

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 well—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 concert 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 five 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.

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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 concluded 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

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.

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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:

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

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, (September/October 1992).

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

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

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

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.

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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

¹⁰³ C. D. Cain, et al., "837 MHz Digital 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.

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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

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

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.

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.

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Early in 1994 research performed in India by S. Sarkar, S. Ali, and J. Behari¹¹¹ 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.

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 animals.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. Gebiski, 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

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.