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MOUNTAIN BELL
IDAHO FALLS, IDAHO

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I. SUMMARY

On March ll, l987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Communication Workers of America, Washington, D.C., requesting a health hazard evaluation of the microwave toll and long distance equipment (including microwave repeaters) at Mountain Bell, in Idaho Falls, Idaho. The request was concerned with the leakage of radiofrequency/microwave (RF/MW) radiation from long distance telephone relay equipment.

Measurements of the RF/MW radiation were made on June l6, l987 around the transmitters, the associated waveguide runs, the transmitting and receiving dishes (antennas) and at the East Butte relay station. All measurements were of electric (E) field strength, expressed as volts squared per meter squared (V^2/M^2), and power density measurements expressed as microwatts per square centimeter (uW/cm^2).

Measurements were made in the Mountain Bell central transmitting station located in Idaho Falls, Idaho and at the East Butte relay station located about 40 miles east of Idaho Falls. Nine transmitter/receivers and one paging system were evaluated in the central transmitting station. All were less than the detection limits of l0 microwatts/centimeter squared for power density and 500 V^2/M^2 for the electric E field measurements. An identical number (9) of transmitter/receivers and one paging system were evaluated at the East Butte relay station. All E field measurements were below the detection limits of 500 V^2/M^2. One detectible reading was found with the power density probe touching the heat sink inside the transmitter. At two inches from the heat sink, levels were non detectable. The measurement found with the probe touching the heat sink was 0.018 milliwatts per square centimeter (mW/cm^2). The current ACGIH TLV is l0 mW/cm^2.

The medical evaluation consisted of interviews with 8 current and one former employee. Five employees worked with microwaves for an average of 8.4 years (range 4 years to 23 years). The other 3 workers may have had occasional exposure to microwave transmitting equipment.None of these employees reported having a medical condition which they believed was work related. All current workers that were interviewed denied having specific symptoms. None of these workers had been diagnosed with cataract, which has been associated with microwave exposure. The retired worker who was interviewed complained of neurologic symptoms, some of which have been reported previously in workers exposed to microwave radiation. Medical evaluation of this worker's symptoms did not identify a cause.

Based on the measurements for E-fields and power density, employee interviews and evaluation of the two work sites, the investigators concluded that a health hazard from microwave radiation did not exist at the time of this evaluation.

KEYWORDS: SIC (4811) Telephone communication (wire or radio) radiofrequency, microwave, telephone relay station, nonionizing radiation

II. INTRODUCTION

On March ll, l987, NIOSH received a request from the Communication Workers of America, l925 K Street, N.W. Washington, D.C. In the request, the employee representative asked for an evaluation of the testing of microwave toll and long distance equipment (including microwave repeaters). The evaluation was conducted on June l6, l987 by measuring the RF/MW radiation from the transmitters under actual use conditions.

III. BACKGROUND

This Mountain Bell facility is part of a grid of microwave telephone relay stations. Through the stations, long distance (toll calls) telephone calls are transmitted from point to point by frequency modulated electromagnetic radiation. The relay antennas are usually located atop buildings or mountains since it is line of sight transmission.

The transmitter/receiver frequency is either 6 or ll GHz and the output power of the generators is either 0.5, l.0, or 3.2 watts. Incoming calls are received by the receiving antennas, sorted and routed through the waveguide systems, amplified and transmitted via the transmitting antenna to the next relay station.

IV. METHODS

The transmitting equipment of interest to this request is located at 299 C. Street, Idaho Falls, Idaho and at a location referred to as East Butte Relay station which is about 30 miles east of Idaho Falls. Measurements for RF/MW radiation were made on all the transmitting, receiving and paging system equipment at both locations.

A Holiday Model HI-3002 meter equipped with the electric field probe was used to measure electric field strength. The meter reads out in volts squared per meter squared (V^2/M^2). The minimum detectable radiation limit is approximately 500 V^2/M^2. Power density measurements were made using instrumentation owned and operated by an engineer from Bell Laboratories, Murray Hill, New Jersey. The instrument used was the Narda 8316 series with an 8321 probe.

Only technical personnel are present in the transmitter areas. Employees position with respect to the microwave sources varies. All measurements were made at a distance of 5 cm or at the closest possible distance. Any worker exposure would be far less than that measured because workers are located much farther from the source than the points where measurements were taken. This was not a problem during this survey since no E-field strength exposures were found and only one slight reading was observed with the power density probe. This reading was 0.0l8 mW/cm^2 and was well below the ACGIH TLV of l0 mW/cm^2.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH recommended exposure limits (REL's), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH REL's and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH REL's and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH REL's, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Presently, there is no federal radiation protection standard for occupational exposure to RF radiation at frequencies greater than 100,000 MHz [1]. However, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended threshold limit values (TLVs) for electromagnetic energy with frequencies from 10 KHz to 300 GHz [2]. In the frequency range from 1 to 300 GHz, ACGIH recommends that the E-field strength be kept below 3.77×10^4 V^2/M^2 and that the power density be kept below 10 mW/cm^2 or 10,000 uW/cm^2. These TLVs were based upon the belief that the primary physiological effect of exposure to electromagnetic energy (in the 10 KHz to 300 GHz frequnecy range) is thermal, although nonthermal effects were also considered. The absorption of RF energy into the human body appears to be highest in the frequency range of 3 to 300 MHz.

B. Biological Effects of Radiofrequency Radiation

Radiofrequency (RF) radiation is that portion of the nonionizing electromagnetic spectrum from approximately 0.01 - 300,000 MHz. The principal biological effect of RF radiation is heating of tissues.[3] The extent of heating is primarily dependent on the water content of the tissue and the intensity and duration of the RF energy. Most parts of the body have sufficient blood supply to dissipate heat resulting from absorption of RF radiation. however, the eye (especially the lens) is particularly vulnerable to heating since it lacks an efficient blood supply to dissipate heat. Consequently, damage may occur to the transparent cells around the lens resulting in the formation of cataracts.[4] Other tissues which display high sensitivity to heat include the testes and brain (specifically the reticular formation of the brain stem and hypothalamus).[5]

In addition to thermal effects, absorption of RF radiation may results in nonthermal effects which may occur without a measurable increase in tissue or body temperature, and at RF field strengths lower than those necessary to cause thermal effects.[6] Nonthermal effects have been widely reported in the Soviet and Eastern European literature. Effects which have been described but poorly substantiated include those on the nervous system (headache, fatigue, irritability, altered memory function, altered EEG recordings, and sleep disturbances), and effects on the blood (leukocytosis, thrombocytopenia). Also reported are sweating, hypotension, dyspnea, chest pain, cardiac arrhythmias, and changes in blood levels of enzymes, hormones, and immunity factors. These studies, however, have been severely critizied for problems with subjective measurements and for lack of appropriate experimental design and statistical analysis of data.

Experimental and observational data from animal and human studies have not shown carcinogenic or mutagenic effects resulting from exposure to RF radiation. Human studies indicate that no teratogenic effects occur, but are inconclusive as to whether reproductive effects occur. Animal studies have shown some reproductive and teratogenic effects, but the evidence is often contradictory. It appears that the

reproductive effects in animals correlate well with RF-induced heat production. NIOSH will soon complete a criteria document which will review in detail the potential health hazards of RF radiation.

VI. RESULTS

A. Environmental

Radiation measurements were made on nine transmitter/receivers and one paging system at the two locations. Neither leakage nor exposure was found at the two stations located in Idaho Falls and East Butte. The only reading found was 0.0l8 mW/cm^2 for the power density at the East Butte Relay station. This measurement was taken with the measuring probe touching the heat sink on the back side of the unit. At two inches from the heat sink levels were below detection limits (l0 micro watts/cm^2). There were no significant exposures during this survey. Results of all equipment monitored at the central transmitting and Butte relay stations are presented in Tables l and 2, respectively.

B. Medical

The medical evaluation consisted of interviews with 8 current and one former employee. Five employees worked with microwaves for an average of 8.4 years (range 4 years to 23 years). The other 3 workers may

have had occasional exposure to microwave transmitting equipment. None of these employees reported having a medical condition which they believed was work related. All current workers that were interviewed denied having specific symptoms. None of these workers had been diagnosed with cataract, which has been associated with microwave exposure. The retired worker who was interviewed complained of neurologic symptoms, some of which have been reported previously in workers exposed to microwave radiation. Medical evaluation of this worker's symptoms did not identify a cause. This worker has not worked around the transmitter/receivers for some time and his symptoms still persist. His symptoms are exacerbated whenever he feels he is exposed to microwaves. It cannot be determined if his condition is work related.

VII. CONCLUSIONS

There were no significant exposures to RF/MW radiation during this survey. There have been very little modifications in this machinery in several years and it would be safe to assume that hazardous exposures are very unlikely to have ever occurred around the current equipment.

VIII. RECOMMENDATIONS

There is no corrective action needed since all measurements were below detection limits with the exception of one and it was well within safe limits.

IX. REFERENCES

1. Occupational Safety and Health Administration. OSHA safety and health standards, 29 CFR 1910.97. Occupational Safety and Health Administration, revised March 1983

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5. International Labour Office Encyclopedia of Occupational Health and Safety. Volume 2. 3rd Revised Edition. L. Parmeggiani editor, pp. 1983-78, 1973.

6. National Institute for Occupational Safety and Health. Current intelligence bulletin 33 - radiofrequency (RF) sealers and heaters: potential health hazards and their prevention. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1979. (DHHS (NIOSH) Publication no. 80-107).

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Mountain Bell
2. U.S. Department of Labor/OSHA - Region VIII
3. NIOSH - Denver Region
4. Idaho State Department of Health

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Radiofrequency Measurements at Central Transmitting Station
at Mountain Bell
in Idaho Falls, Idaho
June 16, 1987

Bay No.	Transmitter Receiver I.D.	Power Output (W)	Nominal Frequency (GHz)	E-Field (V^2/M^2)	Power Density (mW/Cm^2)
219.3NT	Western Electric TL-1	0.5	11	-	ND
219.4RR	Western Electric TN-1	3.2	11	-	ND
219.6NT	Western Electric TL-1	1.0	11	-	ND
220.2	Western Electric TM-1	1.0	6	ND	-
220.6RR	Western Electric TM-1	1.0	6	ND	-
221.14 (position 1)	Western Electric TL-2	0.5	11	-	ND
221.14 (position 2)	Western Electric TL-2	0.5	11	-	ND
221.15 (position 1)	Western Electric TL-2	0.5	11	-	ND
221.15 (position 2)	Western Electric TL-2	0.5	11	-	ND
-	Motorola Paging System	200	0.15	ND	-
Evaluation Criteria (ACGIH 1987)			$3.77x10^4$		10

ND = less than 10 uW/cm^2 for power density measurements and less than 500 V^2/M^2 for E-field measurement.

Table 2
Radiofrequency Measurements at Butte Relay Station
at Mountain Bell
in East Butte, Idaho
June 16, 1987

Bay No.	Transmitter Receiver I.D.	Power Output (W)	Nominal Frequency (GHz)	E-Field (V^2/M^2)	Power Density (uW/cm^2)
305 S2RR	Western Electric TL-1	0.5	11	-	ND
304 RR	Western Electric TN-2	0.5	11	-	ND
303 FR	Western Electric TL-1	0.5	11	-	ND
302 NR	Western Electric TL-1	0.5	11	-	ND
301 RR	Western Electric TN-1	3.2	11	-	.018*
402FRDRR	Western Electric TM-1	1.0	6	ND	-
403FRD	Western Electric TL-1	0.5	11	-	ND
405S1RR	Western Electric TL-2	0.5	11	ND	-
406RRSID	Western Electric TM-1	1.0	6	ND	-
-	Motorola Paging System	200 —	0.15 —	ND	-
Evaluation Criteria (ACGIH 1987)			$3.77x10^4$		10,000

ND = less than 10 uW/cm^2 for power density measurements and less than 500 V^2/M^2 for E-field measurement.