no sensation of warmth would be felt in the skin, or scalp, until a dose of radiofrequency radiation was so high that internal damage to deep tissue was certain to result.

Researchers have pointed out that electromagnetic energy in the 900MHz region may be more harmful because of its greater penetrating capability compared to 2450 Mhz. [17,18] More of the energy in the 900 MHz frequency range is deposited deeply within biological tissue.

J. C. Lin concluded that 918 MHz energy constitutes a greater health hazard to the human brain than does 2450 MHz energy for a similar incident power density.

For these experiments he used a complex six-layered model of the human head that indicates peak SARs approximately 50 percent higher than simpler models and an average head absorption about five times higher than the single layered homogeneous models.

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[17] *J. C. Lin, "Interaction of Two Cross-Polarized Electromagnetic Waves with Mammalian Cranial Structures," IEEE Transactions on Biomedical Engineering BME-23, no. 5 (September 197 6): 371-75.*

[18] *E. Friedenthal, et al., "Hyperthermia in the Treatment of Local Recurrence of Breast Cancer," Microwave Journal, May 1984, pp. 275-82. .*

Radiofrequency radiation and radiofrequency energy generated by cellular telephones are comprised of both electric and magnetic fields. Some researchers prefer to work only with the magnetic fields while ignoring the accompanying electric fields. An SAR relationship that is based exclusively on magnetic fields also indicates that the ANSI safety standards cannot be met for existing portable radio and telephone products. For an antenna placed at 1.5 cm from the surface of a flat layered model and radiating 0.6 watts, the experimental data indicate an energy absorption level of about 3.0 mW/g inside a human skull and a penetration depth of about 3 cm into the simulated brain tissue.[19]
The information simply reconfirms the body of research that has preceded. That is, energy absorbed into the head and brain of a user is dangerously high and in excess of the safety standards—if only the safety standards applied.

Twenty years ago industry researchers pitched the notion that the radiofrequency energy from portable transmitting devices was not absorbed into the head.
Now they admit that the energy is absorbed deep within the head. When these researchers established their original position it was based on the premise that there was a "peculiar nature" of the fields that stopped the energy at the surface of the human head. Apparently that `special physics` for portable transmitting radios and portable cellular telephones has become outdated.

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[19] *N. Kuster and Q. Balzano, "Energy Absorption Mechanism by Biological Bodies in the Near Field of Dipole Antennas above 300 MHz," IEEE Transactions on Vehicular Technology 41, no. 1 (February 1992).·17—23.*

These industry researchers have provided even more convincing data from experiments with models simulatiung the human head as energy absorption levels of about 3.5 mW/g were reported.

Industry researchers, typically, have employed the most favorable models possible to yield the lowest level of energy absorption. Nevertheless, they arrive at absorption levels in the 3.0 mW/g range. Other researchers have shown that multilayer laboratory models provide energy absorption results that are 3 to 5 times higher than the simplified models. As such, we would expect that more accurate SARs would be in the range of 9-15 mW/g with a multilayered model.

To this point "hot spot" absorption mechanisms and nonuniform radiation emission in the near-zone have been ignored. If the numerous energy focusing and "hot spot" mechanisms are factored into the calculations the peak levels will be much higher; they would be on the order of 20-50 mW/g at very localized areas of a human head and brain. It's not difficult to envision that the human brain is a collection of billions of molecules and interconnecting links, or bonds. Even one cubic centimeter of brain tissue includes billions of molecules and interconnecting bonds. Each of these molecules or bonds may be susceptible to extremely high energy absorption under certain conditions even while other molecules, only a short distance away, might be exposed to lower energy levels. Even as large variations in absorption levels are reported for macroscopic measurements we should expect even greater variations in absorption levels when looking at the microscopic or molecular level. Large temperature changes can be expected within biological tissue as a result of absorbing high levels of radiofrequency radiation.

Experiments show that a five—minute exposure to a surface power density of 100 mW/cm² at 710 MHz yields an internal temperature rise of 12°C.[20] If that exposure level were scaled back to what users of portable telephones experience, 10-20 mW/cm², the equivalent temperature rise within the tissue would be about 1.2—2.4°C, not counting any increased absorptions due to "hot spots." That is for only a five-minute exposure.

Tissue destruction is a sharp function of temperature, and a variation of only a fraction of a degree can mean the difference between acceptable and unacceptable damage to normal tissue.[21] We are reminded that low-frequency (less than 100 MHz) and very high-frequency radiation (more than about 3,000 MHz) is not well suited for deep absorption into biological tissue, the reason being that radiofrequency radiation of intermediate frequency, such as 918 MHz, is most efficiently absorbed into tissue. For his purposes, hyperthermia treatment of patients, L. S. Taylor advises that complex systems must be designed to prevent "hot spots." Although many "hot spots" and "hot spot" generating mechanisms have been related to cellular telephone transmitting antennas there are still no designs, or redesigns, to eliminate the "hot spot" radiation absorption.

In the following chapter the topic of "hot spots" will be considered in detail.

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[20] *O. P. Gandhi, "Conditions of Strongest Electromagnetic Power Deposition in Man and Animals," IEEE Transactions on Microwave Theory and Techniques MTT-23, no. 12 (December 1975):1021-29.*

[21] *L. S. Taylor, "Implantable Radiators for Cancer Therapy by Microwave Hyperthermia," Proceedings of the IEEE 68, no. 1 (January 1980):142-149.*

6

In studies of diathermy applications it is consistently shown that electromagnetic energy at frequencies near and below 900 MHz is best suited for deep penetration into brain tissue. The depth of penetration is noticeable greater at this lower frequency range, which includes the portable cellular phone transmit frequencies.[22,23,24]

Diathermy treatment experiments conducted at 750 MHz and 915 MHz yield energy absorption and tissue-heating characteristics so similar as to be indistinguishable.[25] The researchers who performed these particular experiments found that deep tissue heating is obtained at either frequency without significant heating in the surface tissues.

It is important to note that researchers interested in characterizing the performance of diathermy applicators will naturally conduct experimental research at those frequencies authorized for diathermy use. That's why nearly all of the diathermy energy absorption work is performed at about 750 MHz, 915 MHz, or 2,450 MHz. In the preceding work the researchers confirmed that

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[22] *J. F. Lehmann, et al., "A Comparative Evaluation of Temperature Distributions Produced by Microwaves at 2,456 and 900 Megacycles in Geometrically Complex Specimens," Archives of Physical Medicine and Rehabilitation (October 1962):502-07.*

[22] *A. W. Guy, et al., "Therapeutic Applications of Electromagnetic Power," Proceedings of the IEEE 62, no. 1 (January 1974):55-75.*

[24] *J. F. Lehmann, et al., "Comparison of Relative Heating Pat-*
9 terns Produced in Tissues by Exposure to Microwave Energy at Frequencies of 2,450 and 900 Megacycles," Archives of Physical Medicine and Rehabilitation, February 1962, pp. 69-76.

[25] *J. F. Lehmann, et al., "Evaluation of a Microwave Contact Applicator," Archives of Physical Medicine and Rehabilitation, March1970, pp. 143-46.*

there is no difference in the energy absorption characteristics between 750 MHz and 915 MHz.
Of course, for diathermy treatment tissue damage is undesirable. But some researchers began to develop an idea that heating cancerous tissue to destruction could be a useful technique in the treatment of tumors. This technique is known as hyperthermia therapy. Hyperthermia has been defined as any temperature in human tissue exceeding 41°C, but not including fever or heatstroke. Research has concluded that the frequency range of greatest energy penetration and practical hyperthermia application extends from about 100 MHz to 1,000 MHz.[26]
Although 915 MHz is authorized in the United States for hyperthermia, researchers have found that 750 MHz is also a good choice due to the excellent deep energy absorption at that frequency.

By their nature the frequencies that provide the best therapeutic heating would also be frequencies that could be most hazardous to man in an uncontrolled situation.[27]

High absorption in inner tissue such as the brain occurs while fat and bone absorption is many times less. That is, radiofrequency radiation passes through fat and bone to be absorbed within the brain. Researchers note that

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[26] *J. G. Short and P. F. Turner, "Physica1 Hyperthermia and Cancer Therapy," Proceedings of the IEEE 68, no. 1 (January l980):133-42.*
[27] *C. C. Johnson and A. W. Guy, "Nonionizing Electromagnetic Wave Effects in Biological Materials and Systems," Proceedings of the IEEE 60, no. 6 (June, 1972):692-718.*

"local lesions of the skin and underlying tissues due to thermal arrears from microwave exposure have been observed. These microwave burns tend to be deep, like fourth-degree burns, due to the deep penetration of the energy". (see footnote 27).

They also remind us that the heating characteristics of RF energy provide deep heating of 43°C-45°C, which is in the range where tissue destruction occurs. Human brain tissue is even more susceptible—perhaps the most sensitive—to increases in temperature. Brain tissue can begin to suffer damage with a temperature increase of as little as (0.5°C). Particularly, it is known that radiofrequency energy absorption causes heating in tissue that has three primary effects: (1) tissue destruction and death; (2) inhibition of normal cell growth through depression of enzyme activity; and (3) increase in membrane permeability. This last effect is the low-level exposure—induced effect being researched by Adey and others.

As if the energy absorption issue itself weren't enough, there is considerable evidence that radiofrequency energy exposure may inactivate enzymes or proteins that are involved in the repair process to correct DNA breaks. As long ago as 1980 it was proposed that radiofrequency energy exposure was responsible for inhibiting repairs to DNA.

7

Researchers have confirmed that localized hyperthermia is much easier to induce using radiofrequency energy deposition than with other methods. Further, they reported

that. 915 MHz is suitable to heat more massive and deeper tissue. Using 915 MHz radiation researchers have found that they can focus energy absorption into highly localized regions of deep penetration up to 6 cm.[28] By focusing the energy into a "hot spot" the amount of power required from an energy source is reduced by a factor of more than 20. Conversely, this means that an energy-radiating element, such as an antenna, can provide enhanced focused energy deposition.

The destructive effect of heat on malignant as well as healthy tissues is a function of the temperature to which the tissue is raised.[29]

In similar research at other universities, techniques were developed for deep tissue absorption of 915 MHz energy by using antennas.[30,31,32]
This knowledge of the deep penetration of radiofrequency radiation has made hyperthermia very attractive. 'The frequency range 700-950 MHz continues to be the

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[28] *C. Q. Wang and O. P. Gandhi, "Numerical Simulation of AnnuIur Phased Arrays for Anatomically Based Models Using the FDTD Method," IEEE Transactions on Microwave Theory and Techniques MIT-37, no. 1, (January 1989):118-26.*
[29] *F. Sterzer, "Localized Hyperthermia Treatment of Cancer," RCA Review 42 (December 1981):727-51.*
[30] *A. W. Guy, et al., "915—MHz Phased-Array System for Treating Tumors in Cylindrical Structures," IEEE Transactions on Microwave Theory and Techniques MTT-34, no. 5 (May 1986):502-07.*
[31] *A. M. Tumeh and M. F. Iskander, "Permost studied. However, in the United States 915 MHz is the authorized industrial, scientific, and medical frequency. Researchers, therapists, and oncologists would prefer to use a frequency around 850 MHz since that is the region for maximum energy absorption by living tissue.*
[32] *P. F. Wahid, et al., "Multidipole Applicators for Regional and Whole-Body Hyperthermia," Proceedings of the IEEE 70, no. 3 March 1982):311-13.*

most studied. However, in the United States 915 MHz is the authorized industrial, scientific, and medical frequency. Researchers, therapists, and oncologists would prefer to use a frequency around 850 MHz since that is the region for maximum energy absorption by living tissue.

The frequency range of portable cellular telephone transmissions, 825-845 MHz, was not deliberately chosen to coincide with the most dangerous frequency range known. to man. It was selected because that is the frequency range alloted by the Federal Communications Commission. It may just be coincidence that the manufacturers also possessed a very strong engineering capability at that frequency range. They were already selling mobile radios in the 800 MHz frequency range. That eliminated any need to develop an expertise at a new frequency range. And as anyone familiar with communications and radio engineering knows, shifting to an unknown frequency range brings with it an entirely unknown package of new problems. No doubt the manufacturers have experienced such a new problem set while developing the new personal communications system (PCS), which will operate in the 1700-1900 MHz range. In any event, the 825-45 MHz frequency band was either by accident or by deliberate act the best for the manufacturers and the worst for the consumers. As we have learned, even at the time that the frequency allocation was made the research results clearly indicated the danger.

8

The birth of RF and microwave frequency diathermy and hyperthermia, both of which are controlled clinical exposures, coincides with many uncontrolled exposures. Operators of equipment were exposed to the energy in a way

that was not well known or prescribed. Such uncontrolled exposures are similar to exposures that occur with operation and maintenance of radar systems and communication systems.

Lehmann, Stonebridge, and Guy have advised that

> ***Undesirable side effects of diathermy treatment would include formation of cataracts, degenerative changes of the gonads, and brain damage . . .*** [33]

Earlier research had confirmed the formation of cataracts due to radiofrequency radiation exposure. So, diathermy treatment therapists were considered susceptible to the harmful effects of radiofrequency radiation emitted from the applicators. The concern about brain damage is partly from knowledge that brain tissue readily absorbs energy in the 700-950 MHz frequency range and is also very sensitive to temperature variations. This concern is significant. By comparison radiofrequency energy exposures to diathermy therapists are lower than those experienced from operation of portable cellular telephones.

The maximum allowable stray field exposure levels for diathermy applicators are set at a radiation level of 5 mW/cm². No such restriction is placed on portable cellular telephones, which typically expose operators to radiation levels of 10-20 mW/cm².

The researchers recommended that the manufacturers of diathermy devices should indicate the maximum safe distances and directions that must be maintained by therapists. Of course, the subject undergoing treatment

[33] *J. F. Lehmann, et al., "A Comparison of Patterns of Stray Radiation from Therapeutic Microwave Applicators Measured Near Tissue-Substitute Models and Human Subjects," Radio Science 14, no. 6S (November-December 1979):271-83.*

is not maintaining any distance. However, if there must be defined some safe distance to be maintained from devices emitting 5.0 mW/cm² then certainly we might expect some safe distance to be kept from devices emitting higher levels of radiofrequency radiation - portable cellular telephones. This should be especially true when the spacings are being considered with reference to the human brain.

9

Research reports clearly show that in order to feel any sensation from cellular telephone radiofrequency radiation the energy level would be high enough to cause tissue destruction - prior to noticing any heating sensation.
That's because the radiofrequency energy from a portable cellular telephone is absorbed deep into tissue such as
the human brain. Since the human brain has little, if any, sensory capability, damage or trauma occurring internally will not be felt until the effects, such as heating, are so severe that they work their way outward. If tissue damage occurs within a localized region of the brain it may be completely unnoticed - for the present, that is. These researchers also confirmed that the threshold for irreversible skin damage is about 45°C.[34] which is also the temperature at which pain is felt. So, by the time a person, exposed to radiofrequency radiation, feels pain at the skin that skin is irreversibly damaged, as is the deeper tissue beneath the skin. They also pointed out

[34] *J. F. Lehmann, et al., "Comparison of Relative Heating Patterns Produced in Tissues by Exposure to Microwave Energy at Frequencies of 2,450 and 900 Megacycles," Archives of Physical Medicine and Rehabilitation, February 1962, pp. 69-76.*

that excessive internal heating of muscle tissue is not felt as an burning sensation; it is noticed as a dull aching sensation. Similarly, internal heating of brain tissue would not be sensed as a burning sensation. Likely, there would be no sensation at all.

Interest in the ability to "sense" the presence of high levels of radiofrequency radiation motivated researchers to determine threshold levels for detecting heat sensations due to radiation exposure.[35] These researchers found that at 2,450 MHz a minimum exposure to a power density of 26.7 mW/cm² was necessary to induce a sensation of heating in a test subject. This is very close to the previously reported exposure levels for threshold of warmth sensation at 2,450 MHz. Recall that 2,450 MHz radiation has been found to deposit energy mostly near the surface, whereas 845 MHz energy is deposited into deeper tissue layers. The researchers concluded that "the same set of superficial thermoreceptors was being stimulated" as were stimulated by infrared energy heating. Not surprisingly, infrared energy exposure was detected at a much lower power density of only 1.7 mW/cm2. Research shows that as the frequency is reduced the power density required for a sensation of warmth increases. Infrared energy has a much higher frequency than 2,450 MHz.

At 845 MHz the threshold for sensation shifts to a much higher level. That is, one must be exposed to dramatically higher levels of radiofrequency radiation at 845 MHz before the warmth sensation is noticed. With 845 MHz radiation exposure the threshold power density for

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[35] *D. R. Justesen, "A Comparative Study of Human Sensory Thresholds: 2450-MHz Microwaves vs Far-Infrared Radiation," Bioelectromagnetics 3, no. 1 (1982):117-25.*

sensation of warmth occurs at about 90 mW/cm². Such a high power density level is enough to cause severe destruction to deep tissue.

There is a broad range of potentially lethal exposures below that level that would remain undetected by thermal sensations. Considering our previous discussion of the lack of sensory detectors in the brain, we can expect that no warning of brain tissue destruction would be provided to a cellular telephone user until the damage was so extensive that the scalp, which absorbs very little energy, sensed heating.

10

In an unusual report a product manufacturer provides information related to the "unexplored" area of heating of simulated tissue. It's curious that the researchers should describe the technical area as unexplored, particularly in view of the full body of prior research, only some of which has been described here, and in view of the many products the manufacturers have in the marketplace. Their measurements indicate that radiation exposures could exceed a power density of 10 mW/cm². There is value in the research as they observed and documented an energy absorption "hot spot" associated with high electric fields at the tip of their antenna.

A health hazard is present in the event that the user places the tip of the antenna in the immediate vicinity of the eye.[36]

[36] *Q. Balzano, et al., "Heating of Biological Tissue in the Induction Field of VHF Portable Radio Transmitters," IEEE Transactions on Vehicular Technology VT-27, no. 2 (May 1978):51-6.*

This stems from their findings of high energy absorption caused by the very high electric fields at the antenna tip.

These researchers have also noted that the maximum SAR exists at the antenna "feed-point"—the connection point where the energy is fed into the antenna.

For many antennas the feed-point is located some distance above the bottom of the antenna and would also correspond to the place where the antenna is closest to an operator's head. Now, in addition to internally generated "hot spots" related to head structure, the industry researchers have defined that the antenna structure itself is responsible for introducing another radiation absorption mechanism. This industry research team recites that the fields deposit, "most of their penetrating power in the deeper muscle or brain tissue."[37] They also concluded that

> ***these antennas are capable of depositing high levels of power density in small areas around the feed-point if the radiator is held very close (less than 0.5 in) to the operator.***

One striking example of the penetrating effects of radiofrequency radiation comes from a 1979 report that describes how the energy can be used to kill laboratory rats using only a one- to five-second exposure. The researchers claim that the "in-depth heating" provides a "promising approach." They stated that for the purposes of killing the animals

> ***It soon became evident that it would be preferable to focus the microwave energy into the head of the***

[37] *Q. Balzano, et al., "Energy Deposition in Simulated Human Operators of 800-MHz Portable Transmitters," IEEE Transactions on Vehicular Technology VT-27, no. 4 (November 1978):174-81.*

animal, thereby increasing the efficiency of the energy delivered to the brain.[38]

The idea was to kill the animals as quickly as possible to prevent unwanted changes in the brain structure and to induce only the desired changes. The high intensity radiofrequency radiation provided the necessary deep absorption to kill rats in one to five seconds and mice in less than one second.

One of the problems these researchers encountered was that the animals' brains did not absorb the energy uniformly. Some areas absorbed more and achieved the desired level of "deactivation" quickly. The researchers did not investigate these areas as "hot spots," since they were looking for rapid absorption throughout the brain - the quicker the better. Their solution: apply the radiation long enough to inactivate the entire brain, not just the "hot spots."

11

N. Kuster reported during 1993 that the maximum SAR measured in models of human heads exposed to one watt of energy was greater than 5 mW/g.[39] The antenna that he employed was located at 2.5 cm (about one inch) from the side of the human head models. His graphical representation of the energy absorption profile clearly shows

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[38] *J. L. Meyerhoff, et al., "The Inactivation of Rodent Brain Enzymes in Vivo Using High—Intensity Microwave Irradiation," Proceedings of the IEEE 68, no. 1 (January 1980):155-59.*

[39] *N. Kuster, "Multiple Multipole Method for Simulating EM Problems Involving Biological Bodies," IEEE Transactions on Biomedical Engineering BME-40, no. 7 (July 1993):611-20.*

the high level of energy absorbed into the head and brain in the region very close to the antenna location.

A semispherical region of the simulated brain nearest the location of the radiating antenna absorbs in excess of 5 mW/g. Proceeding inward, more deep into the brain, is a region of energy absorption in the 2-5 mW/g range that penetrates to a depth of about 2 cm. Continuing farther into the brain is a region of energy absorption of 1-2 mW/g, which extends to a depth of about 3 cm. This continuous diminution of the magnitude of absorbed proceeds throughout the extent of the brain. Clearly, the most dramatic and worrisome revelations point out the very high energy absorption levels on the side closest to the antenna.

Other data also shows very high SARs for a standard portable telephone antenna.[40] We have earlier discussed that researchers find increased SARs close to the place on the antenna where the power is fed into the antenna, the antenna feed-point. In this case the researcher reports SARs greater than 20 mW/g at regions near the antenna feed-point. Yet, that high SAR level does not take into account any of the internal enhancement mechanisms.

At about the same time that Kuster released his research findings, December 1993, O. P. Gandhi publicized findings of his own that were contradictory.[41] He reported that the maximum SARs within the human brain would be about thirty times lower than what Kuster had reported. But by March of 1994 the word in the research

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[40] *N. Kuster, "Progress in High Frequency Dosimetry," 2d Congress of the European Bioelectromagnetics Association, December 9 l l, 1993, conf. abstracts, p. 2.*

[41] *O. P. Gandhi, Electromagnetic Absorption in the Human head for Cellular Telephones, unpublished communication to the Federal Communications Commission, October 22, 1993.*

community had spread that the Gandhi team had, in fact, reported incorrect SAR numbers and were about to release a correction revising their "results" upward considerably.

During the 1994 Bioelectromagnetics Society 16th Annual Conference, held in June of that year, Gandhi produced findings of still higher maximum SARs for the same research. During his presentation, SARs corresponded, at times, to levels as much as ten times higher than were previously reported. The conference results, presented in Copenhagen, Denmark, never reached the U.S. audience. In a letter to the Federal Communications Commission of August 1994, Gandhi explained the nature of the errors and revised his experimental results upward. That is, nearly a full year after the initial false claims of safety—and almost six months after his revisions first became known—the Gandhi team provided, an official correction.

Their computer simulations and experimental findings now admit to radiation absorption of about 60 percent in the neck and head of portable cellular telephone users.[42] That is about four times higher than the original data. Their highest SAR numbers are now about ten times higher than was the case with the previous data. Their full-color slides of operator exposure to 835MHz radiation show significant energy absorption and pronounced thermal "hot spots" located at the temporal lobe and parietal lobe corresponding to the location of the radiating antenna. In conversations with Gandhi, he has stated that as a result of the widespread reporting of high radiation

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[42] *O. P. Gandhi, et al., "Electromagnetic Absorption in the Human Head for Cellular Telephones," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994.*

absorption rates, in some cases as much as 90 percent, he has been working for some manufacturers to redesign the portable cellular products. The purpose, as he has stated, is to reduce the objectionably high energy absorption into the user's head.

> ***When close to a narrow source of microwave leakage, one may get up to 100% efficiency of coupling to the target. However, as one moves away from the source, the coupling diminishes rapidly, first due to reduction of field strength . . . and secondly due to the reduction in coupling because of the larger effective width of the fields.*** [43]

When considering exposure to a portable cellular telephone antenna the same highly efficient coupling effect occurs. The coupling of a "target", in this case the human head and brain, to a radiofrequency energy source allows for efficient flow of the energy from the source into the target

12

A. W. Guy and C. K. Chou experimented with 915 MHz energy to study the affects of high energy pulses on brain tissue. Above a "threshold" level the rats they used exhibited seizures and were rendered unconscious. That in itself is not surprising since the radiation exposure elevated the brain temperature significantly. The surprising data come from the pathological findings taken

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[43] *O. P. Gandhi, et al., "Electromagnetic Absorption in a multilayered Slab Model of Tissue under Near-Field Exposure Conditions," Bioeletromagnetics 1, no. 4 (1980):379-88.*

one month after exposure. At that time two of the rats were sacrificed (killed) and their brains were examined; Both rat brains were swollen. Glial nodules (tumors) were also found in both rat brains. Remember that this was one month after the radiation experiments. They wrote:

> ***One month later the only pathological findings in two exposed rats were that the brains appeared'swollen and in one rat a few microfocal glial nodules were present in the basal ganglia anterior to the optic nerves, while in another a single microfoal glial nodule appeared in the cerebral cortex.44***

Of course that is the correct description for small brain tumors.

These findings are of extreme importance because the researchers reported no residual effects immediately after the exposures. However, as part of the program's radiation exposure experiments the researchers followed up with a histological examination and found tumor growth one month after the rats assumed normal activity. Not only that, but the brains were still swollen one month after the exposure. Of the rats that were sacrificed and examined, the researchers initially found no visible differences when compared to controls (nonexposed rats). It was a closer microscopic examination that revealed the growths.

This certainly indicates that determinations of pathological effects should be from a long-term view. That is, only after months, or even years, will the full

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44 A. W. Guy and C. K. Chou, "Effects of High-Intensity Microwave Pulse Exposure of Rat Brain," Radio Science 17, no. 5S (September—October 1982):169S- 178S.

effects of radiofrequency energy exposure become known. In this case they found that what might have been said to be perfectly normal test subjects had in reality developed brain tumors. According to the measurement criteria in use at that time, the rats "appeared" to recover from the exposure. Thus the researchers might have recorded that no irreversible effects were noted.

However, those researchers looked further. Specifically, the researchers stated,

> ***Histological examinations of some of the animal brains indicated some demyelination of neurons one day after exposure and some microfocal glial nodules in two of the rat brains one month after exposure.***[45]

In addition to producing undesirable brain injury, radiofrequency radiation may be employed as a technique for deliberately producing brain lesions. One procedure includes implantation of a small piece of metal into the brain. After the metal implant is in place the subject is exposed to radiofrequency radiation that results in sufficient heating at the location of the implant so that tissue is destroyed.[45]

Researchers previously knew that the presence of metal objects within tissue would result in excess heating because more RF energy would be absorbed at that spot. The implanted metal "seeds" provide a controlled location for the increased heating and tissue destruction. Individuals with metallic implants may be well advised to take heed of what has been reported.

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[45] *J. C. Lin, "Induction Thermocoagulation of the Brain-Quantitation of Absorbed Power," IEEE Transactions on Biomedical Engineering, November, 1975, pp. 542-46.*

Metal-framed eyeglasses, metal implants, orthodontic braces, and even metallic jewelry worn about the head will also modify the radiation absorption. The modifications can result in significantly higher energy absorption at small, localized regions of the head and brain.

13

From another report of industry-conducted research we get some idea of the magnitude of electric fields in close proximity to transmitting antennas. The research was prompted by concerns raised related to excess radiation exposures and in part as background for the meetings of the IEEE/ANSI safety standard committee. Instead of providing proof that the electric fields in the close proximity to transmit antennas were safe, the experimental and theoretical results show that the field intensities near, some parts of a transmitting antenna are higher than predicted.

The researchers state in the publication that

> ***the study of the near field has been substantially neglected.***[46]

Thus it comes from the industry that the most important aspect of research related to portable transmitters has been, in its own words, "neglected."

> ***Dipole antennas, although extensively used in portable and mobile communications, have not been carefully investigated in the near field.***

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[46] *Q. Balzano, et al., "Energy Deposition in Simulated Human Operators of 800 MHZ Portable Transmitters," IEEE Transactions on Vehicular Technology, VT-27 no. 4 (November 1978):174-81.*

The proposed standard recognizes the possibility of encountering fields higher than the maxima of the Protection Guides in the close vicinity of low power radiators, like portable communication equipment. For this reason, an exclusion clause for devices operating at 1 GHz or less and with less than 7 W output power has been proposed." (See footnote 46)

Those researchers have confirmed, by their own measurements, the electric field enhancement effects reported earlier by Iskander and others.

In the near-zone of some radiating antennas there is a large amount of stored energy that is disposed immediately around the antenna. This stored energy is found in what are known as induction zone electric and magnetic fields. For communications purposes stored energy is useless and is considered an undesirable part of a transmitting antenna system.

One method commonly used to obtain selective heating for diathermy and hyperthermia therapy is to expose human tissue to the stored RF energy in the near-zone fields (induction fields) of an energy source. Researchers have repeatedly confirmed that RF energy can be absorbed from the induction fields in the near-zone. However, both therapeutic benefits and cell damage in biological tissues stem from conversion of electromagnetic energy into heat.

Some years before portable cellular phones made their way beyond the industry research labs, researchers reported that as little as 250 microwatts (0.00025 watts) radiated power would be enough to exceed the safety standards when using a helix antenna as the radiator for

near-zone exposure.[47] The helical antenna is commonly employed with portable phones when a user prefers a shorter antenna. A disadvantage of the shorter helical antennas is that they store tremendous amounts of energy in the near-zone.

For example, the helical antennas that those researchers used for their experiments stored ten times as much energy in the near-zone as was radiated. In terms of the allowed radiated energy for a portable cellular telephone, that means the near-zone stored energy equals about six watts. With an operator's head and brain in the near-zone a significant portion of that energy will be drawn into and absorbed by the head and brain of the operator.

Claims of safety, based on the fact that the portables only emit 0.6 watts of power, always neglect to factor in the much higher energy absorption that is available from the stored energy.

The industry researchers warn that

> ***if safety standards of independent and government agencies do not take into account the peculiar nature of the electromagnetic energy in the close vicinity of some radiating devices, it is conceivable that the power of portable two-way communication equipment might be forced down to useless levels.***

They suggested that electromagnetics in the nearzone of antennas is somehow different than elsewhere in the universe. Their proposition is that since they don't

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[47] *Q. Balzano, "The Near Field of Omnidirectional Helical Antennas," IEEE Transactions on Vehicular Technology·VT-31, no. 4, (November 1982):173-85.*

quite understand the physics relating the electromagnetic fields to the near-zone of antennas, safety standards should not be enforced because it would be detrimental to the industry.

Those researchers have found that exposure to the helical antennas yields a power density of as much as 127 mW/cm² when the antenna is placed about 1 cm distant. The radiated power was only 0.02 watts. That's thirty times less than radiated from a portable cellular telephone. Yet the power density was more than one hundred times higher than would be allowed under the exposure limits for a microwave oven. The researchers observe that "this last value should be considered extremely dangerous biologically; yet, in the near field of an antenna, such apparent power densities are reached with only 20mW of radiated power."

Clearly, they comprehended the danger that their own research findings were yielding. They concluded that in order to meet the safety standard, the helical antenna which they employed could radiate no more than 0.00025 watts. That's 2,400 times lower than portable cellular telephones are allowed to emit.

Some antennas are specifically designed to use the nonradiating induction energy for penetration into humans.[48] One such antenna was specifically developed to provide an improved method for depositing energy into tissue for hyperthermia treatment.

Notably, the researchers of that antenna reported that the greatest energy absorption peak is the result of stored energy deposited into the tissue. That is, some of

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[48] *F. Montecchia, "Microstrip-Antenna Design for Hyperthermia Treatment of Superficial Tumors," IEEE Transactions on Biomedical Engineering BME-39, no. 6 (June 1992):580-88.*

the nonradiating energy that is stored around the antenna is deposited into the tissue and results in greater heating than the radiated energy. Both the radiation energy and stored energy absorption take place deep within the tissue with measurable temperature rises more than 10 cm into the tissue. Surprisingly, moving the location of the antenna to 3.0 cm distance, as compared to the original 1.5 cm, has only a small effect on the existence of a "hot spot," which is primarily due to the absorption of stored energy.

This finding is interesting since it gives some indication of energy absorption even as the antenna is moved farther from the absorbing tissue. For portable cellular telephone use, some antennas will still deposit significant stored energy into the head and brain even as the spacing is increased by a few centimeters. This research has verified, once again, that the frequency range that includes the portable cellular telephone transmit frequencies is excellent for depositing energy deep into biological tissue. Others have confirmed the efficient absorption of stored energy with their research of rats irradiated at 918 MHz.[49] Their purpose was to characterize the conditions of radiofrequency radiation exposure that led to convulsions in rats. They found that by using deep-penetrating radiation the surface temperature of the rats could be kept low while brain temperature could be elevated to induce convulsions.

14

On August 31, 1990, an antenna technician, Keith Angstadt, was exposed to radiofrequency radiation that

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[49] *D. L. Hjeresen, et al., "A Microwave-Hyperthermia Model of Febrile Convulsions," Bioelectromagnetics 4, no. 4 (1983):341-55.*

led to color blindness and his loss of night vision. He contacted doctors at Johns Hopkins University's Wilmer Institute for help with his eye injuries. Doctors at the institute, "deduced that the retinas of his eyes had sustained 5mW/cm² of continuous wave radiation for two I5 minute periods" [50] Further, the doctors at the Wilmer Institute were quoted as saying that he "suffered more microwave exposure than any human being ever studied by scientists." So how does that relate to the issue of radiofrequency radiation from portable cellular telephones?

The radiation from portable cellular telephones is acknowledged to be deposited deep within brain tissue. The power density to which operators of portable cellular telephones are exposed is higher than that to which Keith Angstadt was exposed. A primary difference is that 6,000 MHz energy was directed at the face and eyes of Mr. Angstadt. By now we know that the higher-frequency 6,000 MHz radiation would not penetrate as deep into tissue as 845 MHz radiation. Nevertheless, the penetration of the 6,000 MHz energy was sufficient to produce serious eye damage.

The conclusion of the Johns Hopkins University staff was that the radiofrequency radiation absorbed by Mr. Angstadt was responsible for his injuries. Should consideration of similar, and higher, levels of radiofrequency energy absorption into the brains of millions of cellular telephone users provide the same conclusion?

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[50] *"Technician Exposed to MW Radiation Files $5 Million Suit," Microwave News 12, no. 6, (November—December 1992) p. 11.*

15

This solid body of evidence that has been built as a research foundation during the 1950-95 time period confirms over and over again what has been established throughout the period. That is: (1) portable cellular telephones expose operators to dangerously and highly damaging levels of radiofrequency energy absorption; (2) the manufacturers, service providers, government, and scientists have been aware of the hazards; and (3) the manufacturers, service providers, and government have not warned the owners of portable cellular telephones.

Instead, industry and government have chosen to concentrate the arguments about safety on the nearly impossible task of proving that low-level radiofrequency radiation does or does not cause cancer. By focusing attention on this type of research the industry can avoid addressing the known facts.

2

"Hot Spot" Radiation Absorption

There are many cases where the belief system is so absurd that scientists dismiss it instantly but never commit their arguments to print. I believe this is a mistake. Science, especially today, depends upon public support. Because most people have, unfortunately, a very inadequate knowledge of science and technology, intelligent decision making on scientific issues is difficult. Some pseudoscience is a profitable enterprise, and there are proponents who not only are strongly identified with the issue in question but also make large amounts of money from it. They are willing to commit major resources to defend their contentions. Some scientists seem unwilling to engage in public confrontations on borderline science issues because of the effort required and the possibility they will be perceived to lose a public debate.

- C. Sagan
Broca's Brain

1

The human head is a complex structure of many different tissue types. Each of the tissues—skin, bone, cerebro-spinal fluid, fat, brain, dura, and others—absorbs and reflect

RF energy. But the amount of absorption and reflection is different from one tissue type to another. In addition, the human head is far from being a uniform structure.

The skull itself is a virtual landscape of ridges and bony prominences on its interior surface. These ridges and prominences, in addition to seams, are accompanied by areas of varying thickness. A quick look in any reference encyclopedia or anatomy reference will show that the inner structure of the human head exhibits some very pronounced interior ridges in addition to void (empty) areas such as the mastoid region.

Surrounding the skull, beneath the scalp, is a layer of subcutaneous fat. The thickness of that fat layer is different from person to person. Within the skull, of course, is the brain, which is held inside the meninges. We know the brain is also comprised of folds and seams.

All of these features in the internal landscape of the human head, in addition to the fact that head size also varies considerably, cause any penetrating RF radiation to be absorbed in a manner which depends strongly on the features of the head. In many instances the RF energy will interact with human head features in a way that directs and concentrates the absorption into small areas rather than being distributed uniformly throughout.

In 1955, researchers H. P. Schwan and G. M. Piersolcp reported that there is danger of causing burns when radiofrequency energy is applied over bony prominences.
Their reasoning for this effect was that nonuniformities such as bone ridges and irregular fat layers cause the energy to be absorbed nonuniformly within the body or head. At "hot spots" excessive amounts of absorbed radiation can cause selective temperature rise of sensitive parts of the body. Consider what this means today, in

view of the previous finding and also in view of hand held portable phones.

For a human head structure this enhancement of absorbed energy is evidence of an energy absorption "hot spot" beneath the skull and at the surface of the brain. At frequencies of 750 MHz and above the absorption would be primarily in the brain tissue.[51] Again, considering a human head, this research points out that the radio-frequency energy, in a broad range from about 500 MHz to 1,000 MHz, is preferentially deposited beyond the skull and absorbed into the brain.

Energy absorption "hot spots" of greater than ten times the overall average have already been described for a bone/brain interface. Many other "hot spots" within the human head are also well known.

Some interior "hot spots" are related to the radius of curvature of the human head. Other reasons for "hot spot" formation will be described subsequently, including the nonuniformities of skull structure and brain tissue within the head.

2

It only takes a very short time to destroy living brain tissue. RF energy absorbed within a fraction of a second can be enough to damage and modify the structure of brain cells and molecules. For example, a few seconds of intense exposure is enough to kill laboratory rabbits with radiofrequency radiation. Researchers noted that

[51] *H. P. Schwan and G. M. Piersol, "The Absorption of Electromagnetic Energy in Body Tissues." Iriterriatiorial Review of Physical Medicine and Rehabilitation (June 1955):424-48. l A*

experiments in which the head area alone was directly irradiated suggest that the fatal outcome was the result of an excessive rise in brain temperature. The lethal effects of irradiation to a limited area of the body are different from those in which the entire animal is exposed.[52]

That warning was first provided in 1952.

Some researchers have reported that in order to obtain selective "hot spot" heating, it is necessary to expose the tissue to the near-zone fields of the energy source.[53]
From their experimental data at 433 MHz, 750 MHz, and 918 MHz these researchers confirmed that energy is readily absorbed from the induction fields in the nearzone. The absorption within the brain was found to be about twenty times greater than in the skull and subcutaneous fat. That is certainly consistent with all of the earlier reported research.

J. C. Lin, Guy, and Caldwell performed thermal studies of rat bodies radiated in the near-zone.[54] Their meaurements indicate an energy absorption (SAR) of 0.9 mW/g for a power density of only 1 mW/cm². They proposed that nonthermal effects may be masked by heating and that, even at low power density, absorption at local "hot spots" may produce thermal stimulation. This concept has serious implications. These researchers have

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[52] H. M. Hines, and J. E. Randall, Electrical Engineering, 71 (1952):879

[55] A. W. Guy, "Analyses of Electromagnetic Fields Induced in Biological Tissues by Thermographic Studies on Equivalent Phantom. Models," IEEE Transactions on Microwave Theory and Techniques MTT—19, no. 2 (February 1971):205-14. '

[54] . C. Lin, et al., "Thermographic and Behavioral Studies of Rats in the Near Field of 918-MHz Radiations," IEEE Transactions on Microwave Theory and Techniques MTT-25, no. 10 (October 1977):833-36. -

proposed that, even at low absorption levels microscopic “hot spot" destruction may be occurring unnoticed.

In one experiment 0.1 mW/cm² average power density resulted in 140 mW/g "hot spots" in radiated animals. Considering that they had earlier determined that 0.1 mW/cm² should result in an SAR of 0.09 mW/g, this latest finding indicates the presence of "hot spots" with enhancement of more than 1,500 times the expected level.

An important point brought out by this particular series of experiments is that within actual test subjects, whether laboratory animal or humans, RF energy can be concentrated into very high-intensity spots just as sunlight may be concentrated with a magnifying glass. Most of us are familiar with the intense heating effect of concentrated sunlight. The same intense effect occurs within living tissue at radiofrequency radiation "hot spot" locations.

These researchers used a power density level that was about one hundred times less than a human receives during portable cellular phone operation. Even so, the SAR 140 mW/g, was so high that tissue destruction would have been nearly immediate. For human brain tissue less than 5 mW/g is sufficient to cause a temperature rise that initiates tissue damage.

Lin also acknowledged that energy absorption occurs vary rapidly.[55] So, during short exposures of from a few seconds to a few minutes, very little heat conduction—heat energy movement through the tissue—takes place. This is important in view of "hot spot" absorptions. If a "hot spot" situation exists, rapid energy absorption

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[55] *J. C. Lin, "On Microwave-Induced Hearing Sensation," IEEE Transactions on Microwave Theory and Techniques MTT-25, no. 7 (July 1977):605-13.*

will have maximum destructive effect because, in accordance with Lin's reported findings, very little of the heat caused by the absorption will have an opportunity to dissipate. As Lin puts it,

> ***Because, microwave absorption occurs in a very short time, there will be little chance for heat conduction to take place.***

The conduction of heat takes much longer. Alternatively, he advises that

> ***the temperature decay is therefore a slowly varying function of time . . .***

What we expect then is rapid heating and slow cooling. At "hot spots" the inability of biological tissue to get rid of excess heat quickly and efficiently may yet be another mechanism leading to destructive exposure, even at levels previously thought to be incapable of raising tissue temperature.

If "hot spots" occur at localized or microscopic regions within the brain, where there are no thermal or sensory receptors, there is no reason to expect that the body will attempt to compensate for the overheating. The human brain simply does not have the capacity to prevent the damage.

There are, of course, exposures that will result in "hot spot" damage that is significant enough to be readily observable. There is also another less noticeable type of "hot spot" damage. Microscopic "hot spots" can selectively destroy or damage tissue and leave no outwardly visible traces of that damage. In the previous chapter exactly

this type of microscopic "hot spot" damage was described and documented.

Humans operating RF radiating devices expose themselves to similar damage. Within the human brain the regions most closely associated with RF radiation exposures, the temporal lobes, are also the regions most tolerant to damage—that is, most tolerant in the sense that one would never know of an injury. It is possible to continually create uncountable millions of microscopic injuries within these regions and yet the damage could go unnoticed externally even with MRI or CT examination. But the damage would produce an effect internal to the injured person.

Recall what we learned earlier from Michaelson and consider it once again within the context of virtually millions of microscopic brain cell injuries:

> ***It should be understood that a cumulative effect is the accumulation of damage resulting from repeated exposures each of which is individually capable of producing some small degree of damage. In other words, a single exposure can result in covert thermal injury, but the incurred damage repairs itself within a sufficient time period, for example hours or days, and therefore is reversible and does not advance to a noticeable permanent or semi permanent state. If a second exposure or several repetitive exposures take place at time intervals shorter than that needed for repair, damage can advance to a noticeable stage.56***

56 S. M. Michaelson, "Human Exyiosure to Nonionizing Radiant Energy—Potential Hazards and Safety Standards," Proceedings of the IEEE (April 1972):389-421.

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Recall that hot spot absorption is a term that researchers themselves have taken to describe exactly what is happening at specific locations within the brain—or any other tissue mass. That is, excess radiofrequency energy is being deposited into some small region of the brain. Which regions of the brain will be subjected to "hot spot" absorption depends on a number of factors related to head size, shape, curvature, subcutaneous fat layer thickness, internal skull structures, and voids within the skull.

Equally important, "hot spots" are dependent on the type of antenna, the physical structure of the telephone, and how the user holds the telephone during operation. All of these variables combine to create a complex matrix of enhancement mechanisms to provide different energy absorption "hot spots" for users. Unless the radiating elements, including antenna and telephone case, are far from the head of the user "hot spots" should be expected.

This information was well understood by cellular telephone manufacturers during the development phase of the 1970s. Their own publications acknowledge as much. In one such infrequent industry report researchers identified an energy absorption "hot spot" located in the temporal region of the human head.

The temperature profiles generated by both antennas inside the head of the simulated operator indicate the presence of a "hot spot" about 1 in below the surface of the temporal bone.[57]

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[57] *Q. Balzano, et al., "Energy Deposition in Simulated Human Operators of 800-MHz Portable Transmitters," IEEE Transactions on Vehicular Technology VT—27, no. 4 (November 1978):174-81.*

These experiments were performed at 840 MHz, which is within the portable cellular telephone transmit band.

Industry researchers acknowledge the need for concern of operator exposure to radiofrequency radiation because

> ***the 800-900 MHz band is very close to the frequencies used for medical diathermy (918 MHz). Diathermy applicators are well known for efficiently depositing energy deep within human tissue.***

They propose that the energy penetrates deep and causes "hot spot" absorption at about one inch below the surface of the temporal bone. Other researchers have confirmed that curvatures of the head will lead to various "hot spots" and that some of the "hot spots" are strikingly pronounced. The industry researchers conclude that

> ***SAR peaks (sometimes called "hot spots") are probably associated with the "focussing" of this EM energy in the frontal bone.***

These experiments, conducted in 1978, were performed with a portable radio, not a portable cellular telephone. Therefore, the antenna was located at the front of the head. Comparing the front of the human skull with the rear, we notice that equivalent curved areas of the skull are located at the rear on each side above either par. As such, any focusing mechanism that is described would be identically replicated at the rear portion of the human head. Portable cellular telephone antennas are, most typically, disposed immediately adjacent to one of those curved regions during operation. Surface curvature is of primary importance. The region of the human head above and behind each ear is a

region of small radius of curvature. That is, it curves a great amount. If the curvature of that region were completed into a full ball shape the size would be about 4 or 5 cm in diameter or a radius of 2-2.5 cm. That is well within the range of sizes found by researchers to support "hot spot" generation.

In the region through the width of the head, that is, ear to ear, the thickness is generally less than from front to back. When considering the structures that support "hot spot" generation these surface and structural non-uniformities of the human head are more important than the overall head size.

Consider now the same structural features of the heads of children and smaller adults. The curved area behind and above the ears is more severe, and the total width of the head is correspondingly reduced. Since "hot spot" absorption is a function of head curvature, some humans, both children and adults, are more susceptible with this type of "hot spot" formation. Long before the introduction of cellular telephones, researchers provided data that indicated that children absorb approximately 50 percent more radiation within their heads than do adults.[58] These results are provided for plane-wave, far field exposures and do not consider any of the enhancement effects that are introduced by near-zone operation of cellular telephones. This same research study also shows that thin men absorb about 33 percent more radiation than an average 70 kilogram (155 - pound) man.

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[58] *C. H. Durney, et al., "An Empirical Formula for Broad-Band SAR Calculations of Prolate Spheroidal Models of Humans and Animals," IEEE Transactions on Microwave Theory and Techniques MTT-27, no. 8 (August 1979):758-63.*

Lin placed the increased absorption effect into a better perspective when he reported that "hot spot" energy absorption can be as much as ten times higher at certain areas within the brain.[59] From experiments performed using models of the human head he reported energy absorptions in the center of the head that were even higher than absorption levels near the surface. This is a prime example of "hot spot" energy deposition.

The presence of nonuniform energy absorption that treated the new type of "hot spot" was initially characterized by H. P. Schwan.[60] The "hot spots" Schwan discussed were somewhat different from those we have considered previously. In the earlier consideration of "hot spots" the focus was on nonuniform radiation, nonuniform absorption characteristics, and nonuniformities within the head. But this researcher performed experiments using various diameter head models.
His conclusions are that as head diameter is reduced energy-absorbing "hot spots" become pronounced. The research found that for heads significantly smaller than that of a mature man the "hot spot" effect increases and so does the amount of energy that is absorbed into the interior of the brain. Clearly this indicates an increased risk of "hot spot" absorption within the brains of women and children, with small children being at maximum risk a "hot spot" absorption within their brains. Keep in mind that this is an additional "hot spot" formation mechanism

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[59] *J. C. Lin, "Interaction of Two Cross-Polarized Electromagnetic Waves with Mammalian Cranial Structures," IEEE Transactions on Bionedical Engineering BME-23, no. 5 (September 1976):371-75.*
[60] *H. P. Schwan, "Microwave Radiation; Hot Spots in Conducting Spheres by Electromagnetic Waves and Biological Implications," IEEE Transactions on Biomedical Engineering BME—19, no. 1 (Janunry, 1972):53-58.*

that may be present along with the other "hot spot" absorptions described earlier.

Other researchers have recorded this same "hot spot" absorption characteristic across a wide frequency range.[61] They also confirmed that the "hot spot" absorption is dependent on the diameter of the head model that they used. As the diameter decreased the absorption effect became more pronounced. Most notably, the greatest absorption enhancement occurs at frequencies between 800 MHz and 1,000 MHz - effectively covering the portable cellular telephone transmit band.

Researchers also reported that maximum "hot spot" energy absorption enhancements occur in the frequency region around the cellular telephone frequencies.[62,63] Of course, they didn't report their findings as being particularly noticeable for the portable cellular telephone transmit-band, because most of this work took place during the 1970s, from about 1972 through 1976. There were no cellular telephones on the market at that time, but they were under development in the research labs. All of which means that this alarm raised about "hot spot" RF energy absorption related to head size and children has been known in the industry since long before the very first portable was put into the anxious hands of the very first customer.

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[61] *H. N. Kritikos and H. P. Schwan, "Formation of Hot Spots in Multilayer Spheres," IEEE Transactions on Biomedical Engineering (March 1976):168-72.*

[62] *H. P. Schwan, "Microwave Radiation; Hot Spots in Conducting Spheres by Electromagnetic Waves and Biological Implications, "IEEE Transactions on Biomedical Engineering BME—19, no. 1 (January 1972):53-58.*

[63] *H. P. Schwan, "Microwave Radiation; Biophysical Considerations and Standards Criteria," IEEE Transactions on Biomedical Engineering BME—19, no. 4 (July, 1972):304-12.*

These researchers also reported that the "hot spots" are evident in head sizes up to about 6 1/2 inches in diameter. That's a fairly large head diameter and leads to tho conclusion that since many human heads are smaller than 6 1/2 inches in diameter, many human exposures to cellular telephone radiofrequency radiations would include this type of "hot spot" formation.
With reference to figures that document their research findings C. C. Johnson and A. W. Guy state:[64]

> ***The figures clearly illustrate the intense fields and associated absorbed power density directly in the center of the human head . . . for 918 MHz exposure.***

Available research has already been presented here that verifies that the radiofrequency radiation absorption characteristics of biological tissue are indistinguishable, that is, virtually the same, for both 845 MHZ and 918 MHZ. Whatever absorption characteristics are found at 918 MHZ will also hold at 845 MHZ. Similarly those energy absorption characteristics found to be true at 750 MHZ will also be true at 825 MHZ and again at 918 MHZ. This entire range of frequencies is the same with respect to energy deposition into biological tissue. Usually, as radiofrequency radiation penetrates into the brain it is being absorbed so that as it propagates more deeply there is less remaining and the magnitude, or strength, of the radiation decreases with increasing depth. But this is not the situation' where "hot spots"exist. Johnson and Guy report that, at 918 MHZ the depth

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[64] *C. C. Johnson and A. W. Guy, "Non Ionizing Electromagnetic Wave Effects in Biological Materials and Systems," Proceedings of the IEEE, 60, no. 6 (June 1972):692-718. C*

of penetration is 3.2 cm, and that's consistent with what we've reviewed earlier. However they found that

> ***...for human brain exposed to 918-MHz power, the absorption at a depth 2.3 times the depth of penetration (depth of penetration=3.2 cm) is twice the absorption at the surface. This corresponds to a factor greater than 200 times that expected . . .***

This means that at a depth within the human brain of about 7 cm (almost 3 inches) "hot spots" were found that produced energy absorption 200 times greater than would be the case if no "hot spot" existed.

More startling is the observation that at this great depth within the brain the "hot spot" absorption is actually two times greater than the absorption near the surface where the radiation is assumed to be strongest.

> ***The regions of intense absorbed power density are due to a combination of high refractive index and the radius of curvature of the model which produces a strong focusing of power toward the interior of the sphere.***

Focusing due to head curvature is held responsible for the "hot spot" absorption. With this knowledge, along with earlier research findings reporting the same results, we can understand how people with smaller or rounder skull shapes may be at increased risks and how people who operate cellular telephones with antennas placed in particularly dangerous positions at their heads could also be in greater danger.

W. T. Joines and R. J. Spiegel[65] expanded experimentation and computations with human head models by working with a structure comprised of six layers: skin, subcutaneous fat, skull, dura, cerebro-spinal fluid, and brain tissue. A total thickness of the five layers that surround the brain is given as 1.10 cm. However, we must keep in mind that the layers, most principally the subcutaneous fat layer, will vary appreciably from one human to another.

Computerized calculations indicate enhanced energy absorption in the six-layer models of the human head compared to what had been reported by earlier researchers. To this point we have noted that developments moving from flat homogeneous models—slabs of simulated tissue—to two layered spherical models and then to six-layer model consistently yield findings of higher RF energy absorption. As the models become more complex and increasingly representative of an actual human head the findings continue to indicate that the energy absorption is much higher than previously thought. Although the primary importance of their work rests with the effects of the multilayered model, these researchers also found that an absorption peak occurs at approximately 750 MHz and near 2,100 MHz for a 7 cm radius sphere.

Interestingly, both of these frequencies are almost exactly where the cellular telephone industry has chosen to operate their portable transmitters. The PCS devices operate near 2,100 MHz—actually in the I700—1900 MHz range.

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[65] *W. T. J oines and R. J. Spiegel, "Resonance Absorption of Microwaves by the Human Skull," IEEE Transactions on Biomedical Engineering (January 1974):46-48.*

Still other independent researchers reported that "hot spots" are formed inside models of human heads with radius of from 0.1 to 8.0 cm for frequencies between 300 and 1,200 MHz.[66,67] The range of sizes includes almost all human heads. It is clear that what was first observed as a danger to those with smaller cranial structure, and most notably including children, has been extended by additional scientific studies to include nearly all humans. Of course, the most dramatic "hot spot" peaks are within the smaller heads.

D. T. Borup and O. P. Gandhi[68] have published SAR distributions from a computer analysis of the human head. They found that for a plane-wave arriving from the front of the head, distinct energy absorption "hot spots" are shown. This is interesting, since the computer analysis confirms that even plane-wave induced radiation absorption results in interior energy absorption "hot spots." In this instance the observed "hot spots" amount to an energy absorption (SAR) of 0.6 mW/g for an incident power density of 1 mW/cm². At portable cellular telephone power densities, 10-20 mW/cm², the SAR would be 6-12 mW/g—enough to cause substantial temperature rises.

In the near-field, that same incident power density would result in a much higher SAR due to a number of

[66] *H. N. Kritikos and H. P. Schwan, "The Distribution of Heating Potential Inside Lossy Spheres," IEEE Transactions on Biomedical Engineering BME—22, no. 6, (November 1975):457-63.*

[67] *G. H. Wong, et al. "Probing Electromagnetic Fields in Lossy Spheres and Cylinders," IEEE Transactions on Microwave Theory and Techniques MTT—32, no. 8 (August 1984):824-28.*

[68] *D. T. Borup and O. P. Gandhi, "Calculation of High-Resolution SAR Distributions in Biological Bodies Using the FFT Algorithm and Conjugate Gradient Method," IEEE Transactions on Microwave Theory and Techniques MTT—33, no. 5, (May 1985):417-19.*

enhancement factors including the near—zone "matching" effect discussed earlier.

The cellular telephone manufacturers have maintained, until recently, that any radiofrequency energy absorption would be primarily superficial and lead to a sensation of heating before excessive or dangerous levels were reached. Of course, that position cannot be supported in view of the many research findings that show that most of the energy radiated from the phones ends up as absorbed energy in a "hot spot" within the user's brain. Our earlier review of radiation absorption and heat sensation has shown the industry claims to be quite absurd.

In 1955, researchers investigated this very topic and concluded that if the power level was sufficient to produce a "feeling of warmth on the skin, the deep temperatures, which are higher than the superficial ones, will be elevated to a point that may bring about tissue destruction.[69] In those types of experiments the temperature rise in brain tissue is much higher than that of the skin and fat layers.

4

Researchers have also investigated the effects of nearby radiation reflectors. Energy-reflecting surfaces or materials can be thought of in the same way as one would think of a mirror acting on visible light. The same is true with radiofrequency radiation except that the reflecting surface might be a metallic conductor or wire mesh rather

[69] *H. P. Schwan and G. M. Piersol, "The Absorption of Electromagnetic Energy in Body Tissues," International Review of Physical Medicin and Rehabilitation, June 1955, pp. 424-48.*

than a mirror. In terms of radiation absorption within a person's head, it's somewhat like operating two portable cellular telephones or a single phone at a much higher power setting.

Gandhi has reported experimental research that was performed to confirm the radiation absorption enhancement that occurs when subjects are close to reflecting surfaces.[70] According to theory, as the ratio of the body diameter (such as the diameter of the head) to wavelength is reduced the enhancement factor increases and as the distance from the reflecting surface to the absorbing object decreases the enhancement factor also increases.

Therefore, we would expect that operation of a portable cellular telephone in close proximity to energy-reflecting surfaces, such as automobiles or metal structures, would result in enhanced energy absorption within the head and brain of a user. A secondary effect is that as the signal received by the "cell site" is weakened, the portable will receive coded instructions to increase its radiated power level. This provides even more radiation to be absorbed within the user's head. Gandhi reported a measured energy absorption enhancement factor of as much as 27 in close proximity to corner shaped reflectors and about 4.7 for flat reflectors. The first of these numbers, twenty—seven times greater absorption, is truly astounding. But when we consider that more than 50 percent of the energy radiated by portable cellular telephones is absorbed within the user's head without the presence of a reflector, it becomes clear

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[70] *O. P. Gandhi, et al., "Deposition of Electromagnetic Energy in Animals and in Models of Man with and without Grounding and Reflector Effects," Radio Science November—December 1977, pp. 39-47.*

that the enhancement by a factor of 27 is an upper limit that would not be reached.

The other condition, that of enhanced absorption in (close proximity to a flat reflector, is reported to provide a 4.7 —fold increase in absorption. Again, since more than 50 percent of radiated energy is already absorbed by the user, the 4.7—fold increase represents the potential for t enhanced absorption and should be viewed as an indication of what actually happens as one operates a portable phone close to reflectors. That is, of the energy which is actually radiated, and not initially absorbed by the head and brain of a user, much will be reflected by the metallic surfaces and deposited into the user's head. This certainly doesn't leave much energy to be radiated for communications purposes.

This work by Gandhi highlights consideration of yet another absorption "hot spot" mechanism. Although this is not a "hot spot" in the strict sense of others that have already been discussed, it remains a "hot spot" issue related to where a user operates the phone and how that user might move about during operation.

For example, a portable telephone user may initiate a call while standing on a city sidewalk with no reflecting surfaces nearby, in which case the absorbed radiation, although excessive and dangerous, would not be enhanced by reflecting surfaces. Then, during that phone call a truck or bus or even an automobile may drive up and stop alongside the caller, in which case the reflection mechanism occurs and the enhanced absorption takes place. More insidious is the enhancement that may occur in the presence of reflecting surfaces that cannot be seen. Examples would include the metal framing of buildings, metal office furniture, and even the reflections from steel and cast iron bathtubs.

Gandhi also states that

in view of these observations and also since the hot spots may shift rather readily upon placement of other targets in close proximity, the entire region may be considered as one that is potentially capable of creating large enhancements. Furthermore, the reflecting surfaces need neither be good conductors nor solid in construction to cause enhancements.

When these researchers note that "hot spots" may shift readily due to placement of conductive reflectors in close proximity to the entire region this paints the clear picture that as a portable telephone operator moves about, for example by moving his or her head within an automobile, the absorption "hot spots" within the head will also shift.

Gandhi's observation that it is not necessary for reflectors to be good conductors or solid surfaces to cause the enhancements is also very informative. He points out that insulating surfaces, such as, for example, glass with embedded conducting rods, can act as solid reflecting surfaces. Consider, for example metallic screening in screen windows, metallic window shades, or the thin wires in automobile windows that are used for window defogging or for automobile radio antennas. It would be a fairly safe conclusion that the cellular telephone industry has failed to warn users about the enhanced radiation absorption related to operating a portable cellular telephone: (1) while in an automobile or bus, (2) in or near metal-framed buildings, (3) in close proximity to metal window screens or metal window shades, (4) close to metallic office furniture, (5) near large metal objects, (6) while wearing metal-framed eyeglasses, or (7) near any other type of radiofrequency radiation reflecting objects.

In a 1980 report on energy absorption, researchers determined that average SAR may only be employed for plane wave exposure.[71] In the near-field absorption enhancements completely negate any meaning of the term average SAR exposure. Also, as reported earlier by others, those researchers believe that some biological effects that occur at power density levels of less than 0.5 mW/cm² can be attributed to “hot spots" which produce thermal effects in localized areas of tissue. They also explain that

> ***because of the complications associated with defining, calculating, or measuring the near-field radiation, problems that are associated with near-field irradiation of biological models have not been solved.***

Let’s rephrase that last statement. Since the problems associated with near—zone radiation exposure are difficult, they have not been solved.

R. G. Olsen and T. A. Griner[72] also provide a communication related to their earlier, 1980, research. They identify in the update communication that

> ***Results of those experiments showed a distinctive internal ‘hot spot’ of microwave absorption in the head of the model.***

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[71] *M. F. Iskander, "Irradiation of Prolate Spheroidal Models of Humans in the Near Field of a Short Electric Dipole," IEEE Transactions on Microwave Theory and Techniques MTT—28, no. 7 (July 1980)801-7.*

[72] *R. G. Olsen, T. A. Griner, Bioelectromagnetics 3, no. 3, 1 1982):385-90. .*

The "hot spot" information was not released with the original published research.

It should be remembered that the earlier research to which this correction refers was a plane—wave (far-zone) radiofrequency radiation exposure of a homogeneous material, and yet it produced a "hot spot" within the head.

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R. J. Spiegel[73] considered the existence of "hot spot" absorption in relation to the existence of nonuniform electric fields in the near-zone of antennas. Other researchers had already investigated and verified very large nonuniformities of the electric fields near the antennas. Spiegel reported that damaging biological effects may be observed at temperatures above 41.6°C and that the severity of effects can be expected to be greater in organs such as the brain. He stated in 1982 that

> ***there is virtually no quantitative information in regard to the heating patterns in a human subjected to near-zone antenna fields. For ethical reasons this information cannot be acquired using actual human subjects.***

Why is this report of significance? Remember that by 1982 the cellular telephone industry had developed within its research and engineering laboratories the first generation of portable telephones. At the same time, the

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[73] *R. J. Spiegel, "The Thermal Response of a Human in the Near-Zone of a Resonant Thin-Wire Antenna," IEEE Transactions on Microwave Theory and Techniques MTT—30, no. 2 (February 1982):177-85.*

research community had warned the manufacturers that:
(1) the work related to safety had not been performed; (2) the overwhelming indications are of a hazard to nearzone exposure; (3) many types of "hot spot"—generating mechanisms compound the effects of even low-level radio-frequency radiation exposures; and (4) humans cannot be eased for the potentially deadly experiments to determine safety/hazard levels.

A short time thereafter researchers proved, once again, that focusing radiofrequency energy is effective for providing deep penetration and "hot spot" absorption.[74] The focusing effect was so pronounced that those researchers considered applications of radiofrequency energy for hyperthermia by utilizing absorption "hot spots" for tissue heating and reported that focused deep penetration depths of as much as 6 cm were obtained. The researchers pointed out that by focusing the energy into a "hot spot" the amount of power required from an energy source is reduced by a factor of more than 20. Conversely this means that an energy-radiating element, such as an antenna, can provide greatly enhanced and focused energy deposition. Because of nonuniform absorption, localized "hot spots" may arise without any significant increase of the overall temperature. Small regions of the tissue may reach damaging temperatures while the total body doesn't exhibit an increase. This supports the earlier finding that reported significant internal "hot spots" at very low radiation levels.

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[74] *H. Ling, et al., "Frequency Optimization of Focused Microwave Hyperthermia Applicators," Proceedings of the IEEE 72 no. 2 (Februairy 1984):224-25.*

Spiegel recites some of the concerns related to localized "hot spots" that exist even when the overall temperature rise is inconsequential. They include

> ***localized temperatures above 41.6°C cause protein denaturation, increased permeability of cell membranes, or the liberation of toxins in the location where the hot-spot exists. The severity of the resultant physiologic effect produced by localized temperature increases can be expected to be worsened in critical organs, such as the brain.***[75]

Spiegel recognized the particular susceptibility for damage to the human brain and the complex functions that the brain performs and was concerned with the local "hot spot" absorption effects. He was also cognizant of the nonuniform focusing effects of near-zone exposure to radiating antennas and reported that "localized SAR distributions produced by the antennas are much different than those generated by plane-wave fields.

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A technique commonly employed to disguise the seriousness of the nonuniform energy absorption in biological tissue is to present data in terms of average whole body terms. In that way, no issue can be raised concerning possible local high—energy density absorption. As an extension of the averaging techniques and homogeneous

[75] *R. J. Spiegel, "A Review of Numerical Models for Predicting the Energy Deposition and Resultant Thermal Response of Humans Exposed to Electromagnetic Fields," IEEE Transactions on Microwave Theory and Techniques MTT—32, no. 8 (August 1984):730-46.*

modelling, which is nonrepresentative of human structures, researchers have employed materials which represent "average tissue characteristics." That is, they take an average of the electrical properties of materials such as fat, muscle, bone, brain tissue, and skin to arrive at some agglomeration that represents nothing that can be identified as a biological tissue.

Then, using this nonrepresentative material as a ho-. mogeneous gel-like mass that is poured into a human skull, or some material that "represents" a human skull, the researchers perform their tests.

Fortunately, not all researchers employ such nonrep-resentative structures, and we have already reviewed reports related to the inaccuracies that they can produce liven more fortunately, the simplified, nonrepresentative structures do not mask the most significant absorption effects.

In a publication by I. Chatterjee, et al., they elected to utilize a nonrepresentative "tissue cocktail" mixture that Guy developed some years earlier.76 It has become known as "2/3 muscle" tissue. That is, the energy-absorbing characteristics of the material are supposed to be approximately two-thirds that of muscle. A mannequin filled with the mixture corresponding to the electrical characteristics of two-thirds muscle properties is used by those researchers to draw conclusions on absorption characteristics.

The homogeneous phantom was irradiated at 800 MHz, and the experimental measurements confirmed the existence of a "hot spot" in the temporal lobe region that

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76 I. Chatterjee, et al., "Quantification of Electromagnetic Absorption in Humans from Body-Mounted Communication Transceivers," IEEE Transactions on Vehicular Technology VT—34, no. 2 (May 1985):55-62.

had been observed some years earlier by industry experimenters. Another energy absorption "hot spot" that those researchers found includes the region where an eye would be located, but we should keep in mind that this homogeneous single—material model has no distinct structures or humanlike organs.

In spite of the shortcomings of the model, the researchers were still reporting "hot spots" and radiation absorption in excess of 2 mW/g. Since the radiating antenna was disposed at the front of this experimental model we would anticipate that other "hot spot" generating mechanisms would come into play and cause higher absorption if the experiments were conducted with the antenna at the side of the head and behind the ear of a more representative human head structure. It may be worth noting that the form in which the "tissue cocktail" was poured was a fiberglass mannequin. Not quite the same as a subcutaneous fat layer over bone of a skull.

An unrelated series of near-zone exposure experiments using a whole-body homogeneous model yielded data showing distinct "hot spot" energy absorption.[77] Most of the energy was deposited in the part of the "body" nearest to the antenna, with near-field enhancements of from 30 to 250 being reported. It is puzzling that the researchers chose to place the radiating antenna at the back of the model—approximately at the height of the shoulder blades for a human. However, that odd placement for the antenna still yielded data showing that most of the energy is deposited in the head and neck.

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[77] *S. S. Stuchly, et al., "Energy Deposition in a Model of Man: Frequency Effects," IEEE Transactions on Biomedical Engineering BME—33, no. 7 (July 1986):702-11.*

Even with the unrealistic placement of the radiating antenna, the researchers have found significantly enhanced energy absorption in the head of the human model. As a result of their experiments they have determined that whole-body average SAR is not a proper dosi-metric measure. In other words, they believe that it is improper to take a localized very high exposure and average it over the total body surface in an attempt to meet the IEEE/ANSI standards. They have instead acknowledged that high energy absorption in a small localized area must be treated as a completely different circumstance from plane-wave exposures.

They also point out, and their data support the position, that most of the radiofrequency energy absorption takes place within the human model at locations very close to the antenna. Again, there is nothing surprising in the findings, as they are in concert with the earlier reports of many other scientists. One revealing distinction of this data is an energy absorption "hot spot" located in the model at a position next to the antenna feed-point. Recall that others have earlier found the same type of "hot spot" and associated the increased energy deposition with higher radiation at that point on the antenna.

High SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous. For antennas located close to the body, the high values of the peak SAR on the body surface, compared to the whole body average SAR, result in exceeding ANSI condition of 8 W/kg in one gram of tissue even for transmitters with relatively low RF output power.[78]

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[78] *S. S. Stuchly, et al., "Energy Deposition in a Model of Man: Frequency Effects," IEEE Transactions on Biomedical Engineering BME-33, no. 7 (July 1986):702-711.*

8

During 1991 P. J. Dimbylow and O. P. Gandhi calculated SARs in heterogeneous models over a frequency range covering 600 MHz to 3 GHz with a view toward focusing, resonance, and enhanced energy absorption. Their concerns Were with radiofrequency energy deposition in the human head, particularly the eyes and brain. Although a broad range of graphical data representing the results of the experiments is included, some graphical data at 800 MHz for the adult human head is notably missing. It is intriguing that a blank space exists where the data would have been placed.

From the graphical and tabular data presented, the researchers reconfirm that exposure to radiation in the 800 MHz range leads to nonuniform absorption. For a radiation source located in front of the model the researchers note energy absorption "hot spots" in the eyes and at the center of the brain in the adult human head model. At the same frequency and also for frontal exposure, a model of a smaller head representing a child yields a much higher energy absorption "hot spot" in the brain center in addition to the "hot spots" at the eyes.

For radiation exposure coming from the side of the head only the graphical depiction of the child size head is shown. That graph illustrates significant "hot spot" absorption predominantly at one side of the head and at one eye. Coincidentally, the missing graphical data corresponds to experiments performed with the radiation incident at the side of the adult head model and at 800 MHz. These data would correspond to the type of exposure and absorption we would expect from a cellular phone.

The researchers provide tabulated data for the full range of frequencies covering 600-3,000 MHz. However, the data do not document the absorption peaks but, rather, only averaged values. Some indication of the peaks may be learned by looking to the highest averages listed for each of the exposures.

Even without employing any enhancement mechanisms the researchers have shown that relatively low level radiation, at 1 mW/cm², will result in significant energy absorption levels in the human brain.

For a child's head, irradiated from the front with 800 MHz energy, a maximum average energy absorption of 1.23mW/g is listed. For frontal exposure with the adult human model at 800 MHz a maximum average energy absorption of 0.9mW/g is given. For side exposure at 800 MHz to the head of a child the maximum average absorption level is given as 0.8mW/g. Similarly for the adult model the maximum average is given as 0.6mW/g. Keep in mind that all of the "maximums" are, in fact, averaged over one gram of tissue. That is, averaged over a cube of tissue about 0.4 inches on each side. The opportunity for significantly higher energy absorption "hot spots" within such a large volume is most probable. Recall that within a 1 cm cube of tissue there are billions of molecules and bonding links, some of which may be particularly susceptible to high energy absorption.[79]

More significant than the averaging technique the researchers employ, is the fact that these calculations have been performed by simulating plane-wave exposure.

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[79] *P. J. Dimbylow and O. P. Gandhi, "Finite-Difference Time-Domain Calculations of SAR in a Realistic Heterogeneous Model of the Head for Plane-Wave Exposure from 600 MHz to 3 GHz," Physics in Medicine and Biology 36, no. 8 (1991):1075-89.*

Recall that plane-wave radiation assumes the energy radiating element is very far from the human. The result is that the energy arrives at the human as a uniform "wave" of energy without variations in intensity. Since these researchers did not employ real exposure conditions, their results do not incorporate any of the known enhancement mechanisms.

When we relate these findings to the power density levels known to exist as a result of using portable cellular telephones, approximately 10-20mW/cm², it is evident that energy absorption levels of 10-20mW/g can be expected at some localized regions in the brain of an operator of the portable telephone. That's also without factoring in any of the absorption "hot spot" mechanisms or nonuniform radiation mechanisms. The potential for highly focused lethal levels of energy deposition is well defined—and documented earlier by Lin.

Consider now, for example, the low-level radiofrequency radiation exposures, without factoring in the effects of reflectors, head curvature, nonuniformities of absorption, nonuniformities of antenna radiation, different tissue interfaces, temperature compensation mechanisms, metal-framed eyeglasses, internal skull ridges, brain size, or any of the other enhancement mechanisms

Then begin to factor in the effect of each of the possible enhancement mechanisms that have already been identified. It doesn't take long before we're ready to conclude that even at low radiation exposure levels these I other mechanisms may provide for local "hot spots" that are truly extraordinary in magnitude and undoubtedly destructive to human tissue, in particular highly sensitive brain tissue. Recall that Lin had already reported in a separate paper a single "hot spot" formation mechanism that provides for local enhancement by a factor of

1500. What should we conclude the total enhancement factor will be when some of these other absorption enhancement mechanisms also come into play?

3
Biological Effects of Radiofrequency Energy

Some of you might plead the excuse of your ignorance, of a limited mind and a limited range. But the damned and the guiltiest among you are the men who had the capacity to know, yet chose to blank out reality, the men who were willing to sell their intelligence into cynical servitude to force: the contemptible breed of those mystics of science who profess a devotion to some sort of 'pure knowledge"— the purity consisting of their claim that such knowledge has no practical purpose on this earth—who reserve their logic for inanimate matter, but believe that the subject of dealing with men requires and deserves no rationality, who scorn money and sell their souls in exchange for a laboratory supplied by loot. And since there is no such thing as "non-practical knowledge" or any sort of "disinterested" action, since they scorn the use of their science for the purpose and profit of life, they deliver their science to the service of death . . . They, the intellects who seek escape from moral values, they are the damned on this earth, theirs is the guilt beyond forgiveness.

—A. Rand
Atlas Shrugged

1

The earliest safety standards were based on energy absorption and temperature increases within tissue.[80] The two are mentioned together because it is a natural consequence of energy absorption that there will be a temperature increase in tissue. But subsequent revisions of the standards shifted attention to consideration of behavioral effects only. The shift away from internal biological effects became even more pronounced when the guideline for determining biological effects was changed to only "observable" effects. In other words, if an exposure doesn't result in an observable reaction or malfunction of the test subject, then the exposure isn't deemed to cause a biological effect. But what of the nonobservable effects or long—term consequences? Let's review some of the research results to determine the effects not included in determinations of safe radiation exposure levels. In a restatement of absorption characteristics, which by now must seem somewhat elementary, researchers again concluded in 1984 that to achieve deeper penetration of radiofrequency energy the 750-900 MHz range is better than 2450 MHz.[81] Particularly, it is known that radiofrequency energy absorption causes deep heating in tissue, which can lead to molecular damage, cell damage, or cell death. Any discussion of radiation exposure standards points out a serious bias that has been used effectively by opponents to stricter exposure limits. Safety standards are almost exclusively based on behavioral studies

[80] *H. P. Schwan, "Nonionizing Radiation H,azards," Journal of the Franklin Institute, December 1973, pp. 485-97.*
[81] *E. Friedenthal, et al., "Hyperthermia in the Treatment of Local Recurrence of Breast Cancer," Microwave Journal, May 1984, pp. 275-82.*

of laboratory animals. Usually laboratory animals are the test subjects and are trained to perform specific tasks such as running a maze or pressing a lever for food pellets. In order to assess the effects of radiofrequency radiation exposure, trained laboratory animals are observed while being irradiated with the energy. With testing repeated at various radiation levels the researchers can determine at which exposure levels the animals begin to lose the ability to perform the trained task. That's the process.

The very same safety standard that determines safe exposure of humans to radiofrequency radiation is based on whether or not it causes a rat to take more time to run a maze or causes a duck to peck for food pellets at a slower rate.

This then brings us to consider the fundamental flaw of the entire issue. Portable cellular telephones expose users to radiofrequency radiation and energy absorption in excess of the safety limits published by the Institute of Electrical and Electronic Engineers and adopted by the American National Standards Institute. These levels have been shown to cause behavioral effects and biological damage in laboratory animals.

In addition to simple behavioral effects there are nonbehavioral effects to be considered. Is the safety of the entire portable telephone—using population to depend on whether or not laboratory rats suffer memory deficits significant enough to cause the rat to forget how to run in maze? Does this also mean that the cellular telephone industry is prepared for the human user to suffer equivalent memory degradations and loss of capabilities?

In the past scientists were less certain of the danger threshold than they are today, but they were, nonetheless, greatly concerned that exceeding the threshold would lead to irreversible biological damage and harm.

Even exposures at levels generally thought to be non-damaging result in temperature rises of some tenths of a degree Celsius within the brain of humans. And that's without enhancements or consideration of "hot spot" formation. Nonuniform electrical properties of tissue result in nonuniform absorption and heating. Such nonuniform absorption and heating can lead to areas of damage and destruction within the head and brain even when the "average" exposure would seem to be not excessive.

2

During 1948 researchers reported that electromagnetic radiation at 2,450 MHz "is highly productive in producing lenticular opacities.[82] The lenticular opacities of which the researchers were speaking are more commonly referred to as cataracts. During the experimental portion of the research it was found that exposure of the eye (in this case rabbit eyes) to radiofrequency radiation sufficient to raise the temperature in the eye to 46°C resulted in cataract formation from six to twenty-four days after exposure.

The researchers comment that in addition to the introduction of cataracts in eyes exposed to radiofrequency radiation, "microwave generators serve adequately for producing temperature increases in selected areas of the body." These same researchers reported that exposures (if rabbits' eyes at lower power density also leads to creation of cataracts.

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[82] *A. W. Richardson, T. D. Duane, and H. M. Hines, "Experimental lienticular Opacities Produced by Microwave Irradiations," Archives of Physical Medicine, December 1948, pp. 765-69.*

In another independent study, researchers found that radiofrequency radiation exposure could result in permanent eye damage at temperatures much lower than that reported by the Richardson team. This group reported that exposure of dog eyes to microwave energy sufficient to induce a temperature rise of from 1.9 to 3.2°C also produces cataracts. Tissue necrosis (death) and disorganization of the pigment layer were also observed under microscopic examination.83

Another report, by a Johns Hopkins researcher, Henry A. Kues, also contradicts the industry position. In the Kues report morphological changes, cell destruction, and cell death comparable to that which would be expected from ultraviolet radiation are reported for exposure of rhesus monkeys to 1,250, 2,450, and 2,850 MHz radiofrequency radiation. The researchers made a point of advising that the exposure levels were too low to produce any heating in the tissue84. These results are consistent with the findings of others that identify cell and DNA damage at low exposure levels. Because of this low level radiation damage these researchers have proposed that SAR may not always be an appropriate indicator of biological effects.

The 1980 research by L. S. Taylor indicates that radiofrequency energy exposure may inactivate enzymes or proteins that are involved in the repair process to correct DNA breaks. Thus, he indicated that, in addition to the prospect of causing direct DNA damage, radiofrequency

83 L. Daily, et al., "Effects of Microwave Diathermy on the Eye,"Society Proceedings, December 1948, p. 432.
84 H. A. Kues, "The Importance of Specific Microwave Parameters for the Induction of Ocular Effects in the Non-Human Primate," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 7.

energy exposure may be responsible for inhibiting inherent DNA repair processes.[85]

3

Early reports of a long-term study using laboratory rats to detect radiofrequency radiation-induced cancers became known during 1984. At the annual Bioelectromagnetic Society conference two researchers from a team at the University of Washington headed by Guy made presentations of their research that indicated an excess of malignant tumors in laboratory rats. Dr. Chang, of the National Institute of Occupational Safety and Health, and Dr. Milham, of the Washington State Department of Social and Health Services, "immediately deduced a pattern of increased malignancies in the endocrine system."[86] On the basis of the scientific presentations, conference meetings, and discussions with the researchers, Microwave News reported that,

> ***microwaves can promote cancer, according to the first long-term study of microwave exposure ever carried out in the United States.***

The research was sponsored by the U.S. Air Force and they forwarded the experimental findings to Dr. Vernal. Of the Toxic Hazards Research Unit at the University of (California at Irvine. According to Microwave News, Dr. Vcmot responded that the "finding of excess malignancies in the exposed animals is provocative."[86] The

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[85] *L. S. Taylor, "Implantable Radiators for Cancer Therapy by Microwave Hyperthermia," Proceedings of the IEEE 68, no. 1, (January 1980):142-49.*
[86] *Microwave News 4, no. 6, (July/August 1984):1.*

research findings were not published but instead became available as a series of air force reports that were not widely distributed.

The radiofrequency energy/cancer link debate heated up even further the following year, 1985, when Szmigielski reported an epidemiological study performed with Polish military personnel. The data indicate an increased incidence of cancer by as much as 6.7 times. Szmigielski stated that

> ***I am very surprised with the results we obtained. There is an urgent need to repeat this study using another well-defined and well-controlled population.87***

Not surprising is the fact that funding for replication studies has never been provided. However, that is no more surprising than the lack of funding for follow-up of the study that reported the significant increase of malignant tumors found in laboratory animals exposed to low-level radiofrequency radiation.

Recall that the U.S. Air Force sponsored the original study and that researchers have been clamoring for replication ever since the initial findings were made known. Since the original data was released three additional malignancies have been discovered which raises the total to eighteen for exposed rats versus five for controls. But, the research study has never been replicated.

As guest editor of the March 1987 edition of the IEEE Engineering in Medicine and Biology Magazine Gandhi wrote:

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87 "Polish Epidemiological Study Links RF/MW Exposures to Cancer," Microwave News 5, no. 2 (March 1985).

The coupling of electromagnetic radiation to the human body is quite complex, as it depends on frequency, polarization, far-field versus near-field, corporeal posture, etc. Funding for research in this area has generally been limited, which causes most of the studies to focus on acute short-term exposure levels. These studies are not relevant to an analysis of chronic low-level exposures lasting several years. Although an expanded research effort is needed, we are instead witnessing a rapid reduction in research efforts due to cutbacks in funding.

At that time the studies showing increased malignancies in laboratory animals and the data that found increased glial nodules as a result of low-level radiofrequency radiation exposure were well—known. The radiofrequency radiation exposures used for those studies were much lower than operators of today's portable cellular telephones experience.

Although never officially confirmed, there are reports in the scientific community—among the researchers-that the air force did replicate the low-level exposure studies first performed at the University of Washington. The unconfirmed reports are that the results were identical to what the university researchers found, that is, a dramatic increase in malignant disease due to low-level radiofrequency radiation exposure. If the reports of the secret research are true, it only confirms the findings of Guy and his team.

If the secret replication studies were never performed, it leaves the obvious question—how and why could such significant findings be cast inside by the government without replication studies?

In a 1985 survey of the literature, researchers R. S. Lin, et al., reported that a "greater—than-expected" incidence of gliomas and astrocytomas is related to occupations connected with exposure to radiofrequency electromagnetic fields. They also report that animal studies have shown proliferation of microglia in the brain following exposure to radiofrequency electromagnetic fields. The presence of microglia is a strong indicator of earlier tissue damage and a subsequent repair process. The cited study, that by Y. A. Kholodov (1966), predates the experiments Guy performed that yielded the glial nodules in the brains of his test subjects.88

Some researchers funded by industry or the military, faced with the prospect of releasing undesirable experimental findings, will employ a broad range of "devices" to put a favorable "spin" on the results and change the perspective of those findings. In a restatement of the effects to rats chronically exposed to low—level radiofrequency radiation some researchers seem to refute their own findings of a statistically significant increase of tumors in laboratory animals exposed to low-level electromagnetic energy. The report is an attempt to claim an effect in the unexposed control group by using the experimental group as a basis.

In that article the researchers describe the long-term U.S. Air Force—sponsored study performed by A. W. Guy, et al., over a three-year period.

It compared 100 rats that were irradiated for most of their lives with 100 rats that were not exposed to

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88 R.S. Lin, et al., "Occupational Exposure to Electromagnetic Fields and the Occurance of Brain Tumors," Journal of Occupational Medicine 27, no. 6 (June 1985):413-19.

radiation but were otherwise treated identically 89

Thus Guy has described the environment: 100 control group rats and 100 radiation exposed rats, all of which lived in identical environments.

After the experiments were completed, the researchers reported that eighteen malignant tumors developed in the exposed rats as compared to five in the control group rats. Such a difference the researchers claim is "statistically highly significant." They also state that

at face value this last finding suggests that low levels of microwave radiation can cause cancer in mice (and by inference to humans) . . . (see footnote 89).

The initial research findings were made known substantially as stated earlier. However, sometime later the researchers "reconsidered" their results and reversed their opinions.

The "politically correct" position is restated in the *Scientific American* article as:

For one thing, the total number of malignant tumors in the control animals was lower than the number expected for the particular strain of rat; the rate of malignancies in the exposed rats was about as expected . . . (see footnote 89).

Now let's review this data. All of the laboratory rats lived their lives in the same environment. Would we not expected that the entire group of 200 rats exhibit some similar level of tumor formation but not necessarily the same

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[89] *K. R. Foster, and A. W. & Guy, "The Microwave Problem," Scientific American 255, no. 3 (September 1986):32-39.*

as that of the worldwide universe of rats? Would we not expect the level of tumor formation to be the same between two groups, say 100 rats in each group? And would we not also expect the ratio of tumor formation between one of those groups and the outside universe to be the same as for the other group and the outside universe?

That is not to say that the rate of tumor formation for the two groups of 100 rats will be the same as the rest of the universal population of the same type of rats. It simply means that the two groups of laboratory rats should show the same rate of tumor formation independent of the outside world.

Laboratory practice, health care, feeding, and other environmental factors will determine whether or not any isolated group of laboratory rats will develop malignant tumors at a rate identical with, exceeding, or, as in this case, less than the average for the overall rat population. That is exactly the purpose of maintaining a control group for such experiments.

With a control group to which the exposed group can be compared, only the experimental variable need be considered as providing the stimulus for any significant research results. These researchers found extraordinary results. They found entirely unexpected results. They found results that the business community, in concert with the U.S. military, could not accept. The researchers initially published those research findings as what the findings represented: evidence of cancer formation in rats that had been exposed to low-level radiofrequency radiation. Interestingly, since the initial findings were published and since the time of the restatement of those? findings, the principal researcher of that team has received very little research funding from the sources that had funded him generously earlier.

S. S. Stuchly has reported that .

> ***high SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous.***[90]

while M. A. Stuchly provided interesting insight into the thinking of some researchers with her review of Canadian protection guides. With respect to "hot spots" and near-zone exposures she wrote:

> ***One of the most important findings is that the SAR distributions are highly nonuniform, with typical ratios between spatial peak and whole-body average SA Rs of the order of 150:1 to 200:1. Even cursory consideration of physiology would suggest that high SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous.***[91]

In her review she also noted the U.S. EPA stated that “the data currently available on the relationship of SAR to biological effects show evidence for biological effects at in SAR of about 1 W/kg.” That is 1mW/g.

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[90] *S. Stuchly, et al., “Energy Deposition in a Model of Man: Frequency Effects," IEEE Transactions on Biomedical Engineering BME-33 7 (July 1986)702—11.*

[91] *M. A. Stuchly, Canadian and Other National RF Protection Guides, Electromagnetic Interaction with Biological Systems, ed. J. C. Lin (New York; Plenum, 1989) PP. 257-70.*

6

In 1990, S. F. Cleary[92] provided one of the first advances in the study of cell-level bioeffects with a research report that indicates glial tissue, such as that which is found in the supporting structure of the brain, may be induced to increase in proliferation rate due to exposure to electromagnetic energy. This is in addition to any restoration processes that may occur subsequent to a damaging thermal insult from high-level electromagnetic energy exposure. Also significant is that the increased cell proliferation persists after the radiation stimulus is removed.

Cleary tells us:

> ***Persistent indications that the mammalian central nervous system is perhaps the most sensitive tissue for RF-induced alterations has provided the rationale for in vitro studies of effects on brain tissue and brain and neural cells. Not surprisingly, in vitro brain cell sensitivities to RF exposure are among the highest reported.***[93]

At the same time, the U.S. Environmental Protection Agency released a draft copy of its report on the evaluation of the potential carcinogenicity of electromagnetic fields. The report, first of all, finds that

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[92] *S. F. Cleary, et al., "Glioma Proliferation Modulated in Vitro by Isothermal Radiofrequency Radiation Exposure," Radiation Research 121, (1990) pp. 38-45.*

[93] *S. F. Cleary, Biological Effects and Medical Applications of Electromagnetic Energy, ed. O. P. Gandhi (1990), p. 348.*

In view of these laboratory studies, there is reason to believe that the findings of carcinogenicity in humans are biologically plausible.[94]

Of course, they were referring to laboratory studies that they had reviewed. This admission by the EPA means that the carcinogenic effects of electromagnetic energy are valid or likely.

The report continues with a reasonable clarification about the energy stored in the near-zone of transmitting antennas:

A dielectric or conductive object placed in the field will absorb more power (energy/time) than is predicted to be incident on the object by the power density calculation.

As has been described, some stored energy is also absorbed into the head and brain of a portable phone user. Industry researchers and spokesmen often claim that the stored energy collapses back into the antenna and is restored twice each cycle. That physical action has already been addressed with the explanation of how the energy is stored in the fields around the antenna and how some of that energy is drawn into the head of a nearby operator. The EPA, confirmed exactly the same phenomenon by reporting:

In such cases, the object is absorbing stored energy from the electric field as the movement of charged particles or polarization of the dielectric produces thermal motion . . . (see footnote 94).

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[94] *U.S. Environmental Protection Agency, Office of Research and Development, EPA 600 6-90 005B, October 1990.*

The EPA researchers were describing an actual physical mechanism that takes place in the biological tissue when A radiofrequency energy is absorbed. That is, it is converted into heat by causing molecules, electrons, and ions in the tissue to move. For an operator of a portable cellular telephone much of that motion is within the brain. The operator's brain cells are excited into motion to change the radiofrequency energy into heat energy.
The EPA continues:

> ***The body may be thought of as an antenna that absorbs energy from the field . . . (see footnote 94).***

Although the analogy is somewhat removed from what is actually happening, it does point out that the EPA acknowledges that both radiated and stored energy are absorbed by biological tissue in close proximity to a radiation source.

On a smaller scale, the EPA acknowledges that microscopic interactions occur at the level of individual cells and at cell membranes and are observed to have effects on the motion of ions.

Although the precise mechanism of interaction that leads to adverse biological effects, such as cancer, was not yet known in 1990, some of the possibilities the EPA has listed include electrical current in the body and electromagnetic fields in "critical organs such as the brain." A comment related to the lack of knowledge of the specific damaging mechanism clarifies that the EPA is also lost in the investigation for a single specific causal connection. It would seem to be a questionable approach when dealing with a technology that has been shown over a period of thirty or more years to be harmful if applied improperly.

The position of the EPA is wholly inappropriate. There is ample evidence that exposure to excessive levels of radiofrequency radiation will cause permanent damaging effects to humans. There is also wel1—documented research evidence that operation of portable cellular telephones exposes humans to those excessive levels.

But instead of withholding the portables from the market until the devices can comply with existing safe exposure limits, the manufacturers are demanding proof of a specific interaction mechanism that connects low-level radiation exposure to cancer. The two issues are entirely separate. However, government agencies, in convert with the cellular telephone industry, are using the low—level exposure issue to avoid any action on the immediate, verified excessive exposure problem.

Some of the cited research studies have identified that electricians, engineers, and technicians had an increased incidence of brain tumors. We are expected to conclude that those individuals, more likely to be exposed to electromagnetic energy, developed the cancers because of the electromagnetic energy exposure. The real world is much different today than it was when those study subjects died. Today virtually every person becomes a candidate for dangerous radiofrequency energy exposure just by picking up and operating a portable cellular telephone. Just as the excess brain cancers were associated with certain professions prior to 1980, future excess brain cancers will be tied to the general population of cell phone users after the 1990s.

The EPA has concluded that

the results of the occupational cancer studies are remarkably consistent .... [T]he consistency and

specificity of the findings provide evidence that EM- field exposure in the workplace may pose a carcinogenic risk for adults . . ." (see footnote 94).

Radiofrequency energy exposure has moved into the everyday environment for most people. What was true for the relatively few individuals in the past is now, by the EPA's own conclusions, the norm for the entire population.

In summary form, the EPA's report of five case control studies found that

four of the jive noted significantly elevated risks of cancer in the following categories of employment; (1) gliomas and astrocytomas in Maryland electricians, telephone servicemen, linemen, railroad and telecommunication workers, engineers as well as electronic engineers; (2) primary brain cancer in workers of Philadelphia, northern New Jersey, and south Louisiana involved with design, manufacture, repair, or installation of electrical and electronic equipment; (3) brain cancer in East Texas male workers involved in highly exposed (EM fields) occupations in the transportation, communication, and the utilities industry; (4) brain cancer in workers identified in a 16-state NCHS survey of industries and occupations" (see footnote 94).

One common thread that runs through these four case studies is brain cancer. Realize now that the levels of electromagnetic energy to which those workers were typically exposed were much lower than the exposure to which a portable cellular telephone user is subjected with each telephone call.

The EPA, in this report, concedes that "There is a link between exposure to EM fields and certain forms of

site-specific cancer, namely leukemia, CNS, and lymphoma" (see footnote 94). Of course, in the instances when the exposure is directed at the head and brain of the human subject, as it is with portable cellular telephone use, we should expect that the predominant form of cancer would be central nervous system (brain) cancer.

7

Prior to 1992, Dr. Vera Garaj-Vrhovac investigated effects of radiofrequency energy and found chromosomal abnormalities among workers exposed to radar radiation. During the epidemiological study the health of 40 workers was monitored. From this study the researchers coneluded that “microwave radiation can induce damage in the structure of chromosomal DNA."[95] When six of the men under study were inadvertently exposed to a high level of radiofrequency radiation they were examined for resultant effects. High levels of chromosomal alterations were found. However, that was not the only evidence that came from the study. Lens opacities, cataracts, were also found among the exposed workers.

Those men were working while being exposed to levels of radiation, typically less than 5mW/cm2, generally thought to be too low to induce any behavioral, biological, or thermal effects. The cellular telephone industry’s scientific researchers have continued to hold fast to the belief that radiofrequency radiation cannot modify chromosomal structure or DNA. Their argument is based on a misapplication of some physical principles while ignoring

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[95] *"Human and Cellular Studies Point to Similar Mutagenic Effects to Radar," Microwave News 12, no. 3, May—June 1992.*

the actual physical principles that should be used. The result is a financially motivated debate about the possible interaction mechanisms that cause the chromosomal or DNA damage.

8

Recall the long-term radiofrequency radiation exposures using laboratory rats as the test subjects. The low-level exposures produced a significant increase in the number of malignant tumors that developed in the rats. The researchers reported those findings but later retracted the conclusions and, instead, claimed that the dramatic increase in cancers in the laboratory animals was meaningless. The reason given was that all of the cancers were not the same type. That is, they were proposing that the test data showing a nearly fourfold increase in cancers (primary tumors) among animals exposed to low-level radiofrequency radiation shouldn't be used because the cancers were not all identical.

In 1992 C. K. Chou, et al., provided an "official" re-interpretation of the test data. They wrote at that time:

> ***The finding of a near fourfold increase of primary malignancies in the exposed animals is provocative. These data cannot be considered as an artifact because different statistical analyses led to similar results.96***

Let's review some of the findings from the original study:

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96 C. K. Chou, et al., "Long-Term, Low-Level Microwave Irradiation of Rats," Bioelectromagnetics 13, no. 6, pp. 469-96.

· The exposed group developed three cortical carcinomas -- the control group developed zero.
· The exposed group developed seven pheochromocytomas -- the control group developed one.
· The exposed group developed two cases of liver adenoma -- the control group developed zero.
· The exposed group developed two cases of thyroid carcinoma C-cell -- the control group developed zero.

In all, the search identified more than eighty different types of tumors. Of these, the four types of cancers identified here are remarkable in that the incidence in the exposed group varies significantly from the control group. These tumors were located in the adrenal glands, liver,·thyroid, and pituitary glands of the exposed rats.

Consider now the logic of the unfounded doctrine the IGPA has attempted to espouse in support of the "corrected" conclusions to the Guy, et al., research. We know full well that X-ray radiation exposure can lead to a variety of cancers, including leukemia, bone cancer, thyroid cancer, lung cancer, brain cancer, skin cancer, and more. The list goes on to include virtually every organ and area of the body, whether human, primate, or laboratory rat. If`, as the EPA proclaimed in 1986, evidence of carcinogenicity must be confined to a specific tumor type, then, according to the EPA, X-ray radiation should not be considered as a cancer-causing agent. Of course, this is ridiculous. Just as ridiculous is the EPA posture with respect to the powerful and compelling RF energy research data. A significant indicator related to the long-term exposure is the time during the life cycle of the rat when the primary tumors were found. For both the exposed and control group, no primary malignancies were found up to the time the test animals were eighteen months old.

However, a dramatic difference occurred in the age group of nineteen-to-twenty-four-month-old laboratory rats. In that age group, nine of the exposed animals developed malignant tumors while only one of the control group developed a malignant tumor. Similarly, in the twenty-five to-thirty-month-old rats seven exposed group malignancies were found versus two in the control group. In all, during the last twelve months of the program sixteen malignancies were found in the exposed group, compared to only three in the control group. That's more than a fivefold difference.

The purpose of the experiment was to identify long-term effects of exposure to low-level radiofrequency radiation. A very dramatic long-term effect was found, reported, and suppressed.

If a reasonable argument were to be placed before the research community it would take the form entirely different from the tangential one that has been waged from 1983 to the present. The real argument to be made is how much greater the cancer incidence will be when laboratory animals are exposed to the same power density levels that humans experience every day by operating portable cellular telephones.

Research work that complements that of Guy was presented by L. Andriyenko and A. Serdyuk. They documented an increased incidence of malignant tumors in the large intestines of rats as a result of exposure to pulsed electromagnetic radiation (0.1-2.5 mW/cm²). The experiments were performed at power density levels lower than typical for cellular telephone exposures. Yet the increase in tumor formation was observed.[97]

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[97] *L. Andriyenko, and A. Serdyuk, "Effect of Extremely-High Frequency Pulsed EMF on White Rats' Organism and Antenatal Hereditary Development," 2d Congress of The European*

An instance of personal injury relates to the earlier research findings that metal objects within biological tissue can alter electric fields in a way that increases the field strength or results in sufficient heat to cause tissue destruction resulting in lesions.

A World War II radar specialist was periodically exposed, over a three-year period, to radiofrequency radiation at a power density of about 32mW/cm². Because of a metal implant in the right side of his mouth the radiation caused heating, which he claims damaged the facial nerve tissue. He experienced severe swelling and numbness after one particular exposure during 1944. The swelling eventually subsided, but the numbness was permanent. Medical examination indicated that demyelination, today associated with excessive radiofrequency radiation exposure, had occurred similar to a diathermy injury or X-ray exposure injury. At the time he told his doctors of the radiation exposure, but his doctors were ignorant of radiofrequency energy effects.[98]

Had this man or his doctors known of the existing research evidence which clearly demonstrated the effects of metal implants in concert with radiofrequency energy, he may have been able to obtain medical benefits for his injuries. Instead the Veterans Administration has denied this man benefits even though solid scientific research supports his account of how the injury occurred.

Bioelectromagnetics Association, December 9-11, 1993, conference abstracts, pp. 20-21.

[98] *"Radar and Nerve Damage; A WWII Veteran's Case Report, "Microwave News 12, no. 5, (Sepember/October 1992).*

10

It was late in 1993 that A. Maes, et al., succeeded in having their research related to chromosomal aberrations published. The experiments, performed during mid-1992, involved assessment of the effects of non-thermal (low-level) radiofrequency radiation exposure to human blood lymphocytes. Their findings indicated "a marked increase in the frequency of chromosome aberrations....and micronuclei.[99] The experimental data shows increased chromosomal damages as a function of exposure time. The researchers found that the aberrations were characteristic of what would be expected from exposure to ionizing radiation, such as X rays. The micronuclei, which they found, are the result of cell divisions that include a parent cell that had a damaged nucleus or from which incomplete cell replication took place. They wrote:

> ***It may be stressed that chromosome aberrations in exposed cells included a number of dicentric chromosomes that may be considered hallmarks of ionizing radiation exposure.***

They seemed to anticipate a hostile reception, or had already been subjected to disagreement about their findings and as if in response to some unmentioned argument wrote that

> ***Taking into account that the microwave energy (as that of other non-ionizing electromagnetic fields) is***

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[99] *A. Maes, et al., in "Vitro Cytogenetic Effects of 2450 MHz Waves on Human Peripheral Blood Lymphocytes," Bioelectromagnetics 14, no. 6 (1993): pp. 495-501.*

far too low to break chemical bonds it may be considered surprising to find chromosomal breaks and micronuclei, which also originate from breaks or chromosome lagging, following microwave exposure.

Of course, the belief that microwaves cannot cause bond breaking in chromosomes or DNA or damage tissue more generally is quite inaccurate. Since the energy absorption mechanism is not the same as that for ionizing radiation, such as X rays, the mechanisms of energy transfer that cause the bond breaking may be different. However, the result is quite evident—DNA and chromosomal damage.

Other researchers have documented evidence that human and rat whole blood samples exposed to 450 and 954 MHz radiofrequency radiation provided RF radiation induced DNA breaks.[100] The cellular industry has insisted for nearly fifteen years that no such effect could be obtained from radiofrequency energy. This research, by L. Verschaeve, is but one of many similar reports that became known during 1994 and supports the earlier findings by S. F. Cleary. M.

For example, Cleary has, for some years, maintained that exposure of brain cells to radiofrequency radiation will result in increased proliferation of the cells. The cellular industry has refused to accept Cleary's findings on the grounds that they have not been replicated at other laboratories. However, the industry has not funded independent researchers to make the attempt. Cleary, et al., reported their own replication and confirmation of the

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[100] *L. Verschaeve, et al., "Genetic Effects Associated with Microwaves from Mobile Telephone Frequencies," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 5.*

earlier research.[101] The experimental results indicate an increase in cell proliferation when exposed to RF radiation of 2,450 MHz at 25 mW/g SAR.

In still another presentation related to modifications to tissue, S. Chegrinets and A. Gotz reported that pulsed 150-300 MHz electromagnetic radiation at 5.0 mW/cm² causes chromosomal changes in human peripheral lymphocytes and whole blood cells.[102] The significance of the work becomes evident when we consider that researchers are finding these same results all across the radiofrequency portion of the spectrum. It's not just happening at one frequency, and it's not just being observed by researchers in one laboratory. The same chromosome and DNA damages are being reported at frequencies across the entire range, including 100 MHz, 300 MHz, 837 MHz, 954 MHz, 1,250 MHz, 2,450 MHz, and up to 9,000 MHz.

In a more alarming report C. Cain, et al., disclosed that 837 MHz radiation at a power density exposure level of 3.7 mW/cm² produced a 40 percent increase in what the researchers refer to as "focus formation." To these researchers the results indicate that the radiofrequency radiation was acting as a copromoter for cancer formation. This team is part of the same Loma Linda, California, research group that also reported increased cell proliferation. The data coming from this laboratory seem all to be indicating the same conclusion—radiofrequency

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[101] *S. F. Cleary, et al., "Effect of Isothermal RF Radiation on Cytotoxic T-Lymphocytes," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 5.*

[102] *S. Chegrinets and A. Gotz, "Cytogenetic Effects of , Pulsing 150-300 MHz Electromagnetic Field on Human Lymphocytes In Vitro," 2d Congress of the European Bioelectromagnetics Association, December 9-11, 1993, conference abstracts, pp. 22-23.*

energy emitted from portable cellular telephones causes brain cell modifications.[103]

In the past the cellular industry has been funding the Loma Linda group quite heavily to conduct the research. It would seem probable that on the basis of their own funded research the industry would take some precautionary action to prevent or mitigate the damage to present and future users of these products. Instead the industry continues to respond with the defense that *"there is no proof." The entire worldwide research community is laying the results on the table piece by piece to complete the puzzle. Yet the industry interests refuse to be moved.

11

At the European Bioelectromagnetics Association 2nd Congress, Kuster provided computational and experimental data indicating excessive energy absorption in the heads and brains of operators of portable cellular telephones. SARs of 4.3 mW/g and as much as 8 mW/g were reported in that presentation. These levels by far exceed the recommended maximum exposure of the ANSI standard and are high enough to result in significant temperature increases within the brain. Those research findings seemed to stir the research community into an active mode, which became evident at the Bioelectromagnetics Society meeting the following summer. At that subsequent meeting many researchers reported experimental

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[103] *C. D. Cain, et al., "837 MHz Digitial Cellular Telephone RF Fields and Copromotion of Focus-Formation, In Vitro," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 69.*

results much the same as Kuster reported at the earlier conference—high levels of energy absorption by the phone users.

At the same time, and quite independently, other researchers are reporting the findings of chromosome damage and DNA modifications resulting from radiofrequency radiation levels many times lower.

Also at that earlier European conference, S. Kwee and P. Raskmark reported that a thirty—minute exposure to 50 Hz fields resulted in distinct increases in both cell growth and DNA replication.[104] This report was a prelude to the more definitive DNA effects that were reported throughout 1994 and ties in with the work being performed by the Adey team—that is, research on effects induced by low-frequency modulation of radiofrequency radiation.

12

Looking again to low-level exposure, H. Lai, et al., presented a report that indicates low-level (0.6 mW/g SAR) radiofrequency radiation exposure at 2,450 MHz results in memory deficits for experiments conducted with rats.[105] This was a follow-up presentation to an article by H. Lai, A. Horita and A. W. Guy published only a few

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[104] *S. Kwee and P. Raskmark, "Changes in Cell Proliferation Due to Environmental Electromagnetic Fields," 2d Congress of the European Bioelectromagnetics Association, December 9-11, 1993, conference abstracts, p. 10.*

[105] *H. Lai, et al., "Microinjection _of an Opioid Antagonist into the Septum Blocked Microwave-Induced Decrease in Hippocampal Cholinergic Activity in the Rat," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 5.*

months earlier that provided substantially the same information. The memory deficits were observed as an inability of the rats to perform in a maze experiment. In effect the rats forgot their way around a familiar area.

The researchers explain the effect as being caused by a decrease in brain activity.[106] The low-level radiation exposure is extremely significant. Virtually all operators of portable cellular phones subject themselves to such exposure and energy absorption while operating the phone. Further, the memory deficits do not stop when the exposure ends. Researchers have learned that the effect persists for five days or more.

In another research presentation directly related to the memory deficits and motor control deficit issue, G. Thuroczy, et al., have shown that modifications to EEG are a result of exposure to 2,450 MHz pulsed radiation at 3 mW/cm².[107]

A. Smolia has also performed and reported experiments using laboratory rats exposed to low level pulsed radiofrequency radiation at power densities of from 0.5 to 1.5 mW/cm².[108] That's about ten times lower than the typical exposure from a portable cellular telephone. During and after radiation exposure the test animals exhibited EEGs that show complex functional changes. The changes were dependent on the level and duration of the

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[106] *H. Lai, A. Horita, and A. W. Guy, "Microwave Irradiation Affects Radial-Arm Maze Performance in the Rat," Bioelectromagnetics 15, no. 2 (1994):95-104.*

[107] *G. Thuroczy, et al., "Acute Changes in Brain Electrical Activity (EEG) after GSM Modulated Microwave Exposure on Rats," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 57.*

[108] *A. Smolia, "The Dynamic of EEG Spectral Density in Rats Exposed to 10cm Pulsed Microwaves," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 8.*

exposure and persisted for quite some time after the exposure was stopped. The researcher concluded that the EEG modifications are a result of exposure to the radiofrequency radiation.

Other researchers found, and reported that exposure of unanesthetized rabbits to 800 MHz radiation at 40 mW/cm² for twenty seconds also results in changes in the electrical activity of the brain (EEG).[109]

Yet another report of EEG modifications was presented by L. von Klitzing. He found that humans exposed to low-levels of pulsed RF radiation at less than 1.0 uW/cm², exhibit altered EEG signals. That level is about 10,000 times lower than the radiation level to which users of portable cellular telephones are exposed. Further, this research reports that the alterations persist for up to a week after exposure.“[110] That is, after the last exposure has ended the EEG modifications in one’s brain will
continue to affect memory and motor skills for about a week.
If a cellular telephone operator picks up a portable and makes a call it should be with the knowledge that he will also be modifying the functioning of his brain for about the next week. Every action that occurs within that individual’s life during that next week will be affected by the EEG modifications resulting from the portable cellular telephone call.

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[109] *R. A. Chizhenkova and A. A. Safroshkina, "Electrical Reactions of Brain to Microwave Irradiation," 2d Congress of the European Bioelectromagnetics Association, December 9-11, 1993, conference abstracts, p. 23.*

[110] *L. von Klitzing, "What May Be the Biological Relevance of Altered EEG-Signals in Man Induced by Pulsed EM-Fields‘?" 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 70.*

13

Early in 1994 research performed in India by S. Sarkar, S. Ali, and J. Behari[111] confirmed that DNA modifications result from low-level exposure to radiofrequency radiation. The conclusions brought forward from that research included a call for a reevaluation of the belief that radio-frequency radiation could not cause cancer. Clearly, if radiofrequency radiation can rearrange the DNA in tissue then it can initiate cancer. These findings should have also prompted the U.S. Environmental Protection Agency to reopen its investigation related to the cancer causing effects of radiofrequency energy exposure.

In the EPA's draft report, "Evaluation of the Potential Carcinogenicity of Electromagnetic Fields" they concluded that radiofrequency energy was not capable of causing DNA damage. That conclusion was simply a restatement of the unscientific hopes and wishes of the telecommunication industry. On that basis, they determined that there was no direct link to classify radiofrequency energy as a direct carcinogen even though other exposures did indicate a definite relation to cancer. With the recent revelations of DNA damage tied to radiofrequency radiation, the EPA's argument simply evaporates.

It almost seems as if the EPA's position, regarding a lack of evidence related to DNA damage, has been taken as a challenge among researchers. It is only a few years since the EPA's review of the research base claimed to find no conclusive evidence to support the DNA damage theory; now the research data are coming from independent researchers located at laboratories around the world.

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[111] *S. Sarkar, S. Ali, J. Behari, "Effect of Low Power Microwave on the Mouse Genome: A Direct DNA Analysis," Mutation Research 320 (1994):141-47.*

Late in 1994 H. Lai and N. P. Singh made known the results of their research that should have been received by the cellular telephone industry as the conclusive proof it claims to be seeking. This was yet another study of the effects of low-level radiofrequency radiation to DNA and was performed with live laboratory anima1s.[112] Their findings provided a significant confirmation of the previous studies out of India, Belgium, and Kiev. Low-level radiofrequency radiation exposure causes DNA modification. Dr. Lai summed up the findings by stating:

DNA damage is related to the initiation of cancer- if there is an error in the repair process, it could lead to a problem.[113]

The problem Lai suggests is cancer.

Lai and Singh repeated the experiments and in 1996 reported again that low-level exposure to radiofrequency radiation causes an increase in single- and double-strand breaks in DNA.[114]

And as recently as 1997 M. H. Repacholi, A. Basten, V. Gebski, D. Noonan, J. Finnie, and A. W. Harris published research results that demonstrate that mice exposed to low levels of 900 MHz RF radiation exhibited a higher incidence of cancers than did their nonexposed laboratory counterparts. In this study the exposed mice

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[112] *H. Lai and N. P. Singh, Acute Low-Intensity Microwave Exposure Increases DNA Single-Strand Breaks in Rat Brain Cells, in press.*
[113] *"Microwaves Break DNA in Brain; Cellular Phone Industry Skeptical," Microwave News 14, no. 6 (November/December 1994).*
[114] *H. Lai and N. P. Singh, International Journal of Rad. Biology 69 (1996):513-21.*

suffered a greater than twofold increase in the occurance of lymphomas.[115]

These findings were further evidence implicating RF radiation with cancer causation, as have been additional follow —up findings by Lai and Singh which suggest a possible mechanism by which the radiation causes DNA damage. These researchers conclude that

Data from the present experiment confirm our previous finding that acute RFR exposure causes an increase in DNA single-and double-strand breaks in brain cells of the rat.[116]

14

Many years earlier H. P. Schwan reminded us that the Western standards are based solely on behavioral effects.[117] He observed that some considerations for establishing safety standards are based on economics over safety. In his example, Dr. Schwan points out that a safety standard of 10 mW/cm² would burden the broadcast industry (TV and radio stations) since the field intensities around many antenna sites provide power densities higher than that limit.

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[115] *M. H. Repacholi, A. Basten, V. Gebski, D. Noonan, J. Finnie, and A. W. Harris, "Lymphomas in Eu-Pim1 Transgenic Mice Exposed to Pulsed 900 MHz Electromagnetic Fields," Radiation Research 147 (1997):631-40.*

[116] *H. Lai and N. P. Singh, "Melatonin and a Spin-Trap Compound Block Radiofrequency Electromagnetic Radiation Induced DNA Strand Breaks in Rat Brain Cells," Bioelectromagnetics 18, no. 6 (1997):446-54.*

[117] *H. P. Schwan, "Nonionizing Radiation Hazards," Journal of the Franklin Institute, December 1973, pp. 485-97.*

Further, he mentions that some sections of our largo cities would need to be evacuated unless radiation from the broadcast antennas was reduced. How is it that tho various industries can justify such exposure levels? For one they point to therapeutic applications of radiofrequency energy. Industry spokesmen would like us to accept that since higher levels of radiofrequency energy are used for medical applications such exposures must be suitable for the general population.

But should the general population moving about the cities and countryside be bombarded by therapeutic doses of radiation? Should the general population, going about its everyday business, be subjected to doses of radiation that effectively raise the internal temperature of parts of their bodies and result in biological modifications?

15

J . A. D'Andrea performed experiments with laboratory rats to determine at what power densities behavioral effects could be observed.[118] The rats were trained to press a lever for food and the effects of radiofrequency radiation were determined by observing variations in the performance of the rats. Behavioral effects were observed in the test subjects for exposure to 600 MHz radiation and at a power density of 7 .5mW/cm². The behavioral effects were documented as work stoppage. More accurately, the rats stopped working for food. At higher power levels, 20mW/cm², the rats stopped the activity sooner.

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[118] *J. A. D'Andrea and O. P. Gandhi, "Behavioral and Thermal Effects of Microwave Radiation at Resonant and Nonresonant Wavelengths," Radio Science, November—December 1977, pp. 251-56.*

It should be noted that the researchers did not consider a behavioral effect—work stoppage-—until the rate of work dropped to 33 percent of the average the rats were trained to perform. Clearly, something was happening to the rats much sooner than the "threshold" point that, was defined as an "effect."

Consider such a gross change if it were to take place with human performance. For example, a brick mason may lay about 900 bricks during a full day of work. According to the guidelines defined previously for behavioral change, the bricklayer would only be classified as exhibiting a behavioral effect when his production fell to 300 bricks a day. We can all be fairly confident that by then he'd already be looking for a new job, or he'd be out of business if he were a private contractor.

Consider further how the same effects in laboratory animals would be expected to show up in human activity. Consider athletes as a next example. Most professional athletes are specialists within the overall game. Football has its premier receivers, and basketball has its all star shooters. Baseball is known for its Golden Glove fielders and excellent hitters. But what might we find when any of these specialists is impeded, as were the laboratory animals in the previous experiment? How about unexplainable fumbles, poor shooting percentage, fielding errors, and low batting average, which appear from one season to another or seemingly overnight and persist without apparent cause?

Aside from the curious way of defining when an effect was present or absent the researchers have provided valuable information. Since the exposure levels from portable cellular telephones may exceed 7.5mW/cm² it should be apparent that radiation absorption in some areas of the human head is at least as high as that which causes

laboratory animals to cease an activity that provides them with food.

Some years later, during 1986, these same researchers performed a long-term radiation exposure experiment during which rats were irradiatied with low-level radio-frequency radiation. During and after the exposure the rats were tested and evaluated to determine the presence of any physiological and behavioral effects. The results showed that the radiation exposed rats suffered from aloss of ability to perform tasks for which they were previously trained. The researchers felt that the performance deficiencies of the rats were not significant enough to form a definite conclusion. Therefore, they reran the experiment at a higher radiation exposure level.[119] That is, even though there was some deficiency in the performance of the rats, the researchers decided not to state an effect at the original exposure level. They chose to repeat the experiment at a higher exposure level.

This second report by D'Andrea, et al., included similar experiments during which rats were exposed to radiofrequency radiation for fourteen weeks. The researchers found that

> ***significant differences between the two groups were also observed when the rats were tested after the 14 weeks of intermittent microwave exposure.***

The two groups to which they refer are the exposed and control groups. The differences, once again, are a diminished capability to perform tasks for which the rats had been previously trained. In the instance of this second

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[119] *J. A. D'Andrea, et al., "Behavioral and Physiological Effects of Chronic 2,450-MHz Microwave Irradiation of the Rat at 0.5mW/cm²,". Bioelectromagnetics 7, no. 3 (1986):45-56.*

experiment the researchers point out that the effects remained even thirty days after the exposures were ended.
They comment:

This decrement in performance of the schedule-com trolled behavior becomes more prominent as the dose-rate is increased from 0.5 to 2.5 mW/cm².[120]

Research into the physiological and behavioral aspects continued, during 1988, with additional evidence that exposure to radiofrequency radiation results in memory deficits and motor skill loss. C. L. Mitchell, et al., found that rats exposed to radiation at a power density of 10mW/cm² suffered from degradations in "locomotor" capability. This decreased motor activity was also accompanied by a decrease in "startle response."[121] In other words, the test subjects were not alert to danger in addition to suffering the reduction in motor skills. These findings are consistent with earlier research results that also indicated loss of motor skills as a result of exposure to radiofrequency radiation.

The memory deficits that have been observed in the laboratory rats have also been indicated in humans exposed to radiofrequency radiation. One method of monitoring such effects is by use of the electroencephalogram (EEG). Changes in EEG readings that persist for days or weeks after radiation exposure has ended are indicators of long-term modification to brain activity. These modifications have been observed in the rats as an inability to

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[120] J. A. D'Andrea, et al., "Intermittent Exposure of Rats to 2450 MHz Microwaves at 2.5mW/cm²: Behavioral and Physiological Effects," Bioelectromagnetics 7, no. 3 (1986):315-28.
[121] C. L. Mitchell, et al., "Some Behavioral Effects of Short-Term Exposure of Rats to 2.45 GHz Microwave Radiation," Bioelectromagnetics 9, no. 3 (1988):259-68.

carry out tasks for which they have been trained. In humans such EEG brain activity changes would be observed as diminished memory and capability to perform manual tasks that require motor skills. Some motor skill tasks include operation of an automobile and participating in skilled sports. Note that since the brain activity modifications continue for up to weeks after exposure, the corresponding deficits in operational performance will also continue.

Such mental degradations in humans are clearly a danger to those operating motor vehicles or machinery. Oftentimes it's our startle response that allows us to react to situations and avoid accidents. If a decrease or blockage of the startle response is coupled to a generalized decrease in mental activity and motor skills capability the combination points to the prospect for increased accidents and injuries.

16

In a first report on the effects of modulated radiofrequency radiation A. R. Sheppard, Bawin, and Adey confirmed that low —intensity modulated (16Hz) 450MHz fields produce modified calcium efflux through brain cell membranes. The researchers observed the effect for power density levels lower than 2.0 mW/cm² [222] Significantly, the cellular telephone system in the United States currently operating as an analog system, is in the process of changing to a digital signal system. A digital system

[222] *A. R. Sheppard, et al., "Models of Long-Range Order in Cerebral Macromolecules: Effects of Sub-ELF and of Modulated VHF and UHF Fields," Radio Science 14, no. 6S (November-December 1979):141-45.*

utilizes low-frequency switching, such as those that these researchers are investigating.

At the same time, it is also necessary to consider that even the analog system, although thought by some to operate at a single frequency, does in fact operate with frequency modulation. Electronic circuitry used in handheld cellular phones may also allow the transmit frequency to change over small ranges that is effectively the same as the frequency modulation used by the researchers. In effect, these research findings are relevant for both systems.

Evidence that weak modulated radiofrequency radiation causes effects at the level of individual cells is significant since it brings out another mechanism for interaction. This interaction is distinctly nonthermal in nature. It has been proposed by Adey that communication between cell occurs along pathways between the cells and that interruptions in the communications may lead to disruptive growth. The findings of modifications in passage of calcium through the cell membranes provides a basis for continuing the work along those lines.

H. P. Schwan and K. R. Foster have also investigated the possibility of weak field interactions with biological tissues. In their work the researchers do not describe any theoretical interaction mechanism, but they do confirm earlier findings that the cell membrane plays an important part in determining the cell electrical characteristics with respect to radiofrequencies.[123]

At this opposite end of the energy exposure issue, low-level exposure, we find that researchers are consistently reporting biological effects at surprisingly low radiation levels. In very early experiments, conducted to

[123] *H. P. Schwan and K. R. Foster, "RF-Field Interactions with Biological Systems: Electrical Properties and Biophysical Mechanisms," Proceedings of the IEEE 68, no. 1 (January 1980).*

investigate microwave induced hearing sensations, J. C. Lin confirmed that a biological hearing effect is induced at power density levels hundreds or thousands of times lower than levels previously thought to cause any effects. In essence, Lin confirmed what USSR researchers have been insisting all along. That is, the exposure limits in the United States and other Western countries are much too high and not really based on biological effects.

Interestingly, the IEEE/ANSI standards are claimed to have been established at a level that is ten times lower .
Than any measured biological effect. But in 1977 Lin demonstrated just such an effect at levels much lower than the limit of the safe exposure standard. The effect was described as a thermal shock wave caused by a rapid expansion of tissue due to energy absorption and propagating within the brain. Today's "safe level" of radiofrequency exposure remains at least 100 times higher than the threshold levels found by Lin. At that time Lin stated:

The effect is of great significance since the average incident power densities required to elicit the response are considerably lower than those found for other microwave biological effects and the threshold average power densities are many orders of magnitude smaller than the current safety standard of 10mW/cm².[124]

In a follow-up, or follow-on, to previous research reporting modifications in brain cells at low-level radiation exposure W. R. Adey also reported that weak modulated radiofrequency radiation results in major physiological

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[124] *J. C. Lin, "On Microwave-Induced Hearing Sensation," IEEETransactions on Microwave Theory and Techniques MTT-25, no. 7 (July 1977):605-13.*

changes. These weak exposures, less than that which would result in temperature increases of 0.1°C, have also been observed to produce chemical and behavioral changes. Adey's findings indicate a particular sensitivity of brain tissue to radiofrequency radiation exposure that is modulated at between six and twenty Hz (cycles per second).[125] One way of observing this sensitivity is to record the changes in the brain wave patterns (EEG) of humans and other animals as they are exposed to the low—level radiation. In some cases the modified EEG patterns persisted for several days. Adey has proposed that the radiation fields lead to a disruption of inter-cell communication and that the disruption of that communication can lead to uncontrolled cell growth. But, the safety standards do not consider that low level radiofrequency energy absorption reorients cells or disturbs the equilibrium of biological and electrophysical processes of cells within the brain of humans.

These researchers have long been engaged in the investigation of the effects produced in brain tissue as a result of low-level exposures to radiofrequency radiation. Typically, they employ radiation levels low enough to rule out any measurable tissue heating and concentrate instead on the effects of low frequency modulation of the applied frequency. In their most recent report they state that

Evidence has accumulated that sensitivity of brain tissue to specific weak oscillating electromagnetic

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[125] *W. R. Adey, "Frequency and Power Windowing in Tissue Interactions with Weak Electromagnetic Fields," Proceedings of the IEEE 68, no. 1 (January 1980):119-25.*

fields occurs in the absence of significant tissue heating.[126]

The sensitivity includes modifications of the passage of conductive ions through the membrane of brain cells.

The researchers go on to explain that the passage of calcium and potassium ions through the brain cell membrane is fundamental to brain activity. Disturbances in this communication link are shown by modifications to the EEG readings of test subjects. These modifications have been/demonstrated and documented by these and other researchers, as described earlier.

During 1988 S. F. Cleary presenteda review of the state of research related to nonthermal interactions and effects of radiofrequency radiation. His conclusions include the understanding that

> ***cellular studies provide convincing evidence that RF radiation, and other types of electric or magnetic fields, can alter living systems via direct nonthermal mechanisms, as well as via heating.*** [127]

Cleary also pointed out that since there was, at that time, a lack of understanding about the interaction mechanisms and effects of low-level radiofrequency radiation exposure, the safety standards should be considered only an interim expedient. More specifically, the safety standards established during 1982 were only a guess.

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[126] *W. R. Adey and S. M. Bawin, "Binding and Release of Brain Calcium by Low—Level Electromagnetic Fields: A Review," Radio Science 17, no. 5S (September—Cctober 1982):149S—57S.*

[127] *S. F. Cleary, "Biological Effects of Radiofrequency Radiation: An Overview," Electromagnetic Biointeraction (New York: Plenum, 1989), pp. 59-80.*

17

S. Szmigielski proposed that cellular or systemic damage may be related to long—term exposure to weak electromagnetic fields. His basis for such a proposition is tied to the many reports of behavioral, neurological, and reproductive abnormalities resulting from such exposures.
He also finds that

> ***"there were no evidences and arguments to support this view . . . that EMFs were not carcinogenic."***[128]

In other words, there never has been any evidence to indicate radiofrequency radiation is less harmful than X rays or UV radiation.

There is nothing inherently special about radiofrequency radiation that should make it less harmful. Simply because the scientific community has not established the specific interaction mechanisms does not warrant premature claims regarding safety. The industry and government have not performed research to warrant any claims of safety.

The industry claims of safety amount to a belief system but not science. They have repeated the wishful thinking among themselves so often and for so many years now that they have come to think that it has some basis, but it has none. The industry would have us believe that since only some of the research provides evidence of tumor growth and mental function effects there is no scientific proof of danger.

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[128] *S. Szmigielski and J. Gil, "Electromagnetic Fields and Neoplasms," Electromagnetic Biointeraction (New York: Plenum 1989), pp.81-98.*

For example, if someone throws 100 darts at a balloon and only the last dart thrown strikes and breaks the balloon are we to conclude that darts do not break balloons? Are we to interpret the results as an average of all the darts thrown? The average indicates that thrown darts do not break balloons. But we surely know that one well thrown dart will indeed break the balloon. More likely we conclude that the previous ninety-nine tests, or experiments, did not provide accurate results.

Let's apply the same basis for judgment with respect to the hundreds of reports of experiments and computer analysis related to biological effects due to radiofrequency radiation exposure. Some of those reports provide no findings of excess energy absorption, excess heating, or biological effects of any kind. But not finding an effect doesn't mean that there is no effect. It just means the research experiments did not find it—the "darts" may have missed the target.

However, much of the research provides experimental findings that do conclude that the absorption of radiation is excessive; that there are local "hot spots" of intense energy absorption in the human brain; that low-level exposures cause mutations of DNA and chromosome structure; and that radiofrequency energy exposure results in memory changes. Just as with the balloon and dart experiment, ninety-nine poorly performed experiments do not wipe away the scientific importance of one valid experiment that shows that radiofrequency radiation has the damaging effects that we now know.

With that in mind we return to Szmigielski's comments on the state of the scientific knowledge of these effects. He states that it appears that two types of neoplasms predominate-leukemias and brain tumor.

Of course, he is referring to radiofrequency radiation as the initiator or promoter of the malignancies.

In his conclusions Szmigielski indicates that there are two problems to be considered:

> ***Increased risk may refer evenly to all members of the population, but the risk may be assessed as tolerable in terms of population and costs of advancing civilization.***
> ***. . . In the population there are individuals that are exceptionally sensitive to the applied factors and these individuals develop neoplasms with enormously high odds and increase the rate for the whole population. Recognition and elimination of sensitive individuals would lower the population rate to normal values.***

Let's consider the two problems one at a time. The first that has been identified suggests that everyone will be at some increased risk, but that somewhere some unknown group of almighty individuals has "assessed the increased risk to be tolerable." That is, if you develop brain cancer the risk is tolerable to the group who performed the assessment. If you die of brain cancer the risk is tolerable as a cost of advancing civilization. That is the decision that the "assessors" have made. Typically those, who assume the burden of a risk are not the assessors of that burden. Usually it's some financially interested group making the decisions—so, too, in this instance. Who decided that the Challenger space shuttle astronauts should assume the risk of an explosion caused by rocket motors not designed for freezing temperatures? Not those at risk.

Who decided that the passengers of a ferryboat crossing the Baltic Sea should assume the risk of sinking because of leaky doors on the ship? Not the passengers.

Who decided that owners of pickup trucks with side-mounted gas tanks should assume the risk of explosion?
Not the owners.

Who decided that the owners of portable cellular telephones should assume the risk of developing brain tumors, brain cancer, memory deficits, or increased accidents? Not the owners?

Typically those who make such decisions are the economically interested parties. In the case of the issue at hand, those interested parties include the cellular telephone manufacturers and service providers acting in concert with your government. Make no mistake, the success of the cellular telephone industry is significant revenue business for the government. In addition, the military loves the technology; the FBI loves it; the CIA, the BATF, the INS, the IRS all love it. What's not to like about it? The technology is wonderful. The hidden dangers are the problem. The powers and significant players in government and industry don't want to concern themselves with the real-world issues of danger and damage to the population. They, instead, determine that the population will assume an "acceptable risk."

And so we progress to the point where some researchers, in concert with the industry interests, propose cost/benefit decisions, biased epidemiological studies, and "risk assessment" as a balance for their conclusions that radiofrequency radiation is dangerous, all of which is coupled with regulatory agencies proposing multiple "options" for safety standards, some "less costly" than others.

How is it that they have not expressed any concern for human safety? Isn't that the purpose of all of this research?

4

The Safety Standard Smoke Screen

I know very well that to sound a false alarm is a shallow and contemptible thing. But I know, also, that too much precaution is safer than too little, and I believe that less than the utmost is too little now. Better, it is said, to be ridiculed for too much care than to be ruined by too confident a security.

—Rufus Choate

1

The American National Standards Institute (ANSI) has adopted a set of electromagnetic energy exposure levels that the Institute of Electrical and Electronic Engineers (IEEE) has determined to be safe for humans. The ANSI safety standard was initially developed during the 1960s modified during the early 1980s, and modified again, most recently, during the early 1990s.

One particularly important aspect of the guidelines is that portable cellular telephones were completely exempted from compliance, testing, or regulation of any kind.

In its initial form, during the 1960s the IEEE/ANSI safety standard, known as ANSI C95.1, established a

maximum safe exposure level for radiofrequency radiation at 10.0 mW/cm². The modified version of the standard, ANSI C95.1-1982, set the maximum level for radiofrequency exposure on a sliding scale. To find the maximum exposure level it is necessary to divide the frequency, in MHz, by 300. At 845 MHz the limit would be at about 2.8 mW/cm². However, the standard was again written to exclude portable transmitters from compliance. If it were not for the categorical exclusion that exempted portable cellular telephones from any radiation exposure regulations, the devices would have been barred from the marketplace as unsafe for humans.

But how does the standard setting committee really know what is and isn't safe for people?

Most people think that regulatory agencies, such as the Food and Drug Administration and the Environmental Protection Agency, are staffed with research experts who conduct experiments and evaluate the effects of products. Most think that these government agencies take a leading and active role in performing research and establishing the safe exposure standards. This is not true in most cases. Typically, these government agencies rely on the research community to produce findings that can be evaluated to determine regulatory action. And, as noted, the research community is comprised of industry researchers and independent researchers, many of whom are funded by industry grants.

This shortage of independent government research capability becomes quite evident in view of one industry researcher's observation that

with the current budget cut-backs, the agencies of the Government will not have the time, the funds and the personnel to research the particular exposure conditions of the mobile communications

transmitters. The Government agencies however, are receptive to and take into account well documented characterization of the exposure from some RF sources. It is up to the industry to show reasonable evidence of adherence to safety standards and receive categorical exclusions. [129]

Very early in the 1980s, Gandhi[130] advised that many countries, including Canada and Sweden, had abandoned the U.S. standard of 10 mW/cm² and were moving their safe exposure standard more toward that of the former USSR, which was 1,000 times lower (0.01mW/cm²) than the U.S. standard.

Any exposure limitation that relies on power density as the guide for limiting radiation ignores much of the research of enhancements and "hot spots" that has been made known during the 1970s. Our primary concerns now are with near-zone exposure to radiation. The planewave experiments and findings ignore the enhancement effects and nonuniform radiation absorption conditions that exist with transmitters close to the human head. In 1984 R. J. Spiegel wrote that

for humans exposed to electromagnetic (EM) radiation, the resulting thermophysiologic response is not well understood. Because it is unlikely that this information will be determined from quantitative experimentation it is necessary to develop <u>theoretical</u> models.[131]

[129] Q. Balzano, "Evolution of RF Safety Standards and Their Impact on Mobile and Portable Transmitters," IEEE (1986):26-31.

[130] Gandhi, O. P., "State of the Knowledge for Electromagnetic Absorbed Dose in Man and Animals," Proceedings of the IEEE, Vol. 68, No. 1, January 1980, Pp. 24-32

[131] R. J. Spiegel, "A Review of Numerical Models for Predicting the Energy Deposition and Resultant Thermal Response of Humans Exposed to Electromagnetic Fields," IEEE Transactions on Microwave Theory and Techniques MTT-32, no. 8 (August 1984):730-46.

That researcher was conceding the fact that research, using human test subjects, was unethical and would not be performed. Instead, as we already know, safety standards would be based on nonhuman effects and results—laboratory animal test results.

2

Some years ago concerns about radiofrequency radiation leaking out of microwave ovens was coupled with concerns for safety by some users of portable two-way radios. At that time, the late 1970s, there was also some concern among users of portable radios that the energy radiating from a transmitting antenna could cause tissue damage. Owners and operators of those two-way radios began making demands for research evidence that would "prove" the radios were safe.

In one effort to defuse concern, research experiments were performed and subsequently published in a technical journal of the Institute of Electrical and Electronic Engineers (IEEE). Instead of yielding test results that would disprove claims of hazardous exposure to radiation, the results proved exactly the opposite—electric fields close to radiating antennas were excessive. One would expect that with these facts in hand and published worldwide the manufacturers would become alarmed and move to a position of increased research and, perhaps, take steps to safeguard the health of their customers. Instead, in a bewildering leap of illogic the industry scientists proposed that the research findings were not a concern. They brazenly proposed that physical

principles should not apply in close proximity to radiating antennas.

Imagine: industry researchers had discovered that physical principles, which held true everywhere else in the universe, did not apply in close proximity to transmitting antennas! Having taken this bold leap, based on the published research of the industry's own research scientists, the manufacturers of portable and mobile transmitting communication devices then lobbied the IEEE/ANSI standard setting committee. The industry convinced the committee to exempt portable hand-held communications devices from the safe exposure limits of the safety standard. That is, portable radios and cell phones, were categorically exempt from compliance with maximum safe exposure limits.

Consider again that the industry's own research findings during the 1970s proved that there was excessive exposure to users of portable transmitting devices, so the manufacturers decided to throw out the laws of physics. They exempted themselves from the laws of the universe in order to continue to market their products to the unsuspecting public.

The industry research clearly shows the industry's economic concern by stating that

> ***if safety standards of independent and government agencies do not take into account the peculiar nature ofthe electromagnetic energy in the close vicinity of some radiating devices, it is conceivable that the power of portable two-way communication equipment might be forced down to useless levels.***[132]

[132] Q. Balzano, "The Near Field of Omnidirectional Helical Antennas," IEEE Transactions on Vehicular Technology VT-31, no. 4 (November 1982):173-85.

They suggest that electromagnetics in the near-zone of antennas is somehow different than elsewhere in the universe. Their proposition is that, since they don't quite understand the physics relating the electromagnetic fields to the near-zone of antennas, safety standards should not be enforced because it would be detrimental to the industry.

Those researchers found that exposure to some antennas yields a power density of as much as 127 mW/cm² when the antenna is placed about 1 cm distant. The radiated power was only 0.02 watts. That's thirty times less than radiated from a portable cellular telephone. Yet the power density from such a low-power device was about fifty times higher than safety standards would allow. The researchers further observed that

> ***this last value should be considered extremely dangerous biologically; yet, in the near field of an antenna, such apparent power densities are reached with only 20mW of radiated power.***

Clearly, they comprehended the danger that their own research findings were yielding. They concluded that in order to meet the safety standard, the antenna that they employed could radiate no more than 0.00025 watts. That's 2,400 times lower than portable cellular telephones are allowed to emit.

3

Throughout the 1980s industry researchers continued their opposition to the proposed lowering of allowable exposure levels. They provided great insight into the thinking of the industry's lobbying tactics and interests. By

lowering of exposure limits it is meant that the allowable maximum of exposure to radiofrequency radiation was to be reduced. One industry lobbyist posed an argument in reverse logic by proposing that

> ***the old (repealed) OSHA standard level of 10mW/cm² was sufficiently high to require only relatively few precautions to ensure the safety of the workers of the land mobile industry.***

Clearly, the industry confuses compliance with a standard as ensuring safety. The researchers added:

From the above considerations it should be clear that the possibility of product liability, personal injury and negligence law suits increases with falling EME human exposure protection guides. The manufacturers of mobile and portable transmitters seem to be condemned to severe limitations in antenna installation and RF radiated power, if they want to avoid some legal consequences of the falling exposure limits.[133]

Again, the industry researchers note, in the article that was directed as a warning to manufacturers and service providers, that stricter safety guidelines will lead to increased legal problems. Never does it mention that there is a concern for the health of human operators or customers who buy the products. Industry researchers and industry-sponsored researchers had already, consistently, determined that the radiofrequency radiation to which users are exposed is dangerous.

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[133] Q. Balzano, "Evolution of RF Safety Standards and Their Impact on Mobile and Portable Transmitters," IEEE, 1986, pp. 26-31.

During research and experiments some of those same researchers have cautioned that the near-zone of radiating antennas is particularly dangerous because of the nonuniform radiating characteristics of portable antennas and because of the added presence of the energy stored around the antenna.

Nevertheless, they choose to ignore the research, some of it their own, and misrepresent the state of research in saying that

> ***all existing or proposed U.S. standards for safety of human exposure to RF EME have very poorly defined the near field and the partial body exposure conditions. These areas have not been researched extensively and much work remains to be done to complete this task. . . (see footnote 133)***

This is undisputably incorrect. Industry scientists and others have performed substantial research that demonstrates: (1) near-zone radiation “hot spots"; (2) near-zone measurements that confirm high energy in the vicinity of the antenna; (3) radiation absorption "hot spots" in the human head; (4) efficient radiation absorption into the human head from near-zone transmit antennas; (5) that the radiation levels emitted by portable cellular telephones cannot meet any IEEE/AN SI safety standard provision (which is why they have been exempted from compliance); and (6) that to meet the safety standards the power levels of some of the portables would need to be reduced by more than a factor of 1,000.

Industry researchers by 1986 must have realized that something was happening as a result of radiofrequency radiation exposure. Even at that time some standards were being reevaluated with a downward revision in mind.

Exposure standards currently recommended by international health organizations and under consideration by U.S. Government Agencies restrict the occupational exposure to 500 µW/cm² and the environmental (general public) limit to 200µW/cm² in the band of land mobile frequencies (see footnote [133]).

This continual lowering of the maximum allowable radiation exposure had to be supported by documented research. Also, the continual reduction of the maximum radiation exposure levels had to, take place in an environment where industry lobbied heavily against the reductions. Most probably the safe exposure levels would have been proposed at much lower levels, as are the USSR standards, if not for pressure by the industry and military interests.

In an article that speaks of problems associated with the setting of safe exposure levels, Gandhi wrote that IEEE/ANSI safety standards are based on behavioral effects of laboratory animals. In order to establish a dangerous level of exposure an observable disruption of behavior must be documented.

In the absence of verified reports of injury or adverse effects on the health of human beings who have been exposed to RF electromagnetic (EM) fields, the ANSI standard was based on the most sensitive measure of biological effects—the behavioral effects on laboratory animals.134

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134 O. P. Gandhi, "The ANSI Radio Frequency Safety Standard: Its Rationale and Some Problems," IEEE Engineering in Medicine and Biology Magazine, March 1987, pp. 22-25.

Imagine—the basis of the maximum safe exposure for humans is whether or not laboratory animals are observed to be adversely affected when exposed. Of more concern is the manner in which disruption of behavior was measured. Some researchers have documented that they did not count disruption until the laboratory animals had nearly ceased all activity.

The example detailed earlier, of observed behavior disruption in laboratory rats, underscores the point vividly. Even though the rats were exhibiting clear signs of behavior modification, the effects were not considered until the animal had a decrease of activity by 67 percent. Researchers then arbitrarily determined that if the laboratory animals resumed normal activity after the radiation ceased the long—term effects were not to be considered.

Let's take another look at the brickmason of a previous example. Assume that the bricklayer can usually lay 100 bricks each hour - all day long. However, for this experiment the bricklayer is exposed to radiofrequency radiation. As the level of radiation is increased the bricklayer begins to lay bricks more slowly. First, only 80 bricks an hour; then 50, and finally only 33. Recall that the bricklayer was able to consistently lay one hundred bricks hour after hour without let—up, but during exposure to the radiofrequency energy he continuously slowed as the radiation level was increased. Now wouldn't it make sense to notice something happening to this man when he slowed to 80 bricks an hour or even 50 bricks an hour? At 33 bricks per hour he is nearly incapacitated. But, according to the biological effects researchers that is the detection point. They would have the threshold level for observable effects set at the point where the bricklayer was only laying 33 bricks an hour.

What would they set the threshold level to for someone operating an automobile? What about a surgeon just prior to performing a difficult operation?

Gandhi writes that behavioral disruptions have been observed at 4 mW/g. However, other researchers have documented behavioral disruptions at much lower levels - less than 1 mW/g. Our earlier review of the *Scientific American* article discussed a group of such research findings at 0.1mW/g. That article also points out the concern related to "the highly nonuniform nature of SAR distribution, including some regions where there may be fairly high local SARs."[135]

4

There are also research findings that have shown that exposure to radiofrequency radiation causes damage to the DNA structure of brain cells. This is a dramatic revelation, as the cellular telephone industry has maintained that no harmful mechanism could be identified because it was not possible to cause DNA modif1cations at radiofrequencies. Now we have research reports coming from the United States, Sweden, India, Belgium, Croatia, and Germany, with others no doubt to follow, which conclude that radiofrequency exposure does cause DNA damage.

While the telecommunications industry spokesmen publicly argued that their research proves such effects are impossible, the industry's own researchers made it clear that the industry hadn't even developed the skills to perform the necessary testing.

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[135] *K. R. Foster and A. W. Guy, "The Microwave Problem," Scientific American, 255, no. 3 (September 1980) 32-39.*

Their researchers stated that

the study of the near field has been substantially neglected.

How then can we accept the cellular industry representations of proven safety, made to the standard setting committee, when it concedes that it has neglected to perform the research? As we pointed out earlier, those industry researchers admit that

"dipole antennas, although extensively used in portable and mobile communications, have not been carefully investigated in the near field."[136]

This admission clearly indicates a lack of concern on the part of the portable communications industry as it continued with product development—Without the supporting biological effects research. It would be reasonable to presume that extensive research had been performed to provide some confidence that the devices were not dangerous. That is what the industry has been stating publicly. Instead we learn from industry engineers and scientists that very little research was conducted up to that time.

We also see how industry researchers tied their experimental results to the lobbying effort that would exempt portable products from the safety standards.

The proposed standard recognizes the possibility of encountering fields higher than the maxima of the

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[136] *Q. Balzano et al., "Energy Deposition in Simulated Human Operators of 800-MHz Portable Transmitters," IEEE Transactions on Vehicular Technology, VT—27, no. 4 (November 1978):174-181.*

Protection Guides in the close vicinity of low power radiators, like portable communication equipment. For this reason, an exclusion clause for devices operating at 1 GHz or less and with less than 7 W out-put power has been proposed" (see footnote 136).

They have clearly stated that since the safety standard cannot be met by portable hand-held transmitters; such transmitters, portable radios and portable cellular telephones for example, should be exempt.

They continue by verifying that portable transmitter products cannot meet the safety standards. The researchers state that

the Radio Frequency Protection Guides of the American National Standards Institute at 750MHz would be violated at 0.3 cm distance by a resonant dipole radiating about 1mW and at 0.5 cm distance by a radiated power of 4mW (see footnote 136).

Interestingly, a "resonant dipole" provides the most favorable condition of minimum stored energy around the antenna. For antennas of different configuration, the stored energy is many times larger. This would force the allowed radiated power level to much lower levels in order to comply with safe exposure requirements.

The researchers themselves concede that

A rigorous enforcement without exclusion of the Radio Frequency Protection Guides would render portable radios practically useless.

Strict enforcement . . . technically forbids the exposure to a resonant dipole about 19cm long, radiating 1mW. . . (see footnote 136).

Having examined their own data, these researchers conclude that in order to meet the requirements of the proposed ANSI safety standard the power from a transmitter would need to be reduced to less than 1.0 mW. That means as long ago as 1981 industry research confirmed that the transmit power level from portable cellular telephones was about six hundred times higher than the ANSI safety standards would allow. Their solution to the dangerous radiation exposure problem: exempt the portables from the safety standard.

At the outset the industry researchers established their purpose by stating,

> ***This paper addresses the question of how low the power radiated by a dipole has to be so that the field near the antenna never exceeds the ANSI·proposed protection guides for distances greater than 0.3cm, which is the spacing that at times separates the antenna from the head of a portable radio user .... [A] radiated power of a few milliwatts is enough to exceed the proposed radiation protection guides at 750MHz .... [S]uch reticence in accepting the clause probably resides in the fact that the near field of antennas is largely uninvestigated.***[137]

The experimental data, presented in graphical form, clearly demonstrate nonuniform electric field intensity in the near—zone of the radiating antenna. The significance of that disclosure is to confirm the concept of nonuniform near—zone radiation and energy. But these scientific revelations couldn't deter an industry that exists solely by

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[137] *Q. Balzano, et al., "The Near Field of Dipole Antennas, Part 1: Theory," IEEE Transactions on Vehicular Technology, Vol. VT-30, no. 4, (November 1981) 161-174.*

product development and sales. A problem of this magnitude needed to be dealt with or else the notion of portable transceivers was dead. And the problem was dealt with—by suppression.

5

The cellular telephone industry spokesmen would like to argue that there is no proof that operating a portable cellular telephone while driving an automobile has led to an increase in traffic deaths. This is a very narrow measuring stick to use in its argument, for we know that most cellular telephone calls are not performed on the freeways at high speed. Most calls are made within cities and suburban areas where traffic incidents are likely to be less severe and result primarily in property damage and personal injury but less often death. The diminished motor skills of drivers are more likely to show up in these accidents and also in accidents where the cellular telephone user is an uninvolved contributor, due to erratic driving, who simply drives away from the scene and leaves the damage behind.

The 1986 Scientific American article that carried the "correction" of Guy and Foster provided additional graphical data related to the IEEE/ANSI safe exposure setting process.[138] The safe exposure level is supposedly set to be ten times lower than the level at which behavioral or biological effects have been observed in laboratory animals. That SAR is set at a level of 0.4 mW/g. The graphical data of reported behavioral and biological effects show

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[138] *K. R. Foster and A. W. Guy, "The Microwave Problem," Scientific American 255, no. 3 (September 1986):32-39.*

a number of findings at less than 0.1 mW/g. Two such findings occur at about nine hundred MHz while three others occur at about fifteen hundred MHz. That cluster of behavioral effects data is certainly at a much lower level than the IEEE/ANSI committee reports to be the "lowest" level of observed effects.

If the data cluster at 0.1 mW/g had been considered, the IEEE/ANSI level would be revised downward to 0.01 mW/g, which is strikingly close to what the Russian scientists have been advising—and using-for all of these years. But to do so would be to eliminate the portable cellular telephone industry and maybe some military programs. Certainly many high-power broadcast towers would need to be modified or moved. Instead, the standard setting committee determined that

> ***many of the effects reported at lower levels were not considered indicative of a hazard (see footnote 138).***

Very informative.

Now we learn that the IEEE/ANSI committee decided which behavioral or biological effects they wanted to include and which they didn't. Earlier we were told that the standard was based on a level below which no behavioral or biological effects were observed. Something in their subtle change of guidelines doesn't sound just right. Of course, more disturbing is that the general public still hears the older version of the safe exposure setting method.

How is it that the general public is expected to rely on the representations of the IEEE/ANSI radiofrequency exposure standards when we also learn that the committee that establishes those standards dismisses the research findings that don't suit them? It has already been

established that they will not consider any research that has not been replicated, now we also learn that the committee applies other subjective grounds for excluding research findings.

6

As the industry continues to wage its public relations battle it must do so even with the growing reports of dangerous radiofrequency radiation exposure. Industry researchers who attempt to counter the unfavorable reports—the industry's "damage control" researchers—have been known to resort to questionable models in an effort to provide results less damaging to the industry. For example, we have already learned that seemingly identical experiments performed by two groups of independent researchers have tended to provide two distinctly different results. One research team, not supported by the industry, employed a representative, although simplified, human head model to obtain radiation absorption results. Other researchers, employed or funded by the cellular telephone industry, have found a completely different level of radiation being absorbed within simulated human brains. Not surprisingly, the industry researchers reported a level much lower than the nonindustry-funded researchers.

Upon closer examination and spirited discussions at technical conferences at which the research findings were reported, it has come out that the industry-sponsored researchers have taken the liberty to modify the features of the human head and the placement of the portable telephone in an unrealistic manner. When presented to the audience the depiction was so ridiculous as to incite

laughter by the attending researchers. For one example, experimental results proudly reported at a technical conference relied on a laboratory human head model that had extremely protruding ears. The ear, projecting outward about 2 cm from the head, provided the "advantage" the experiment needed to yield favorable results. The scientists reported that the portable cellular telephone was placed against the ear of the model. Never mind that the "ear" had no basis in reality. And never mind that virtually no one would operate a phone in the positions depicted and tested. What does matter is that research findings of this nature form a significant part of the data base from which the safety standards are formed.

However, during these same conferences the nonindustry-funded researchers who provide findings of dangerous radiation absorption levels are typically met with silence by industry representatives and with concern by the others. There's nothing funny about the hazardous findings of the nonindustry research reports.

It is very clear that the stepping-stones of the published research results lead toward a conclusion of harmful effects from exposure to radiofrequency and microwave energy. The industry, instead of referring to the research base, prefers to draw from its own limited file of research results.

However, it matters not how much time or money is expended performing research and arriving at favorable results if the research is performed with the objective of steering clear of potentially disfavorable conclusions. Just as if one were searching purposely for a man lost in the woods but with the intent not to find the man, research that yields negative results can be performed repeatedly and for all time if the research is designed not

to yield the unwanted result., It takes but a single repeatable research study, performed by competent researchers, that indicates a harmful effect to render obsolete and invalid an entire storehouse of contrived research reports to the contrary.

By 1987 researchers were reporting that measurements showed actual radiation absorption is from two to five times higher than computer modeling predicted, and they were also warning that higher energy absorption could be expected in very sensitive tissues such as a human brain.

Also, it was again reported that local peak values of energy absorption vary over several orders of magnitude the “hot spot" effect. The response: some researchers suggested that a cost/benefit consideration be included when deciding safety issues. This last point is sometimes referred to as “risk management" or "acceptable risk." The problem is that the industry manages the risk and determines what is acceptable.
In this case, the decision is based on profits. The industry managers, executives, and sales representatives perceived such an enormous untapped gold mine that there was just no way that these products were going to be held back. The industry, even in 1987, was charging ahead at full steam to capture the markets while prominent university researchers were cautioning that much more research needed to be performed.

A paper by M. Stuchly[139] brings out the inconsistency of thinking among those who would establish safe exposure levels for humans. First we were educated repeatedly that safety levels were set by using laboratory

[139] M. Stuchly, "Proposed Revision of the Canadian Recommendations on Radiofrequency-Exposure Protection," Health Physics 53, no.6 (December 1987):649-65.

animals. Then we learn that, adverse effects or not, a cost/benefit consideration may be more important than real dangers from radiation exposure.

> ***There should be a sufficient data base of adverse effects on human beings and their mechanisms, which permit a quantitative analysis of health risks related to any proposed protection limit. Additionally, it may be desirable to consider a cost/benefit analysis. RF exposure standards are almost exclusively based on experimental evidence from animals . . . (see footnote 139).***

With the exception of the comment about a "cost/benefit analysis" nothing is new in that statement.

However, it is indeed striking, if not alarming, to witness supposedly independent scientific researchers speaking of cost/benefit analysis. Perhaps these researchers propose to determine if the harmful effects of the technology are outweighed by the benefit to society. If so then we must assume that the industry, government, and their researchers have determined for us just what will be an "acceptable risk." Again, as in the past, we find the clear picture of no informed consent. Government and industry have made these decisions for the population in the past. Their track record is decidedly negative and self-serving.

We have already reviewed research findings that indicate short-term biological effects at about 1 mW/g. We have also reviewed research findings that indicate that energy absorption of from 5 to 10 mW/g will result in a significant temperature rise of about 1°C in brain tissue. Stuchly, in her 1987 report, reconfirmed those findings. She continues on to clarify that the ANSl standards are

violated "even for the transmitters with relatively low RF output power" (see footnote 139).

The U.S. Environmental Protection Agency supports those findings. In the summary, Stuchly quotes the EPA as stating:

> ***The data currently available on the relationship of SAR to biological effects show evidence for biological effects at an SAR of about 1W/kg . . . (see footnote 139).***

That is, the EPA has found biological effects at 1 mW/g. Yet the IEEE/ANSI standard—setting committee ignores the 1 mW/g findings.

The U.S. EPA has recommended exposure guidelines and provided four options for consideration.

• Option #1 limits SAR due to radiofrequency radiation exposure to 0.04 mW per gram—that is, 0.00004 watts per gram. This safety level is thought to protect against all thermally related health effects. That would be a tenfold decrease compared to the current 0.4 mW/g limit.
• Option #2 would lower the existing exposure limit by a factor of 5 to 0.08 mW/g, instead of the factor of 10 proposed in option #1. Option #2 is proposed as less costly than Option #1. Why would the safety standard setting options be based on cost? Should they not be based on safety?
• Option #3 is a proposal to maintain the current exposure level limits.
• Option #4, is to provide no regulation at all but only information and technical assistance. This is not really an option but an unacceptable alternative to any regulation.

Comparing the IEEE/ANSI radiofrequency exposure limits to limits established elsewhere provides some interesting information. The IEEE/ANSI protection guide limits exposure at 845 MHz to 2.8 milliwatts per square centimeter of surface (2.8 mW/cm²). Germany limits that same frequency to 2.5 mW/cm². Great Britain limits exposure to 1.1 mW/cm². The International Radiation Protection Association limits exposure to 0.4 mW/cm². The former USSR limited exposure to 0.01 mw/cm².

If one single piece of information becomes clear from this litany of exposure limits, it should be that the IEEE/ANSI safety limits are the least restrictive, least "safe,"of the standards. That is, compliance with ANSI exposure standards still means violation of all the other standards. The USSR standard was stricter by a factor of 280. With a history of conscious disregard for their population, does it not seem peculiar that the former USSR should establish a radiofrequency exposure standard so much lower (more safe) than our ANSI safety standard? Even without consideration of the former USSR standard we observe that virtually all other countries noted have stricter standards than the IEEE/ANSI limits.

The original safe exposure recommendation was established at 100 mW/cm2. Today every bioeffects scientist would quickly admit that such an exposure level is, without any doubt, dangerous. Nevertheless, that level was established because no "reliable" evidence existed at that time that any biologically hazardous effects occurred at radiation exposure levels lower than 100 mW/cm². During the early 1950s Schwan proposed that the safe exposure level be set at 10 mW/cm². More recently, the safe exposure to radiofrequency radiation has been lowered to about 2.8 mW/cm² at cellular telephone frequencies. Today we know that it is difficult, if not impossible, to

use the power density as a measure of safety or hazard. We cannot prescribe a level of radiation at the surface of the head, for example, to specify a safe exposure. The current method of determining the presence of danger or a hazardous exposure is to measure the absorption of energy within the tissue that is being irradiated. But remember, the standards have set allowable absorption levels that are based solely on behavioral effects.[140] Some safety standards now prescribe that the maximum absorption of radiofrequency energy into any one gram of tissue should be no greater than 1.6 mW/g. Over the last forty years the "safe" exposure levels have been consistently reduced. Presently the standards propose levels that are about fifty times lower than was first thought to be "safe." This trend has continued for about forty years, and there is no reason to expect that revisions won't continue for some time into the future.

It will come as a surprise to most to learn that the IEEE/ANSI committee is not an IEEE or ANSI committee at all. The process that leads to a designation as IEEE/ANSI safety standard is not rooted in any activity within either of those organizations. The "committee" process begins when a group of interested scientists and researchers get together and form a committee on their own. It could be a mutual interest that brings them together; but most likely it will be an industry interest. This independently formed committee acts on its own to establish any standard.

Only after it is completed is the final product presented to the IEEE for publication. In order to publish, the standard must pass the approval of the Standards

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[140] *H. P. Schwan, "Nonionizing Radiation Hazards," Journal of the Franklin Institute, December 1973, pp. 485-97.*

Board of the IEEE. The board votes on whether the standard should be published under the IEEE label or logo. Interestingly, in the case of the radiofrequency radiation safe exposure standard many of the committee members were also IEEE Standards Board voting members.

After publication by the IEEE, but not necessarily

any endorsement by the IEEE, the American National Standards Institute is free to review and adopt the standard, reject it, or ignore it. In any case, neither the IEEE nor the ANSI performs the technical or scientific research. Instead they rely on the original independent committee to have done the right thing.

7

Only since the Bioelectromagnetics Society Conference of 1994, which provided a forum for presentation of the overwhelming and multiple reverification of the energy penetration from exposure to radiofrequency radiation, did the industry researchers finally modify their posture and concede the point. As a result the cellular telephone industry quietly began a broad program to redesign its products to reduce the amount of radiation that is absorbed by the users of the portable cellular telephones. The redesign program is not widely known but includes the most significant manufacturers working in concert with some of the most prominent researchers who have confirmed the excessive energy absorption.

However, any newly designed portable phones may prove pointless, as newer research results have moved the issues to a broader front with additional revelation since 1993 and 1994 of DNA modifications and chromosome damage from radiofrequency radiation. Even before

the most recent bioeffects studies showing DNA and chromosome damage were known the extent of industry and government complicity became evident through a private conversation with a representative of the Federal Communications Commission (FCC) when he confided that

> ***the FCC doesn't want to regulate portable cellular telephones because it doesn't want to create a panic.***[141]

Yet another government agency, the EPA, reports:

> ***In the past few years, there has been a marked increase in epidemiological studies reporting an association between cancer and electric and magnetic fields.***

The U.S. Environmental Protection Agency has some fundamental problems with the way that the ANSI/IEEE committee, which produced the safe exposure document, handles the research results that it supposedly uses to establish safe exposure levels. The EPA has never adopted the IEEE/ANSI standard. Their reluctance is due in part to the committee's refusal to consider all available research data when setting the levels. Marty Halper of the EPA is quoted as saying:

> ***The group did not deal with all the data—specifically the nonthermal effects. As long as the public sees the ANSI/IEEE committee as being biased, its usefulness is limited.*** [142]

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[141] *R. Cleveland, unpublished communication.*
[142] *"The RF Problem," Microwave News 13, no. 3 (May/June 1993).*

And the bias of which Halper speaks is obvious. We've seen it not only among the safety standard committee members but also concertedly by the military and industry. So long as the military and industry are so heavily represented on the committee they will be successful in pressing their own agenda. That agenda is to continue the production and use of radiofrequency-radiating products unhampered by restrictions and guidelines.

Those groups have been successful at using their "trump card" over and over again. That is, research funding. They control the research purse strings. They determine which programs will be funded. They determine which research studies will be replicated and which will not.

On another point the FDA's Centerfor Devices and Radiological Health strongly objected to the categorical exclusion clause even when it was reduced to 0.7 watts from 7 watts. At 0.7 watts the exclusion still exempted all the portable cell phones. They stated that

> ***the concept of limiting the SAR induced in the body appears to be disregarded. '[The] low-power exclusion clause . . . exempts certain RF devices from the provisions of the standard only because they emit less than a specified amount of power. Recent data from technical publications and other sources indicate that certain lower-powered RF devices, such as hand-held, portable, two-way radios, cellular phones, and other personal communication devices can introduce relatively high SARs in portions of the body [the head and brain] of nearby persons. Indeed, some devices that meet the requirements of the low-powered exclusion clause can induce SARs that exceed the local-SAR limits specified elsewhere in the same standard-making the standard appear self contradictory.***

Exempting hand-held portable cellular telephones on the basis of dubious conclusions published nearly twenty years earlier by a single industry research team no longer makes sense. The EPA states that it makes no sense. The FDA states that it makes no sense. The unbiased research community doesn't think it makes sense. And by now you might also think it makes no sense.

The industry has relied on its ability to forestall any new exposure level decisions based on harmful effects because researchers have been sidetracked for years trying to isolate a specific mechanism that would prove that tumors or cancer are a result of nonthermal, low-level exposures. However, the unique and critical circumstances of exposure of the human head and brain to radiofrequency radiation seem now to be recognized even by some industry proponents.

M. A. Stuchly points out the sensitivity of the brain to radiofrequency radiation:

> ***Even cursory consideration of physiology would suggest that high SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous.***[143]

And she made it quite clear that the safe exposure levels recommended by C95.1 had been set too high when she repeated the earlier observations of the U.S. EPA.

> ***The data . . . show evidence for biological effects at an SAR of about 1 W/kg.***

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[143] *M. A. Stuchly, Canadian and Other National RF Protection Guides, Electromagnetic Interaction with Biological Systems, ed. J. C. Lin (New York: Plenum, 1989), pp. 257-70.*

8

Exposure to radiofrequency radiation for the typical consumer now is greatest when that consumer picks up the portable telephone and places it against his head during a call. The select part of the body that absorbs that radiation is none other than the user's brain. And the selective temperature rise is in a small portion of that brain closest to the radiating antenna.

What researchers confirmed nearly forty years ago has been only grudgingly, quietly, and reluctantly admitted to by the cellular telephone industry; radiation absorbed from portable cellular telephone antennas selectively heats specific parts of the brain of the user.

In fact, in presenting research data at various scientific conferences it is typical to show the profile of absorbed energy within human head structures by plotting measured temperature rises. Two-dimensional views are used to represent cross-sections taken through various regions of a human head. Then the calculated absorbed energy or measured temperature increase is shown via color coding. These temperature profiles invariably show that the temperature rise, and therefore the radiation absorption, is concentrated in the part of the brain nearest the antenna.

But, with all of this research data in hand, some of which has been available for twenty or more years, and with the research now out of the industry's control, the battle over the safe exposure level continues. In the typical style of self-interested corporate executives, the managers are digging in their heels to protect their little empires—their stock options, bonuses, and other benefits. For them it's not a matter of doing the right thing for the industry, their companies, or their customers.

A good example of their outdated efforts is the continued industry attempts to convince regulators and standards committee members that a human head does not absorb energy from a transmitting antenna if the antenna is placed very close to the head. This is analogous to saying that if you sit around a campfire, a few feet away, on a cool autumn evening you will be warmed, but if you move right next to the fire, perhaps an inch or two away, you will not be warmed or burned.

But even when the unscientific arguments are exposed, the cellular industry, in concert with the military interests, can still apparently muster enough support, or muscle, to sway the outcome of the standards setting committee deliberations.

During a 1989 meeting of the ANSI committee, held in Tucson, the “interested parties" attended in force. Microwave News reported that

> ***Of the approximately 50 people at the Tucson meeting, there were eight representatives from the U.S. Navy and two each from the U.S. Army and the U.S. Air Force. In addition there were representatives from companies with major military contracts. The broadcasting and communications industries were also in evidence. 144***

This certainly appears to be a show of force by government and industry. We can judge the impact that such a gathering would have on the nonindustry committee members. Keep in mind that some of the committee members are university researchers. They must rely on government and industry for research funding.

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144 "Revising ANSI RF-—MW Limits: Debate Often Contentious," Microwave News 9, no. 5 (September/October 1989).

In spite of, or perhaps because of, the watchful eyes of government and industry, the meeting was marked by disagreement among members. With respect to the seven-watt exclusion clause, some wanted the clause eliminated. Industry representatives indicated that the clause was justified because millions of people use the products. Still others argued that because of those millions of users the clause should be abandoned.

This provides a prime example of how the industry interests view the safety of humans. They don't argue that their devices should be proven safe. They argue that their products should be exempt because millions of people are already using them. If we extend their thinking to other products, then, in effect, the industry people are saying that the drug thalidamide should not have been regulated and removed from the market, because a lot of is women were already using it. Never mind the horrendous effects the drug produced; just leave the manufacturer alone.

Eventually the exclusion clause was deleted from the radiofrequency exposure standard. It seemed that the committee had finally realized that the exclusion was based on unfounded scientific conclusions that just couldn't pass the common sense test. It also seemed as if, finally, the industry would be forced into compliance with the safe exposure provisions of the safety standard. But a short time after that meeting, at another quietly held committee meeting attended by a select, smaller group of committee members, the exclusion clause was replaced into the standard.

Other issues of serious disagreement bring to light the manner of establishing safe exposure levels for hundreds of millions of people. At the same meeting during which the exclusion clause was thrown out, even if only

for a short time, Dr. Elder and Dr. Adair argued whether or not environmental conditions affected the level at which radiofrequency radiation becomes hazardous.

They could not even agree as to whether the ambient conditions of temperature and humidity are factors. The committee could not even agree on the most fundamental aspects of the statement of risk for humans. The entire civilized world thinks that these committee members are dedicated to scientific-based interpretation of research data. Instead they squabble amongst themselves on fundamental issues and use artful dialogue to disarm their opponents.

The ANSI C95.1 committee is outwardly represented as a group of distinguished researchers and scientists who independently and without prejudice establish the guidelines for safe exposure of the population to potentially hazardous radiofrequency radiation. We have learned that they are instead a group with divisive self-interests that employs the art of debate rather than research data to decide the issues. We have also learned that this is a group with strong industry and government ties and that during their deliberations representatives of those government and industry interests are in prominent attendance to monitor committee actions. Is there any chance that we can believe that the ANSI C95.1 committee is acting in the best interest of any except their "sponsors"?

9

Early research has established solid evidence of: (1) excessive energy absorption conditions; (2) situations where

enhanced energy absorption occurs due to the multiple layer structures of the human head; (3) nonuniform bone structures, such as internal ridges of the skull, causing increased energy absorption at some regions; and (4) dramatic increases in energy absorbed in the brain as a result of metal objects, such as metal-framed eyeglasses, in close proximity to the transmitting antenna.

Certainly this collection of scientific data should alert intelligent researchers to the prospect for harmful interaction from radiofrequency radiation. This should be especially obvious when considering placing a radiating antenna less than one inch from the head or brain of a human or when considering what safe radiation exposure conditions should be established.

Dr. Swicord, formerly of the U.S. Food and Drug Administration and now with Motorola, proposed some years ago that the exposure limits should be reduced—that is, made more restricted. He stated that

> ***at the FDA, we get information from medical device manufacturers which states that they can get beneficial effects at levels specified as safe in this guide. 145***

The medical benefits of which Swicord spoke include deep tissue heating. The guide he was speaking of is the ANSI C95.1 —1982 safety standard. That guide has supposedly established the "safe exposure" level so that no thermal, biological, or behavioral effects will occur.

That "safe" level is supposed to be ten times lower than any reported effects. Nonetheless, we read that the

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145 "Revising ANSI RF/MW Limits: Debate Often Contentious," Microwave News 9, no. 5 (September/October 1989).

FDA representative protests he has knowledge of these effects occurring at radiation levels lower than the "safe" level. That means the safety standards must be reduced by at least a factor of 10. Or at the very least the commit we should certainly investigate the exposures. But, that did not happen. Swicord was overruled.

One other point on the IEEE/ANSI safety standard issue: As of 1989 the revised safety standard had not been approved. This was primarily due to the divisive interests among the committee members. As *Microwave News* noted,

The standard has a long way to go before publication. When it is completed, it must be approved by a number of different committees. Some members such as Pollack [Dr. Herbert Pollack] and Swicord, are betting that the standard will never be approved. "[146]

The revisions that were originally argued during the 1980s became the revised safety standard C95.1—199O and again evolved into yet another version that eventually became C95.1-1992. ANSI has finally adopted the revised safety standard, but that does not mean to say that it has been adopted by the industry or government agencies. However, *Microwave News* has reported that the Board of Standards Review is investigating comments made by Dr. Swicord. Dr. Swicord is quoted as stating that

it is generally recognized that the current member-ship is not balanced in representing government, industry, and the general public. [147]

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[146] *Ibid.*

[147] *"AN SI OKs RF/MW Standard; Questions Makeup of Committee," Microwave News 12, no. 6 (November/December 1992).*

As the entire research base points out, deep tissue destruction may have occurred by the time a warming sensation is felt in the skin. Thus we should not reasonably expect to be unharmed by these exposures just because no sensation of heat or pain is felt on the skin or scalp. We would also not expect that a laboratory animal would provide a behavioral symptom under similar exposure. We have already discussed how the brain is relatively insensitive to pain or thermal sensation. This being the case, tissue destruction in one's brain or the brain of a laboratory test subject may be occurring without the slightest indication that anything is happening. And the damage may be repeated, over and over again, each time the energy exposure takes place.

Absorbed energy levels in humans, more particularly in the human brain, have been determined analytically by computer methods and experimentally verified with laboratory models. Over the years both computer methods and laboratory models continue to increase in level of sophistication and, we trust, accuracy. From those scientific tools we know that the everyday exposures to radiofrequency energy due to operation of portable cellular telephones exceed the stated SAR safety levels.

The IRPA (International Radiation Protection Agency) has adopted 0.4 mW/g as a safe exposure level for humans based on behavioral effects in animals at 4 mW/g. Researchers have measured from 2 to 8 mW/g peak levels in laboratory models of human heads with portable cellular telephones in the operating position.

The best remedy is to avoid the use of the apparatus that causes the damaging exposure. Interestingly, that is exactly what some industry statements have advised.

They recommend only using the telephones for emergencies and using regular telephones for all other communication needs. They further recommend to limit the duration of calls to the absolute minimum. Can you imagine going to an automobile dealer and having him tell you not to drive your new car except in emergency situations and to limit your use to an absolute minimum? Wouldn't you be a little bit curious about the reasons?

We have already made note of the recent dramatic increase in near-zone exposures as a result of portable cellular telephones, but it is also important to tie this new epidemic of exposures to what researchers have been warning about since the 197 Os. That is, accepted concepts and standards were based on simple plane—wave (far zone) electromagnetic field propagation and were inadequate for the complicated near-zone fields.[148]

The industry typically proclaims that their portables are well within the requirements of the safety standards.
First of all, it must be made clear that the safety standard has been worded to exempt portable cellular phones from safety requirements or limitations of exposure to humans. One industry manufacturer has boldly stated, in an internal industry memorandum, that the portables are completely exempted from the safety standards.[149] If the exemption were to be removed and portable cellular telephones tested for compliance, it would be found that exposures are well in excess of the safety standard levels.

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[148] *P. F. Wacker and R. R. Bowman, "Quantifying Hazardous Electromagnetic Fields: Scientific Basis and Practical Considerations," IEEE Transactions on Microwave Theory and Techniques MTT—19, no. 2 (February, 1971):178-87.*

[149] *Memorandum, Motorola, Inc., to Ameritech Mobile Communicntions, September 12, 1984.*

11

Who among you would consider sitting down in front of your microwave oven with the side of your head about one-half inch away from the door while the oven was in operation? Who among you would consider doing so for fifteen or thirty minutes? Microwave ovens are regulated to emit a very low level of radiofrequency energy, less than 1.0 mW/cm². This regulation is in effect for a good reason, that being that the very energy that is heating and cooking the food inside the oven may do exactly the same thing outside the oven.

So for microwave ovens the radiofrequency energy is regulated to be confined within. However, operating a portable cellular telephone exposes the user to higher radiofrequency radiation levels than does sitting next to a microwave oven. Why, you may ask, is it necessary to limit radiation exposure for microwave ovens in the first case but not limit exposure to radiation from cellular telephones in the second case? The answer lies in the regulatory process.

The safe exposure level for microwave ovens has been established at 1.0 mW/cm² Public exposures to broadcast transmission towers reach levels in excess of 10 mW/cm². Portable cellular telephone users are exposed, regularly, to radiation levels even higher. Any flim-flam man can provide "proof' to support whatever scam he may be promoting at any given moment. In the case of the $100 billion dollar cellular telephone industry the spokesmen and in-house researchers had a particularly interesting explanation for why they thought the high-level radiation very close to portable cellular telephones was not dangerous. These individuals, speaking for the industry, had concluded that the

electromagnetic fields near portable transmitter antennas were of a "peculiar nature" and that physical principles did not apply.

The industry exempted portable hand-held transmitters from everyday physics, and the regulatory agencies, relying on the expertise of the industry researchers, bought the line. Today we know that even though the industry researchers declared cellular telephone radiations exempt from the laws of physics, the rest of the universe has not. The evidence proves the notion of "peculiar" electromagnetic radiation to be foolish and without scientific basis.

On the representations from industry researchers, standards-setting agencies, such as the American National Standards Institute, exempted portable transmitters from any safety requirements. The repeal of that exemption to safety standards, which the cellular telephone manufacturers lobbied into existence, has finally occurred. The FCC, however, will not retroactively place exposure limits on existing models of portable cellular telephones. The reason is that in doing so consumers would learn that most of their portables operate above the accepted safety levels and either widespread outrage or panic would result. Can you imagine the concern when the 80 million owners and 150 million regular users of portable cellular telephones learn that use of these phones exposed them to excessive levels of radiofrequency radiation: that is, levels of absorbed energy into their heads that have already been shown to result in brain tissue damage?

Research Labs: The Good, The Bad and the Biased

In any science there is a harmony between practitioners. A man may work as an individual, learning of what his colleagues do through reading or conversation; or he may be working as a member of a group on problems whose technical equipment is solitary in his own study. He, as a professional, is a member of a community. His colleagues in his own branch of science will be grateful to him for the inventive or creative thoughts he has, will welcome his criticism. His world and work will be objectively communicable and he will be quite sure that, if there is error in it, that error will not be long undetected.

--J. Robert Oppenheimer

1

Over the period of the 1970s and 1980s, during which the cellular telephone system was being engineered and developed, virtually no industry-sponsored research took place to determine the biological impact that portable cellular telephones could have on humans. Extensive research was conducted and reported on the transmission

and reception characteristics of the cellular system. Conferences were held and dedicated to the evolving scientific and engineering understanding of the cellular telephone system. Careers and fortunes were risked and made with the evolution of that technology, but the research into the biological effects never happened within the industry.

Before we ask why the researchers, in general, never performed the research, it is necessary to understand the "research-funding engine." In order that a program or set of experiments can be performed there must be a sponsor to pay for it. Outside of the industry's own labs, no professors or scientists can afford, for long, to engage in research for which there is no funding. How do you imagine laboratories, equipment, technicians, and other daily expenses could be paid for if not through funding of each and every program?

Now, from where does funding, or payment, for research come? Do universities provide money to their professors to conduct research? Not likely, for they have a difficult enough time meeting educational and administrative needs without doling out funds to researchers. Tobthe contrary, universities typically rely on their researchers to bring moneyinto the system by going out and actively pursuing research grants.

If that's the case, then who provides the funding?

For one, the U.S. government is a good source of research funding. But the government usually only provides funding in technical and medical areas that have been previously identified as being of strategic importance, such as development of the semiconductor industry, or for topics that have raised alarms in the populace, such as the effects of exposure to electric fields from power lines.

More typically, university and independent researchers must rely on industry to fund their programs. But that reliance also tends to remove the independence. With industry in the driver's seat it would not be unreasonable to expect that research that will provide favor-able results will be enthusiastically funded, while programs that are likely to provide potentially detrimental results are less likely to be funded.

Further, private industry-funded research often involves contracts drawn in a manner that allows the industry sponsor to own the results. Other contracts are drafted so that the industry sponsor can edit or censor publication of research results. Private corporations are not foolish. If they're paying the bills, they want some control.

On one side of the balance we have industry, which seems to have a stranglehold on the funding pipeline. On the other side are independent researchers who propose research that delves into areas that industry is less than enthusiastic to have cultivated.

The small amount of industry-funded research, more often than not, seems to be designed in a way that would make it difficult to come up with findings adverse to the industry's own product interests. This is called file building. By performing many research experiments that don't find a cause, or effect, or harmful exposure the industry can hope to argue by volume of research instead of validity or quality.

Occasionally the industry-funded research does report adverse results. When that happens and the research cannot be withheld from publication, there is usually some kind of "spin control" used in the discussions and conclusions of the report in an attempt to diminish the importance of the findings and to divert the reviewers' attention elsewhere.

On the other side we will always have some enterprising nonindustry scientists who still manage to perform meaningful bio-effects research. We should be grateful for those few, because they usually force the full research community into areas that industry would prefer be left uninvestigated.

Most of the credible biological effects research has been funded to some extent, and to the credit of the U.S. government, by various federal health organizations. Although much more should have been done (but that's always the case in hindsight), the research base that was established is sufficient to complete the picture.

It might seem unlikely, but also on the industry side of the balance there is a storehouse of` available published research. That industry data clearly indicates that the cellular telephone manufacturers and service providers knew, or should have known, through their own studies that exposure of humans to radiofrequency radiation emitted by transmitting portable cellular telephones is dangerous and causes biological and cognitive effects. However, the cellular industry manufacturers and service providers never cite this research.

We may think of researchers as being in either one of two possible groups—that is, those who are proponents of the telecommunications industry and those who are skeptical of the claims of the industry. Of particular interest should be the type of research conducted by each group. Those who attempt to confirm the safety of` exposure of humans to electromagnetic energy typically conduct experiments that are nonrepresentative of` actual exposures to humans and imply or explicitly claim that there is no danger. Many of the conclusions drawn by these researchers are extrapolations based on results obtained from studies of unrealistic models and plastic dolls

irradiated under circumstances much different from those used by persons operating portable transmitting devices. Many studies have been designed and reported that utilize bizarre laboratory models that provide data from which claims of safety for humans are made.

On the other end of the researcher spectrum we have the skeptical scientists who, once they have overcome the obstacles of funding, more often than not perform and report research that does not agree with the body of industry-sponsored work. In nearly all instances the new research findings and indications of hazards are reported by those researchers who are not funded by the industry.

If the system Worked differently, if the research community could draw from a pool of resources made available without contingencies imposed by the founder, then we might expect most or all of the research reports to indicate the same thing—that is, exposure to radiofrequency radiation results in biological effects to humans, some of which are temporarily disabling, some of which are permanently damaging, and still others that lead to fatal disease.

2

During the 1950s university researchers provided experimental evidence that electromagnetic waves result in effective, rapid, deep, localized tissue heating.[150] The deepest penetration of energy and greatest temperature rise was provided by radiators, or antennas, using reflectors. The reflectors are useful in redirecting some of the

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[150] *H. P. Schwan and G. M. Piersol, "The Absorption of Electromagnetic Energy in Body Tissues," International Review of Physical Medicine and Rehabilitation, June 1955, pp. 424-48.*

radiated energy back toward the subject. In that way, not only does the subject absorb the energy with which it would normally come in contact but it also would absorb some of the reflected energy. It's exactly the same as using a sun reflector while sunbathing.

However, in the case of radiofrequency energy reflections the extra energy absorption may not be desirable. It depends on the purpose of the radiofrequency radiation. If the energy is intended for use with a diathermy or hyperthermia application, then the extra reflected energy may be of value. If the intended purpose of the radiation is for communications, such as a cellular telephone call, then any radiation absorption is not desirable; and extra radiation absorption from reflections is equally undesirable.

These research results have become increasingly important in view of the fact that not only do many operators of portable cellular telephones utilize the devices from within their automobiles but also from the fact that a large percentage of portable cellular telephone user wear metal-framed eyeglasses.

The connection to automobile use is important because the reflective metal components, components that virtually surround the occupants, play a part in modifying and enhancing the energy directed toward the head of a user. Some of the radiation from antennas located within an automobile will be reflected by the metal structure. Persons inside the automobile will absorb some of the reflected radiofrequency energy—in addition to that which they will absorb due to direct exposure. If the reflecting structure is very close, such as a door post or the metal roof, the reflected energy can be significant.

In their 1955 summary of the available research university scientists cautioned that

metal objects can modify the electromagnetic field and its effects. Any of these objects may concentrate the field . . . 151

When one is making a telephone call with a portable phone the area around the antenna is exposed to a high level of radiofrequency energy. Placing metal objects in the region of antennas and biological tissue can cause significant changes to the radiofrequency radiation patterns and energy absorption. In some cases the changes dramatically increase the amount of energy that is absorbed within parts of the brain.

M. Stuchly, et al., have found that "a resonant dipole with a reflector, may be considered as representing the worst-cause conditions, as the energy couples very well to the body."152 The "worst—cause" of which the researchers speak is maximum energy absorption. They are acknowledging that a radiating dipole antenna (resonant dipole in this instance) near a reflector will be the most dangerous in terms of depositing energy into a user. Many portable cellular telephones employ dipole antenna structures to radiate the energy.

Reflecting objects have been shown to provide large enhancements in the energy absorbed by human operators, and also induce local "hot spots" in the human brain. Another undesirable effect is produced with portable cellular telephone operators who wear metal-framed eyeglasses.

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151 H. P. Schwan and G. M. Piersol, "The Absorption of Electromagnetic Energy in Body 'l`issues," International Review of Physical Medicine and Rehabilitation, June 1955, pp. 424-48.

152 M. Stuchly, "Exposure of` Human Models in the Near and Far Field-A Comparison," IEEE Transactions on Biomedical Engineering BME—32, no. 8 (August 1985):609-16.

The metal frames are good conductors and tend to redirect and focus the radiating energy in a way that causes increased deposition into the head and brain. N. Davies and D. W. Griffin reported that

> ***it has been found that the introduction of a pair of metal-framed spectacles can, in certain cases, cause an increase in field levels by up to approximately 20dB [ten times], a significant perturbation of the incident microwave field which should be accounted for in the setting of safety standards relating to acceptable levels of incident power.*** [153]

Clearly these researchers have warned that the effects of metal-framed eyeglasses must he considered when establishing safety standards. To date that effect has not been considered, nor has any other effect of reflectors.

The issue of metal-framed eyeglasses as an enhancer of radiofrequency energy absorption has been confirmed repeatedly but not passed along to users of portable phones. A number of independent researchers have reported that wearers of metal-framed eyeglasses who use portables will suffer an increase in absorbed radiofrequency radiation of up to 60 percent more than users who do not wear metal-framed eyeglasses. Since portable cellular telephone users are known to absorb about 50 percent of the total energy that the antenna radiates, the enhancement from metal-framed eyeglasses means that those users will absorb about 80 percent of the total radiated power.

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[153] *N. Davies and D. W. Griffin, "Effect of Metal-Framed Spectacles on Microwave Radiation Hazards to the Eyes of Humans," Medical and Biological Engineering and Computing, March 1989, pp. 191-97.*

Also at the 1994 BEMS conference, A. H. J. Fleming reported calculations that indicate RF energy absorption by users of portable cellular telephones is in excess of 1 mW/g and recommended that some form of shielding should be incorporated to reduce the absorption of energy by the operator.[154] The researchers also confirmed that the presence of metal—framed eyeglasses will, in accordance with their experimental findings, result in a significant increase in radiation absorption.

3

Independent researchers agreed, for once, with industry researchers when the former acknowledged that work must continue to quantify near-zone exposures that are of great concern.[155] At that time, 1980, the university researchers, of course, could not anticipate the explosive growth of portable cellular telephones, but the industry researchers were well aware of` the product development within their own labs. 'l`he independent scientists, were, concerned about the dangers of` energy absorption due to near-zone exposures from other radiofrequency radiation sources.

Of most significance, at that time, was the position of the researchers that there had been little work done

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[154] *A. H. J. Fleming, "A numericul Estimate of SAR Levels in a Heterogeneous Model of the Head due to Exposure by a Mobile Phone," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 65.*

[155] *I. Chatterjee, et al., "EIectromagnetic-Energy Deposition in an Inhomogeneous Block Model of Mun for N ear-Field Irradiation Conditions," IEEE Transactions on Microwave Theory and Techniques MTT-28, no. 12 (December 1980):1452-59.*

with near-zone exposures. Only a few months later the industry researchers confirmed that position in a published paper that states:

> ***One can reasonably presume that most human exposures of any concern are and will be in the near field of electromagnetic sources. Yet the study of the near field has been substantially neglected.***

By that point in time industry research and engineering teams had been investigating portable cellular telephones for quite a few years. Even without the evolution of the portable cellular telephone, many manufacturers had been providing portable radios for commercial use for many years. Keeping this in mind, it becomes alarming to find the industry researchers admitting that

dipole antennas, although extensively used in portable and mobile communications, have not been carefully investigated in the near field.156

It was only two years later, during 1983, that the portable cellular telephone became commercially available, yet industry researchers admitted that they had not done the necessary investigation of the effects from energy radiation antennas placed next to the human head. At about the time that the revelations about the lack of research in the near-zone of antennas were made known, other researchers performed experiments with scaled-down miniature salt-water-filled spheroidal phantom models to determine near-zone exposure and energy

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156 Balzano, et al., "The Near Field of Dipole Antennas, Part II: Experimental Results," IEEE Transactions on Vehicular Technology VT-30, no. 4 (November 1981):175-81.

absorption for humans.157 It seems that not only was meaningful near-zone research an unfulfilled need, but that which was performed took on some rather strange characteristics. It's difficult to imagine the intricate features of the human head and brain being simulated by a salt-water-filled ball.

Although the concept of using scaled—down salt-water—filled plastic spheroids to represent humans is inapplicable for any comparative purposes, the experiments do provide some data that is valuable. For one, it revealed that in the near-zone the electric and magnetic field intensities increase at a faster rate than the far-zone rate of increase predicts.

Earlier research, performed at about 1980, has provided an interesting view of the type of laboratory models that were used in some experiments to determine energy absorption and safe exposure levels for humans. In this instance, the experimental model only vaguely represents any recognizable form and is wholly comprised of a mixture of salt water and plastic powders to simulate muscle tissue. No bone, fat, or skin layers were included as are so important for any energy absorption experiments.

However, even that crude model of a rhesus monkey provided energy absorption data that was almost three times higher than the researchers expected. They commented that

> ***it is surprising that the average SAR of the rhesus model. . . is nearly three times the expected value***

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157 M. F. Iskander, et al., "Mcasurements of the RF Power Absorption in Spheroidal Human and Animal Phantoms Exposed to the Near Field of a Dipole Source," IEEE Transactions on Biomedical Engineering BME—28, no. 3 (March 1.981):258-64.

based on the empirical formula found in the dosimetry handbook of Durney and co-workers [1978].

The handbook, to which they refer, is a product of the USAF School of Aerospace Medicine at Brooks Air Force Base, Texas.[158]

The researchers at that particular air force base figure prominently in other questionable research reports, as We shall review shortly. For the present it is interesting to note that the U.S. military, which has a history of presenting research data to "dispel fear and improve morale of personnel," has provided the handbook of radiofrequency radiation absorption. Researchers have frequently determined that the findings in the handbook understate the actual absorption of radiation that laboratory experiments conclude. They also wrote:

The strong absorption caused the average SAR of the rhesus model to exceed the theoretical predictions by a factor of 2.67. The disparity between experimental and theoretical results cannot be completely explained . . .
Certain combinations of fat and skin thicknesses produce resonances such that . . . [absorption efficiencies] may be on the order of 70% to 100% . . .
(see footnote 157).

The resonances refer to optimal conditions for the absorption of energy—the "matching" effect. That is, 70 percent to 100 percent of the energy may be absorbed. Not only are the various thicknesses of the tissue layers

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[158] *C. H. Durney, et al., Radiofrequency Radiation Dosimetry Handbook, Rep. SAM-TR-78-22, 1978, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas, 1978.*

important, but so, too, is the distance at which the radiation source, the antenna, is held during operation. In the region of a few centimeters from the human head, approximately 0.5-7 cm, there will be energy absorption resonances that allow for a very large portion of the energy radiated by the portable antenna to be deposited into the user's head, instead of radiated to the atmosphere.

Also, the high levels of stored energy will couple efficiently into the head and brain in addition to the 70-100 percent of the radiated energy. It's like a double dose of energy deposition. The first, radiated energy deposition, the industry reluctantly talks about because bioeffects researchers are familiar with the concept. The second source, energy stored in the near-zone fields close to the antenna, the industry never speaks of because very few, except antenna engineers and electromagnetics researchers, are aware of its existence. Under some circumstances the stored energy is 10 to 100 times greater than the radiated energy. It depends to a great extent on the configuration of the antenna. Knowledge that this great amount of stored energy may be "eff1ciently" coupled into the head and brain of a user should be enough to keep all but the most daring from using portable cellular telephones.

R. G. Olsen, et al., documented energy absorption in a full-sized human model. The absorption is again about three times higher than that which was predicted by the air force's dosimetry handbook. As with the previous experimental setup, the researchers employed a simplistic homogeneous mold of "muscle tissue equivalent" comprised of salt-water and plastic powders.[159] And as with

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[159] *R. G. Olsen, "Far ficld Dosimetric Measurements in a Full-Sized Man Model at 2.0 GHz," Bioelectromagnetics 3, no. 4 (1982): 433-41.*

the previous experimental results the findings would have been higher by a factor of 3 to 5 if the researchers had constructed a multilayered model for the experiments.

While some researchers have employed scaled models of humans to measure radiofrequency energy absorption, others have lectured on the serious shortcomings of such methods. The fundamental problem is that the radiation exposure and energy absorption in humans has no connection to that which is observed in miniature models. A. Kraszewski, et al., agree and have stated that

> ***The main limitations of this technique are a limited spatial resolution due to the small size of the models and a difficulty in incorporating the anatomical structure into such a small model.160***

Of course, when a scaled-down model of a human that has no features such as skin, fat, bone, brain tissue, or nonuniformities is used to determine energy deposition within humans one wonders how the experimental results might be presented. Certainly there can be no correlation between the energy absorption in the model and that which is found at small "hot spot" areas in the living human brain.

These researchers confirm that scaled models used for thermographic measurements of SAR do not allow for resolution of anatomical features. Significant differences between calculated absorption and that measured in the sealed models indicates that the scaled models underestimate the energy absorption in some areas by as much as ten times.

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160 A. Kraszewski, et al., "Specif1c Absorption Rate Distribution in a Full-Scale Model of Man at 350 MHz," IEEE Transactions on

Reports of researchers using printed circuit board antennas for hyperthermia therapy highlight an important point about using energy—radiating structures close to the human head. The researchers observed that the radiating element could be "matched" to their phantom model when the distance separating the two was less than 1 cm.[161] The term *matched* refers to optimal conditions, or best conditions, for transferring radiofrequency energy to the body in close proximity to the radiating antenna. When the radiating antenna is "matched" to the load, for instance the human head and brain, maximum energy absorption will occur. Those researchers have reconfirmed the experimental findings of others that indicate that in the near-zone absorption is enhanced by the improved "match" between the antenna and absorbing body. The "matching" effect is another enhancement mode that must be, or should have been, considered in research related to safety of portable transmitting devices such as portable telephones.

Once again, as with others in the past, those researchers reported that radiation in the near-zone is highly nonuniform. That is, in the near-zone there are regions of very high radiation and regions of very low radiation, regions of very high energy density and regions of lesser energy density. The near-zone peaks and dips average out in the far—zone to yield the uniform level of radiation.

Microwave Theory and Techniques, MTT—32, no. 8 (August 1984):779-83.

[161] *I. J. Bahl, et al., "Microstrip Loop Radiators for Medical Applications," IEEE Transactions on Microwave Theory and Techniques MTT—30, no. 7 (July 1982):1090-93.*

Two years later, during 1984, another group of independent university researchers again acknowledged that characterization of fields very close to radiating elements had not been completed and that much work remained to be done.[162] However, by that time it was too late. The genie was already out of the bottle; portable cellular telephones were available in the marketplace.

5

H S. Stuchly, et al., performed a series of near-zone exposure experiments by using a whole-body homogeneous model of a human. Not surprisingly they measured and reported the presence of "hot spot" energy absorption. Most of the energy was deposited in the part of the "body" nearest to the antenna, with near-zone enhancements of from 30 to 250 times greater than the average for the whole body.[163] It is puzzling that the researchers chose to place the radiating antenna at the center of the back of the model. But even that odd placement for the antenna yields data showing that most of the energy is deposited in the head and neck.

It just doesn't seem to make any sense that a human operator would place a transmitting portable radio or portable cellular telephone at the center of his back. However, even with the unrealistic placement of the radiating

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[162] *D. T. Borup and O. P. Gandhi, "Fast-Fourier-Transform Method for Calculation of SAR Distributions in Finely Discretized Inhomogeneous Models of Biological Bodies," IEEE Transactions on Microwave Theory and Techniques 32, no. 4 (April 1984):355-60.*

[163] *S. S. Stuchly, et al., "Energy Deposition in a Model of Man: Frequency Effects," IEEE Transactions on Biomedical Engineering BME-33, no. 7 (July 1986):702-11.*

antenna, the researchers have found significantly enhanced energy absorption in the head of the human model. As a result of their experiments they determined that whole-body average SAR is not a proper dosimetric measure. In other words, they believe that it is improper to take a localized very high exposure and average it over the total body surface in an attempt to meet the IEEE/ANSI standards. They, instead, acknowledge that high energy absorption in a small localized area must be treated as a completely different circumstance from plane-wave exposures.

Another contribution to the portfolio of "nonrepresentative" research findings provides data for energy absorption within a laboratory model. However, the model is irradiated by placing the transmit antenna at the chest area of the model.164 This work was performed by the same research team that gave us data for an antenna placed at the back of a human model. An improvement over those earlier experiments is that the model currently used includes discrete materials to simulate organs such as lungs and brain.

But the researchers employ a type of "tissue cocktail," representing no known living tissue, to fill the model. It's the same type of all-purpose simulated tissue mixture that other researchers have been using instead of providing accurate simulating materials. The mixture has a combination of the electrical properties of many tissue types but none of the real properties of any actual human tissue. As mentioned, the evaluation of near-field exposure employed an antenna placed in front of the

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164 M. Stuchly, et al., "Exposure of Man in the Near-Field of a Resonant Dipole: Comparison between Theory and Measurements," IEEE Transactions on Microwave Theory and Techniques MTT—34, no. 1 (January 1986):26-31.

model at the chest area. The researchers report that SARs approximately two to five times higher than for homogeneous models were found, which certainly conforms with the data that has been reported for many years prior to this study. That is, multilayered, heterogeneous models will more accurately represent real humans.

The researchers then make a truly unconnected leap in concluding that

the antennas and their orientation can be considered as representative of the operation of portable (hand-held) transmitters. [165]

Clearly these experiments were not designed to represent any actual radiation exposures. What the experimental findings do provide is a repetitive confirmation that simplified homogeneous models are underestimating the actual energy absorption by significant amounts; a factor of 5 was documented from this research team alone.

This research paper also serves to provide notice of the apparent "hand-in-glove" cooperation between governments and the industry, as the principal researcher was employed by the Bureau of Radiation and Medical Devices, Health and Welfare Canada, and the funding came from the U.S. Environmental Protection Agency. Another of the researchers was with the U.S. FDA and is now employed by Motorola.

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[165] *M. Stuchly, et al., "RF Energy Deposition in a Heterogeneous Model of Man: Near-Field Exposures," IEEE Transactions on Biomedical Engineering BME-34, no. 12 (December 1987):944-49.*

Another industry research report proposes to provide information related to the "unexplored" area of heating of simulated tissue.[166] It's A curious that the researchers should describe the technical area as unexplored, even at that time, particularly in view of the full body of prior research, only some of which has been described here. In any event, the report on the heating effects to persons who operate portable radios indicates that radiation exposures might exceed a power density of 10 mW/cm². The measurement technique employed, thermal measurements taken by inserting a probe after exposure to radiofrequency energy, has been considered poor by others.

Since their measurement method is time-consuming it typically understates the maximum heating and, therefore, understates the maximum energy absorption. In addition, the experiments were performed with models employing a homogeneous gel-like substance to simulate the human brain. The industry researchers state:

> ***At the end of the exposure, the thermal probe was immediately reinserted in the dummy and the temperature increase recorded.[166]***

The researchers reported that they observed and documented an energy absorption "hot spot" associated with high electric fields at the tip of the antenna. But if the published research is any indication, they never pursued any further investigation of the "hot spot" absorption.

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[166] *Q. Balzano, et al., "Heating of Biological Tissue in the Induction Field of VHF Portable Radio Transmitters", IEEE Transactions on Vehicular Technology 27, no. 2 (May 1978):51-56.*

Researchers have found during this period that the SAR in man models exposed to cellular telephone mobile antennas does not meet the IEEE/ANSI standard. That's not surprising, since other, earlier, researchers have consistently reported that transmitting antennas could not be operated close to the human body—the human head—without violating the safe exposure limits. That is why the industry has argued, and was successful in obtaining, a categorical exemption for their products.

During 1986 a team of university researchers performed a series of radiofrequency energy exposure experiments to determine the SARs in human models exposed to radiating antennas that were mounted on the roof—top and trunk lid of an automobile.[167,168] As in the past they employed the fiber—glass mannequins filled with the "tissue cocktail" material.

It has previously been described that this pseudo-tissue material is of no practical value in determining accurate radiation absorptions. The researchers recognize this shortcoming by stating that

> ***though it has been demonstrated by other researchers that homogeneous whole-body phantom models with an electrical conductivity 2/3 that of muscle will provide the most realistic condition for determining whole body average SAR, this is not valid for local partial body exposures nor is it valid for***

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[167] *A. W. Guy and C. K. Chou, "Specif1c Absorption Rates of Energy in Man Models Exposed to Cellular UHF Mobile-Antenna Fields," IEEE Transactions on Microwave Theory and Techniques MTT—34, no. 6 (June 1986):671-80.*

[168] *A. W. Guy, "Dosimetry Associated with Exposure to Non-Ionizing Radiation: Very Low Frequency to Microwaves," Radio Physics 53, no. 6 (December 1987):569-84.*

determining SAR distribution within the model (see footnote 167).

Let's consider what these researchers have said. First, they have said that other researchers have validated the model that is being used. That is not true. Although the nonrepresentative mixture has been used by others and those other researchers have published experimental findings, there is nothing that indicates that the practice of using the "tissue cocktail" gives meaningful results or has been validated.

Second, by the researchers' own admission the homogeneous model mannequins: (1) will provide no information related to specific absorption in particular organs; (2) will provide no information related to energy absorption distributions within any organs, such as the brain; and (3) are not suitable for determining partial body exposures such as the amount of energy absorbed within the head.

Further, these researchers have documented other shortcomings of the mannequins as:

No attempt was made to simulate skin, fat, bone, or internal organs. (see footnote 167).

In summary, what they have provided is some gelatinous mass of material shaped in the form of various-sized humans (man, woman, child), which they have exposed to radiofrequency energy. Even with the gross misrepresentation, with respect to any living being, the results of this research are not encouraging.

Exposures were made with the mannequins positioned at various locations around the automobile. In one instance, the adult male—size mannequin was exposed

while positioned directly in front of the antenna, which places the antenna immediately in front of its stomach. A standing smaller adult-size mannequin, having surface contours similar to those of a woman, was also similarly positioned and exposed to the radiation. The child-size mannequin was positioned as kneeling in the rear seat of the auto approximately two to three feet from the antenna.

As if the nonrepresentative materials weren't sufficient to skew the data, the researchers used thermographic methods for determining the energy absorption. This technique has been evaluated earlier and found to be unsuitable. The long set-up and measurement time makes accurate measurements unlikely, as the temperatures in the mannequins change during the set-up. This results in serious understatement of the maximum energy absorption locations. The researchers alluded to the shortcomings by stating that

> ***The thermographic method used in the past was first used for determination of the SAR in the foam woman and child models exposed to the roof-mounted antennas. For later thermographic work with the trunk-mounted antenna, however, an improved thermographic technique was employed with digital recording and interactive-computer analysis. (see footnote 167).***

In spite of the "improvements" it was still necessary to physically disassemble each mannequin every time a thermal scan was to be taken.

The experimenters concluded that

> ***the maximum power densities and SARs for the worst-case exposure conditions tested with this input power to the antenna does not satisfy the ANSI***

primary exposure criteria; however, it does satisfy the 7-W and 8-W/kg exclusion clauses. (see footnote 167).

What these researchers are stating is that the experimental results do not fall within the constraints of the overall safe radiation exposure limits of the IEEE/ANSI standards; but since any portable transmitting antennas radiating less than seven 7 watts are exempt, the antennas meet the standard by virtue of that exemption.

They continue with their own description of the shortcomings of their models with statements such as:

The models used in this research were simple, homogeneous figures, but there are no technical restrictions in fabricating more advanced and realistic designs. . . (see footnote 167).

That particular research publication provides a very clear indication of how prominent researchers can produce experimental results, which do not represent energy absorptions in any living creature, and by making their own bold self-proclamations of validity try to elevate a very suspect set of experiments to the level of acceptable science. Further, and perhaps most dangerous, they try to extend the limited value of the findings to statements regarding radiofrequency energy exposures and radiation absorptions in general.

7

Average and maximum (peak) SAR may vary over several orders of magnitude for a given exposure level. That

is, the peaks of the SAR at certain spots may be hundreds or thousands of times greater than the average SAR over the whole of the tissue. For example, a human brain exposed to radiofrequency energy will have a susceptibility to absorb great amounts of energy at certain spots that may be hundreds and thousands of times more than for the rest of the brain. Quantifying near-zone exposure remains difficult, although progress is continually being made in this area. Every time a research experiment identifies a new "hot spot" location, or a new mechanism for depositing energy in a non-uniform manner the total picture becomes more clear.

During 1987 university researchers concluded that

> ***the actual SAR patterns in exposed subjects in bio-logical systems have such great variability that it is impossible to establish any meaningful relationship between SAR distributions and safe exposure standards.***[169]

That conclusion brings our attention to the fact that the industry and independent researchers are both experimenting with simulated human heads and brains. In most cases the simulated structures have none of the features of actual human heads. We have already learned to be wary of researchers voicing opinions based on experiments conducted with simplified models and experiments conducted with radiating antennas located at misleading positions. Now they have told us that, since the structure and features of the human head change so much from one individual to the next, the variability with

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[169] *A. W. Guy, "Dosimetry Associated with Exposure to Non-Ionizing Radiation: Very Low Frequency to Microwaves," Radio Physics 53, no. 6 (December 1987):569-84.*

energy absorption may be so great that what may be a safe exposure level for one person will be dangerous for others.

Of course, this line of thinking is not difficult to follow. The physical characteristics of a small head make the small head more prone to higher levels of energy absorption than a larger head. We've already considered the research that found "hot spot" absorptions due to smaller head size. Also, the shape of the skull, thickness of subcutaneous fat, muscle layering, and how an individual holds a portable cellular telephone each contribute to make the energy absorption different from one individual to another. The important common factor, however, is that all individuals will absorb a large portion of the radiation.

Guy tells us that

> ***For a more exact SAR analysis, one should take into account the bone, the subcutaneous fat, and the complex inner geometry of the body. This would require the development of much more sophisticated models.***[170]

Given this statement, one must wonder how it is that some researchers, using simplified models, have made such bold claims of safety.

A controversy seems to have developed and some researchers are questioning the accuracy of results obtained by using the most simplistic models. Those researchers have confirmed that the simplified spheroidal models are inadequate for considering real power absorption in humans:

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[170] A. W. Guy, "Dosimetry Associated with Exposure to Non-Ionizing Radiation: Very Low Frequency to Microwaves," Radio Physics 53 no. 6 (December I987):569—84.

It appears doubtful, however, that any useful theoretical or numerical solutions can be economically obtained for figure shapes as complex as man.[171]

K. Foster, R. Kritikos, and Schwan also determined from their research that radiofrequency irradiation of simulated biomaterials is not likely to provide accurate estimates of radiation induced temperature distribution in actual tissue.[172] Simplified structures seriously understate energy absorption and temperature rise.

Some reasons for the shortcomings are readily evident. If, for example, a researcher employs a head structure comprised of some single material (saline solution or some gel material), the results cannot reflect the important contributions of nonuniformities and dissimilar layers of an actual human head and brain which are known to dramatically affect absorption. Researchers have learned that as the complexity of laboratory models improves toward more accurate representations of the human head, the experimental results also yield increased absorption findings.

Their belief that useful data could not be economically obtained was destined to be proven wrong. In fact, even the six-layered models in use at that time were providing useful results of real power absorption. Of course, the MRI-based analytic tools developed during the 1990s are superior.

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[171] *A. W. Guy, et al., "Determination of Power Absorption in Man Exposed to High Frequency Electromagnetic Fields by Thermographic Measurements on Scale Models," IEEE Transactions on Biomedical Engineering BME-23, no. 5 (September 1976):361.*

[172] *K. R. Foster, et al., "Effect of Surface Cooling and Blood Flow on the Microwave Heating of Tissue," IEEE Transactions on Biomedical Engineering BME—25, no. 3 (May 1978):313-16.*

Surprisingly, the same group of researchers who were so outspoken about the use of simplified models have reported that their own research, sponsored by the U.S. Air Force, employed those very same types of scaled homogeneous models. Not only were the models scaled down to about one-tenth the size of a human, but also the researchers made the models out of that same "one type fits all" mixture that they say represents the combined properties of all of the different human tissue types. This combination yields a "tissue" that has none of the properties of any human tissues. The researchers call it "2/3 muscle tissue." Nevertheless, from this "tissue cocktail" they have constructed the scaled-down doll-like structures that they used for their "scientific" experiments.

As if the nonrepresentative structure were not enough to violate the standards of good laboratory practices, the researchers also used thermographic measuring techniques to detect energy absorption. Their comments of the technique state that "the heat loss during the several minutes needed for the measurements was negligible."[179]

Other researchers have reported earlier that they were concerned with the validity of measurements that took several seconds; but these researchers were unconcerned with thermographic measurements that took several minutes. We have already discussed that thermal measurements that take long periods of time, that is, several seconds, tend to blur the temperature distinctions in tissue and completely mask thermal "hot spots." A

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[179] *A. W. Guy, et al., "Average SAR and SAR Distributions in Man Exposed to 450-MHz Radiofrequency Radiation," IEEE Transactions on Microwave Theory and Techniques MTT—32, no. 8 (August 1984):752-63.*

measurement that takes several minutes no doubt compounds the errors and would provide little, if any, valid information.

On the basis of those toy models of human shapes, made out of a single substance that does not resemble any biological tissue and using poor thermographic methods, those researchers declared that their experimental findings prove exposure to 1 mW/cm² radiofrequency radiation is safe. The models and methods gave absolutely no indications of energy absorptions within any part of any human structure; no measurements within head models; no measurements within human torso models; no computer calculations; only radiation of little dolls. A whole body of literature is available to contradict those simplistic findings. Yet, the researchers have not referred to that published data.

Since the industry identifies the market for their products to be in the region of $100 billion it should be reasonable to expect that funding be made available to construct the more representative models. It's not as if the capability did not exist. It's just that researchers have not been funded to do the work.
Guy underscores this need by writing that

> ***since it is impossible to do many biological effect studies on man, the development of safe human exposure standards must be based on animal experimentation. (see footnote 173).***

The cellular telephone industry has taken this a step further. Rather than provide the realistic models for the researchers, industry has elected to use the public for its experiments. Others reconfirmed what Guy reported.
They stated in 1987 that

among the remaining areas where more work is still needed in RF dosimetry research is the quantification of the near-field absorption by biological models. It is generally feared that the near field may possibly contribute to excessively hazardous absorption conditions.[174]

Perhaps this scientist has been remiss in keeping up with the research literature, but the prospect of near-zone absorption hazards has been proposed, quantified, confirmed, and reconfirmed. There is no maybe about it: "hot spots" dominate the concerns when the human head is exposed in the near-zone of radiating antennas.

Usually the purpose of computer analysis is to verify the experimental results obtained by others or to evaluate new techniques that others have proposed. However, these researchers employ the "tissue cocktail" material characteristics that have become all too familiar by now and which admittedly resemble no known biological tissue. In spite of this, they have performed analyses with the nonexistent material parameters in a computer model (see footnote 174). It would have been just as easy to enter accurate human tissue values, in which case the results would have some basis in reality instead of being related to a nonexistent being.

Other researchers have published depictions of SAR distributions, taken from a compu***174***ter analysis of the human head, that show that for a frontally impinging plane-wave distinct energy absorption "hot spots" are formed

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[174] *M. F. Iskander, et al., "Near-Field Absorption Characteristics of Biological Models in the Resonance Frequency Range," IEEE Transactions on Microwave Theory and Techniques MTT—35, no. 8 (August 1987):776-80.*

within the brain.[175] This is interesting since it confirms that even plane-wave induced radiation absorption results in interior energy absorption "hot spots." In this instance the observed "hot spots" amount to an energy absorption (SAR) of 0.6 mW/g for an incident power density of 1 mW/cm². In the near-field, that same incident power density would result in a much higher SAR due to a number of enhancement factors, including the nearzone "matching" effect.

8

P. W. Barber, et al., also used a six-layer model in their analyses to arrive at findings that confirmed the earlier work of Joines and Spiegel. That is, a 30 percent increase in radiation absorption results for complex six-layered models rather than the simpler homogeneous and inhomogeneous models previously employed[176] Interestingly, for this study, the greatest peak of the enhancement effect, which the researchers call layering resonance, occurs at about 1,900 MHz—the frequency range of the PCS portables.

The researchers have found that constructing models with representative layers of skin, fat, bone, etc., leads to the “matching" effect, which actually helps the radiofrequency radiation penetrate the head structure most

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[175] *D. T. Borup and O. P. Gandhi, "Calculation of High-Resolution SAR Distributions in Biological Bodies Using the FFT Algorithm and Conjugate Gradient Method," IEEE Transactions on Microwave Theory and Techniques MTT—33, no. 5 (May 1985):417-19.*

[176] *P. W. Barber, et al., "E1ectromagnetic Absorption in a Multilayered Model of Man," IEEE Transactions on Biomedical Engineering BME-26, no. 7 (July 1979):400-405.*

readily. We've discussed the research findings of "matching" effects earlier, and Barber has reconfirmed the effect. Since the thicknesses of these layers vary from person to person we should also expect that the exact frequency of maximum "enhancement" will vary from one person to another.

In another report, which comes from the same research lab, the researchers replicated the earlier work of Joines and Spiegel to detail a more than twofold increase (108 percent) in average SAR in a layered model over that of a homogeneous model at exposure to 1,200 MHz radiation.177 As would be expected, their data show findings of about the same increase (92 percent) at 900 MHz. Reverification of the earlier published findings confirms the need to distinguish experimental results according to the complexity of the models used. Simplified models underestimate the energy absorption by about a factor of 2 compared to a three—layer model. Earlier researchers I have reported that the energy absorption, when using a six-layered model, is higher yet by a factor of 2 to 3 times.

9

T. Kobayashi has warned that typical gel-type materials are prone178 to dehydration, deterioration and invasion by molds and bacteria. All of these effects lead to inaccurate experimental data, yet nearly all researchers who experiment with laboratory models use the gel mixtures.

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177 H. Massoudi, et al., "Electromagnetic Absorption in Multilayered Cylindrical Models of Man," IEEE Transactions on Microwave Theory and Techniques MTT-27, no. 10 (October 1979):825-30.

178 T. Kobayashi, et al., "Dry Phantom Composed of Ceramics andIts Application to SAR Estimation," IEEE Transactions on Microwave Theory and Techniques MTT-41, no. 1 (January 1993):136-40.

He has found, and other independent researchers have verified his findings, that the gelatinous concoctions do not faithfully duplicate the electrical properties of living human tissues over any period of time. For example, a mixture may be prepared for experimental study and only a few hours later the properties of that material will have changed. Most experiments are conducted over a period of several days or weeks. In those instances the properties of the material are continuously changing during the entire course of experimentation.

Aside from his observations about the gelatin mixtures, Kobayashi provides a number of thermographic images that clearly, and dramatically, depict that radio-frequency energy is absorbed in the head substantially at the location nearest the placement of the antenna. For his experiments he has employed a mixture of dry substances. While this is still far from representing a living human head and brain, at least the electrical properties are not shifting all over creation during the data gathering process.

His findings show that even at an antenna distance of 5 cm, which is a relatively large distance by today's portable telephone designs, the energy absorption maximum is about 1 mW/g. At a more typical antenna to head spacing of 2 cm, as would be the case with some of the "flip-phone" style telephones, the energy absorption is about 3 mW/g. That's far above the safe exposure limit of the IEEE/ANSI standard, but once again, the standard exempts the phones from compliance. Again, keep in mind that this laboratory model is homogeneous —having been constructed with the new "recipe" of materials that these researchers have developed.

A series of experiments, which were designed to quantify the SAR Within a human head model, was performed with a rather interesting structure.179 Although the radiation-generating devices were portable transmitter radios and not portable cellular telephones, valuable energy absorption data would be expected. The interesting part of the experiment comes from a close inspection of the human head model.

In order to construct the model the researchers chose not to use an available human skull but, rather, fabricate a model from synthetic materials. They have provided data that show that the electric fields within the "synthetic skull" are much different from those within the human skull. But they performed the experiments with the "synthetic skull" only.

Continuing, they filled the "synthetic skull" with synthetic brain material and also included a "synthetic eye," but they acknowledge some significant variation in the material properties of the eye compared to what it should have been. This then provided an assembly comprised of a nonrepresentative synthetic skull, filled with homogeneous, featureless, synthetic brain matter, and a nonrepresentative synthetic eye. One might expect that they would begin radiation experiments at that point, but instead they did something that seems at least peculiar, if not suspect.

They added large masses of "simulated muscle tissue" to strategic areas on the surface of the "synthetic

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179 R. F. Cleveland and T. W. Athey, "Specific Absorption Rate (SAR) in Models of the Human Head Exposed to Hand·Held UHF Portable Radios," Bioelectromagnetics 10, no. 2 (1989):173-86.

skull." At the forehead of the model they placed a layer of muscle material that is approximately 1/2 inch, or about 1.25 cm, thick. A rather large nose is formed entirely of muscle material. Each eye is completely surrounded by a circular area of muscle material, which appears to be about 3/4 inch thick. At the lower jaw areas, on each side, they have added areas of muscle tissue approximately 1 inch thick. Also, along each side of the "synthetic skull" they have added layers of muscle tissue approximately 1/2 inch thick. Finally, at the particularly susceptible region of the temporal area that has been identified by other researchers as a “hot spot" absorption area, these researchers have added a second, additional, layer of muscle material.

Now, starting with that preposterous model of a human head, which more closely resembles Mr. Bill, a claymation character from a popular television show, they performed a series of radiation exposure experiments and measured the electric field intensity within the simulated brain matter, which was itself inside the "synthetic skull."

We should keep in mind at all times that the measurements were taken at regions that were effectively shielded by the thick layers of muscle material. The significance of this human head model configuration lies in the fact that any energy radiated to the model would first be partially absorbed in the exterior coating of nonrepresentative muscle material before any of the remainder could be transmitted through the skull and into the brain material.

The experimental data show that energy absorption (SAR) within the simulated brain material, at what would be the temporal lobe of the brain, is about 2.3 mW/

g for a radio or telephone radiating 0.6 watts. For operation with the antenna in front of the face the experimental results show that as much as 2.2 mW/g will be deposited in the eye.

Now, we should recollect that earlier researchers have repeatedly determined multilayered structures (models) comprised of skin, fat, bone, dura, CSF (cerebro-spinal fluid), and brain layers provide a much higher level of absorbed energy than simplified "brain-stuff-in- skull" models. The reason is that the layers can interact to enhance the radiation absorption in a way that makes the layers covering the brain appear to be substantially invisible to the radiation. Not only have these researchers excluded the multilayering details of a proper model, but they have also compounded the error by covering the model with a layer of energy—absorbing musclelike material. This is about as realistic as placing a window shade over the outside of a window and then measuring how much visible light is passing through to the inside of the room.

But, at the same time we should not lose sight of the impact of this research . The findings of greater than 2.0 mW/g of radiofrequency energy absorption within the brain are dramatic. The ANSI safety standards limit exposure to 1.6 mW/g. If the ANSI standards were to apply to portable hand-held transceivers this would be a clear violation of the maximum exposure limits, but existing portables are not regulated.

In addition, one of the reasons for the concept of the exclusion clause in the ANSI standard is that industry researchers argued that radiation from hand-held transmitters is not absorbed into the brain. Their reasoning stated a "peculiar nature" of the electric and magnetic fields but never described that peculiarity in physical or

any other scientific terms. In direct contradiction of those representations, Cleveland and Athey have found deep energy penetration and absorption even with a laboratory model that was constructed to minimize any energy absorption of radiofrequency radiation.

6

"Damage Control" I - the Birth of Public Deception

"I am Oz, the Great and Terrible," said the little man, in a trembling voice, "but don't strike me—please don't—and I'll do anything you want me to."

Our friends looked at him in surprise and dismay.

"I thought Oz was a great Head," said Dorothy.

"And I thought Oz was a lovely Lady," said the Scarecrow.

"And I thought Oz was a terrible Beast," said the Tin Woodman.

"And I thought Oz was a Ball of Fire," exclaimed the Lion.

"No; you are all wrong," said the little man, meekly. "I have been making believe."

—L. F. Baum
The Wizard of Oz

1

These issues of danger related to radiofrequency radiation and portable cellular telephones began taking form nearly twenty years ago. And as with most conflicting views that erupt into battles or wars, it is seldom the

igniting spark that is really the focal point of disagreement; so, too, with the developing battles over radiofrequency radiation. The issues were defined and resolved in the past by scientific research. However, the telecommunications industry can't abide by those research findings.

The telecommunications industry would never have grown to the global force, with virtually unlimited power, that we know it to have today if it accepted the scientific research. So the industry did as has been done throughout history. The industry developed a "belief" system. The wonderful thing about a "belief" system is that it doesn't require any scientific findings. And any contrary findings that do develop are easily dismissed—as being unbelievable.

The authoritative community does quite well with "belief" systems from time to time. Some examples: (1) the scientific community and dominant religious authorities "believed" that the Earth was flat; (2) the scientific community and, again, the dominant religious authorities of the time "believed" that the Earth was the center of the universe; (3) scientific calculations supported the "belief" that man could not survive travel at speeds greater than sixty mph; (4) tobacco industry representatives "believe" that cigarette smoking is not harmful and that nicotine is not addictive; (5) prior to 1900 physicists were convinced that all significant discoveries had already been made and only minor technical corrections would occur in the future.

But as Carl Sagan so elegantly phrased it and as we've taken the liberty of pointing out in the introduction to an earlier chapter,

There are many cases where the belief system is so absurd that scientists dismiss it instantly but never

commit their arguments to print. I believe this is a mistake. Science, especially today, depends upon public support. Because most people have, unfortunately, a very inadequate knowledge of science and technology, intelligent decision making on scientific issues is difficult. Some pseudoscience is a profitable enterprise, and there are proponents who not only are strongly identified with the issue in question but also make large amounts of money from it. They are willing to commit major resources to defend their contentions. Some scientists seem unwilling to engage in public confrontations on borderline science issues because of the effort required and the possibility they will be perceived to lose a public debate. [180]

Prior to 1976 there was little need to establish any defined points of view on the issues of radiofrequency energy exposure. Up to that time there were few personal transceiver devices except for the low-frequency walkie talkies used by the military and a few law enforcement groups. But with the introduction of higher-frequency portable transceivers, a distinct division among bioeffects researchers became noticeable.

Up to that time the influences of product manufacturers appeared to be less strong or, perhaps, less visibly applied possibly due to a lack of products that would have turned their attention to the bioeffects issue. However, any lack of interest was quickly replaced with a highly focused awareness, due to the fact that by the late 1970s the manufacturers were well on their way with development of the technology that would produce the first generation of portable cellular telephones. Couple to

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[180] *Carl Sagan, Broca's Brain (New York: Random House, 1979), p. 59.*

that an emerging concern related to the safety of portable radios, such as those used by law enforcement and emergency services personnel, and it is not hard to understand how a shift in published research could ensue.

Once the bioeffects research field captured the attention of industry, it moved quickly to sweep away the body of unfavorable research and implement its own "belief" system. That system has been functioning for these past twenty years.

For whatever reasons, from about 1976 forward there has grown an increasingly marked division among researchers that places them into two distinct camps. The first subscribes to the belief that radiofrequency radiation exposure, under some conditions, will cause destructive effects in humans. The second group of researchers maintains, as does industry, that if you can't specify one, and only one, definitive causation mechanism, then there is no harm.

That is the challenge to the bioeffects research community. If researchers identify two, five, or ten interaction mechanisms that lead to the damage, the industry won't buy it. They say it must be one cause. That amounts to having a burglar demand that the victim must be able to tell the court what color shirt he, the burglar, was wearing on the night of the burglary or he gets off free. Never mind any other evidence. But how is it that such a twisted situation is allowed to exist with this telecommunications industry?

2

As researchers have continued to expand their understanding and describe the interactions of low-level radiofrequency energy with biological tissue, the conditions of

the exposures also began to draw some serious attention. Since some of that work has indicated that exposure of the brain is more critical than exposure of other parts of the body, more work in that area was, naturally, expected. At the same time, other researchers continue to emphasize that energy absorption "hot spots" are ubiquitous in biological systems.

So many different "hot spot" locations and mechanisms for creating the "hot spots" in the human brain have been identified that it's really difficult to imagine operating a portable cellular telephone without believing that one or more such "hot spots" are being continually energized within one's brain. Even today while the investigations of "hot spot" effects and mechanisms continue, researchers report additional findings of low-level radiation effects. With all of the information tying localized absorptions to the specific features of the human head and brain, shouldn't we expect that the industry and its funded researchers would insist on using laboratory models that more closely resemble the models used for computer analysis?

After all, the telecommunications industry typically employs material science specialists and university researchers to develop materials with specific properties needed for electronic circuitry. But after working the bioeffects field for more than twenty years this same innovative group of product manufacturers hasn't been able to, or hasn't thought it important enough to, develop a suitable set of synthetic materials to be used in the systems for testing the safe exposure of humans to radiofrequency radiation from transmitting antennas?

There is no problem with radiating antennas in and of themselves. The problem arises when the antennas are operated very close to an energy-absorbing material. The

human head is an excellent radiofrequency energy—absorbing material. At some frequencies it acts like a sponge and placing a radiating antenna close to the head will cause the stored energy and radiated energy to be "sucked" into the head and brain. Iskander's group reconfirmed the physics of much higher stored energy and graphically depicted the enhancement effects as a human head model is moved ever closer to a radiating element.

3

Some of the reasons given to justify the exclusion clause have already been discussed. But it may be more important to make known the fact that only a fraction of the overall committee membership is well schooled in the principles of electromagnetics and energy propagation. Those who aren't will rely on those who are—mostly industry and military scientists. Since there is a diversity of groups within the committee, each with its own particular agenda, there is also opportunity for striking mutually beneficial agreements or exerting a special kind of influence that might seem out of place in a more open forum.

Industry proponents worked closely with committee members in carving the portable transmitter products away from any regulations, much the way tobacco company lobbyists and representatives have been able to exempt their products from the various agricultural, drug, and environmental regulations.

The addition of a single paragraph or sentence, properly placed into an otherwise well drafted safety standard, can render that standard useless for the control

of radiation deposited into the brains of tens of millions of people.

Industry research both internal and published clearly indicates that company engineers and scientists are well aware of the excessive and dangerous power density levels to which users of the portable products, such as portable cellular telephones, are exposed. In some examples, which have been discussed, industry researchers confirmed that in order to comply with the proposed safety standards the portable transmitter power level would need to be reduced to about 0.001 watt. That means in order for some of the companies' portables to comply with the proposed safety standard the power would have to be reduced by a factor of about 600, and that's just to meet the power density safety level. That doesn't even consider "a safety margin for the many enhancement and "hot spot" mechanisms.

4

The IEEE/ANSI C95.1—1982 safety standard also included a safe energy absorption level based on the amount of energy absorbed within the body. However, as with the power density guide, portable radios and portable cellular telephones were categorically exempted. If the portables were required to comply with the SAR (Specific Absorption Rate) levels it would have meant a limit of 8.0 mW deposited into any one gram of tissue. The standard is also conveniently, and artificially, structured so that highly localized "hot spots" can be "averaged out" over a full gram of tissue. One gram is the smallest unit of tissue that the standards consider. Further, the standard has defined that the one gram of tissue

must be in the form of a cube. This allows researchers, motivated to do so, to arbitrarily select—to hunt, so to speak, for areas of lower energy absorption that can be used to help lower the "average" absorption level that is reported.

We already know that energy deposition into tissue results in heating. Absorption of 8 mW into a single gram (8 mW/g) or into approximately one cubic centimeter results in approximately a 1—2°C temperature increase in that tissue. We also know that temperature increases within the brain of 1—2°C will result in tissue damage. So the safety standard effectively established a "safe" exposure level that first allows for damage or destruction of brain tissue and, second, exempts the most serious offenders. Since 1982, the IEEE/ANSI standard has been further revised to limit the maximum absorption to 1.6 mW/g. Even though a blizzard of research reports now find that the portables exceed that radiation absorption level, no action is taken—the portables remain exempt by virtue of the FCC's "grandfathering" of existing products.

Without fear of being corrected, the cellular industry has always stated that their portable telephones meet the IEEE/AN SI standards. However, the industry never says that the ANSI safety standards didn't apply to portable cellular telephones. The industry never says that the ANSI safety standards categorically excluded portable cellular telephones from any of the radiation exposure limits.

Even with all of the background activity related to tailoring the safety standards to suit the manufacturers and system operators, research continues to uncover disturbing pieces of evidence. Rather than the benign technology tho industry claims, the evidence continues to

paint a malignant picture of the effects to be expected due to human exposure to radiofrequency radiation.

Exposure standards, such as ANSI C95.1, are based on a biophysical approach that looks for observable behavioral and immediate physiological effects in laboratory animals. But damage to brain tissue is not expected to result in immediate physiological symptoms unless the damage is extensive. Long-term effects are also an entirely different matter. Even when behavioral and otherbioeffects, such as tumors, are documented in laboratory animals, a typical industry response is that the results cannot be used or extrapolated to humans. But why, then, do we not hear the same criticisms voiced when supposed "safety levels" are established by using the same laboratory animals?

C. H. Durney pointed out the apparent Catch—22 when he observed that humans cannot be used as test subjects —"guinea pigs".[181] If the cellular industry convinces the responsible government agencies that laboratory data from animal experiments cannot be used and also convinces those agencies that human experiments are unethical, then the industry is free to do as it pleases. What a wonderful environment for the free reign of unencumbered commercialization of technology. In that environment the saying "let the buyer beware" will take on a whole new meaning.

But Durney's admission is unusual because even with nuclear radiation experiments humans were used. With radiofrequency radiation it may be that the potential for harm to human test subjects is already so well

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[181] *C. H. Durney, "Electromagnetic Dosimetry for Models of Humans and Animals: A Review of Theoretical and Numerical Techniques, "Proceedings of the IEEE 68, no. 1 (January 1980):33-40.*

known that human testing is unthinkable. With radiofrequency energy testing there should never be an instance when the testing is performed without the informed consent of the test subject—such as portable cellular phone users.

As such, the other laboratory techniques are employed to determine exposure, absorption levels, and effects. Numerical analysis is commonly employed to provide solutions for radiation absorption by computer-simulated human bodies. Sophisticated computer analysis is available for frequencies including the cellular telephone transmit range and with complex models of the human head and brain.

Currently computer models comprised of millions of cells can subdivide the human head into as many layers as exist in reality. Further, a cell size of only a couple of millimeters greatly improves the resolution available to detect localized "hot spots." Couple this with MRI techniques and the picture is of a truly sophisticated modeling capability, but it still requires proper data input for accurate output data. The old saying "garbage in - garbage out" remains true especially for the computer modeling experiments. If researchers insert nonrepresentative material characteristics, tissue types, or physical structures, their sophisticated results will be little more than sophisticated garbage.

We already know of at least a couple of instances when nonrepresentative input data and test conditions were used to arrive at completely erroneous conclusions that have been broadcast worldwide. The basis on which the industry's representations of safty have been established is rooted solely in the "belief' that any short-term exposure that does not cause an

immediate, observable effect must be safe. The standard-setting committee has taken the position, in the past, that if any effect were to occur they "believe" that researchers should be able to observe and measure that effect immediately. Of course, we realize that such thinking is as nonsensical as "believing" that exposure to nuclear radiation is harmless because the effects take years to be seen.

Some in the research community do not buy into the dogmatic posturing and continue the research to learn bioeffects interaction mechanisms. Today research activity related to finding biological effects tied to low-level exposures to radiofrequency radiation has moved into the forefront, while research into thermal effects continues in the background.

Most notable is a 1980 review of scientific research that nicely describes the conflicts between the two opposite research groups. In that review H. Cook, who received his funding from the National Science Foundation, concluded that some of the prior research did not proceed in a professional or scientific manner.182 Therefore, no conclusions could be drawn, with respect to dosimetry and experimental techniques, from papers presented at the suspect Fourth Tri-Services Conference (1960). In effect, Cook was indicating that the dosimetry studies had provided artifically optimistic findings.

It's very enlightening to learn that even during the early 1980s a few researchers were outspoken on the issue of research bias. They judged some research and perhaps the industry- and military—sponsored researchers as

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182 H. J. Cook, et al., "Early Research on the Biological Effects of Microwave Radiation: l940—1960," Annals of Science 37 (1980):323-51

biased toward industry expectations rather than scientific knowledge.

That's a very strong conclusion to draw so early in the evolution of radiofrequency technology. We might expect that charge to be made today, in view of the raging controversy over safety issues of millions of hand-held radiofrequency transmitters. But for the industry bias in research to have become evident so long ago, when the stakes were very low, raises extreme alarm today in view of the $100 billion industry now at stake. If researchers and industry were painted as biased and disingenuous at that time, when no corporate or economic survival was at stake, what might we expect to be occurring today that has not yet come to our attention?

The shift in focus to effects caused by low-level exposures occurred for two reasons. First, effects due to high-level exposures have been fairly well documented and accepted. Second, the telecommunications industry had been successful in convincing government agencies and a large part of the research community that damaging effects must be tied to low-level exposures. This came at a time when the industry also claimed that their portable products exposed operators only to low-levels of radiation.

Inquiries questioning the safety of radiofrequency energy absorption invariably were answered with the industry response that no link had been found between low-level radiofrequency radiation exposure and hazardous biological effects. Of course, this is a false statement. Keep in mind that with the ever-present "hot spot" absorption mechanisms, even very low radiation exposures can provide enhanced locally high-level absorptions within the brain.

5

Let's reconsider the issue from a different perspective. Instead of pointing out reasons and evidence that confirm hazards or dangers, let's look at what researchers interested in utilizing the medical applications of radiofrequency energy absorption have observed.

In the United States, 915 MHz has been allocated by the FCC for medical use. If other frequencies were available for medical therapy, researchers and therapists would, no doubt, have selected a slightly lower frequency, because the frequency range just slightly below 900 MHz is optimal for absorption of radiofrequency energy—the frequency range corresponding to the portable cellular telephone transmit band.

Generally, these researchers with medical applications in mind are supporting the findings of electromagnetics and bioeffects researchers. That is, radiofrequency radiation is absorbed so well at frequencies in the range of portable cellular telephone transmissions that they, the hyperthermia researchers and therapists, will use it as a method of inducing heating or to destroy tissue. In the case of hyperthermia treatment the medical therapists intend to destroy cancerous tissue. In the case of portable cellular telephones, dangerous absorption levels and tissue destruction make no such distinction.

Moving ever closer to the time when the portables were placed on the market, researchers continued to voice their concerns about adverse biological effects in humans. At the same time, medical therapy researchers were enthusiastically enjoying the findings that the deep penetration effects of energy in the 700-950 MHz range were ideal for hyperthermia treatments. It might seem as if the researchers were working at cross-purposes, but

as with nuclear radiation, which can be medically beneficial as well as lethal, radiofrequency radiation can be medically beneficial as well as lethal. Recall that when nuclear radiation experiments began early in this century, no one understood that there was a danger. It was only years afterward, when some of the most creative and gifted researchers became ill and died of radiation poisoning, that the world believed there to be a danger. As with nuclear radiation, radiofrequency radiation is a two-edged sword.

6

In the search for that one specific causation trigger, one of the mechanisms for activation of latent tumor cells has been proposed that could lead to expression of malignant neoplasia. The mechanism includes promotion via a proliferation stimulus. In his hypothesis C. E. Easterly identified magnetic fields as the stimulus that can cause latent tissue damage or cell modifications.[183] When the cell subsequently reproduces, the modifications become fixed in the cell genetics.

He compares this type of tissue injury to other widely known, causes of cancerous growths resulting from trauma, including nuclear radiation, chemical exposure, and surgical wounds. Of course, since he was only proposing a mechanism, rather than confirming one, his work was easily ignored by the industry. But it was only a matter of time until the experimental research caught up

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[183] *C. E. Easterly, "Cancer Link to Magnetic Field Exposure: A Hypothesis," American Journal of Epidemiology 114, no. 2 (August 1981):169-74.*

with his hypothesis and began providing findings of DNA and chromosome damage—exactly as he predicted.

It is interesting to note that this researcher has included surgical trauma as a known or suspected cause of cancer, since that type of trauma is a single occurrence. Some other researchers subscribe to the belief that only multiple or long-term exposures can promote uncontrolled growth. That school of thought resides in a belief of an irritant as stimulus rather than direct destruction or damage of tissue. An irritant such as, for example, asbestos or cigarette smoke residue produces a result after a long-term continual exposure. However, exposures such as nuclear radiation and radiofrequency radiation are known to cause destruction and damage to tissue even with a single exposure. Today we know that even a single exposure to low-level radiofrequency radiation causes damage to the DNA makeup of brain cells.

While scientists argue the precise mechanism that causes the chromosomal and DNA changes, the general population needs to know that exposure to radiofrequency radiation, in fact, causes the alterations. The next obvious step in public discussions is to recognize that the reported genetic effects lead to mutations of cells which is manifested as cancer.

At a U.S. Senate hearing held during August 1992, Dr. W. Ross Adey confirmed that cellular telephones produce high electromagnetic fields in the brains of users. Dr. Adey is one of the most highly respected of all researchers in the field investigating biological effects of radiofrequency radiation as well as power line effects. In his statement about the high fields, Adey highlighted the cellular telephones in a group that included microwave ovens.

The same physical processes that heat and cook tissue in the microwave oven are at work in the human brain when radiofrequency radiation is absorbed. The distinctions to be made are that: (1) in the case of the microwave oven the tissue is dead and heated deliberately; (2) with portable cellular telephones the tissue is a living human brain; (3) with portable cellular telephone use the radiation source is placed directly to the head of the user; and (4) radiation levels from microwave ovens are regulated while portable cellular telephone power densities are many times greater.

7

"Damage Control" II—A

Continuing Public Deception

In each, three elements kept suggesting the involvement of Nixon despite his constant denials:

1. Nixon had the opportunity to plan and order the obstruction of justice (as indicated in this first instance by his many meetings with men who later were indicted in the Watergate conspiracy).

2. Such plans indeed were put into effect.

3. Despite persistent appeals that he do so, Nixon never produced evidence to clear himself and, in fact, resisted releasing evidence or allowed evidence to be destroyed.

—B. Sussman

The Great Cover- Up: Nixon. and the Scandal of Watergate.

1

Even without that one specific link the FDA has stated that there is no evidence to show that the portable cellular telephones are safe, this in spite of the industry's insistence that there are 10,000 such studies. The FDA knows no such studies exist. The cellular telephone industry knows no such studies exist. You now know that no such studies exist. Now you know that

many studies contradicting the cellular industry's position do exist.

Even as research into the hazards of radiofrequency radiation exposure is taking place, communications researchers and engineers are advancing the technology to newer and expanded capabilities. A. J. Rustako, et al., have reported that microcellular communication systems at 900 MHz and at 11 GHz (11,000 MHz) may provide for significantly reduced radiated power levels necessary from portable and mobile cellular telephones.184 The idea is to place cell sites closer together so that portable cellular phones don't need to transmit as much power for the signal to reach the cell site. The reduced power radiated, about three hundred times lower than that of today's portables, would mean less power absorbed in the user's brain.

If, at the same time, the newer system were set up at 11 GHz the energy absorption within the user's brain would also be reduced significantly. Recall, other researchers have repeatedly documented that higher frequency results in reduced deep penetration of radiofrequency radiation. So, by shifting the system operation to 11 GHz the problems of energy penetrating into the human brain will be significantly reduced. However, there is a downside. Even though increased frequency provides a reduction in deep tissue penetration, it simultaneously produces an increase in superficial tissue absorption.

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184 A. J. Rustako, gp et al., "Radio Propagation at Microwave Frequencios for Line-of-Sight Microcellular Mobile and Personal Communication," IEEE Transactions on Vehicular Technology VT-40, no. 1(February 1999):203-10.

Keep in mind, though, that the research base has indicated biological effects at very low—level exposures. The shift to 11 GHz eliminates one set of problems but not all problems. The low level radiation exposure effects and the nonuniformity effects will persist.

2

During a July 1993 press conference the CTIA (Cellular Telecommunications Industry Association) took the public relations offensive by proclaiming that their new research program Was meant to reassure the users of portable cellular telephones that they, the portables, were safe and that their research would reaffirm that position. Officials at the U.S. Food and Drug Administration were angered by the disdainful attitude of the CTIA.

In a letter to CTIA president Thomas Wheeler, Elizabeth Jacobson, deputy director for science at the Center for Devices and Radiological Health, Food and Drug Administration, wrote:

> ***Both the written press statements and your verbal comments during the conference seemed to display an unwarranted confidence that these products will be found to be absolutely safe. In fact, the unremittingly upbeat tone of the press packet strongly implies that there can be no hazard, leading the reader to wonder why any further research would be needed at all. (Some readers might also wonder how impartial the research can be when its stated goal is "a determination to reassure consumers," and when the research sponsors predict in advance that "we expect the new research to reach the same conclusion, that the cellular phones are safe.")***

We are even more concerned that your press statements did not accurately characterize the relationship between CTIA and the FDA .... [S]ince it is not yet clear whether we will help to direct the research program, it is premature to state that we will credential the research.

To sum up, Mr. Wheeler, our role as a public health agency is to protect health and safety, not to reassure customers. I think it is very important that the public understand where we stand in evaluating the possibility that cellular phones [portable cellular telephones] might pose a health risk. [185]

So there it is—the cellular industry's flagrant misrepresentation that the government agencies are participating in and supporting the program. The fact is that the FDA has not been able to come to an agreement with the CTIA because the CTIA would not provide the FDA with the necessary control over the program. In essence, the objections raised of research bias, peer review bias, and industry control of the entire program have not been removed. And the CTIA's conduct seems to reinforce those concerns.

As if that weren't enough, the U.S. Environmental Protection Agency (EPA) made charges against the adequacy of the new ANSI C95.1-1992 safety standards. The EPA has admonished the FCC not to adopt the newly revised standard because it does not represent the scientific knowledge on a number of points.

For one, the new IEEE/AN SI guideline neglects all consideration of the voluminous research data that now

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185 *"FDA to CTIA: There Isn't Enough Data to Gauge Cellular Phone Risks," Microwave News 13, no. 4 (July/August 1993).*

indicate the existence of nonthermal effects of radiofrequency radiation exposure. In this regard the EPA disagrees with the standards committee position that they have considered all possible bioeffects mechanisms in arriving at the new standard —it has not considered low-level radiation effects. These effects have been known and continue to be revalidated with new research regularly.

Not surprisingly, the telecommunications industry has urged the FCC to adopt the revised ANSI C95.1-1992 safety standard. Om Gandhi wrote that

> ***The power limit prescribed in ANSI/IEEE C95.1-1992 under exclusions for the uncontrolled environment is certainly quite conservative for the present-day cellular telephones operating at 820-850 MHz.***

This correspondence was provided as Gandhi sent his false research findings to the FCC. In view of his "corrected" energy absorption numbers, Gandhi's endorsement of the ANSI/IEEE standard is meaningless.

How can we rely on the assurances of a researcher who splashes false research findings across the newspapers of the world one day and then quietly modifies those findings in private communications to the FCC almost a full year later?

A statement from McCaw Cellular Communications, Inc., dated January 25, 1993, cited Gandhi's wholly inaccurate, unverified, unpublished, and unreplicated research findings without a corresponding statement of concern or correction when Gandhi's gross errors became known only a short time later.

Gandhi finally reported his errors to the FCC during August 1994. He first presented evidence that his earlier

results were incorrect at the Bioelectromagnetics Society meeting during June of that year. Nonetheless, he withheld that information from the FCC and the public. According to Microwave News,

when asked why he waited so long to acknowledge them [the errors] he said that he was under no obligation to do so. [186]

We have already noted that the experimental findings that Gandhi first released at the European Congress were not peer-reviewed or published. That is one of the requisite steps the industry claims to be necessary before it will accept research findings. Curiously, those findings were never validated before being enthusiastically embraced by the cellular telephone industry.

Instead, the "news" was released to the worldwide media as "proof" that portable cellular telephones were safe. The national media picked up the proclamation and broadcast it widely. When the retractions by Gandhi came, they did so through private communications to the FCC. No news blitz and no press release accompanied the new Gandhi calculations, which, in fact, "proved" that SARs were much higher than originally proclaimed. As a matter of fact, some of the SARs were, but for the exclusion clause, above the maximum allowed by the ANSI safety standards.

As our earlier review of the radiation absorption research has pointed out, the only noteworthy findings of Gandhi's research are that the modified and corrected absorption data are now nearly identical to the findings of

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[186] *"Cellular Phone Notes," Microwave News 14, No. 5 (September/October 1994):8.*

many nonindustry researchers. That is, the results agree that most of the radiation is absorbed within the head and brain of the user.

Even while the numerous reports of high energy absorptions continue, manufacturers claim there is no possibility of harm as a result of operating their portable cell phones. However, it is known that they engaged in research to shield the heads and brains of users from the penetrating radiation—but only after the hazard issue became public.

A number of quick fixes proved only about as effective as would reducing the power of the telephones. That is, if one simply reduced the power of the portable it would accomplish the same reduction in radiation absorption. However, that effectively makes the portables useless. Recall that many years earlier industry researchers proposed exactly the same thing. Prophetically they wrote that in order to reduce the absorption from radiation to acceptable levels the radiation from the portables would need to be reduced to levels useless for communications.

Interestingly, at the same time that the cellular telephone industry was scrambling to shore up the indefensible position, a controversy regarding safe exposure levels erupted within the U.S. Air Force. Apparently, researchers at Kirtland Air Force Base have determined that the most recently proposed IEEE/ANSI safety standards are not representative of the real hazards associated with radiofrequency radiation exposure. They have recommended that the maximum exposure level be reduced by 100 times to 0.1mW/cm2 and have adopted the reduced maximum exposure as a guideline for Kirtland workers. This is a sharp contrast to the representations coming from the air force's researchers at its Armstrong Lab in

San Antonio. Armstrong Lab spokesmen remain adamant that no harmful effects can come from radiation exposures below the thermal threshold.

This new, lower exposure standard adopted at the Kirtland Lab is consistent with a reduced exposure standard adopted at the Johns Hopkins University Applied Physics Lab and at the Ground Systems Group at the Hughes Aircraft Company.[187] The newly adopted exposure level is 100 times lower than recommended in the most recent proposed revision to the ANSI safety standard.

Isn't it interesting to watch the military react to the low exposure restrictions that have been imposed by researchers within one of its own labs? It is equally interesting to notice that a leading industry participant, such as Hughes, has adopted such drastically reduced exposure guidelines. And isn't it also interesting to find that both of the reduced exposure guidelines conform with the safety levels established by the highly regarded Johns Hopkins University?

3

Patience isn't usually a virtue in the world of manufacturing, but in this instance it may prove to be exactly that for the telecommunications industry. The industry interests know that sooner or later the current form of cellular telephone communication must change. Otherwise, the public uproar will become so great that the status quo and media control will no longer be maintainable.

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[187] *"ANSI RF/MW Standard Challenged," Microwave News 13, no. 5 (September/October 1993):1*

The industry's hope is to have enough time to develop and implement the low-power next-generation cellular telephone system. Research into that area is ongoing. H. H. Xia, et al., have reported on a microcellular communication systems operating at 900 MHz and 1900 MHz.188
The new system is proposed to operate at a reduced power level of 10.0 mW. That is 60 times lower than the current 600 mW (0.6 W) portables and at least 300 times lower than for the satellite systems power level.

The current generation portables, operating at 0.6 watts, are a compromise between radiated power and service efficiency. Since the original cellular system was put into operation with cell sites anywhere from five to ten miles apart, it was necessary to provide portable units with as much radiated power capability as possible.

At the time that the cellular communication system was introduced there just weren't enough cellular subscribers to make it profitable to locate cell sites much closer together. Now, with the phenominal success of the cellular technology the industry is poised to remedy two ills. By putting in place a completely new cellular system with cell sites only about one thousand feet apart, instead of ten miles, the service providers will be able to operate portable units at 0.01 watts and at the same time improve service.

It's as if the two schools of research, communications and bioeffects, were finally progressing together. The advances in the "microcell" concept. are becoming very important in view of additional reports of energy absorption experiments that are continually and consistently yielding higher SAR numbers.

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188 H. H. Xia, et al., "Radio Propagation Characteristics for Line-of-Sight Microcellular and Personal Communications," IEEE Trans. on Antennas and Propagation 4l, no. 10 (l993):1439—47.

But with these new "microcell" systems there is in downside to go along with the reduced power from the hand—held units. That downside is the need for hundreds of thousands of new cell sites. That's right—the new systems will require a cell site on almost every light, telephone, or power pole.

4

Some reporters and magazine feature writers, confused on the physics of radiofrequency radiation, have erroneously reported that we need not be concerned about energy radiated from cellular telephones because it is low-energy radiation. Such statements, clearly, reflect the reporters reliance on industry scientists to provide them with explanations, and those explanations are wrong. Certainly X rays, photon for photon, are more energetic than RF photons. But the issue here is not that of the energy of single photons. The industry representatives are confident in their belief that few nonscientific persons will understand the distinction in what they falsely represent. The fact of the matter does not lie with the energy of a single photon but, rather, with the total numbers of photons.

To put it more clearly, the energy radiated from the antenna of a portable cellular telephone typically is comprised of 1.7 x 1023 photons each second. Written in standard form this becomes 170,000,000,000,000,000,000,000 photons each second. Now it can be seen how differently the argument shapes up when we look at the real radiation from a cellular telephone antenna instead of the misrepresentations to which the comparison of photon energies lends.

Let's take it another step further. We know that X rays penetrate tissue and can cause tissue damage through cell destruction and damage. We need about 1 million microwave photons at cellular telephone frequencies to provide the same energy as an X-ray photon. So, we see that the typical radiation from a portable cellular telephone antenna is equivalent in magnitude to about 1.7 x 1017 (170,000,000,000,000,000) X-ray photons per second.

Since the radiofrequency and microwave photons each carry a smaller packet of energy than do X-ray photons, the absorption results in a different mechanism leading to cell damage. Nevertheless, the results are the same. The end result is that the absorbed energy, whether from X-ray or radiofrequency radiation, will lead to tissue damage if the energy density is high enough. In the past the industry's often—stated "belief" was that radiofrequency radiation was not energetic enough to cause DNA or chromosomal damage. Now, faced with contradictory research findings coming from all points of the earth—the industry has changed its defense by claiming that no research is available at exactly the cellular transmit frequencies. Well, if that's true then there is also an absence of safety-related research.

During 1998 J. L. Phillips189 reported research that was conducted at the cellular telephone transmit frequencies. His research did employ human cells. His research was conducted at very low power levels—low enough to rule out any heating effects. Phillips essentially replicated the DNA damage studies of Lai/Singh.

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189 J. L. Phillips, "DNA Damage in Molt-4 Lymphoblastoid Cells Exposed to Cellular Telephone Radiolrequency Fields in Vitro," Bioelectrochemistry and Bioenenergetics 45, (1998):103—10.

His results are the same. Exposure to low levels of radio-frequency radiation causes DNA damage.

Consider the overwhelming research reporting high SAR and total energy absorption. How has the industry, the CTIA, or its WTR (Wireless Technology Research) reacted to the research of Kuster, Hombach, Lovisolo, Fleming, Garn, and even Gandhi. All of these researchers report that more than 50 percent of the radiated energy is absorbed within the head and brain.

Previously the cellular industry spokesmen pronounced that the radiation was reflected away from the user's head—even though the manufacturers have known since the late 1970s that most of the radiofrequency energy is absorbed by the user. Their response to this definitive research, which is again reported independently from all corners of the world, is to ignore that it exists. They have done nothing by way of response to their customers or future owners of their products.

They have, however, prepared a media response kit, complete with questions and answers. Some of the answers to the questions are blatantly false except for the very specific and tailored phrasology used in wording the responses.

For example, the CTIA has recommended that industry representatives reply that, "The overwhelming consensus is that these products are safe under conditions of normal use."

Who provided the consensus and what constitutes normal use? The industry has strenuously objected to research findings that included operation of the portables with the radiating antennas in a variety of positions. After all, that's exactly the operating environment for the phones. Given a roomful of users, we're sure to find ouch of them holding their phones in any of a countless variety

of positions. The industry prefers only experimental data with the antenna positioned at the maximum distance from the user's head, but that's not how most people use the phones.

In response to their own question, "Can you cite any studies indicating that cellular phones are safe?" the CTIA's own Resource Manual cites no studies—there are no reports that indicate portable cellular phones to be "safe."

There are, however, many research reports that prove exactly the opposite: that exposure to radiofrequency radiation such as that from portable cellular telephones is dangerous, causing tissue damage, DNA damage, mental defects, EEG changes, and brain tumors.

During 1993 the EPA issued a draft report of their study of the hazardous effects of exposure to radio frequency radiation. The report concluded that not enough research had been performed to say that cellular phones were safe.

During November 1994 the Government Accounting Office (GAO) issued a report of its own investigation of the health hazard issue related to cellular telephones. The report concluded that there still wasn't enough research.

Neither of those reports considered the presentations of the 16th Bioelectromagnetics Society meeting. Nor did they consider the DNA chromosomal damage reported during 1994. Since 1994 the DNA damage and chromosome change research has been reinforced manifold.

5

During the annual Bioelectromagnetics Society conference of June 1994 a special daylong "workshop" session

was organized so that researchers could present their findings in a forum dedicated to the portable cellular telephone safety issue. The industry was represented heavily by Motorola, which had been scheduled to provide both the opening and closing technical presentations. Most of the other presentations, made by a broad worldwide cross-section of researchers, appeared not to be closely tied, in the sense of funding, to industry. The results of that single day-long session proved to be devastating to the cellular telephone industry's research position.

Not surprisingly, the news of the "corrected" Gandhi research findings, first revealed during the workshop, did not receive quite the same press and media coverage as did the claims of "safety" that were trumpeted at the time of the erroneous first report. Actually, the entire conference remained unnoticed by the U.S. media even though the most definitive research to date was reported.

The workshop became a litany of similar research findings, and the truth of the matter is that the results, presented by independent researchers working around the world were consistently alarming—high SARs from typical operation of portable cellular telephones.

The majority of presentations during the workshop took the Same tone; excess energy absorption, excess SARs, and EEG modifications. However, if any one presentation was to be a blockbuster presentation it had to be Adey's.[190] Recall that Adey has been researching low-level radiofrequency radiation effects for many years. Co-incidentally, he was heavily funded by Motorola. Toward the end of a rather lengthy presentation covering a broad

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[190] *W. R. Adey, Bioeffects of Mobile Communications Fields: Possible Mechanisms for Cumulative Dose, 16th Annual Bioelectromagneics Society Meeting, June 12-17, 1994, abstract book, p. 68. .*

scope of the work at his laboratory, Adey advised the audience that he has found exposure of cells to radiofrequency radiation results in increased proliferation, which continues long after the exposure is discontinued. This, in effect, confirms the twice-reported findings of Cleary. Of equal importance, Adey then continued that radiofrequency radiation produces DNA defects. That was a second report of DNA modifications. Recall that Verschaeve also reported DNA modifications at this same conference. Adey's reference to DNA modifications comes from research performed by Sarkar in New Delhi.

According to the way the workshop had been originally set up, the industry, represented by Motorola researchers, was to provide a technical presentation as an overview of mobile and personal communications. That presentation was not made. In its place a Motorola manager provided a very nice marketing pitch. The presentation seemed designed to let everyone in the audience, primarily researchers in need of funding, know from where the funding would come and that it hinged on the continued success of the cellular telephone industry. It was an unashamedly bold marketing statement made by a representative of the largest manufacturer in the industry.

Following the technical presentation, which did not take place, Dr. Guy was scheduled to provide a tutorial on methods of dosimetry. Dr. Guy, a longtime researcher in the field of bioeffects, as we knew by now, turned to the CTIA as one of three members of its Science Advisory Group. Guy did not attend.

Finally, the workshop was originally scheduled to conclude with a wrap-up presentation from Motorola's Balzano. Balzano did not make his presentation.

In essence, Motorola and the industry withdrew all of their presentations. Their withdrawal may have been due to the overwhelming nature of the research findings, which indicated that typical operation of portables is dangerous.

6

Recall that the WTR set out some very clear guidelines for pursuing research into areas that had earlier been found to indicate hazards. Well then, let's consider the chromosome and DNA research that indicates that low-level radiation exposure causes damaging biological effects. Certainly the WTR will place a high priority on that work. Certainly those studies qualify as "new research breakthroughs" to be replicated as quickly as possible. Or maybe the proposals to replicate that research didn't "best meet [the] needs" of the WTR and the industry. Surely the WTR would rush to have a number of qualified researchers investigating this most important issue. After all, the charter of the WTR is to ensure unbiased, independent research funded through a blind trust so as to remove any suspicions of industry corruption of the results.

It's somewhat intriguing that Motorola has privately funded a follow-up study to replicate the Lai—Singh research but not with Lai and Singh as the researchers. Funding of the replication study is viewed by some in the media as nothing more than a necessary public relations move. Since the Lai—Singh research findings have become widely known the industry has been pressured to replicate the tests—quickly.

The replication studies were performed at the Washington University at St. Louis, not to be confused with the University of Washington, at Seattle. Lai and Singh are with the University of Washington at Seattle.

Certainly some questions of research independence need to be answered. This is hardly the format that the CTIA has prescribed for independent research. The replication studies are funded by Motorola, and therefore the results will be the property of Motorola. The CTIA has maintained since early 1993 that all research will be funded through a blind trust to ensure independence. Now we find that the replication studies for the most significant, and potentially damaging, research findings will be performed with funding by and at the direction of the industry's most prominent corporation. It would seem that in order to avoid any suggestions or appearances of bias or loss of independence, the work would have been funded through the very mechanism established by the cellular industry.

In its own published documents the CTIA has stated that

by trusting the research to outside scientists and subjecting their findings to independent peer review, we are determined to assure that this process is objective. In addition, a trust arrangement funds the peer review process and the outside, independent research. [191]

It all sounds very aboveboard until we see how things have really evolved.

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[191] *Industry response, Ans. #10, Procedures and Resource Manual for Public Health and Safety Issues, Cellular Telecommunications Industry Association (1994):B11.*

First of all, the government agencies that were supposed to take an active role in this research process have opted out because of the strong industry bias that they perceived was pushing the effort. Without a strong capability to govern the process or even participate in determinations, the government agencies would be nothing more than rubber stamps. The industry would just be using the names of those agencies, such as the FDA and EPA, to add prestige to any "findings" that the CTIA research produced.

Second, the research is not being funded by a blind trust. The research proposal for replication submitted to WTR by Lai and Singh was pidgeonholed. It was never forwarded to the peer review board. Instead, WTR took nearly a year to publicly argue small details of the research methodology, until the original researchers became discouraged and withdrew their proposal. So much for independence and blind trust funding. At the time of this writing, it is understood that no funds have actually been placed into any blind trust for research purposes.

In spite of WTR's representations of independence and research integrity, Gandhi's lab has been funded to perform dosimetry research. That is, the same research group that provided the false data and misrepresentations of safety will be performing WTR's research for energy absorption once again. But Lai and Singh—not funded. The CTIA's own procedures and resources manual insists that the research agenda highlights the "use of Good Laboratory Practices and Good Epidemiology practices in all studies conducted under the research program[192] Clearly there seems to be something amiss in

[192] *Procedures and Resource Manual for Public Health and Safety Issues, Cellular Telecommunications Industry Association, (1994):B5*

one lab that allows for research findings of radiation absorption to be reported and released worldwide only to be re-released at a later time with findings of energy absorption about ten times higher than initially reported.

7

Most interesting is an epidemiological study that, WTR informs us, "is designed to investigate the possible effect of exposure to radiofrequency waves on human health."[193] But wait a minute. The CTIA, WTR, and the cellular industry have insisted for the past eight years that there is a body of research that "proves" that these portables are safe. They have repeatedly told us about the "10,000 studies and forty years of research."

Now WTR has selected millions of` unwitting portable telephone users as "guinea pigs" for an epidemiological study. Certainly we can assume that when a customer approaches a salesman to make a portable cellular telephone purchase the salesman does not tell the customer, "Oh, by the way, we want you to take part in a study to see if you develop brain cancer or mental defects." The salesman tells the potential customer, if anything at all, that the telephones are "proven sale."

The CTIA's and WTR's research agenda specifically points out the epidemiological study. George Carlo, chairman of CWTR, has spoken openly about tracking the health of more than 3 million unknowing users. In the research agenda they state that "epidemiological evaluations and longitudinal [long-term I surveillance of cellular phone users, employing real-life exposure measures" will be performed.

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[193] *Ibid., B4.*

"The SAG is also seeking proposals for investigator initiated projects consistent with the goals of the SAG program."

Research proposals are usually held in confidence. In the case of the Lai and Singh proposal, however, WTR made a public issue of the proposal. In their Fall 1994 newsletter, WTR took an opportunity to publicly deprecate the Lai and Singh research, although it had not yet, been published and was confidential information.

In the same issue of the WTR newsletter, immediately below their one-sided discussion of the Lai/Singh research, the WTR states that

All scientific proposals that have been submitted to the SAG are currently undergoing review. Proposals for concept papers critically evaluating the relevance of experimental promotion studies to human health risk assessments of RF, extrapolation of animal studies to human exposure pertaining to RF, and genotoxicity studies are still being accepted. Requests for additional proposals will be issued by the SAG in the coming months.194

The review of which WTR spoke was supposed to be an independent peer review coordinated by Harvard University's Center for Risk Analysis. The Lai/Singh proposal never made it that far. It was dragged through the mud and dumped in the gutter. But at the same time and as stated previously, WTR was seeking proposals from, researchers for exactly the same kind of research. Maybe the Lai/Singh team didn't provide the "proper" answer.

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194 "SAG Releases Research Agenda," Science Advisory Group on Cellular Telephone Research 2, no. 1 (Fall 1994).

The final statement of WTR, given earlier, is very troubling. Just what were the goals of the WTR program? In their documents the CTIA wrote that

> ***A the overall goal of the program is to establish a solid scientific basis for policy decisions regarding wireless technology and health concerns.***[195]

Again, why don't they simply use the scientific basis of 10,000 studies and forty years of research?

Alarmingly, they have said nothing about scientific study to prove or determine the safety of their products.

The CTIA continues:

> ***It was also important that the program include a public health intervention plan that could be activated rapidly should any evidence he uncovered that use of wireless communications poses a human health risk.***

How and When does this plan become active? From the available CTIA documents it appears that the plan is already activated. Certainly the published scientific literature is now substantial in its evidence of hazards due to radiofrequency radiation exposure.

That mission statement was clearly put into effect when the Lai and Singh work became known, but put into effect in a rather bizarre manner not designed to provide timely verifications to the very significant results found by Lai and Singh. The CTIA and its Science Advisory Group recommended performing studies of the

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[195] *Procedures and Resource Manual for Public Health and Safety Issues, (Cellular Telecommunication Industry Association, (1994) B1.*

methods and then consideration of the proposals for replication studies. That is a process that would have taken at least a year before any additional research could begin. However, Dr. Elizabeth Jacobson of the U.S. Food and Drug Administration wanted further studies to begin immediately. It is now six years since the reports of DNA damage were made known and yet there is no replication data from the CTIA's WTR. But we have had replications and additional research reported from Phillips (Loma Linda), Adey (Riverside), Roti-Roti (St. Louis), Repacholi (Australia).

As we might have anticipated, WTR did wait the year while a committee of its own experts scrutinized the methods and techniques of Lai and Singh. That further review has shown that the methods and techniques Lai and Singh used were proper. But the review bought the industry one more year.

8

The CTIA's working documents include a second-track approach to the issues of portab l e cellular telephone safety. They refer to it as risk management.

Their plan for risk management is to answer the question: "If a health problem exists, how can it be fixed?" (see footnote 192).

Wait a minute. How is it that the industry's representatives are asking questions today about hazards and issues that were supposedly resolved years ago? The answer, of course, is that the industry doesn't like the answers, which the existing research data base provides. So it ignores the findings. On the one hand the industry claims 10,000 studies proving safety; while on the other,

the industry proclaims that it is looking to find out if health problems exist.

The CTIA even proposes some action plans to respond to future research findings. Their solutions include:

> ***labeling changes, geared toward influencing the way people use cellular phones;. . . (see footnote192).***

The world has come to believe, because the industry has vowed it to be true, that portable cellular telephones are proven absolutely safe. Now their industry association proposes to use labels to tell people how to use the phone to minimize danger.

> ***design changes, that would alter exposure patterns;. . . (see footnote 192).***

Since the cellular manufacturers and the CTIA have never informed their customers that large amounts of radiation are being deposited within the user's brain, that should be an easy fix. Simply produce a "new improved" portable and who's to know the difference? In the meantime users of the current generation portables continue to act as radiation sponges.

> ***usage restrictions .... (see footnote 192).***

That is, the industry may impose restrictions or else recommend that the owners impose their own restrictions on use of their products. We might envision the restriction as something of a warning that owners who exceed a certain usage for a day or month are at greater risk of developing brain cancer.

The CTIA's resource manual continues:

> ***Should a need become apparent, these options could be implemented singly or in combination to mitigate risk. Recommendations on all of these considerations have been devised and are ready to-be put into place if need be. . . (see footnote 192).***

The truth of the matter is that all of the recommendations have already been "put into place." The industry's manufacturers now include warnings within the literature accompanying their portable phones. Design changes are already well under way. For example, in a conversation with Gandhi he offered that he is under contract with Motorola to redesign antennas and portable telephone packages to reduce the amount of radiofrequency radiation that is absorbed into a user's head. Kuster has indicated that he is also involved in antenna and package redesign for one of the largest phone manufacturers.

The FDA and EPA have already advised operators of the portables to limit the use to emergency situations if possible; to minimize use at other times; and to use regular telephones whenever they are available.

Does this not appear to be exactly the "risk management" that the CTIA has indicated within its Resource Manual? How then can the consumers be expected to continue to believe claims of "safety," since all of the steps of the CTIA risk management plan are in operation?

The most recent four or five research reports documenting the chromosomal and DNA damage are too much for the industry to tolerate without a broad public relations response. That response program is now in motion. The CTIA plans to outflank its critics with a structured program to convince the majority of the population

by using public relations statements and benign-sounding phrasology and generally acting as the likable "good old boy."

The CTIA's formal plan is to meet with local church groups, fire and emergency services departments, law enforcement agencies, and any other local groups within communities. One of their primary purposes is to convince small groups of people by using public relations rather than more broadly by using research results.

In small groups it is not so likely that someone in the audience will have the technical skills of an electromagnetics or bioeffects researcher. And when that rare occasion occurs it will be only one disaster out of hundreds of other successful meetings. Dividing, separating, and brainwashing through slick public relations is a strategy that will work if there is no opposing viewpoint. Unless there is an opportunity to present the much stronger "other side" of the issue, the industry interests will become the accepted belief`. Hut belief is not necessarily the same as truth or fact.

It seems to be increasingly clear that the industry is now faced with knowledge that both thermal and nonthermal radiofrequency radiation can cause brain tissue damage. Also, there are the memory deficits and motor skill deficits that have been confirmed repeatedly. Add to these the effects that portable cellular telephones have on pacemakers, wheelchairs, and electronic medical equipment (commonly referred to as EMI).

The industry response has been to organize a meticulously defined battle plan to blunt the inquiries made by the media and attorneys for injured consumers. That battle plan is extremely clear in view of the CTIA document "Procedures and Resource Manual for Public Health and Safety Issues." The CTIA has gone to some

effort to convince everyone that their Science Advisory Group is completely independent. The CTIA wants us all to believe that the research activity run through WTR is not influenced by the CTIA or any cellular industry members.

In reviewing the CTIA "Procedures and Resource Manual for Public Health and Safety Issues" the first statement we see is a foreword written by none other than George Carlo, chairman of WTR. In that statement Carlo wrote:

> ***[They] have developed a high-quality scientific program that is funded by the industry, but independent of its influence.*** [196]

He also wrote:

> ***If we identify any danger or potential hazard during our evaluation, the program will move immediately into a risk-management mode.***

He hasn't specified whose risk is of concern. Judging from the cellular industry's activities to date it certainly is not the risk to the public; it must be the risk to the industry. Consider the WTR response to Lai and Singh, Sarkar, Maes, Cleary, and Verschaeve. All of those researchers independently found chromosomal and DNA damage as a result of their experiments. How did WTR respond? They either assaulted the research directly or redefined their mission statement to narrow the area of interest in a way that excludes the reported research.

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[196] *Procedures and Resource Manual for Public Health and Safety Issues, Cellular Telecommunications Industry Association, (1994) foreword.*

Compare truly independent research to the structure of the WTR—funded work. For one example, a prominent university researcher, Dr. Ken Foster, has been funded, as part of the WTR $25 million research effort, to perform radiation absorption studies. However, as part of the study he would be collaborating with WTR and with Dr. Gandhi. Where is the independent research?

Foster was supposed to be determining SARs based on measurements taken within the familiar “biomass soup" representing a human. One would expect that by now even the WTR wouldn’t try to use that antiquated practice to measure SARs. Certainly, with the open checkbook and $25 million, they can build some representative structures such as a simulated human brain that could be placed Within a simulated human skull—or real human skull—having believable interior features.

Even Dr. Foster admitted that the results he expects to obtain, using the "human soup," will be of questionable value.

However, even the most up—to-date analytic and laboratory models cannot take the place of a live-functioning human head and brain. A live human head and brain has the advantages of actual biological tissue, not the laboratory mixtures that simulate tissue. The live head and brain has contours, folds, protrusions, voids, different tissue interfaces, and shapes. The problem—it is unethical to use live humans for these kinds of laboratory “guinea pig" tests.

But the cellular telephone industry doesn’t think it’s unethical to use millions of portable cellular owners as "guinea pigs." Their epidemiological study is meant to track the health of 3 million owners. By matching owners

with phone bill information and medical information, the CTIA's Science Advisory Group (WTR) tells us, they will have an epidemiological study that concludes how great the effects of portable cellular telephone use are. What it appears they are really doing is spying on 3 million customers for a number of years to see how their product affects the users' health. That work was supposed to he done in advance of sales instead of spying on people to learn which users die, become mentally deficient, become disabled, or are involved in traffic accidents.

10

Many of the problems of the industry could have been avoided had the influences of the scientific researchers superseded those of the product marketers. But the industry chose to ignore researchers who were providing unfavorable answers. The industry instead organized a broad and comprehensive public relations campaign to persuade users of portable cellular telephones that the operation was safe. The cellular telephone industry engaged in the business of preaching a "belief system."

Never mind that the most current research findings report DNA damage to brain tissue as a result of exposure to radiofrequency radiation.

Never mind that recent conferences, sponsored by the cellular telephone industry manufacturers and service providers, were dominated by reports of research findings that show that most of the energy radiating from the portable cell phones is absorbed in a small region of the user's brain.

The CTIA representatives tell industry insiders that a scientists are very dangerous and if the scientific process

is used the scientists would come back with more questions than answers, which is very risky. This information comes as part of a series of CTIA seminars held to teach cellular industry people how to wage the public relations battle for the minds of the public. This is termed research by press release or research by public relations instead of good old-fashioned scientific research. Of course, research by press release is more predictable than the laboratory research, which could provide embarrassing evidence of biological hazards.

However, owners of portable cellular telephones are now warned that if they are concerned about the radiation then they should limit their use to the shortest time possible and completely avoid use except for emergency situations. Is it possible that by now even the manufacturers of these "high-tech" wonder devices and their association spokesmen are prepared to admit that they may have unleashed the next unseen plague on humanity? Probably not—there are still too many executives and managers looking for their next promotion and continuing their long careers.

The cellular telephone industry is the observer, or spectator, at a game. The game includes about 200 million participants. It is nothing less than cellular telephone Russian roulette. The only difference is that with regular Russian roulette the results are immediate. You know immediately if you're a loser or not. With the cellular telephone Russian roulette you may not know for years if you are the loser. You may not know of a brain tumor until five or ten years after the day you "lost" at the game.

You pick up the phone, once, twice, ten times a day—or only a few times a month. But each and every

time you're gambling that "this time" won't be the occasion when the radiation causes irreparable damage to your brain. It only takes a seemingly small trauma at a very small location to result in tissue damage, DNA damage, or chromosome mutations.

This nonscientific industry experiment using the general population is unique in the history of humanity. Never before has such a large "guinea pig" experiment been performed. Even the government experiments with nuclear radiation only exposed a few thousand uninformed people. This bold experiment may expose virtually the entire segment of the population that can afford to operate the high-tech portables.

It is cellular telephone Russian roulette. Go ahead and make the call. Do you feel lucky today?

$12.95

They are everywhere, but should they be? While most consumers assume that cellular phones have been thoroughly tested and proven safe, that is not the case. Since the 1950s studies have evidenced possible brain damage through radiation emitted by the phones.

However, the industry battle to sell this product has been successful in circumventing, to a large extent, the type of regulation that affects such industries as cars and drugs. The author suggests that "Rather than the benign technology the industry claims, the evidence continues to paint a malignant picture of the effects to be expected due to human exposure to radiofrequency radiation." Sound unbelievable? *Cellular Telephone Russian Roulette*, by Robert C. Kane, reviews and analyzes the research base extensively, and the news is not good.

An eye-opening report, this volume should receive widespread attention.

"[T]issue destruction in one's brain may be occurring without the slightest indication that anything is happening. And the damage may be repeated, over and over again, each time the energy exposure takes place."

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