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

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[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.

[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/ cm^2 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.

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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.*

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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.