Recently, melatonin has been shown to be able to block the effect of 0.6 W/kg of radiofrequency at 2450 MHz causing increased single and double DNA strand breaks[190]. A recent 776 page book describes the evidence available as well as studies underway to understand further the melatonin-EMF-cancer relationship[191].

Regarding how RF base stations may affect melatonin production during the night, consider that melatonin production was caused to drop by 60% in some human volunteers upon irradiation of less than *2 microwatts/sq. cm.* of visible light, when the lens was dilated[189]. Since RF can pass through the entire eye, perhaps less may be needed to stimulate the retina to send the appropriate signal to the pineal gland near the center of the head. Also, since 915 MHz can cause RF hot spots near the center of the head (see quote above)[178] perhaps the pineal could be directly stimulated by RF, as if it were receiving a stimulus from the retina, and thus reduce melatonin production. While the above is speculation, it illustrates that there have been observed changes in melatonin production due to very low energy levels, i.e. below 2 microwatts /sq. cm[189], which during the day, or when awake and using cellular phone may not be a problem, but could be a problem if the head is even slightly stimulated at night.

31.3.4 The pituitary gland is also located near the center of the head, and thus near the RF 'hot spot' for frequencies near 915 MHz, such as for cellular phone frequencies. A study reported on the egg laying rate of chickens exposed to 9300 MHz at power densities of 400 picowatts per sq. cm. (0.0004 microwatts per sq. cm), at 0.02 picowatts per sq. cm. (0.00000002 microwatts per sq. cm.) , and a control group at 0.005 picowatts per sq. cm. for 476 days. Chickens exposed to either exposure level had a 15% increase in the rate of lay above that of the controls. The author's concluded, *"Therefore, the effect of microwave irradiation was only to increase frequency of ovulation as manifested by increased rate of lay, possibly through stimulation of the pituitary."*[214].

31.4 At SARs as low as 0.02 mW/kg (0.00002 W/kg) it was reported in June 1997 that at 960 MHz and with a transmission pattern simulating the European Global System for Mobile communications (GSM), that,

"It was determined that cell growth (of human epithelial amnion cells) in the exposed cells differed from that in the control and sham exposed cells and a decrease in cell growth was seen."

32. Often buildings provide little or no attenuation, and some studies finding no attenuation, with average attenuation being about 50%, and attenuation by buildings appears to depend upon frequency, with around 900 MHz being able to best penetrate buildings. This information is offered to the Commission so it will know that exposures to occupants in some residences, schools, and other structures can be close to the same level as outside exposures, or even higher due to reflections (see item #24.7 and footnote 159). The impact of this information may be that the Commission will recognize the potential risks, and not incorrectly believe that exposure levels will be 1/10 to 1/100th of outside exposures and thus not feel the urgency to be concerned.

32.1 A Department of Commerce report found no attenuation for 25% of home residence measurements for 900 MHz signals [NTIA #94-306 1994 pg 29]; some interior power densities were greater than the exterior signal [NTIA #94-306, 1994 pg A-41]; this may be due to reflections as described above in item #24.7 [and in footnote 159]. The average attenuation reported was 52.1% in single family residence rooms with an external wall facing the signal source [NTIA #94-306 pg 23]. Note that a 52.1% attenuation means the power density inside a building is 47.3% of the expected strength if there were no attenuation by the building.

Likewise, another Department of Commerce report found for 860 MHz that attenuation was 49.1% in single family residence rooms with only blown-in ceiling insulation, wood exterior, and on an outside wall facing signal [OT #76-98 1976 pg 29-31]. Similarly, a recent Department of Commerce report for 912 MHz found for some single family residence rooms measurements an attenuation of about 37% [NTIA #95-325 1995 pg 54, 58], meaning an average of 63% of the power was present in the room compared to what was expected if there were no attenuation. Sometimes a whole room can have a median power density higher than for outside [NTIA #95-325, at 5990 MHz on pg 52], this may be due to reflections off objects certain wavelengths from one another.

Using the variation of power density attenuation to estimate the spread of individual attenuation measurements about the expected room average for the latter two reports, it appears

as if some locations in residential buildings can be expected to have no attenuation. (see methods described in OT Report 76-98, 1976, pg 29-31).

Hence, for all three of the Department of Commerce reports reviewed some rooms had average attenuation in some residential homes of about 50%, sometimes less, and in some locations appeared to have no attenuation. Indeed, sometimes the median power density in a residential room was higher than outside.

Thus, exposure conditions in this report assume no attenuation of radiofrequency radiation, since research indicates the plausibility of "worst case" environmental conditions resulting in no attenuation of electric fields near cellular frequencies.

32.2 Building attenuation is frequency specific, since at lower and higher frequencies that at the proposed facility greater attenuation by buildings has been observed

Please note that other studies of both lower and higher frequencies indicate that there is greater attenuation by buildings than for the 860-915 MHz range relevant to the proposed facility. Studies of 60 Hz electric power frequencies[196] reported 90% or more attenuation, as did a study of radio frequencies from 20 kHz through 1 MHz[192]. Likewise, the three Department of Commerce studies mentioned previously [NTIA Report 94-306[193], NTIA Report 95-325[194], OT Report 76-98[195] found more attenuation by residential buildings at frequencies of 1920 MHz and greater than between 860 MHz and 915 MHz. It is interesting that one study found that as frequency increased from 1 MHz to 500 MHz that attenuation decreased steadily "to zero at 500 MHz."[192]. Also, the same just mentioned studies typically found greater attenuation in concrete office buildings than residential buildings.

Thus, the Commission should not take lightly the adverse effects reported in this proceeding because the Commission might think that interior exposures will be much lower. The studies above show this should not be expected. Hence, it is very important the Commission act with due diligence and prudence and approve of the requests of the Ad-Hoc Association.

The above indicates sometimes due to reflections the interior exposures can be higher also justifies the Commission requiring its licensees to provide educational information on how to place furniture, especially large metal pieces such as metal storage cabinets, refrigerators, and

large file cabinets so that reflections will not unnecessarily increase exposure. Also, the information can note cautions about placing children outside of a house with aluminum siding where there are also nearby base station transmitters; this is because flat surface and corner reflections could increase exposures 4 fold and 16 fold respectively[159], as noted above in Item #24.7.

33. The Commission should be cautious when interpreting 'conflicting' results

33.1 Negative results may be due a sample being so small that due to variability, a real effect cannot be distinguished

Example: Consider the University of Washington study exposing rats for up to 25 months at 10% of the Commission's limits. It was reported,

"If long-term exposure to pulsed RF fields disrupts normal physiological functions or is psychologically disturbing to the animal, an increased basal level of corticosterone can be expected."[125].

It was reported that in the 25 month study that at the first quarter sampling that a significant increase in corticosterone was observed, with the likelihood of the increase occurring by chance being less than 4%. In a follow-up study was done, measurement of corticosterone were made to help determine if this effect was real, or just an accidental occurrence among the many parameters tested. The authors reported, "Corticosterone measured at 6 weeks, 6 months, and 12 months did not show any statistically significant differences between 20 control and 20 exposed rats,"[125] and elsewhere report, "This effect was not replicated in the present study, so the previously observed effect was most likely a random variation."[130].

While a random variation may have occurred in the original study, another possibility for the outcome of 'non-significance' was the smaller sample size. Consider that the original study had a total of 156 animals, while the follow-up study had only 40. Since the amount of increase in corticosterone concentration of the exposed over the controls in the follow-up study was almost the same as in the original study (approximately 3.09 μg/100 ml in the original study[129] vs. 2.85 μg/100 ml in the follow-up study[130], it is possible the finding of 'non-significance' was due to the small sample size. For example, if the mean increase and variability were identical to that of the

original study, the Ad-Hoc Association has determined the smaller sample size would have also led to a decision of 'non-significant'

33.2 "Negative" results can also occur depending on whether an effect continues or is transient. Example: For the above University of Washington study125 it was reported that during the first assessment of open field activity that the young exposed rats had a statistically significant lower level of activity. The authors note that this pattern was not subsequently repeated. Since it only happened when the animals were very young, the author's appear to consider it of no consequence. Likewise for oxygen consumption, they state, "Oxygen consumption and CO2 production were lower in the young rats. These effects were not observed in mature rats," and conclude, "Overall results indicate that there are no definitive, biologically significant effects..." It is not clear to the Ad-Hoc Association why lower activity levels and lower oxygen consumption only when young is not biologically significant just because it occurred only to the youngest animals. The Ad-Hoc Association is concerned about affects that may only impact on very young children, as this is a critical period of physical and metal development.

33.3 Testing only for a beneficial effect vs. "any" effect

If a researcher is interested in learning if there is a difference for good or bad of a factor such as RF, then both possibilities need to be considered when performing tests. However, in many cases we just want to test for harm. For example, the authors report that 7 exposed rats out of 100 developed benign pheochromocytoma of the adrenal medulla, while this occurred to only 1 of 100 of the controls. Had the authors decided only to test to see if only the RF had an adverse effect, then the results would have met the criteria for statistical significance; however they chose a different approach and found results 'non-significant'.

33.3 Another perspective: In the Encyclopedia of Energy, Technology and the Environment, Stephen Cleary of the Medical College of Virginia reviewed this same study[204]. He listed 11 parameters as having "statistically significant alterations" in addition to the increase in primary malignant tumors - these are:

"behavior, serum corticosterone, lymphocyte(B and T cell) number, lymphocyte mitogenic stimulation, eosinophil and neutrophil counts, adrenal mass, O2 consumption and CO2 production, and benign adrenal neoplasia....There was also a statistically significant decrease in time of occurrence of primary tumors in microwave exposed animals[204]."

Given the considerable different perspective of Cleary on this same important study, the Commission may request of the federal health agencies to comment on the above different approaches, and to make other analyzes on this study, with particular focus on testing for adverse effects and in providing confidence intervals, so that even if results may not be statistically significant, it can be seen if they are consistent with a hypothesis of an effect.

34. Section 704 preemption does not apply to fear of exposure

34.1 The issue - is fear of environmental effects an environmental effect on the basis of which regulation of certain Commission facilities is preempted?

Because many jurisdictions are unsure and confused about what exactly is preempted and what is not, it is important that the Commission clearly state its understanding, rationale, and intentions concerning the extent of the preemption. In this regard the Commission should state that states making regulations when there are bona fide public fears of a level of exposure, that such regulation is not preempted by the Telecommunications Act of 1996.

The Ad-Hoc Association does not agree with the view that Sec. 704 of the Telecommunications Act of 1996 takes precedence over Sec. 253 which specifically authorizes states to regulate for the public safety and welfare - as noted elsewhere in this proceeding by the Ad-Hoc Association.. However, even if the Commission disagrees, then the Commission must distinguish in its preemption between regulating based upon the actual environmental effects, and regulating due to any reasonable, science-based fears and anxieties of the public and workers concerning a level of RF exposure. One might argue, although the Ad-Hoc Association does not agree with this view, that Congress felt the scientific issues too complex to leave them to states and local jurisdictions. However, even if this is so, states and local jurisdictions are competent to determine whether their residents and workers have a legitimate, bona fide fear of the potential effects of the exposure, whatever the actual environmental effects may be. Therefore, if the basis and rationale for a regulation is not on any actual environmental effect of the emissions, but rather on a clear and reasonable fear amongst its residents and workers of the exposure, and the 'test' of 'reasonable' is how a person would feel who is knowledgeable about the findings in the scientific literature concerning RF effects and its characteristics.

34.2 Application in tort liability concerning distinguishing between effects and fear of effects. Consider the decision of the Kansas Court of Appeals in Willsey v. Kansas City Power and Light Co. 631 P.2d 268. It stated,

"While these courts hold that, conjectural damages are non-compensable, if the fear is shown to be reasonable (or at least not wholly unreasonable) and in fact affects the market value, the loss is compensable," [Wilsey, 631 P.2d at 274] (and that) *"logic and fairness dictate that any loss in market value proven with a reasonable degree of probability should be compensable."* [Id.]

Also, in Kansas was the case of Ryan v. Kansas Power& Light Co, 815 P.2d 528, 535 (1991) where the Kansas Supreme Court allowed the introduction of expert witness testimony based on "newspaper and magazine articles and other literary works...to support the allegation of fear in the marketplace.".

Other courts have not even required proof of reasonableness and include Arkansas, California, Florida, Indiana, Kansas, Ohio, Oklahoma, and the U.S. Court of Appeals for the 6th Circuit, with its many Tennessee Valley Authority cases. In Florida Power & Light Co. v. Jennings 518 So. 2d 895 (Fla. 1987), the court held,

"[t]the impact of public fear on the market value of the property is admissible without independent proof of the reasonableness of the fear." [FPL v.Jennings, 518 So. 2d. 895 (Fla. 1987)].

The court decided that,

"...any factor, including public fear, that impacts on the market value of the land taken may be considered to explain the basis for an expert's valuation opinion." [Id. at 899]

Likewise, a California court decided, "the truth or lack of truth in whether electromagnetic projections caused a health hazard to humans or animals was immaterial. Rather, the question is whether the fear of the danger existed and would affect market value." [San Diego Gas and Electric v. Daley 205 Cal. App. 3d 1334,1349 (1988)].

Similarly, in 1993 a New York Court of Appeals followed the California court. It ruled,

"evidence of fear in the market place is admissible wit respect to the value of the property taken without proof of the reasonableness of the fear." [Criscuola v. Power Authority of the State of New York, 81 N.Y. 2d 649, at 652 (1993)], (and required of future claimants that they) *"still*

establish some prevalent perception of a danger emanating from the objectionable condition." [Id. at 653] ,and further that,

"Some credible, tangible evidence that a fear is prevalent must be presented to prove the adverse market value impact. Claimants should have to connect the market value diminution of the property the particular fear in much the same manner that any other adverse market effects are shown, e.g. by proffering evidence that the market value of property across which power lines have been built had been negatively affected in relation to comparable properties across which no power lines have been built." [Id. at 654] (and) "...while a personal or quirky fear or perception is not proof enough, the public's or the market's relatively more prevalent perception should suffice, scientific certitude or reasonableness not-withstanding. [Id. at 654].

Thus, in New York, and in many other states the test is not what a scientist says about the truth of an environmental effect, but rather, regardless of that effect, what is important in property compensation claims is not what a scientist or doctor says, but what the appraiser says. A fear need only to be shown to exist, and no proof of its reasonableness is required - thus avoiding scientific or medical battles.

For further information and further examples which support allowing fear of an effect which causes loss to be a basis for compensation, please see footnote 202, 203].

34.3 Extension of the tort liability compensation law to Commission preemption authority

One of the key points in the cases above is that tort liability claims can be decided on the basis of the impact of public fear regardless of whether or not there is any environmental effect. Thus, the courts are clearly distinguishing between (1) an actual environmental effect and any regulations, such as tort liability action, that are based upon these actual effects vs. (2) the effect of public fear regardless of what the environmental effect is, if any. Hence, the courts distinguish between (1) regulations enacted on the basis of an environmental effect, and for which scientific evidence may be required to justify the regulation, vs. (2) regulations, such as awarding a tort compensation award, that are not made on the basis of the environmental effects of a factor, and where such regulations (court award) may be decided regardless of whether there are actual environmental effects.

Accordingly, regulations made on "the basis of the environmental effects of radiofrequency emissions" would be expected to have a scientific basis for the regulation. However, a regulation whose intent is to address public fear, and perhaps to avoid public panic, need not consider whatsoever the actual effects of radiofrequency. In this case the regulation is not made "on the basis of the environmental effects of radio frequency emissions." Rather, such regulations may well find such effects irrelevant when addressing the concerns of maintaining civil order, avoiding panic, and enhancing the mental well being of citizens - where these latter concerns can well be made completely avoiding the question of whether environmental effects exist or not.

34.4. It is a proper role of a federal government agencies to make clear its regulations so that states and local jurisdictions may clearly know what is expected, and need not have to press a court case in order to get an agency clarification. Therefore, the Commission should revise 47 CFR §1.1307(e) and state,

(e) No state or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio-frequency emissions to the extent that such facilities comply with the regulations contained in this chapter concerning the environmental effects of such emissions. Regulating the placement, construction, and modifications of personal wireless service facilities not on the basis of the actual or perceived environmental effects, but on the basis of limiting public fear of such facilities is a proper exercise of state jurisdictions. Also, placing conditions upon the operation of a Commission facility concerning the manner of allowed use and intensity of use (e.g. power density), may be regulated by jurisdictions insofar as regulation of operation after placement and construction is not one of the preempted functions.

35. The Commission must regulate wisely on the basis of knowledge, and since much knowledge is still lacking, the Commission must apply a proper unbiased means getting the needed questions answered. Accomplish similarly as was done in California, by ordering the formation of a stakeholder group of all interested parties, and to order funds be placed in a trust to spent for the following, upon appropriate approvals.

35.1 Objective of a funding effort: The Commission must find a way of assuring the funds are available and the stakeholder structure is available to appropriately guide a funding mechanism so needed information is available

(i) for wisely setting standards and to perform needed research to achieve this

(ii) for providing a better means for the Commission to assess standards,

(iii) for promoting the standard setting process by way of assisting in transportation, materials cost, providing advisors, and other support,

(iv) funding research on means of supporting telecommunications while also finding ways that would incur the least potential risk to human health and that of the environment.

35.2 The Commission must find a way of assuring needed information is available for proper science risk based decision making to occur. If the Commission finds it and those making standards need questions answered then the Commission has the moral, ethical, and legal authority to so order such a mechanism. If Congressional statute limits the fees the Commission can collect, then let the Commission, with other interested parties encourage the formation of a representative group of stakeholders, including the concerned public, and let the Commission require its licensees to participate in supporting this entity. For example, the Commission may determine that for any common carrier to be considered as having a proper RF health and safety program that such must include membership in the entity which will help guide funding - and the entity must clearly have a wide base of different interest groups, not just industry.

35.3 There is a great need for research

35.3.1 NCRP 1986 states, *"Among the experiments yet-to-be performed are those that address at all levels of biological analysis the greatest void of scientific knowledge: the systematic and functional responses of the organism that are observed over the long term after intense (acute) or low-level (chronic) exposures to fields that range the spectrum and that are evaluated for modulation-specific influences" [pg. 190 at footnote 161]*

35.3.2 ANSI/IEEE C95.1-1991 states: *"While it is generally agreed that measurements of the responses of human beings are the most pertinent to the establishment of guidelines for exposure to say any noxious environment, few data of this type exist. (and that) Because of the paucity of*

reliable data on chronic exposures, IEEE Subcommittee IV focused on evidence of behavioral disruption under acute exposures..." [Sect. 6.4 Assessment Criteria].

Thus, both sets of standards upon which the Commission relies agree that the data to set proper standards is lacking.

35.3.3 The Bioelectromagnetics Society sent the following to members of Congress on June 24, 1996. In part they wrote:

"There is a potential for benefit from these fields, as well as the possibility of adverse public health consequences. Understanding their biological effects may allow us to increase the benefits as well as mitigate the possible hazards. But these processes cannot be understood without further research.

We believe it is essential that research in this area be continued. Without U.S. government funding, the remaining available sources of funds are too limited, too focused by discipline and may in some cases carry questions of bias....without U.S. leadership, the task of determining the potential health risks and benefits involved in the distribution and use of electric and magnetic energy will be difficult to complete.

"Failure to continue this research could ultimately result in extensive costs to the energy and communications industries, both in litigation and product development. Public concern can be reduced only when the issues and questions are resolved by careful research." [Microwave News July/August 1996, page 9]

35.4 Industry sponsored research is not sufficiently meeting the needs - consider

35.4.1 *"The FAD workshop (in February 1997) was held four years after the Cellular Telecommunications Industry Association (CTIA) launched its five year research program designed to show that its products are safe. Wireless Technology Research (WTR), created by CTIA to run the program, has yet to sponsor a single biological experiment."* [Microwave News March/April 1997]

35.5 Let the Commission consider the California Public Utilities Commission model for funding On November 2, 1993, the California Public Utilities Commission (CPUC) approved an order[205]

"instituting investigation on the Commission's own motion to develop policies and procedures for addressing the potential health effects of electric and magnetic fields of utility facilities."

Prior to this order, it is understood that CPUC Administrative Law Judge Meg Gottstein order relevant parties to meet, participate in informational workshops and subsequent meetings to determine the nature and scope of what is to be investigated. The CPUC order is the result of these meetings.

The CPUC order had the following elements which it was implementing

o No-cost or low-cost steps to reduce EMF levels

o Workshops to develop EMF design guidelines

o Uniform residential and workplace EMF measurement programs

o Stakeholder and public involvement

o A $1,489,000 four-year education program

o A $5,600,000 four-year non-experimental and administrative research program, and

o An authorization for federal experimental research conducted under the National Energy Policy Act of 1992

Therefore, let the Commission order and establish to achieve a similar implementation, modified to meet the needs of the RF stakeholders and the public. Do this by additions to the Code of Federal Regulation, by a Rule and Order, or by other appropriate means within the context of ET-Docket 93-62, or by other appropriate means. Since Congress has given to the Commission the responsibility to properly set standards, the Commission must order in whatever manner is required so there will be public funds, not linked to the hand of industry for supporting standard setting efforts.

If Congressional statute limits the fees the Commission can collect, then let the Commission be creative, and with other interested parties encourage the formation of a representative group of stakeholders, including the concerned public, and let the Commission require its licensees to participate in supporting this entity. While there can be cooperation with WTR, this effort must be seen as not linked to industry, with a strong public representation and public health orientation. Let the order establishing this be part of this docket insofar as its purpose would be to provide the means of improving the standard setting process, to monitor it, and to assure the needed research answers are available so future standards will have sufficient information.

36. The Commission must explore how exposures may be kept as low as reasonably achievable, and do this soon before a massive capital investment in inappropriate designs or equipment occurs. These explorations should include the role of satellites in order to reduce the number of

base stations which cause such controversy. Also, it has been reported that, Japan's Ministry of International Trade and Industry,

"has been developing a solar-powered, remotely piloted airship . Earlier this year (1997), the ministry pilot-tested one such cruiser, which resembles an egg-shaped zeppelin with a finned tail. Designed as an inexpensive replacement for communications satellites, this vehicle can continuously ply the skies in an altitude of about 100,000 feet, almost 20 miles, for periods of up to 2 years.[206].

This distance would be far closer to the user than LEO (low Earth orbit) satellite systems orbiting the Earth at about 600 to 800 miles above the Earth[224]. As a result, the amount of power needed by the hand held phone will be less, thus being a lesser potential danger to the user. Especially important, by being so relatively "close" to the surface, it would seem that antennas with a narrow angle of irradiation would be able to focus the signals onto a relatively small geographic, and thus enable the same frequency to be shared by many areas, and be able to keep exposure levels to extremely low levels, far lower than what might be the exposure from ground based systems, and the 0.05 microwatts per sq. cm. may then be a quite feasible option.

This is because for ground base stations, those nearest the base station receive relatively high exposures so that there will be sufficient signal strength for those users near the edge of a coverage area. However, with an 'air-station', then all users will be about the same distance away, so that the minimum power to reach the users will be the same for all populations - thus dramatically reducing exposures - since in such an application, no one would be close to the 'air station.'

Since most of the he infrastructure is still yet to be built for many of the wireless services, the Commission is seriously being asked to study what would be the economical and technical feasibility and challenges for developing such a 'air-station' based approach for our nation. Should it be feasible, then because the costs may be greater for such systems, the Commission should establish a means whereby such systems may be competitive or preferred over landbased systems.

If application may be made of such high altitude remotely piloted, solar powered airships which apparently will have the ability to maintain their location, then only transmission systems which are well suited to such an application should be allowed, or at least the ones encouraged by

the Commission. For example, it is understood that there are some major differences between digital systems based on TDMA (time division multiple access) and CDMA (code division multiple access). Some of these relate to the feasibility of air-station transmitters and receivers. For example it is reported that CDMA *"allows the cellular system to use the same RF channel in each and every cell, and even 3 times in a 'sectorized' cell. This universal 'reuse' makes design of future networks much easier than any other technology.*[225]" Also, it is understood that, *"CDMA encodes up to 61 conversations onto a single 1.23 MHz channel. A CDMA receiver can extract the desired conversation and ignore the rest by using the proper code.*125"

Thus, CDMA technology may be well suited to a 'air-station' system where there may be some interference from transmissions and reception from other users - but by way of the coding system, it may be that interference can be avoided.

The Ad-Hoc Association is focusing attention of the Commission on the possibility of using air-ships, as described above, because it demonstrates that the very low exposure levels sought by the Ad-Hoc Association are still compatible with providing universal wireless services, but in a manner that keeps exposures as low as reasonably achievable, such as may be the case for the air-telecommunications stations described in this section.

That such systems may offer promise of being economically feasible is suggested in that it was reported that such air-ships were seen as *"an inexpensive replacement for communications satellites*" and it was reported that development has advanced to the stage of pilot testing. Thus, it may be a real possibility for the achievement of low exposure and a relatively low cost deployment of telecommunications transmitters.

Hence, the Ad-Hoc Associations requests for extremely low exposure levels seem feasible.

Likewise, it would seem that if transmitters were put at high heights and far from populated areas, that also low exposure goals can be reached. Thus, the Ad-Hoc Association's request are reasonable and feasible, and do not prevent the development of a universal wireless services infrastructure.

The Commission should actively pursue technologies which offer promise, and seek how it can through rule making encourage its operators to seek out how to keep exposures as low as reasonably achievable and to collect the data that will help answer perplexing health concerns.

37. The Commission's new limits in FCC 96-326 should not increase as frequency increases, but decrease, or at least stay flat, so as to keep from increasing the maximum local hot spot risks, especially to the head. Rather than requesting that power density exposure limits vary as a function of frequency, the Ad-Hoc Association has requested limits based on a constant power density[207]. For the range 30 to 300 MHz, the Commission's exposure limits are constant, but in the range 300 to 1500 MHz, the Commission's limits increase. This is not prudent and should not be done, but rather should be kept at a constant value, as proposed by the Ad-Hoc Association[207]. The reasons for this are as follows.

37.1 The dosimetry study of Gandhi(1992)[209] shows that as frequency increases from 300 to 915 MHz that SAR for the eyes and brain increases, being greatest in the 700 to 915 MHz range. The U.S. EPA has reported central nervous system biological effects due to RF at SARs as low as 0.0001[208], including changes to EEG and calcium ion efflux at extremely low SARs (0.0001 W/kg in live rabbits and 0.0006 W/kg, respectively [see page 5-51 of footnote 15, Takishima 1979; and see page 5-93 of footnote 15, Blackman et al. 1981].

In addition, a 1995 study be L.von Klitzing reported that power density levels for 150 MHz pulse modulated at 217 Hz and at an estimated 1 microwatt per sq. cm at 6 cm. into the head, had the effect of changing the pattern of the brain EEG readings of human subjects. The author concludes stating, "Our hypothesis is that intercellular communication paths, based on activities at the membrane surface might be disturbed by magnetic fields, pulsed with constant sequency at low frequencies."[215].

Therefore it is prudent to keep RF exposure to the brain as low as reasonably achievable.

37.2 Additional evidence for keeping exposure as low to the brain, is that recent evidence from Lai et al. (1997)[216,217] suggests that free radicals are created in the brain due to RF at 0.6 W/kg, and that this is a direct action of the RF exposure on the brain. H. Lai announced at a Food and Drug Administration Workshop on February 7, 1997[216] that he was able to replicate previous

findings reporting increased single and double strand DNA breaks when exposed to RF at 2450 MHz 2 microsecond pulse duration and 500 pulses per second. He also found that the affect disappeared when the rats were injected with either melatonin or another compound known to be a free-radical scavenger. The authors report,

"Since both melatonin and PBN are efficient free radical scavengers, it is hypothesized that free radicals are involved in RFR-induced DNA damage in the brain cells of rats. Since cumulated DNA strand breaks in brain cells can lead to neurodegenerative diseases and cancer and since an excess of free radicals in cells has been suggested to be the cause of various human diseases, data from this study could have important implications for the health effects of RFR exposure.[217]"

Since free radicals have a short life this suggests they are generated close to sites where the DNA had been damaged. Thus, it is reasonable to conclude this is a direct RF effect on the brain, and hence that RF exposure to the brain should be kept as low as possible. The exposure was at 2 mW/sq. cm with an average SAR of 1.2 W/kg; based on previous studies218 Lai et al. report that the SAR in the brain range from 0.5 to 2 W/kg per 1 mW/cm2 irradiation in their exposure system, i.e. here 1 to 4 W/kg. Since an actual increase in the concentration of free radicals resulted, a lower value would seem appropriate for a threshold, say 0.5 to 2 W/kg as a 'guesstimate'. Then applying a 'safety factor of 100 yields 0.005 W/kg to 0.02 W/kg as limits. These low exposure values are much lower than the 8 W/kg of exposure allowed in any local part of the body, and thus even for very low power densities, these results support keeping exposures to the head low, and for the Commission to not allow its limits to increase from 300 MHz to 1500 MHz as frequency increases.

37.3 Generation of oxygen free radicals at 0.2 W/kg in tissues with melanin indicate exposure to the eyes and skin should be less than 0.2 W/kg with limits for an adequate measure of safety - justifying not increasing exposures for frequencies above 300 MHz. Phelan et al., 1992 have reported,[218]

"The data indicate that a significant, specific alteration of cell-membrane ordering followed microwave exposure. This alteration was unique to lemanotic membranes and was due, at least in part, to the generation of free radicals.[218]"

Also, the authors report, *"Melanin is a ubiquitous polymeric pigment that occurs in membrane-bound organelles or melanosomes of epidermal cells and several cell types in the eye.*[218]"

Accordingly, even if these results may not have been replicated, it is prudent for the Commission to rely upon them as correct until subsequent experimentation shows otherwise[122,123], and as discussed elsewhere in this proceeding.

Applying the traditional 'safety factor' of 100[19] to the 0.2 W/kg yields 0.002 W/kg 'safe' limit for exposure of the eye and skin as they are the tissues that contain melanin, and this may yet be too high since the 0.2 W/kg had not been established as a threshold in this experiment for the generation of free oxygen radicals in melanin containing tissue.

It has been documented that as frequency increases, the depth of penetration of RF energy decreases, with the result being a greater SAR on the surface tissues, e.g .skin and parts of the eye - the very melanin containing tissues that appear subject to free radical damage at 0.2 W/kg.

For example, the 1986 Radiofrequency Radiation Dosimetry Handbook, which was a dosimetry reference recommended by the ANSI/IEEE C95.1-1991 RF standard, states that at 1, 2, 4, 8, 10 and 20 GHz the depth of penetration in centimeters is 4.05, 2.46, 1.66, 0.65, 0.45, and 0.16 cm. Thus, for a fixed power density the SAR for the skin must significantly increase.

Indeed, a study by Gandhi and Riazi (1986) [and referenced by the Ad-Hoc Association FCC 96-326 Petition at item #14.3.14 at page 12] notes that at the millimeter frequencies SARs at the surface of the skin can range up to 65 to even 357 W/kg. Gandhi and Riazi report that when the incident power density is 5 mW/sq. cm - the limit for occupational/controlled exposure for frequencies above 1.5 GHz, that:

A. Frequency in GHz:	30	60	100	150	200	250	300
B. SAR W/kg at skin surface:	65.5	138.3	209.7	270.8	312.0	338.2	357.1

Accordingly, for the general population/uncontrolled exposure of 1 mW/sq. cm. for frequencies above 1.5 GHz, that

C. Frequency in GHz:	30	60	100	150	200	250	300

D. SAR W/kg at skin surface:	13.1	27.7	42	54.2	62.4	67.6	71.4
E. Amount 1 mW/cm2 would need to be divided by to achieve an SAR of 0.002 W/kg 'safety limit'	6,550	13,830	20,970	27,080	31,200	33,820	35,710
F. Resulting power density in microwatts per sq. cm.	0.15	0.07	0.05	0.04	0.03	0.03	0.03

Therefore, even if a traditional 'safety factor' of 100[19] were applied to the 0.2 W/kg, the allowed limit for exposure to the skin would be 0.002 W/kg. To achieve this resulting power density would need to be as in line #F in 367.3 above. Since the 0.2 W/kg was not an observed threshold, the proposed limit of 0.05 microwatts per sq. cm. requested by the Ad Hoc Association FCC 96-326 Petition at page 15 is a reasonable and prudent limit, and which arguably, based on the above even be set to lower limits, especially at the very high frequencies.

38. The Commission is urged request the federal health agencies:

(i) to examine the studies noted and referenced herein,

(ii) to report on effects observed below the present 4 W/kg hazard threshold of the Commission,

(iii) to indicate if "a reasonable person" would want a home, school, hospital, or work place to be exposed to such effects given that their health impacts may remain uncertain but that they effect important biological processes,

(iv) to perform a risk assessment, indicating the different societal values and approaches to risk and their impacts on a RF standard.

39. Footnotes:

1. (i) Action For Children's Television v FCC, 564 F.2d 458,468,469 (1977);
(ii) Joseph v. FCC, 131 U.S. App.D.C. 207,210, 404 F.2d.207,210(1968);
(iii) Gerico Investment Co. v. FCC, 99 U.S. App.D.C. 379,380, 240 F.2d 410,411 (1957); (iv) Saginaw Broadcasting Co. v. FCC, 99 U.S. App. D.C. 282, 286, 96 F.2d. 554, 558, 59 S.Ct. 72, 83 L.Ed. 391 (1938) and other citations at Action For Children's Television v FCC at pg 469.

2. C. Byus and L Hawel III, "Additional considerations about the bioeffects of mobile communications," in Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 133-145

3. See FCC Rule and Order FCC 96-326, footnote 16 for paragraph #13, and see NCRP RF criteria report #86, section 17.4.2 upon which the Commission's external power denstiy exposure limits are based, as stated in footnote #1 of FCC 96-326

4. The American Heritage Dictionary of the English Language, Houghton Mifflin Company, New York, 1992, pg. 1473.

5. A. M. Phelan et al. "Modification of Membrane Fluidity in Melanin-Containing Cells by Low-Level Microwave Radiation," Bioelectromagnetics, Vol. 13: 131-146, 1992

6. B. Hocking et al., "Cancer Incidence and mortality and proximity to TV towers," Medical Journal of Australia, Vol.165, pg. 601-605, 1996

7. H.Dolk et al (1997a) "Cancer incidence near Radio and Television Transmitters in Great Britain, 1. Sutton Coldfield transmitter," American Journal of Epidemiology Vol: 145, No. 1, January 1, 1997.1-9

8. H.Dolk et al (1997b) "Cancer incidence near Radio and Television Transmitters in Great Britain, II. All High Power Transmitters," American Journal of Epidemiology Vol: 145, No. 1, January 1, 1997.10-17.

9. S. Szmigielski, "Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation," the Science of the Total Environment Vol. 180 (1996) 9-17

10. Reported by Enviornmental Protection Agency, "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, Vol. #1, report #402-R-95-009, March 1995, pg. 26

11. A. Sanders et al, "The differential effects of 200, 591, and 2450 MHz radiation on rat brain energy metabolism," Bioelectromagnetics 5: 419-433, 1984

12. A. Sanders et al, "Effects of continuous-wave, pulsed, and sinusoidal amplitude-modulated microwaves on brain energy metabolism," Bioelectromagnetics 6:89-97, 1985

13. R.T. Hitchock, R.M.Patterson, Radio-Frequency and ELF Electromagnetic Fields, Van Nostrand Reinhold, New York (1995)

14. Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997.

15. Environmental Protection Agency, Biological Effects of Radiofrequency Radiation, EPA-600/8-83026F, September 1984

16. Enviornmental Protection Agency, "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, report #402-R-95-009, March 1995,

17. Policy Statement: "Cellular Phone Transmitters on School Sites", issued March 1996, by John Simpson, National Property Manager, New Zealand Ministry of Education, 45-47 Pipitsa Steet, Thorndon, Private Box 1666, Wellington, New Zealand, Tel: (04) 473-5544, Fax: (04) 471-4414

18. News Release, California Public Utilities Commission, 505 Van Ness Avenue, San Francisco, California, 94102-3298, November 8, 1995. Contact Dianne Dienstein (415) 703-2423

19. Federal Register Vol. 51. No. 146, July 30, 1986, EPA Federal Radiation Protection Guidance: Proposed Alternatives for Controlling Public Exposure to RF Radiation: Notice of Proposed Recommendations:pp. 27317-27339
20. D. James, Jr of EPA.,"Radiofrequency Environments in the United States," 15th IEEE International Conference on Communications, 1979, Boston, MA, June 10-14, vol. 2 of 4 pp. 31.4.1-31.4.5, also a selection in, J. Osepchuck, "Biological Effects of Electromagnetic Radiation," IEEE Press, New York, 1983, pg. 552-556
21a. The Telecommunications Act of 1996 VERSION, Doc. No. 36840.02, February 12, 1996, page 446, comments on Sec. 704
21b. The Telecommunications Act of 1996 VERSION, Doc. No. 36840.02, February 12, 1996, Sec. 704(a)(7)(B)(iv).
22a. "The Commerce Clause and Restrictions on State Regulatory Powers," Chapter 8 in Constitutional Law, Fifth edition, by J. Nowak and R. Rotunda, West Publishing Co, St.Paul,Minn, 1995, pg. 281
23. 309 U.S. 598, 60 S.Ct. 726, 84 L.Ed. 969 (1940)
24. H.P. Welch Co. v. New Hampshire, 306 U.S. 79, 85, 59 S.Ct. 438, 441, 83 L.Ed. 2d 717 (1959)
25. See citiations in footnote 22 where on page 322 in cititation 2 are given numerous court decisions which find that the preemption of Congress manifest its intentions clearly. As noted, what is most clear is that in the area of public safety and welfare Congress reserves this power to the states.
26. See citiations in footnote 22 where on page 322 there aer cititations 3,4,5
27. 461 U.S. 190, 203-04, 103 S.Ct. 1713m, 1722, 75 L.Ed.2d 752 (1983). California moratorium on nuclear power plants not preempted by Atomic Energy Act in view of the economic purpose behind the state regulation and the terms of the federal law. [from footnote 22 on its page 323, citation 10.
28. See FCC Rule and Order FCC 96-326, footnote 75
29. H.Lai, A.W. Guy et al. (1994), "Microwave Irradiation Affects Radial -Arm Maze Performance in the Rat," Bioelectromagnetics 15:95-104
30. H.Lai, A.W. Guy et al. (1989), "Low-Level microwave irradiation and central cholingeric systems, Pharmacol.Biochem. Behavior 33: 131-138
31. C. Chou et al., "Specific Absorption Rate in Rats Exposed to 2450 MHz Microwaves Under Seven Exposure Conditions," Bioelectromagnetics, Vol: 6, pg. 73-88, 1985
32. J.Schrot, "Modification of the Repeated Acquistion of Response Sequences in Rats by Low Level Microwave Exposure," Bioelectromagnetics, 1(1) pp. 89-99, 1980
33 J.D. D'Andrea, O.P. Gandhi et al. (1986),"Intermittent Exposure of Rats to 2450 MHz Microwavesat 2.5 mW/cm2: Behavioral and Physiological Effects," Bioelectromagnetics, Vol 7, pg. 315-328
34. C. Durney, 1986: Radiofrequency Radiation Dosimetry Handbook, October 1986, USAFSAM-TR-85-73, Brooks Air Force Base, TX, 78235-5301
35. W.R. Adey, "Bioeffects of mobile communications fields: possible mechanisms for cumulative dose," Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 95-131
36a. See footnote 35, page 116-117, and Ad-Hoc Assn 96-326 petition at item 4.5 pg. 4, and ex parte submission dated June 10 of the Ad-Hoc Assn.
36b. K. Boje et al, "Microglial-produced nitric oxide and reactive nitrogen oxide mediate neuronal cell death," Brain Research, Vol. 587, pg. 250-256, 1992.11

37. See Ad-Hoc Assn. Fcc96-326 Petition at item (4.1) pg. 3, and ex parte submission dated June 10 of the Ad-Hoc Assn, pg 38 item 10.2, and see K. Mann et al., "Effects of Pulsed High-Frequency Electromagnetic Fields on Human Sleep," Neuropsychobiology, 1996, Vol: 33: 41-47
38a. See Ad-Hoc Assn. FCC 96-326 Petition at item (4.2) pg. 3, and see 38b-38e which were footnoted in the Ad-Hoc Ass. 96-326 Petition and shown below.
38b. "Athermal RF Successfully Treats Chronic Insomnia; ELF Modulation Believed To Be Key to New Therapy," Microwave News, May/June 1996 pg 7-8
38c. J.P. Libet et al., "Electroencephalographic Changes Following Low Energy Emission Therapy," Annals of Biomedical Engineering, Vol. 24, pp 424-429, June 1966
38d. M. Reite et al., "Sleep Inducing Effect of Low Energy Emission Therapy," Bioelectromagnetics 15:67-75
38e. B. Pasche et al., "Effects of Low Energy Emission Therapy in Chronic Psychophysiological Insomnia," Sleep: 19(4):327-336, May 1996
39. D. James, Jr of EPA.,"Radiofrequency Environments in the United States," 15th IEEE International Conference on Communications, 1979, Boston, MA, June 10-14, vol. 2 of 4 pp. 31.4.1-31.4.5, also a selection in, J. Osepchuck, "Biological Effects of Electromagnetic Radiation," IEEE Press, New York, 1983, pg. 552-556
40. V. Belokrinitskiy, "Destructive and Reparative Processes in Hippocampus with Long Term Exposure to Nonionzing Microwave Radiation," in U.S.S.R. Report, Effects of Nonionizing Electromagnetic Radiation, No. 7, JPRS 81865, pp. 15-20, Sept. 27, 1982.
Note: in this report an effect deemed adverse by the author was observed at 10 microwatts per sq. cm. at for a 12.6 cm wave length (2380 MHz). Durney (see footnote 28) shows that for a worst case the average SAR = 0.4 W/kg per 1 mW/sq. cm., thus exposure should be about 0.004 W/kg or 1/1000th of 4 W/kg. Thus, an estimate of 0.0067 W/kg is conservatively high, and 0.0067 is 1/600th of 4 W/kg.
41. Footnote 15, Takashima et al. 1979 at pg 5-51 and 6-6
42. S. Cleary, "Biological Effects of Radiofrequency Electromagnetic Fields," Biological Effects and Medical Applications of Electromagnetic Energy, ed. O.P. Gandhi, Prentice Hall, New York, 1990, pg. 248
43. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #92
44a. W.R. Adey et al, "Brain Tumor Incidence in Rats Chronically Exposed To Digital Cellular Telephone Fields In An Initiation-Promotion Model," Abstracts of the18th Annual Meeting of the Bioelectromagnetics Society, June 9-14, 1996, pg. 27.
44b. W.R. Adey, "Bioeffects of mobile communications fields: possible mechanisms for cumulative dose," in Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 95-131
45. "Motorola Keeps a Low Profile on Adey Animal Study Showing Tumor-Inhibiting Effect of Cellular Phone Radiation," Microwave News, New York, July/August 1996, pg. 11.
46a. C. Thompson, "Apoptosis in the Pathogenesis and Treatment of Disease," Science, vol 267, 10 March 1995, pg. 1456-1462.
46b. D. Vaux and A. Strasser, "The molecular biology of apoptosis," Proceedings of the National Academy of Science, U.S.A., Vol. 93, pp. 2239-2244, March 1996
47. A. Phelan et al., "Modification of Membrane Fluidity in Melanin-Containing Cells by Low Level Microwave Radiation," Bioelectromagnetics, Vol. 13, pg. 131-146 (1992). The authors note in abstract, *"This alteration was unique to melananotic membranes ans was due, at leas in part, to the generation of oxygen radicals."* Whether such an effect could occur in brain tissue is not known.

48a. P. McGeer et al, "Microglia degenerative neurological disease," Glia, Vol. 7, pg. 84-92, 1993
48b. D. Piani et al, "Macrophage-induced cytotoxicity of N-methyl-D-aspartate receptor positive neurons involves excitatory amino acids rather than reactive oxygen intermediates and cytokines," European Journal of Immunology, Vol 22, pg. 2429-2436, 1992
48c. K. Boje et al, "Microglial-produced nitric oxide and reactive nitrogen oxide mediate neuronal cell death," Brain Research, Vol. 587, pg. 250-256, 1992.11
49a. E.. Sobel et al, "Occupations with Exposure to Electromagnetic Fields: A Possible Risk Factor for Alzheimer's Disease," American Journal of Epidemiology, VBol 142, No. 5, pg. 515-524, 1995.
49b. Z. Davanjpour et al, "Amyotrophic Lateral Sclerosis and Occupational Exposure to [EMFs]," Bioelectromagnetics, Vol 18, pg. 28-45, 1997
49c. N.L. Petersen et al, "Occupational Exposure to [EMFs] and Alzheimer's Disease," presented at the Annual Review of Research on Biological Effects of Electric and Magnetic Fields from the Generation, Delivery, and Use of Electricity, Paper No. A-47, San Antonio, TX, November 91-21, 1996
50. Footnote 19a. pg. 1, authors state, "Microglia are the brain's representatives of the immune system." Hence, studies which show biological effects of suppression or stimulation on the immune system may impact similarly on the microglia in the brain.
51. B. Veyret et al, "Antibody Responses of Mice Exposed to Low Power Microwaves Under Combined Pulse-and-Amplitude Modulation," Bioelectromagnetics, Vol 12, pg. 47-56, 1991. Authors report that at an exposure of 30 microwatts per sq. cm the whole body average specific absorption rate (SAR) was 0.015 W/kg (which is 0.375% of the 4 W/kg of the FCC hazard threshold upon which FCC limits are derived, safe limits for the public being 1/50th of the hazard threshold, and 'safe' limits for workers being 1/10th of the FCC hazard threshold)
52. Q. Balzano and N.Kuster, "Experimental and numerical dosimetry," in Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 13-64
53. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #167
54. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #118
55. American National Standard: Safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 kHz to 100 GHz (ANSI C95.1-1982)
56. Q. Balzano and N. Kuster, "Experimental and numerical dosimetry" in Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 13-64
57. Kuster, N. (1992) Dosimetric Assessment of EM Sources Near Biological Bodies by Computer Simulations. Diss. ETH Nr. 9697, Zurich.
58. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #71 and footnotes 82, 85 therein
59. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #71, and footnote 85 and 60 therein
60. For the 'controlled environment' the exclusion provides for 7 watts of output power from 100 kHz to 450 MHz, and 7 watts x 450/f in MHz from 450 MHx to 1500 MHz. For the 'uncontrolled environment' limits are 1/5th of that for the controlled environment. See IEEE C95.1-1991 sections 4.2.1.1 and 4.2.2.1.
61. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #49, and footnote 85 and 60 therein

62. See balloting list in the exhibit section of the Ad-Hoc Association FCC 96-326 Petition.
63. R.M.Patterwson and R.T.Hitchock, Radio-Frequency and ELF Electromagnetic Energies: A Handbook for Health Professionals, Van Nostrand Reinhold, New York, 1994, pg. 6
64. S. Forman, C. Holmes, T. McManamon, and W. Wedding, "Psychological Symptoms and Intermittent Hypertension Following Acute Microwave Exposure," Journal of Occupational Medicine, Vol. 24, No. 11, November 1982, pg. 932-934. S. Forman is a phycian who is a lieutenant commander at the Naval Regional Medical Center in Long Beach, California; C. Holmes and T. McManamon are both physicians and commander and captain respectively at the San Diego, California Naval Regional Medical Center; W. Wedding is a lieutenant commander at the Department of Radiology, San Diego, California Naval Regional Medical Center.
65. R.M.Patterwson and R.T.Hitchock, Radio-Frequency and ELF Electromagnetic Energies: A Handbook for Health Professionals, Van Nostrand Reinhold, New York, 1994. It is reported that based on the studies of Tell[66], "The far field was established at 'wavelength/2 π" which is about 1/6th of a wavelength (or better 1/6.28 of a wavelength = 16% of a wave length). Thus for radiation in the X band (8.2 to 12.4 GHz) a wavelength is 3.7 cm to 2.42 cm, and 1/6th is about 0.6 cm or less.
66. R.A. Tell, (1978), Near-Field Radiation Properties of Simple Linear Antennas with Applications to Radiofrequency Hazards and Broadcasting (ORP/EAD 78-4) Las Vegas, NV:EPA.
67. IEEE C95.3-1991, Section 2, definitions, near-field. Note states,"For most antennas, the outer boundary of the reactive near field region is commonly taken to exist at a distance of 1/2 wavelength from the antenna surface."
68. H. Bassen, "RF Interference Of Medical Devices by mobile communications transmitters," Chapter 3, in in Mobile Communications Safety, ed. N.Kuster, Q.Balzano, J.C. Lin, Chapman and Hall, London/New York, 1997, pg. 65-94. It reports, "Usually near field conditions occur at distances that are less or equal to the size of the radiating antenna of an RF transmitter and closer than a wavelength from the antenna." reported on page 91. Since the X band is from 8.2 to 12.4 GHz the wavelengths are less than or equal to 3.7 cm. So the near field is less than 4 cm.
69. "Status of Research on the Safety of Cellular Telephones," U.S. General Accounting Office, report GAO/RCED-95-32 Safety of Cellular Telephones, November 1995
70a. "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, Vol. 1. Analysis of Panel Discussions, U.S. Environmental Protection Agency, March 1995, #402-R - 95-009.
70b. "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, Vol. 2. Papers, U.S. Environmental Protection Agency, March 1995, #402-R -95-011.
70c. "Biological Effects of Radiofrequency Radiation", U.S. Environmental Protection Agency, September 1984, #EPA-600-8-83-026F
70d. Environmental Protection Agency letter from Margo Oge dated November 9, 1993 to the Federal Communications Commisson regarding ET Docket 93-62. In the Comments of this letter is noted *"Meaningful studies of biological and health effects of nonthermal, pulse-modulated RF radiation exist including studies showing injury to the eye."* [page 5 of Comments]
71. Ballots of Dr. M. Swicord and Dr. M. Altman of the FDA were submitted as 2 of the 33 ballots cast concerning the adoption of IEEE C95.1-1991 in April 1991. Both of these scientist rejected this standard, and noted, *"There is other data (work of Kues and others) which suggest that pulsed microwaves may give responses at low average levels than CW* (continuous waves). *This problem should not be brushed aside."* from records of the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY 10017-2394.

72. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #3
73. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #31
74. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #43,44,45 and footnote 56 therein.
75. A 5 second exposure at 90 mW/sq. cm is,
averaged over 6 minutes (1/12 x 90) / 6 = 1.25 mW/sq.cm which is less than 5 mW/sq.cm, and averaged over 30 minutes (1/12 x 90) / 30 = 0.25 mW/sq.cm which is less than 1 mW/sq.cm
76. A 10 second exposure at 90 mW/sq. cm is,
averaged over 6 minutes (1/6 x 90) / 6 = 2.50 mW/sq.cm which is less than 5 mW/sq.cm, and averaged over 30 minutes (1/6 x 90) / 30 = 0.50 mW/sq.cm which is less than 1 mW/sq.cm
77. An 80 second exposure at 90 mW/sq. cm is,
averaged over 6 minutes [(80/60) x 90] / 6 = 20 mW/sq.cm, and averaged over 30 minutes [(80/60) x 90)] / 30 = 4 mW/sq.cm
78. A 75 second exposure at 90 mW/sq. cm is,
averaged over 6 minutes [(75/60) x 90] / 6 = 18.75 mW/sq.cm, and averaged over 30 minutes (7/12 x 90) / 30 = 3.75 mW/sq.cm
79. Peak exposure allowed by ANSI/IEEE C95.1-1992 4.1.1(g) and 4.1.2 (g) for when there are more than 5 pulses per second = MPE x averaging time in seconds /5 =(10 mW/sq cm*360)/5 = 720 mW/sq. cm
80.. Partial body exposure for 8.2-12.4 GHz has a limit of 20 x $(8.2/6)^{0.25}$ = 21.6 mW/sq. cm based upon ANSI/IEEE C95.1-1992, for the 'controlled' environment, and 8.2/1.5 = 5.46 for the 'uncontrolled' environment. See ANSI/IEEE C95.1-1992 Table 3 in section 4.4
81. See Ad-Hoc Association FCC 96-326 Petition at pages 3-4, 11-16, Ad-Hoc Association FCC 96-487 Petition at pages 4-6, in its June 10, 1997 ex parte comments
82. Biological Effects and Exposure Criteria For Radiofrequency Electromagnetic Fields, Report #86 of the National Council For Radiation Protection and Measurements, Bethesda, MD, 1986
83. Institute of Electrical and Electronic Engineers IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, 1991, New York, NY.
84. International Radion Protection Association: Guidelines on limits of exposure to radiofrequency electromagnetic fields in the frequency range from 100 MHz to 300 GHz. Health Physics. 54:11-123.
85. "Power Line Talk", Microwave News May/June 1997
86. FCC Rule and Order adopted August 1, 1996, FCC 96-326 para #46, and see para#1 and footnote 2.
87. Letter of S. Mallinger, Acting Director, Directorate of Technical Support, Occupational Safety and Health Administration, dated March 1, 1994 to T.P.Stanley, Chief Engieer, Federal Communications Commission, regarding ET-Docket 93-62.
88. Letter of August 2, 1996 from Gegory J. Baxter, Acting Director, Directorate of Technical Support, Occupational Safety and Health Administration to Mr. Richard Smith, Chief Office of Engineering and Technology, FCC regarding new approach of FCC to RF safety in ET-Docket 93-62
89. Section 6 of ANSI/IEEE C95.1-1992, see footnote 83.
90. See footnotes in ANSI/IEEE C95.1-1992 sect. 4.11 and 4.12, Table 1 and Table 2 respectively.
91. ANSI/IEEE C95.1-1992 sect. 6.3, 6.4, and see footnote 83.
92. ANSI/IEEE C95.1-1992, 6.3, 6.4, and Appendix B pages 61-68

93. Oscar et al (see footnote 94) exposed rats to 1300 MHz RF irradiation. This is a frequency for which SAR is a meaningful measure (e.g see footnote 89, and see footnote 34). EPA (at page 5-51 of footnote 15) has determined that the average whole body SAR at 1300 MHz for pulsed irradiation for this study was 0.1 W/kg for 0.3 mW/sq. cm irradiation. Accordingly, for 0.03 mW/sq. cm irradiation the SAR is 0.01 W/kg, since SAR is proportionate to power density (for the same frequency and pulsed type of signal), e.g. since the latter power density was 1/10th of the former, the latter SAR is 1/10th of the former (0.1 W/kg).

94. K. Oscar et al, "Microwave Alteration of the Blood-Brain-Barrier System of Rats," Brain Research, 126, pp. 281-293, 1977

95. V.S. Belokrinitskiy, "Destructive and Reparative Processes in Hippcampus with Long Term Exposure to Nonionizing Radiation," in U.S.S.R. Report, "Effects of Nonionizing Electromagnetic Radiation, No. 7, JPRS 81865, pp. 15-20

96. V. Belokrinitskiy, "Destructive and Reparative Processes in Hippocampus with Long Term Exposure to Nonionzing Microwave Radiation," in U.S.S.R. Report, Effects of Nonionizing Electromagnetic Radiation, No. 7, JPRS 81865, pp. 15-20, Sept. 27, 1982.
Note: in this report an effect deemed adverse by the author was observed at 10 microwatts per sq. cm. at for a 12.6 cm wave length (2380 MHz). Durney (see footnote 34) shows that for a worst case the average SAR = 0.4 W/kg per 1 mW/sq. cm., thus exposure should be about 0.004 W/kg or 1/1000th of 4 W/kg. Thus, an estimate of 0.0067 W/kg is conservatively high, and 0.0067 is 1/600th of 4 W/kg.

97. L.Salford, "Permeability of the blood brain barrier induced by 915 MHz electromagnetic radiation, continous wave and modulated at 8, 16, 50, and 200 Hz, Biochemistry and Bioenergetics, Vol. 30: 313-318, 1994. Note this effect and the SAR at which it occured was study was also mentioned in the Ad-Hoc Association FCC 96-326 Petition at page 15

98. M.A. Navaktikian et al, "Phasic Behavioral and Endocrine Effects of Microwaves of Nonthermal Intensity," in Biological Effects of Electric and Magnetic Fields, Academic Press, New York, 1994, Volume 1, Chapter 14, pg. 333-342. Authors report at 100 microwatts /sq. cm using pulsed signals (400 Hz modulation with pulse duration of 2 microseconds) at 3000 MHz there was a statistically significant drop in insulin levels - see Table III on page 338 of this reference. To determine a maximuim whole body SAR use the highest SAR for any size rat using Durney (at footnote 34), and which yields an average whole body SAR of less than 0.4 W/kg per 1 mW/sq. cm for a prolate spheroid of a small rat, and the SARs are smaller for larger size rats. Hence, at 100 microwatts per sq. cm. (0.1 mW/sq. cm) the SAR in this experiment would be less than 0.004 W/kg. Thus, a 26% statistically significant drop in insulin was observed at 1/1000th of 4 W/kg of the Commission's hazard threshold.

99. Enviornmental Protection Agency, "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, Volume 2: Papers, report #402-R-95-011, March 1995.

100. S.Cleary, "Electromagnetic Fields, Health Effects," in Encyclopedia of Energy, Technology, and the Environment, Volume 2, Addison-Wesley, 1995, pg 1100-1110.

101. "A Case For Reducing Human Exposure Limits Based On Low Level, Non-Thermal, Biological Effects, (1994) by A.H. Doull, Health and Safety Advisor of the Commonwealth Scientific and Industrial Research Organization ("CISRO") and Dr. C.Curtain, CISRO Honorary Research Fellow. Commonweatlh Scientific and Industrial Research Organization, 126 Greville Street, Chatswood 2067, Australia. Contact: 61-2-9-412 6009

102. S. B. Barnett, Ph.D., "CISRO Report on the Status of Research On the Biological Effects and Safety of Electromagnetic Radiation: Telecommunications Frequencies," June 1994, Ultrasoics Laboratory, Division of Radiophysics, CISRO, 126 Greville Street, Chatswood 2067, Australia. Contact: 61-2-9-412 6009