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Public Health Management of the  
Radiofrequency Environment  
in the City of New York

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Abstract

In 1978 the Bureau for Radiation Control of the City of New York Health Department recommended to its Board of Health adoption of a permissible level for the radiofrequency/microwave portion of the electromagnetic spectrum of 50 microwatts per cm<sup>2</sup> for areas accessible to the general public. This corresponds to a specific absorption rate (SAR) of 0.018 watts per kilogram (W/kg) for those radiofrequencies of maximum tissue absorption in a 10-year old child. The Board deferred action in anticipation of federal leadership in standard setting for non-ionizing radiation. Since that time the interim recommendation has been implemented by contract for new facilities requiring City of New York official approval. Suitable federal standards are still awaited and urged. The FCC rules of March 1985 based upon the 1982 ANSI standards do not preempt those of states and local jurisdictions. They are inferior in defense of public health to those recommended by the EPA Office of Radiation Programs.

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## Public Health Management of the Radiofrequency Environment

### General Background for New York City

On January 31, 1978 the City of New York Board of Standards and Appeals gave its approval to the U.S. Coast Guard to erect a microwave tower for maritime safety purposes in the residential Todt Hill area of Staten Island (1). After adverse representations by the Borough President of Staten Island and community groups, the New York City Board of Estimate reversed the approval about six weeks later, on March 17, 1978. To my knowledge, the City Department of Health was neither consulted nor involved in either the initial approval nor its subsequent rescinding by the Board of Estimate.

Following the Board of Estimate's action, the members of the Mayor's office senior staff asked the then Commissioner of Health to have his people explore the scientific and public health aspects of the general non-ionizing radiation problem with respect to the radio-frequency and microwave region of the electromagnetic spectrum, insofar as the City of New York is concerned.

In accord with the Commissioner's direction, we researched the matter in some depth. On June 15, 1978, in my capacity, as Director of the Health Department's Bureau for Radiation Control, I recommended to the Board of Health adoption in the City Health Code of a 500 microwatts per  $\text{cm}^2$  permissible level for occupational radiofrequency/microwave exposure and 50 microwatts per  $\text{cm}^2$  for areas accessible to the environment by the general public (2)(3). This was materially less (by a factor of twenty and two hundred respectively) than the 10,000 microwatts per  $\text{cm}^2$  which had been regarded as adequate by the U.S. Occupational Safety and Health Administration (OSHA). As many of us in the public health regulatory area know, the OSHA guideline of 10,000 microwatts per  $\text{cm}^2$  was not really a statutory standard but a legally non-enforceable recommendation based upon early Army, Air Force and Navy sponsored studies and conferences going back to World War Two.

On October 5, 1978 a public hearing was held before the Board of Health in which my proposed recommendations were supported generally by environmental health groups and strenuously opposed by the broadcasting and communications hardware industries. Of interest, and especially welcome to me personally, was the statement by the United States Coast Guard, the agency which precipitated the original investigation. The Coast Guard representative took no essential exception to the recommendations and advised that the Coast Guard would have no problem in complying with them at the contemplated Staten Island installation.

After the public hearing, the Board of Health took the position that the overall matter of radiofrequency/microwave permissible levels transcended the particular regulatory authority concerns or capacities of a local jurisdiction like the City of New York. The Board of Health deferred action pending expected federal initiatives. Regrettably the hoped for federal leadership in this area has not yet been achieved as of this date, nearly seven years later.

How have we addressed the problem in the meantime while awaiting the long postponed federal standards?

Though the matter is still unresolved, the old OSHA guideline of 10 milliwatts per  $\text{cm}^2$  (or 10,000 microwatts per  $\text{cm}^2$ ) is no longer regarded as at all acceptable by the majority of the scientific community knowledgeable in this subject. The more recent American National Standards Institute (ANSI) guideline of 1 milliwatt per  $\text{cm}^2$  (or 1000 microwatts per  $\text{cm}^2$ ) for those electromagnetic frequencies of maximum tissue absorption is certainly an improvement. However, in my scientific judgment, an exceptionally valid case has been made by the Environmental Protection Agency (EPA) Office of Radiation Programs for their proposed standard of 100 microwatts per  $\text{cm}^2$  corresponding to a specific absorption rate (SAR) of approximately 0.035 W/kg in a 10 year old child(4). From the point of view of operational radiological health and safety there is little practical difference between the EPA's 100 microwatts per  $\text{cm}^2$  and the permissible level of 50 microwatts per  $\text{cm}^2$  which we suggested in 1978.

Since that time what we proposed to do by Health Code statute, we have been achieving by contractual agreement when our scientific counsel has been requested by other agencies of New York City such as the Department of Buildings or the Department of Environmental Protection.

We have recommended the 50 microwatts per  $\text{cm}^2$  standard be incorporated into construction contracts requiring City agency approval. In point of fact, this action has not met with strenuous resistance from the engineers, architects, executives or even lawyers responsible for the limited number of installations where our public health surveillance has been involved.

#### Federal Leadership Deferred Presents Problems for Local Jurisdictions

The particular case study just cited for the City of New York is representative of the kind of problem to be confronted by states and local jurisdictions in the management of the radiofrequency environment. As the survey-meter wielding physicists responsible for radiological public health in the City of New York, we were personally disappointed by our Board of Health's postponement in 1978 of statutory action on setting the enforceable permissible levels for non-ionizing radiation in the radiofrequency portion of the electromagnetic spectrum. However considering the broad national and indeed international distribution of an enormous variety of radiofrequency sources, it is evident that federal standard setting is very much to be preferred to public health regulations set by states and municipalities.

The recent (May 11, 1984) E.P.A.'s Office of Policy Planning and Evaluation (OPPE) draft of an option paper(5) took exception to that same agency's Office of Radiation Programs(ORP) scientifically detailed and carefully considered recommendations that would have limited whole-body Specific Absorption Rate(SAR) to no more than 0.04 watts per kilogram (w/kg) or about 100 microwatts per cm<sup>2</sup> for electromagnetic frequencies of maximum tissue absorption. One of the objections offered is as follows: There is "no certainty that states and cities will adopt it; they could adopt more stringent standards." Speaking as a working scientist and not as a legislator or member of a Board of Health, I offer the opinion that this particular argument, as far as the City of New York, is unwarranted. Having gone over the EPA Health Effects Research Laboratory report Biological Effects of Radiofrequency Radiation (4) which contains the ORP recommended standards or guidelines, I would urge their incorporation into the New York City Health Code by our Board of Health if they were finally adopted by the EPA. As mentioned earlier, the factor of two difference between the ORP standard and the one suggested to our Board of Health in 1978, is really inconsequential. In my judgment, in the absence of federal standards, it is far more likely that local jurisdictions will either enact no standards at all or the capriciously more stringent standards which evidently is feared by the EPA's Office of Policy Planning and Evaluation. It is to be hoped that we have not heard the federal last word from the EPA - or no word at all which is the apparent situation at this writing - but a clear decision will be made in favor of its Office of Radiation Programs scientifically vectored recommendations.

Some Historical Precedents in the Setting of Radiation Protection Standards (6) (7)

Without question the most exhaustively and expensively studied ecological parameter presumably capable of inflicting various degrees of harm both in the occupational and non-occupational environment is low-level ionizing radiation. How can the history of standard setting for ionizing radiation help illuminate the directions that should be taken in establishing permissible levels for non-ionizing radiation? As a corollary of this, can this history help the public health community avoid the apparent pitfalls which have arisen in the ionizing radiation area? Though the basic biophysics is materially different, I submit that the experience with ionizing radiation can be operationally instructive in some of today's efforts to set practical safe standards for non-ionizing radiation.

Within a year more or less after the discovery of x-rays by Roentgen in 1895, there was a perception that some protective action with respect to the possible harmful effects of the new radiation was in order. Without going into the antiquity of this subject and the evolution of standards from the first quantitative recommendations of the Deutsche Roentgen Gesellschaft in 1913 and the later considerations of skin erythema production as a guide to allowable dose, I suggest with a certain temerity that our current state of knowledge with respect to the physiological effects of non-ionizing radiation is roughly where radiological health science stood with respect to ionizing radiation in 1934. I select this date of a half century ago, because it was the year that the institutional ancestors of the contemporary International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurement (NCRP) promulgated the first so-called "tolerance" dose level. That level was 0.2 Roentgen units per day in a working x-ray area or 60 rem per year in more modern characterization.

That remained the basic guideline until 1949 and 1950 when the NCRP and the ICRP respectively, reduced the "tolerance" dose from this 60 rem per year to 0.3 rem per week or 15 rem per year. Many of us still reasonably active superannuated physicists remember this standard well when we first got into the radiation protection business under the wings of the old United States Atomic Energy Commission (AEC) which earlier (1948) agreed to follow the recommendations of the NCRP for AEC employees and AEC contractors. The level of 15 rem per year was again reduced by the NCRP in 1958 to 5 rem per year for occupational exposure with the additional important constraint of 0.5 rem per year for the general public. With some minor caveats, such as the Federal Radiation Council (FRC) recommendation of 1959 for an overall 0.17 rem per year maximum permissible dose average exposure for the general public, the 5 rem per year occupational dose and the 0.5 rem per year maximum for a person in the general public are still today's standards.

I do not mean to imply that the present permissible levels under consideration for non-ionizing radiation are necessarily going to be reduced further as we learn more both from laboratory research and epidemiological investigation. Even in the well studied ionizing radiation area there is not unanimous agreement among very knowledgeable people that the consistent lowering of permissible levels was scientifically justified. For example, to quote one of the leading pioneers and experts in the radiation protection field, Dr. Lauriston S. Taylor, currently Honorary President of the National Council on Radiation Protection and Measurements: "...there is not an iota of evidence of specific injury to persons exposed to ionizing radiation since the first numerical standards were set in 1934 at a level of 0.2 roentgens per day..."(7) Many - perhaps most - contemporary workers in the field of radiation protection, including myself, would take exception to the thrust of this assertion which implies that the justification for reduction by a factor of twelve was questionable. However it reflects the latitude of uncertainty which exists even for so thoroughly explored a factor in our environment as low-level ionizing radiation. The need for exceptional prudence and care with respect to setting standards for radiofrequency radiation is strongly reinforced looking back upon our prior experience with ionizing radiation.

## Decision-Making Factors in Non-Ionizing Radiation Permissible Level Standard Setting

In the apparent absence of conclusive epidemiological evidence for physiological damage to humans from low levels of radiofrequency radiation, what are the facts or parameters to be considered in making decisions with respect to public permissible level standard setting? We endeavor to address some of them in the following paragraphs.

### i. The Radiofrequency Environment is New to Humankind

Unlike the carefully measured and evaluated ionizing natural environment of cosmic radiation and cosmic-ray produced products and a multiplicity of naturally occurring radioactive sources, the present radiofrequency environment, which had its start with Hertz, Tesla, and Marconi, is really new to mankind. The human species, and indeed all living things, has evolved in a background of ionizing radiation which varies somewhat with geographical location, altitude, and time. An approximate round figure good for many sea level locations in the Eastern United States is about 10 micro-roentgens per hour, which reduces, with one significant figure accuracy, to 0.1 rem per year. Recalling that the current permissible level for general public exposure to ionizing radiation is 0.5 rem per year, this level is only five times the natural background.

Though small electromagnetic fields are encountered in nature from distant galaxies and elsewhere, they are many orders of magnitude below even small fields generated on earth by radiofrequency generators for communications and other purposes. In time, it may turn out that is an unimportant fact. However, until the overall problem is more robustly resolved, the decision-maker, as a start, must view the manmade radiofrequency portion of the electromagnetic spectrum as a contaminant requiring careful watching in the total ecological coordinate system.

### ii. A Word on Dosimetric Units

Before proceeding further a few words on dosimetric units are in order. It is generally accepted that the most essential physical factor in evaluating radiofrequency radiation is the rate of energy absorption by the body referred to as "specific absorption rate" or SAR in basic power units of watts per unit mass of body tissue in kilograms (W/kg). This is related to first order to another physical parameter - but not in a simple way - that parameter being the radiofrequency power density impinging on the whole human body or a particular organ of the body. The power density for most practical radiological health measurement purposes, is expressed in microwatts per cm<sup>2</sup> (uW/cm<sup>2</sup>). Among the more important factors influencing absorption of radiofrequency power by the body are the frequency or frequencies of the incident radiation and the character of the body e.g. is it human or guinea pig? is it adult or child? is it male or female? what is body orientation with respect to the incident radiation?

It happens that the frequencies of maximum absorption for human beings, which peaks between 70 MHz and 100 MHz, falls in the widely employed VHF-TV and FM radio broadcast transmission bands. We shall use the conversion factor that has been used by the EPA-Office of Policy Planning and Evaluation in their options paper i.e. in the frequency band of maximum human tissue absorption (i.e. highest SAR or specific absorption rate)

$$100 \text{ microwatts per cm}^2 \text{ (uW/cm}^2\text{)} = 0.04 \text{ W/kg}$$

This number is a rounding off of one of the conversions given by Weil and Rabinowitz (8) in the previously cited EPA office of Radiation Programs report Biological Effects of Radiofrequency Radiation. The equivalence is for a 10 year old child weighing 32.2 kilograms and 1.38 meters in height i.e.

$$100 \text{ microwatts/cm}^2 = 0.035 \text{ W/kg}$$

For adults (i.e. a 70-kilogram man, 1.75 meters tall or a 61 kilogram woman, 1.61 meters in height) the equivalence is somewhat different i.e.

$$100 \text{ microwatts/cm}^2 = 0.025 \text{ W/kg}$$

Cahill, formerly of the EPA's Health Effects Research Laboratory has published (9) a power density SAR conversion for the 30-300MHZ human resonant frequency range which reduces to:

$$100 \text{ microwatts/cm}^2 = 0.02 \text{ W/kg}$$

The factor of two difference between these published conversions is not significant for practical radiological health planning purposes.

### iii Radiofrequency Exposure of Population-at-Risk

Certainly one of the decisive parameters in consideration of the problem of radiofrequency management for a local jurisdiction like ourselves, the City of New York, is the population-at-risk. The EPA has found that in fifteen major cities 99.4 percent of the population were exposed to less than 1 microwatt per  $\text{cm}^2$ , 0.3 percent to power densities from one to two microwatts per  $\text{cm}^2$ , 0.07 percent to from 5 to 10 microwatts per  $\text{cm}^2$  and 0.02 percent from 10-20 microwatts per  $\text{cm}^2$ . The median exposure given by the EPA for the cities surveyed is 0.0048 microwatts/ $\text{cm}^2$  with the conjecture that "power densities in non-urban areas would typically be several factors of 10 lower"(5).

These numbers would appear to indicate that only 0.2 percent of the population of these 15 cities experience levels in excess of 20 microwatts per  $\text{cm}^2$ . Suppose we arbitrarily simply define the "population-at-risk" as those persons potentially exposed to more than 4000 times the average median U.S. city exposure of 0.0048 microwatts/ $\text{cm}^2$  or about 20 microwatts per  $\text{cm}^2$ . This definition is not meant to imply that 20 microwatts per  $\text{cm}^2$  is a radiofrequency level that is physiologically harmful - the scientific evidence is quite the other way; it is a safe level on the basis of what we know. However, it is a power density sufficiently large that some of us in the public health regulatory sphere might well consider intensified monitoring and surveillance. Assuming that about half the U.S.

population live in urban areas (I do not know what the ratio is but this is certainly right within a factor of two!) then the population-at-risk according to our controversial definition is of the order of 100,000 men, women, and children in urban areas such as those surveyed by the EPA technical teams. At this time, this does not put radiofrequency radiation into the same major league of public health harm as smoking, asbestos, alcohol abuse, PCB's, or carcinogenic food additives. However, I suggest that it could well transcend the far better studied hazard system of the normal nuclear power fuel cycle which has generated far more apprehension.

iv. Biological Guidelines:

Anyone interested in a recapitulation of the current biological research and human epidemiology information is referred to the voluminous but regrettably inconclusive literature. Special mention should be made of the excellent EPA report edited by Elder and Cahill (4), the shorter Health Physics paper by Cahill (9), and the references contained in these publications.

In general the following observations can be made:

1. Convincingly demonstrated biological effects are observed almost exclusively in animal experiments. Human health effects that have been observed are suggestive but not unambiguously scientifically persuasive as yet.
2. Rise in body core temperature, either induced by elevated radio-frequency SAR or as part of the external environment, seems to be a parameter most importantly correlated with potentially adverse biological effects.
3. A broad group of biological changes have been reported in a variety of organisms as a result of exposure to radiofrequency radiation. These include, inter alia, alterations or departures from collective normal behavior as well as specific central nervous system disturbances; perturbations in the blood and immune systems; genetic mutations and chromosomal dislocations; reproductive and teratogenic effects; and cataractogenesis.

4. Though malignancies allegedly have been promoted in certain animal experiments with microwave radiation (10), the evidence is not adequate for either microwaves or other radiofrequencies to be found clearly guilty or acquitted of potential cancer initiation and/or promotion in humans (11).

5. The more intensively studied area of the biological effects of ionizing radiation yields clear evidence of the distinction between non-stochastic effects like cataract of the lens of the eye and stochastic non-threshold effects, the most important of which is cancer production. Even in this relatively well understood field there is material scientific disagreement as to the appropriate models of radiation damage for setting permissible levels. However, adequate data for knowing whether stochastic effects like neoplasia or general life-shortening is even relevant to the radiofrequency region of the electromagnetic spectrum is still not definitely available.

## Conclusion

Considering the totality of available scientific evidence, there is no real justification for deferring further federal action in setting exposure standards for the radiofrequency portion of the electromagnetic spectrum. The proliferation of radiofrequency sources in broadcasting, radionavigation, medical diathermy, radar and numerous other applications, which transcend national and even international boundaries, call for the federal leadership which local jurisdictions can follow. At this point in time a defensible scientific case has been made by the EPA's Office of Radiation Programs for their proposed standards. As the latitude of biological uncertainties hopefully is narrowed with research and epidemiological investigation in the future, these standards may be relaxed or made more stringent.

However, prudent public health considerations compel the adoption of the proposed standard which is not an inordinate economic obstacle to commerce and is reasonable on the basis of what we concede is incompletely known scientifically. However, the public health risk of postponing effective federal action is even more unknown and simply not acceptable.

This past March (12) the Federal Communications Commission (FCC) amended its rules to incorporate human exposure to radiofrequency radiation as a factor in determining whether an environmental impact statement is required for new facilities or facilities renewing or requesting modification of previously issued licenses. The FCC took the position that though it had neither the expertise nor the jurisdiction to develop its own radiation guidelines, it did have the expertise and authority to recognize technically sound standards generated by other qualified organizations. The standards opted for by the FCC are the ones promulgated by the American National Standards Institute (ANSI) C-95 Committee in 1982(13). As mentioned earlier the ANSI standards are a factor of ten higher than the standards proposed by EPA's Office of Radiation Programs - 1000 microwatts per cm<sup>2</sup> for frequencies of maximum tissue absorption. It should be emphasized that ANSI standards in general are for occupational guidance and not for the protection of the public including potentially exceptionally vulnerable persons e.g. children, pregnant women, and the embryos they are carrying.

To the credit of the FCC they have not elected at this time to exercise their presumed statutory stricter power to preempt health regulations of states and local jurisdictions in the sphere of non-ionizing radiation. They can amplify this credit enormously by recognizing the EPA Office of Radiation Program recommended standards for environmental areas accessible to the general public.

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