Environmental Impact
Equipment Standards
Radiation, Radio Frequency
Safety Regulations

Notice institutes an inquiry into: the effects of radio frequency radiation exposure standards on FCC authorized services; and the need for FCC adoption of interim regulation to protect workers from exposure in excess of the National standard. GN 79–144

FCC 79–364

BEFORE THE

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

In the matter of Responsibility of the Federal Communications Commission to consider biological effects of radio frequency radiation when authorizing the use of radio frequency devices. Potential effects of a reduction in the allowable level of radio frequency radiation on FCC authorized communications services and equipment.	GEN DOCKET NO. 79–144

NOTICE OF INQUIRY

(Adopted: June 7, 1979; Released: June 15, 1979)

BY THE COMMISSION: COMMISSIONER FOGARTY ABSENT.

Introduction

1. The Federal Communications Commission is initiating this Inquiry to gather information and views that will assist it in establishing the course it should pursue in fulfilling its regulatory responsibility to promote communications by radio in light of the increased concern about the biological effects of radio frequency radiation. Publicity over the irradiation of the U.S. Embassy in Moscow, Senate Hearings on Radiation, Health and Safety,[1] the

[1] Radiation Health and Safety, Hearing before Committee of Commerce, Science, and Transportation, U.S. Senate, 95 Cong. 1st Sess. (June 16, 17, 27, 28, and 29, 1977) Serial No. 95–49 at 89.

recent Canadian proposal to lower the limits of exposure of the general population to non-ionizing radiation[2] and numerous reports on radio frequency radiation appearing in the media, have all combined to increase public awareness and interest in radio frequency radiation. As a result, the Commission is receiving an increasing number of inquiries about the health effects of the facilities and equipment it authorizes. While we believe it is important to gather additional information and views to aid us in meeting our regulatory responsibilities, we want to emphasize that, so far as we are aware, the experimental data does not show that there is danger to the public at large from the thermal effects of radio frequency (RF) radiation. However, there are considerable differences of opinion about the biological effects of low level (i.e. non-thermal) and long term RF radiation. (See note 13, *supra*.)

2. Other Federal agencies with responsibility in the area of public health[3] may act in response to this increased public concern by initiating or accelerating rulemaking that may result in stricter Federal safety standards to reduce or limit the level of radio frequency radiation.[4] It is important that the Commission have at its disposal

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[2] *Installation and Safety Procedures for Radiofrequency and Microwave Devices in the Frequency Range 10 MHz–300 GHz,* RPB–SC (1978) Radiation Protection Bureau, Health and Welfare Department, Canada.

[3] The Environmental Protection Agency, (EPA) and the Occupational and Health Administration (OSHA) both have jurisdiction over various regulatory programs relating to RF radiation, including authority to set exposure standards. EPA, under the Reorganization Act No. 3, of 1970, is responsible for advising the President with respect to radiation matters directly or indirectly affecting health, including guidance of all Federal agencies in the formulation of radiation standards and the establishment and execution of programs of cooperation with States. EPA also is responsible for collecting and providing information to the public on environmental levels of radiation. *Radiation Health and Safety, supra* note 1, at 89, 1970 U.S. Code, Cong. and Admin. News 6322. OSHA, which is under the Department of Labor, has responsibility for assuring that all employees in the Nation are provided safe and healthful working conditions by their employers. 84 Stat. 1590, 29 U.S.C. Section 651, 654 (1975).

Within the Department of Health, Education and Welfare (HEW), the Bureau of Radiological Health (BRH) also has responsibilities in the area of radio frequency exposure and emission limits. The Radiation Control for Health and Safety Act of 1968, gives the Secretary of HEW the authority to carry out an electronic product radiation control program which includes emission standards for electronic products. BRH is responsible for the day to day operation in carrying out the Act's mandate for an electronic product radiation control program. *Radiation Health and Safety, supra* note 1, at 583. *Id.* at 39.

New York City has proposed to change their health code to set a maximum permissible level of 50 uW/cm2 averaged over any 0.1 hour period for all frequencies above 10 MHz. Proposed Amendment to Article 175 of the New York City Health Code to add a new Section 175.125: Microwave and Other Radiofrequency Equipment (June 22, 1978).

[4] Over 9 million dollars are spent annually by the Government to fund inhouse and contract research projects in the area of *Biological Effects of Non-ionizing Electromagnetic Radiation,* so it would be impossible to adequately summarize the experiments of other agencies here. Those interested in the scope and content of this

sufficient information to interpret the impact of any such proposed standards and to comment on each proposal.

3. This Inquiry is therefore designed to serve two purposes. We hope to gather information to: 1) assist us in determining whether it is appropriate for us to take any action under existing standards now applied by the health and safety agencies; and 2) provide documentation so that we may adequately participate in any rule making proceedings of these other agencies to ensure that any standard adopted adequately takes into account the impact of any proposal on the licensees and equipment we regulate.

A. Simplified Explanation of the Problem[5]

4. Electromagnetic radiation that may be a potential hazard to humans is either ionizing or nonionizing. The distinction between the two types of radiation is the amount of energy contained in a wavelength. As the frequency increases, the wavelength decreases and the amount of energy it contains is increased, i.e. as frequency increases, the amount of energy increases.

5. Ionization occurs when radiation displaces an electron from an atom. These electrons in turn may ionize other atoms; approximately 30 electron volts (eV) of energy are required to produce one ionization. Radiation with short wavelengths and high energy, such as x-rays and gamma rays, contains sufficient energy to cause ionization. Radiation with longer wavelengths and less energy, such as ultraviolet,[6] infrared, and radio frequencies, does not possess enough energy to produce ionization. The frequencies the Commission presently regulates (10 kHz–300 GHz) do not have sufficient energy to cause ionization and are therefore classified as non-ionizing. In this proceeding we are concerned with the biological effects of non-ionizing radiation from all radio frequencies from the top of the microwave[7] band down; that is, 300 GHz to 0.0Hz (i.e. direct current or DC).

6. The parameter most commonly used to measure the relative capacity of radio frequency (RF) radiation to produce an observable effect on biological material is the power density. The amount of RF

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effort should consult a quarterly digest of this same name prepared by the Franklin Research Center for the National Telecommunication and Information Agency, B. H. Kleinstein and E. P. Sabol (Ed.)

[5] This explanation, paragraphs 3–9, is based on a similar summary submitted by Dr. Stefan O. Schiff during the *Radiation Health and Safety* hearing. *Ibid.* note 1 at 11.

[6] The lower end of the ultraviolet band is the boundary between the frequencies that have sufficient energy to cause ionization in living matter and those which do not. Frequencies below this boundary are therefore referred to as nonionizing.

[7] The term "microwave" has historically been used as a shorthand name for radio frequency radiation in the 300 to 300,000 MHz range. Radiation in that band has wavelengths between 100 cm. and 1 mm. (e.g. *See* Webster's Seventh New Collegiate Dictionary (1969) at 539). This definition of the term has been blurred by popular usage, so that radio frequency industrial heaters are now called "microwave heaters" and fixed point-to-point communications installations operating below 300 MHz are now called "microwave" towers. These services are often actually in the "metricwave" band (i.e. in the 30 MHz to 300 MHz range).

energy absorbed depends upon the electrical properties of the tissues (dielectric constants and conductivity); in general, tissues with high water content will absorb relatively greater amount of RF energy. Theoretically, the higher the frequency, the less deeply it penetrates.

7. The means whereby RF energy produces damage is still controversial. RF with power densities of 100 mW/cm2[8] or greater is generally conceded to be capable of causing thermal damage to biological tissue although such damage may not always occur, and any damage suffered may be reversible. Experiments with animals have shown that prolonged whole body irradiation leads to hyperthermia (over-loading of the temperature regulatory system of a mammal) and possible death.[9] Data on humans are derived primarily from acute accidental exposures to microwave generating equipment and from retrospective studies of occupationally exposed personnel. Although the radiation responses of several types of mammals are similar to those of human beings, the validity of extrapolation of experimental animal data to humans is questionable, especially with respect to the quantity of radiation necessary to produce a given effect.

8. The physical organ studied in the greatest detail is the eye. It is well documented by R. L. Carpenter[10] and others that lens opacities (cataracts) may be induced in rabbits after exposure to 180 mW/cm2 or more of microwave radiation. More recent experiments with rabbits by the Bureau of Radiological Health (BRH) concludes that repeated exposure of rabbits to 10–12 mW/cm2 did not cause cataract formation.[11] Thus the exact level at which this type of radiation damage can be induced (between these two extremes), the mechanism causing the cataract formation, and the applicability of these results to humans is unknown at this time.

9. Determining thresholds for radio frequency damage is, we understand, exceedingly difficult not only because of the low energy

[8] The radio frequency (RF) power density is given in watts (W) per square meter (m2) or milliwatts (mW) per square centimeter (cm2). In this Notice we are using both milliwatts (mW) and microwatts (uW) to express the amount of RF power density being discussed. The conversion between these two units is: 1 mW = 1,000 uW (e.g. 10 mW = 10,000 uW and 100 mW = 100,000 uW).

[9] *See for example, A Technical Review of the Biological Effects of Non-Ionizing Radiation,* A Report Prepared for the Office of Science and Technology Policy by an *Ad Hoc* Working Group (May 15, 1978), Appendix C(a)(2), "Intensities", at C–14. See also, "Human Exposure to Non-Ionizing Radiant Energy - Potential Hazards and Safety Standards" S. M. Michaelson, 60 *Proceedings of the IEEE* 389 (No. 4) (April, 1972) at 407; *Microwave Bioeffects and Radiation Safety,* M. A. Stuckly (Ed.) *Transactions of the International Microwave Power Institute,* Vol. 8 (1978).

[10] "Histopathological Changes During Development of Microwave Cataracts", R. L. Carpenter *et al., Symposium on Biological Effects and Measurement of Radio Frequency/Microwaves* (February 16–18, 1977) at 351. Acute Microwave Irradiation and Cataract Formation in Rabbit and Monkeys, P. Kramer *et al., Journal of Microwave Power,* 13(3), (1978) at 239.

[11] *Chronic Low Level Exposure of Rabbits to Microwaves,* HEW (FDA) 77–8010 Vol. 1 (December 1976).

involved, but also because of the large number of experimental variables. American National Standards Institute (ANSI)[12] currently has a safety standard of 10 mW/cm2. This standard derives from studies demonstrating that 100 mW/cm2 was the lowest power density resulting in thermal damage.[13] ANSI concluded that a safety factor of 10 would be sufficient, and set their standard at 10 mW/cm². This standard was adopted by OSHA in 1971[14] and thereafter incorporated in the Commission's procedures for implementing the National Environmental Policy Act.[15] Although the enforceability of this standard

[12] ANSI is a private organization that devises safety standards to guard against and minimize injury to workers, to provide direction to employers responsible for its application and to guide regulatory bodies in the development, promulgation and enforcement of appropriate safety directives.

[13] The adequacy of the present standard is the subject of some controversy. The U.S.S.R. and other Soviet Bloc countries set a lower general population exposure standard based on non-thermal effects of RF radiation they believe have been shown by their experiments. These results have not been verified by scientists in this country. A number of American researchers, such as Sol M. Michaelson think that the 10 mW/cm2 standard affords adequate protection. Others, including some American, Soviet, and Polish researchers, have a contrary view. The U.S.S.R. has a civilian exposure standard of 1 uW/cm2 for the general population and 10 uW/cm2 for the occupation groups for unlimited exposures. The exposure limit used by the Soviets is raised to 100 uW/cm2 for occupational groups for exposure periods of up to 2 hours in a 24 hour period, and to 1 mW/cm2 for occupational groups for exposure periods of up to 20 minutes in a 24 hour period. Permissible exposure under the Soviet standard is ten times as great for radiation movable beams or antenna (i.e. up to 10 mW/cm2 for occupational exposures of less than 20 minutes in a 24 hour period). Emission and Exposure Standards for Microwave Radiation, M. H. Repachali *et al.*, Paper No. 77114, IEEC & E, '77, Session No. 11.

[14] On April 28, 1971 OSHA became effective. This Act was passed "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions" and was to be achieved in part "by building upon advances already made through employer . . . initiative for providing such conditions." 29 U.S.C. 651. OSHA section 6(a) temporarily authorized the Secretary swiftly to adopt under OSHA without notice or hearing non-mandatory standards published by nationally recognized private standard setting organizations. 29 U.S.C. 652(9), 655(a). OSHA section 6(a) provided the first step in implementing these statutory goals by directing the Secretary "as soon as practicable" to promulgate as a mandatory occupational safety and health standard without notice and hearing, "any national consensus standard . . . unless he determines that . . . promulgation . . . would not result in improved safety or health for specifically designated employees." 29 U.S.C. 655(a). In accord with this directive, the Secretary of OSHA determined that the ANSI non-ionizing Radiation standard had been adopted and promulgated under procedures qualifying them as "national consensus" standards, and promulgated the standard as safety requirements under OSHA. OSHA, "National Consensus Standards and Established Federal Standards", 36 F.R. 10522 (No. 105).

[15] *See, e.g., In re: Application of Far East Broadcasting Inc., Memorandum Opinion and Order,* FCC 77-527, 65 F.C.C. 2d 496 (1977) at para. 18; *Establishment of Domestic Communications-Satellite Facilities by Non-Government Entities,* 38 F.C.C. 2d 665 (1972); and *Implementation of the National Environmental Policy Act of 1969,* 49 F.C.C. 2d 1313 (1974), especially note 12, at 1327 and Appendix 3, at 1366.

has been questioned,[16] the substantive base on which the 10 mW/cm²level was selected has not been legally questioned or criticized.

The Commission's Statutory Obligations

11. As the agency responsible for promoting safety of life and property through the use of wire and radio communications, and making available, as far as possible the use of radio in the public interest, the FCC has long been concerned with biological effects of RF radiation emitted by radio frequency devices.[17] The Commission has also been working with other agencies having jurisdiction in the biological effects area to optimize the effectiveness of Government-wide efforts in this area. Since 1969 the Commission has worked under a cooperative arrangement with the Bureau of Radiological Health (BRH), sharing facilities (e.g. the use of our Laboratory Division's facilities by BRH to check consumer microwave ovens for compliance with their emission standard) and information in the field of microwave oven performance standards and testings. The Commission also has an official observer to the Electromagnetic Radiation Management Advisory Council, which advises the National Telecommunications and Information Administration in the area of electromagnetic radiation policy. The Commission also has representation on several interagency working groups formed to facilitate coordination of government activities and the exchange of information in the area of radiation.

12. The Commission's interest in the biological effects of non-ionizing radiation flows from two basic areas of statutory responsibility. The Commission has licensed the millions of non-government transmitters now in use throughout the Nation and is granting additional licenses at an accelerating rate. In addition, under Parts 15 and 18 of our Rules we authorize microwave ovens, industrial heaters and many other types of unintentional radiating equipment.[18] The Commission's actions as a Federal Government regulatory agency must be consistent with the dictates of our organic statute and the National Environmental Policy Act (NEPA).[19] The Communications Act requires us to promote the use of radio communications service ". . . for the purpose of promoting safety of life . . ." and to exercise

[16] The OSHA standard was ruled unenforceable by an OSHA administrative law judge and the decision was never appealed. *See, In re: Swimline Corp.* OSHRC Docket No. 12715, Dec. 31, 1975; CCH Employment Safety and Health Guide Para. 20, 379, at 24, 308–24, 311, (February 17, 1976).

[17] *See* note 15, *supra.*

[18] 47 C.F.R. 18.1, *et seq.* This type of equipment, grouped under the category of "Industrial, Scientific and Medical Equipment," may be operated without an individual license after it receives FCC certification that it complies with our technical and equipment approval requirement. This section of the rules is being revised in a current rulemaking proceeding, Docket No. 20718, *Second Notice of Proposed Rulemaking*, 44 F.R. 9771 (February 15, 1979).

[19] National Environmental Policy Act, 83 Stat. 852, 42 U.S.C. §4321–4347 (1977).

our power ". . . as the public convenience, interest, or necessity requires."[20] If another agency of the U.S. Government, such as the Environmental Protection Agency (EPA) or Occupational Safety and Health Administration (OSHA), promulgates non-ionizing exposure standards that we thought might be exceeded by an authorized facility, it would be incumbent upon the Commission to consider that agency's determination in our licensing or certification requirements.

13. Moreover, in addition to these implied responsibilities under the "public interest" standard, the Commission, as a Federal Agency, has certain explicit responsibilities under NEPA. Section 102(2)(c) of that statute requires all Federal agencies to consult with and obtain the comments of expert Federal agencies before taking any major action significantly affecting the quality of the human environment. EPA and OSHA (as well as BRH) are the regulatory agencies in the biological effects area. If a contemplated Commission action might create a situation where the resulting RF radiation levels would exceed an exposure guideline or standard by one of these agencies, we would be required to consult the concerned agency before acting.

14. Following such consultation, the Commission may have to prepare an environmental impact statement that would become part of the record on which the Commission bases its decision. The Commission's present policy is to require licensees and manufacturers of authorized equipment to observe applicable exposure safety standards.[21]

15. The Commission, as well as the affected industries, cannot ignore the possibility that one of the health agencies may promulgate stricter standards for radio frequency energy emission[22] or for RF radiation exposure where excessive power densities could pose a potential biological hazard to people. In that event, the Commission must consider those new standards with the possible result that some

[20] The Communications Act of 1934, as amended, 48 Stat. 1064, 1082, 47 U.S.C. Sections 151 and 303 (1978).

[21] *See Report and Order in Docket No. 19555, Implementation of the National Environmental Policy Act* of 1969, FCC 74-1042, 49 F.C.C. 2d 1313 (1974), especially note 12 and Appendix 3. Although the OSHA standard may, subsequent to the adoption of this *Report & Order*, in Docket No. 19555, have been ruled unenforceable because it was written in permissive rather than mandatory language, the validity or reasonableness of the standard adopted by OSHA has never been challenged. (*See* note 16, *supra.*)

[22] An emission standard is a standard which would set a limit or maximum on the amount of RF energy that any particular type of device could radiate. The Bureau of Radiological Health has jurisdiction to establish this type of safety standard. To date, the only device for which RF (non-ionizing) radiation standards have been set is the "microwave" oven. Exposure standards are standards which would set a limit or maximum on the amount of RF energy that people would be allowed to be exposed to from all sources in different environments. EPA has jurisdiction to set exposure standard to protect the health of the general public, but has not done so yet. OSHA has jurisdiction to set exposure standards to protect the health of workers.

of these entities will be required to adjust their operations or equipment accordingly.

16. The issue of exposure standards for RF radiation is also related to the Commission's statutory obligation to ". . . make available, so far as possible . . . a rapid efficient . . . communication service . . . at reasonable charges . . . and to prevent interference between stations . . . .[23] As a result of these responsibilities, the Commission must consider the effect of any particular proposed standard on radio services that it licenses and the equipment it approves. We must be certain that these services are not *unnecessarily* impaired by overly restrictive standards. This is not to imply that the Commission would propose to compromise the health and safety of the public, including communications workers. It means simply that the Commission wishes to ensure that the need for any stricter standard perceived by the policy makers in OSHA and EPA justifies the cost it may impose on the public (*e.g.*, the cost of purchasing new equipment or the effect of reduced radio communications system services).

17. A balance must be achieved between serving the public interest by fulfilling its needs for communications services and adequately protecting the populace against potentially adverse biological effects that may be attributable to excessive RF radiation. Thus, prior to any further action by these agencies, the Commission could make available to them information reflecting the cost of different standards to the communications industry, to communications service and to users of other radio frequency devices. This cost may be in terms of greater expense to provide a radio service or a reduction in the quality of the service. It is possible for an emission or exposure standard to be set at such a low level that some radio services would not be operationally feasible irrespective of willingness to invest in more expensive equipment.

18. The determination of the cost to RF energy users resulting from different standards is a significant undertaking. The Commission needs a definition of the various electromagnetic environments that it is currently creating by authorizing stations and equipment.[24] If we are to have information that would be helpful to the health agencies, this must be followed by economic analyses to ascertain the cost of a change in an environment to comply with a particular standard. This environmental information should be acquired not only for individual RF emitters, but also for combinations of emitters that may be operating in a single geographic area. Some of the information can be derived by analysis, but most of it will require monitoring with test instruments. Such measurements are complex, time consuming, and expensive.

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[23] 48 Stat. 1064, 1082, 47 U.S.C. Sections 151 and 303 (1978).

[24] *See, Notice of Inquiry on Radio Frequency Interference to Electronic Equipment*, FCC 78-801, General Docket No. 78-369, 47 F.R. 56062 (November 30, 1978).

19. To act to ensure that a health and safety standard-setting agency has adequate information on the effect of a standard on manufacturers of RF devices, FCC licensees, and radio communications services to the public, the Commission must have statistical information and studies that can be provided, at least in part, by segments of the industry and the public. This Notice invites private industry and the general public to provide us with appropriate information. The questions listed below are examples of the kinds of data we think relevant for the Commission to be able to assess the effects of various particular standards on the RF energy users and devices we authorize. On the basis of the response to this Inquiry and other information, the Commission will formulate its position on any further guidelines or standards that may be proposed by the agencies directly responsible for setting RF radiation health standards.

20. In addition, on the basis of information responsive to this NOI, it may be appropriate to propose regulations to require those operating under our authority to meet the current consensus standard. For example, until OSHA adopts regulations to implement its current standard, the Commission might adopt a rule requiring licensees to post warning signs or in some other way notify the public and workers that they are entering a hazardous area, and to take reasonable measures to protect against potentially dangerous radiation. The Commission's position is that it has neither the responsibility nor the authority to establish health and safety radiation standards. It does, however, have the responsibility and the authority to consider the guidelines or standards issued by other Government agencies such as the EPA, BRH or OSHA. *See Report and Order in Docket No. 19555*, 49 F.C.C. 2d 1313 (1974).

Current Data on RF Radiation Levels

21. In October of 1975 the EPA began measuring the level of RF radiation from all sources at 373 sites in twelve cities. Values of power densities measured typically ranged from .0001 to 10 uW/cm^2.[25] The data showed that FM radio and VHF television transmitters are the most significant environmental sources of RF radiation, but these levels are relatively low compared to the ANSI[26] and OSHA exposure guide of 10 mW/cm^2.[27] It should be noted that these measurements

[25] The "power density" is a unit used to measure how much RF energy is reaching the organism being irradiated. Power densities above a critical level might indicate a potentially harmful situation. See, paragraph 7 and note 9, *supra*. *Population Exposure to VHF and UHF Radiation in the United States*, ORP/EAD 78-5 (June 1978), R.A. Tell and E.D. Mantiply at iv; *Radiofrequency Radiation Levels and Population Exposure in Urban Areas of the Eastern United States*, EPA-520/2-77-008 (May 1978), T. A. Athey *et al.*, at 5.

[26] ANSI, Safety Levels of Electromagnetic Radiation With Respect to Personnel, ANSI, C95.1-1974, IEEE, New York, 1974. ANSI currently has out for industry comment a proposal to lower its RF radiation standard to 1 mW/cm^2.

were made to determine the radiation environment to which the general population is exposed. EPA stated in their Technical Report, ORP/EAD–77, Non-ionizing Radiation Levels and Population Exposure in Urban Areas of the Eastern United States, that:

> The measurement sites were selected primarily on the basis of population distribution, i.e. sites which cover the most heavily populated areas. Additional criteria were the geographic area to be covered and the distribution of source of radiofrequency radiation.[28]

22. EPA reported on radiation intensities at Mt. Wilson, California in a Technical Note issued in April of 1977.[29] The area surveyed was a multistation broadcast installation (27 broadcast stations—12 FM radio and 15 television) and represented what EPA thought might be the most dense electromagnetic environment for public exposure in the United States. Using a variety of test instruments to cross check results, the investigators found maximum radiation levels at ground level to be in the range of 1–7 mW/cm^2, but the report stated that "the higher end of this range will be encountered near conducting objects and usually encompass only small areas of concern. Levels near 1 mW/cm^{2}may be more common and are likely to be present near the base of FM broadcast towers."

23. It is clear from these data that the EPA results thus showed radiation levels below the ANSI exposure standard of 10 mW/cm^{2}but above the general population long term exposure standards of 1 mW/cm^{2}in force or under consideration by several countries including Canada and Sweden. Although these results cannot be extrapolated to urban environments generally,[30] they do suggest that multistation broadcast installations may be special problem areas if a general population exposure standard of less than 10 mW/cm^{2}is adopted.

24. In contrast to the general population data, EPA issued a Technical Note, ORP/EAD–76–2, *A Measurement of R. F. Field Intensities in the Immediate Vicinity of FM Broadcast Station Antenna*, which states:

> In a recent study of broadcast radiation levels, measured values of the radiation intensity of an FM broadcast tower were obtained. The measured values could lead to exposures in excess of established standards and suggest the need for corrective

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[27] OSHA, "National Consensus Standards and Established Federal Standards", 36 Federal Register, 10522 (No. 105), (1071). Note: The OSHA standard was ruled unenforceable by an OSHA administrative law judge and the decision was never appealed. *See, In re: Swimline Corp.* OSHRC Docket No. 12715, Dec. 31, 1975; CCH Employment Safety and Health Guide Para. 20,379, at 24,308–24,311, (February 17, 1976).

[28] *Radiofrequency Radiation Levels, supra*, note 25, at 4.

[29] *An Investigation of Broadcast Intensities at Mt. Wilson, California*, ORP/EAD 77–2 (April 1977).

[30] *See Population Exposure to VHF and UHF Broadcast Radiation in the United States*, ORP/EAD 78–5 (June 1978), U.S. Environmental Protection Agency which reports, based on 11,000 measurements in 12 large cities, that the median general population level in this country is approximately 0.005 uW/cm^2.

> action to protect *operating and maintenance personnel* who must climb these towers (emphasis added).[31]

The values EPA measured on the tower were in excess of 180 mW/cm², the maximum value their instrument could measure. It is generally agreed in the bio-effects community that power densities that exceed 100 mW/cm²will cause thermal reactions in humans and if exposure is prolonged, thermal damage may occur.[32] This station transmitted at a level of 105 kilowatts on a continuous basis using a circularly polarized antenna. At ground level, EPA found power densities of 1.9 mW/cm², which is consistent with the results of the other Mt. Wilson survey discussed above.

25. These EPA data suggest that, in addition to potential problems that might be created for the user of equipment we authorize by the adoption of an exposure standard below the existing ANSI guideline (i.e. below 10 mW/cm²), by EPA or OSHA, there may be an immediate problem of occupational safety posed by these emitting devices.

> It is clear that exposure intensities on FM broadcast towers can exceed the OSHA recommended safety level by a factor of 10 . . . . While the results apply strictly to FM broadcast antennas, they raise very serious questions about the field intensities of television broadcast towers where the antenna input power can be several orders of magnitude greater . . . and (the) fields on AM antenna towers may also be of concern . . . . The most effective method of controlling excessive exposure would be to turn off or drastically limit the power fed to the antenna while the necessary work is done. This would probably require a rule making procedure by the FCC or promulgation of specific work procedures for broadcast towers by OSHA.[33]

26. National Institute for Occupational Safety and Health (NIOSH) has made field strength measurements near some of the Industrial Scientific and Medical (ISM) equipment the Commission approves. The conclusions of one report on these measurements states:

> Measurements of RF (15 to 40.68 MHz) electric and magnetic-field-strength exposures generated by power sources having application in the textile, lumber and plastics industries are presented. Measurements were taken for near-field conditions (at distances less than one meter from the sources) where operating personnel were located. The measured electric and magnetic-field-strength exposures showed no clear dependence on the RF power output. The field-strength exposures were compared to the ANSI §C95.1–1974 RF/Microwave Personnel Exposure Standard radiation exposure guides. This comparison revealed that 90% of the sources measured exceeded the electric-field-strength guide of 200 V/m and 80% of the sources exceeded the magnetic-field-strength guide of 0.5 A/m.[34] These guides were exceeded by factors as high as five for the electric field and by as high as twenty-five for the magnetic field. Based on the information contained in the ANSI

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[31] *A Measurement of R.F. Field Intensities in the Immediate Vicinity of FM Broadcast Station Antenna*, ORP/EAD 76–2, R.A. Tell (January 1976), at 1.

[32] *See* note 9 *supra*.

[33] *A Measurement of R. F. Field Intensities, supra*, note 32, at 6–7.

[34] Two hundred V/m or 0.5 A/m is approximately equal to 10 mW/cm²in the far field. In this type of near field situation an additional problem exists. Because of the interdistortion of the near field radiation pattern, more or less energy may be absorbed by the object than a simple field strength measurement would indicate.

C95.1–1974 standard at least 80% of these RF power sources represent a potential personnel exposure hazard.[35]

27. A report prepared by a private engineering firm (with the technical assistance of the National Bureau of Standards) presents measurement data of power densities on the John Hancock Center television antenna towers.[36] Two sets of measurements were taken—one in July, 1975 and the second in May, 1976. The first measurement revealed several locations on the towers that exceeded the ANTI standard of 10 mW/cm². The report explained that these high energy density areas occurred near pieces of ungrounded metallic parts of the tower. The intensity of these "hot spots" could be reduced by grounding these tower parts, but this procedure did not completely eliminate the problem. The report recommended a set of voluntary standards that could be followed when maintenance was being performed on the towers.

28. Experiments have been conducted by Mr. Q. Balzano of Motorola, Inc. into "the energy deposition of portable radio operations".[37] The tests investigated radio frequency energy deposition in simulated human operators exposed to electromagnetic fields generated by portable radio transceivers (e.g. a "walkie-talkie"). These tests were conducted at 150, 450 and 840 MHz. Transmitter power in all cases was six watts. The results of these experiments by Mr. Balzano indicated that the maximum power deposition at 840 MHz did not occur immediately below the bone-brain interface, as theoretical calculations predict, but occurred, instead, deeper in the cerebral cortex. These "absorption peaks" were believed to be caused by a focusing of the electromagnetic energy by the curvature of the frontal lobe of the skull. An absorption peak was also located at the surface of the eye. According to Motorola the temperature increase associated with these "absorption peaks" is so small that no thermal damage can be caused by normal use of the radio. In general, Motorola concludes for all frequencies at which tests were conducted that portable hand-held transceivers are not biologically hazardous when operated according to recommended procedures and for short time periods.

29. Nevertheless, the results of these tests exemplify shortcomings of present theoretical methods for analyzing the effects of non-ionizing radiation. Predicting radiation levels close to the source is a complex

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[35] *Measurement of Electric and Magnetic Field Strengths From Industrial Radiofrequency (15–40.68 MHz) Power Sources,* D. L. Conover, *et al.,* Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, Ohio, 45226 (197—).

[36] *Engineering Report to the Chicago Broadcast Antenna Committee* on Power Density Measurements, Smith and Postenko, 2000 N Street, N.W., Washington, D.C. 20036 (December 1977).

[37] Motorola, Inc. is a large manufacturer of mobile radio equipment. *See,* "A Comparison Between the Energy Deposition in Portable Radio Operators at 900 MHz and 450 MHz," Q. Balzano et al, *Record of the Twenty-Eighth Annual Conference of the IEEE Vehicular Technology Group,* (March 22–24, 1978, Denver, Colo.)

problem where the observed results consistently disagree with the predicted results. Greater refinement of analytical tools is thus a major need. In the interim, probably the only way to accurately quantify the levels of exposure created by particular situations is direct measurement.

An Assessment of the Current Situation

30. These findings in the 900 MHz region[38] are especially significant because of the importance of the 900 MHz band to future communications systems. The Commission is currently granting licenses in two new mobile communications services (trunked and conventional private mobile radio and the public mobile telephone systems). These two services are expected to expand over the next ten years to include several million transmitters at the cost of over a billion dollars to private industry and the consumer.

31. In addition, the Commission currently has pending before it a proposal for several new 900 MHz services including an electric utility load management system that envisions a link eventually reaching every home, three new voice paging bands supporting half a million new paging users, a new two way digital paging service starting off with 25,000 hand held units, and a new personal (non-business) radio service expected to attract at least 1 million and possibly 10 million users. If implemented, these new communications systems will require investments on the order of several billion dollars by the American public. If exposure standards ultimately take into account the type of frequency sensitive absorption patterns observed in the Balzano experiments, equipment configuration, transmitter output levels, or even the overall viability of some of these new or proposed systems might be affected.

32. This Inquiry will serve to provide the Commission with information needed to participate effectively in other agency proceedings so that the effects of any changed standards on the subjects of our jurisdiction could be made known and considered by those agencies in reaching a decision as to any new standards, and to supply that information to other agencies with regulatory responsibilities in this health and safety area.

33. We emphasize that the information we request below is not for the purpose of our promulgating radio frequency radiation health and safety standards. That is a function of the health and safety agencies. However, on the basis of information provided, it may be desirable for the Commission to consider the need for applying to the subjects of its jurisdiction one of the existing safety criteria, such as the 10 mW/cm^2short term exposure limit used by ANSI and OSHA, until OSHA has adopted regulation implementing its standard by specifying

[38] The "900 MHz" region is a shorthand term for the 806-947 MHz band, and thus includes Mr. Balzano's work at 840 MHz.

what procedures and practices should be followed by employers to protect their employees from radiation levels considered by OSHA to be harmful (i.e. 10 mW/cm²at present).

Matters to be Addressed in this Inquiry

34. The subjects listed below are not exhaustive. They merely typify the Commission's areas of concern. Information not directly responsive yet relevant to the general subject matter of the Inquiry is welcome and invited. To facilitate staff review, each response should clearly state the precise topic or question being addressed.

A. Factual Information Needed

35. Please provide information on the following:

1. Information concerning the typical near-field, and in the case of very powerful radio stations, the far-field power densities at specified distances from the following kinds of stations or devices:
   (a) Hand-held transmitters operating from 25 to 900 MHz with minimum to maximum powers.
   (b) Land mobile transmitting antennas with gains from 0 to 10 dB operating from 25 to 900 MHz with powers of 200 mW to 400 watts antenna input and mounted on vehicles or towers.
   (c) Point to point relay transmitting antennas with gains from 20 to 50 dB operating below 300 GHz with typical and maximum radiated powers.
   (d) AM radio broadcast antennas with typical and maximum powers.
   (e) FM radio broadcast antennas with typical and maximum powers.
   (f) Television broadcast antennas with typical and maximum powers.
   (g) Industrial, scientific, and medical units at typical maximum power levels now in use.
   (h) Radar transmitters (marine, police, airport, military, etc.) with typical and maximum powers.
   (i) Any other sources of non-ionizing electromagnetic radiation on which experimental or empirical data is available.
2. In discussing question 1 above, consideration should be given to how the human body close to a transmitting antenna or ISM equipment may distort the near-field radiation pattern causing changes in the Voltage Standing Wave Ratio and, if so, the effects of such changes on the absorption of the electromagnetic radiation by that human body.
3. Statistical studies relating to morbidity of electronic equipment users particularly long-term users of hand held portables, marine radio and industrial heating units. Incidence of

cataracts would be of particular interest as compared to that in the general population.

B. Questions

36. Please provide answers and supporting data to the following questions:

4. Describe the applicability (or lack thereof) of the standard adopted for microwave ovens (1 mW/cm²at five centimeters) to other radio equipment with appropriate adjustment for frequency and manner of use. What studies support your conclusion?
5. Describe the pros or cons of adopting the 10 mW/cm²ANSI guideline if it were adopted as an interim standard pending completion of definitive studies establishing safe radiation levels?
6. Should measurements of field intensities within the area of FCC authorized facilities be made? By whom?"
7. Should the Commission do a study to determine what services use FM & TV towers for mounting their equipment (e.g. point-to-point transmitters, CATV receivers and Land Mobile transceiver antennas)?
8. Should measurements of field intensities on all FM & TV towers be required? If so, how, when, where, how often and by whom? If field intensity measurements are required, how would the ability of private industry to perform the required measurements be affected by the current availability of measurement equipment?
9. Should the Commission establish procedures for protecting personnel when working on antenna towers?
10. Are there any procedures used by personnel in the operation, testing and maintenance of transmitting equipment that require personnel to be exposed to high field intensities? If so, what measures can be employed to reduce or eliminate such exposure?
11. Can prediction methods be employed to determine absolute power density at locations of interest and would such methods produce sufficiently reliable results? If so, please describe the method and explain how verification was accomplished.
12. If measurement of power densities is necessary, what problem does this pose for licensees?
13. What possible techniques can be employed at broadcasting stations and other RF emitters to limit their contribution to cumulative power densities that may be deemed to constitute a hazard?
14. If the cumulative power density observed at a particular location is above 10 mW/cm², how can contributions from

individual sources be determined and how should responsibility from reducing contributions be shared?

15. If prediction methods may be employed in determining power densities, what difficulties can be anticipated in determining radiation from antennas at angles toward the base of a tower and up to horizontal?
16. Describe how any standard adopted should differ for the various frequency ranges and state why.
17. If there are places frequented by people where the radiation exceeds 10 mW/cm^2, what action should be taken to reduce this level? Should grants of all radio applications which would tend to raise this level cease? Should a determination be made that a licensee or some radiation source must reduce or terminate its operation, how should such a determination be made?
18. Reduction in output power could have a deleterious economic effect on several of the radio services. It could also cause a reduction in service to the public. Does a health risk, no matter how small, outweigh economic loss or service cutbacks, no matter how large? By how much? Quantify your contention.
19. Does a health risk to animals have to be considered? What if the species being threatened is on the endangered species list?
20. The radiation level in the main beam of a microwave antenna will probably be above the level considered safe (10 mW/cm^2). Should this level be permitted if the chance of a human climbing the antenna structure is small? Should the Commission require fences around such structures?
21. Should licensees be required to warn maintenance people of the radiation hazards involved at each radio site or to post warnings if levels are shown to be above 10 mW/cm^2? Some other specific value? What value?
22. Discuss in detail the impact on Commission licensees in the various radio services we regulate (e.g. broadcasting, mobile, fixed, other) that the various standards mentioned would have (50 uW/cm^2, 1 mW/cm^2, and 10 mW/cm^2), continuous or short-term occupational or general public.
23. What techniques can be employed by each of the Commission's services to limit their contribution to cumulative power densities? What are the costs of employing these methods?
24. What measures can be employed to reduce exposure to high densities, or to reduce any ill effects?

37. Comment in response to this *Notice of Inquiry* will be used to evaluate the issues we have discussed above. It will also assist us to develop comments and information for submission to other Govern-

ment agencies developing standards in this area. Your comments must clearly show this docket number "General Docket No. 79-144" on the first page. Please label each part of your responses to identify clearly the subject you are addressing. If you have general comments which are not on a specific matter listed above, simply label these comments with the Docket number. Section 1.419 of the Rules requires that you file the original and five copies of your comments. If you want each Commissioner to receive a personal copy of your comments, you should include 6 additional copies. The FCC will fully consider all comments, even if only the original is filed. Send your comments to: Secretary, Federal Communications Commission, Washington, D.C. 20554. All comments will be available for public inspection in the FCC Dockets Reference Room, Room 239, 1919 M Street, N.W. Washington, D.C. The FCC is open weekdays between 8:00 and 5:30 pm.

38. FOR FURTHER INFORMATION CONTACT: Will McGibbon, Office of Science and Technology, (202) 632-7060.

39. Sections 4(i), 302, 303(f), (g), (r) and (s), 330, and 403 of the Communications Act of 1934 as amended gives the FCC the authority to conduct this Inquiry. We urge medical and engineering groups, manufacturers, Commission licensees, other Government agencies and all other interested parties to participate in this investigation. You may participate by sending information and opinions that are relevant to the subjects of this Inquiry. Comments must be received by December 15, 1979. You can reply to these comments by following the same procedure for preparing and sending Comments. Replies to comments must be received by March 15, 1980. Accordingly, the FCC ORDERS that this Inquiry is INSTITUTED.

FEDERAL COMMUNICATIONS COMMISSION,
WILLIAM J. TRICARICO, *Secretary.*