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SUMMARY

On September 25, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United States Coast Guard facility at Governors Island, New York, to evaluate occupational exposure to microwave (MW) radiation emitted by the Vessel Traffic Service (VTS) units.

Twenty-five MW measurements were made at different locations on Governors Island on October 19-20, 1992. The highest level recorded among these 25 measurements was 0.025 milliwatts per square centimeter (mW/cm²). The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value for MW radiation in the frequency range for this source is 10 mW/cm², when averaged over any six-minute period.

On the days of this evaluation, the measured levels of occupational MW radiation produced by the VTS unit on Governors Island did not exceed applicable occupational exposure standards. It is concluded that MW produced by the VTS unit does not represent a health hazard.

KEYWORDS: SIC 9621 (Regulation and Administration of Transportation Programs), microwave radiation, radar system.

INTRODUCTION

On September 25, 1992, a request was received by the National Institute for Occupational Safety and Health (NIOSH) from the United States Coast Guard (USCG) facility at Governors Island, New York, to evaluate occupational exposure to microwave (MW) radiation produced by a traffic radar system.

On October 19-20, 1992, NIOSH made occupational MW radiation measurements on an operational Vessel Traffic Service (VTS) unit facility. These measurements were performed to document potential occupational MW exposure to USCG personnel from existing VTS systems as well as to estimate the potential for occupational radiation exposure to future VTS facilities being established by the USCG.

BACKGROUND

One of the functions of the USCG station at Governors Island, New York, is to provide ship traffic control coverage in and around the New York City harbor. At present this traffic coverage is provided by three VTS sites which use radar, radio, and MW systems to detect and display the location of navigational hazards, both fixed and moving. The information obtained from these systems is useful for coastal and harbor navigation and in surveillance. The rotating systems typically operate in a pulsed mode within the frequency band of 9300 to 9800 Megahertz (MHz). The USCG is in the process of providing coverage to areas currently not being served by constructing nine additional VTS sites at various locations along the east coast.

EVALUATION DESIGN AND METHODS

The measurement system consisted of a calibrated Narda Electromagnetic Radiation Monitor Model 8616 connected to either a Narda magnetic field isotropic probe model 8633 (10 to 300 MHz) or an electric field isotropic probe model 8621B (0.3 to 40 Gigahertz [GHz]). Both field probes, when connected to the monitoring system, measure field intensities in milliwatts per square centimeter (mW/cm^2) over their respective frequency region. The lowest meter indication level (LMIL) is $0.05 \text{ mW}/\text{cm}^2$ for the 8616/8633 system and $0.01 \text{ mW}/\text{cm}^2$ for the 8616/8621B system. All instruments used in this evaluation had been calibrated within six months of use by their manufacturer.

On October 20, radiation measurements were made at the VTS site on Governors Island. This particular site operated at 20 kilowatt (kW) peak power during the evaluation period. The two other existing VTS sites can operate at 20 kW peak power at 9400 MHz. The nine new VTS sites will operate at 5 kW peak power at 9400 MHz.

In order to determine if USCG personnel on Governors Island were exposed to MW radiation emitted by any sources, either on or off the island, measurements were made at 25 selected locations around Governors Island. Measurements were made at mid-morning hours with the probe held six feet off the ground.

Page 3 - Health Hazard Evaluation Report No. 93-002

It was estimated by USCG personnel that the rotating MW source, at the VTS site, was positioned about 200 feet above ground. In order to determine if the MW source was capable of being detected at other sites on the Island, measurements were made on top of the Chapel (Building 309). This building was chosen because its roof was positioned in clear view of the rotating source and it was one of the tallest buildings on the island.

Finally, several measurements were taken on the USCG ferry as it crossed the harbor to determine the potential for MW radiation exposure to workers on vessels in the harbor.

Evaluation Criteria^[1-5]

Absorption of MW energy can adversely affect a worker's health. Human and animal studies indicate that this type of radiation can cause harmful biological effects due to excessive heating of body tissues. Absorption of MW energy may also result in "non-thermal" effects on cells or tissues, which occur without a measurable increase in tissue or body temperature. Such effects are reported to occur from exposure to MW energy at levels lower than those sufficient to cause thermal effects. MW radiation can penetrate the body and cause heating of internal tissues. The body's heat sensors are located in the skin and do not readily sense heating deep within the body. Therefore, workers may absorb large amounts of radiation without being immediately aware of the presence of such energy. There have been reports that personnel exposed to MW fields from radar equipment, MW heaters and sealers, and radio/TV towers have experienced a warming sensation some time after being exposed.

Exposure of pregnant animals to high thermal levels of MW energy can cause birth defects and kill the fetus. MW radiation exposures have also been associated with human miscarriages, irregular menstrual cycles, and decreased lactation in nursing mothers. Testicular damage and sterility in male animals have been produced at high intensities of MW radiation. Sterility, decreased sperm production, decreased sperm motility, and decreased libido have been reported in workers exposed to MW. MW radiation-induced heating can damage the brain, spinal cord, muscles, blood, liver, kidneys, and skin. Such effects have generally been attributed to cellular damage resulting from excessive temperature increases. There is little supportable evidence that MW radiation can cause cancer. However, recent evidence suggests that it may act as a cancer promoter in animals.

There is general agreement that the incidence and severity of MW biological effects are related to the magnitude of radiation power absorbed by the body. This absorption depends strongly upon the frequency and intensity of the radiation, the size and shape of the exposed worker, and the worker's orientation in the radiation field. The human body absorbs maximally in the frequency range of 30 to 300 MHz. Outside this range, much less energy is absorbed by the body from the radiation field. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit for MW radiation in this frequency range is 10 mW/cm². Power density levels exceeding these limits are allowed providing the power density, when averaged over any six-minute period, does not exceed 10 mW/cm².

RESULTS

Twenty-five different radiation measurements were made at various locations on Governors Island. These measurements were performed at the VTS site, near the tower, around the island, on top of adjacent buildings, and on an USCG vessel. The highest level recorded among these 25 different measurements was 25 microwatts/square centimeters ($25 \mu\text{W}/\text{cm}^2$, equivalent to $0.025 \text{mW}/\text{cm}^2$).

It was observed by the NIOSH investigators during the evaluation that access to the MW tower housing the VTS system was controlled by locked gates. No measurements were taken at VTS sites other than the one at Governors Island.

CONCLUSIONS AND RECOMMENDATIONS

It is important to know that direct exposure to these types of VTS systems is limited to a narrow beam of MW radiation. As a result, measurement at worker sites will normally be on the order of $\mu\text{W}/\text{cm}^2$ for a very short period of time, unless USCG personnel are stationed on the platform and rotate with the antenna. It is highly improbable that these conditions would ever occur.

All measurements recorded, except two, 20 and $25 \mu\text{W}/\text{cm}^2$, were below the LMIL value. The value of $20 \mu\text{W}/\text{cm}^2$ was measured near the ferry dock and may have been affected by the possible presence of energized marine radar units on vessels in and around this area. The second level of $25 \mu\text{W}/\text{cm}^2$ occurred when measurements were made on top of the Chapel which was about 1/4 mile away from the source. Measurements made on top of the Chapel clearly showed the variance in MW emission as the antenna rotated. While these values are above the LMIL, it is noted that the LMIL value is well below (about three orders of magnitude) both the ACGIH and OSHA criteria for this particular frequency region.

In conclusion, MW radiation levels, measured in and around the Governors Island VTS site, on the day of this survey, do not represent a health hazard to USCG personnel. Since the investigators were not able to make measurements at other active or proposed VTS sites, no inference can be made about potential exposure from these sources. However, it would be appropriate to note that the peak power emitted from some of these other sites is designed to be less than the VTS site measured in this evaluation.

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Page 5 - Health Hazard Evaluation Report No. 93-002

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