



DEPARTMENT OF THE NAVY
BUREAU OF MEDICINE AND SURGERY
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IN REPLY REFER TO
BUMEDINST 6470.13
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10 November 1972

BUMED INSTRUCTION 6470.13

From: Chief, Bureau of Medicine and Surgery

Subj: Microwave health hazard; control of

Ref: (a) NAVSHIPS 0900 005-8000, Technical Manual for Radio-Frequency Radiation Hazards
(b) NAVORD OP3565/NAVAIR 16-1 529, Technical Manual, Radio Frequency Hazards to Ordnance, Personnel and Fuel

1. Purpose. To outline the potential health hazards associated with the use of microwave equipment, including radar; to specify maximum personnel exposure levels, to provide medical surveillance guidance, and to require reporting of microwave overexposure incidents.

2. Background

a. There is a continually increasing potential health hazard from electromagnetic radiation in today's Navy due to the variety of electronic equipment used in increasing the effectiveness of the fleet. The equipment employed for communications, surveillance, and research is increasing in quantity, complexity, and power. The power emanating from this equipment constitutes a potential health hazard unless adequate precautionary measures are taken.

b. The depth of penetration and coincident heating effects of energy on the human body are dependent on frequency. Below 1 gigahertz (GHz) the electromagnetic energy penetrates to the deep body tissues; above 3 GHz, the heating effect occurs on or near the body surface. This surface heating may be compared to enforced radiation or direct sunlight. At frequencies between 1 and 3 GHz, the percentage of energy absorbed ranges from 20 to 100 percent; due to varying degrees of penetration. The heat produced by microwave radiation is capable of adversely affecting living tissue if the organism cannot dissipate the heat as rapidly as it is produced.

c. Certain organs of the body are considered to be more susceptible than others to the effects of microwave radiation. Organs such as the lungs, eyes, testicles, gall bladder, urinary bladder, and portions of the gastrointestinal tract are more likely to be damaged by heat resulting from excessive exposure to radiation. Of the organs just mentioned, presently available information and experience indicate that the eyes and testicles are the most vulnerable to microwave radiation.

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(1) Eye. The transparent lens of the eye appears to be easily damaged by intense radiation energy, whether ionizing, infrared, or microwave. High intensities can cause the development of lens opacities or cataracts. The lens is especially susceptible to thermal damage since it lacks a blood supply to dissipate heat. Temperature elevations within the eye may alter the metabolic processes of the lens cells and lead to cell damage or death. Since damaged cells cannot be shed or replaced, a permanent opacity results. If this opacity is large enough to measurably interfere with vision, it is termed a cataract. The earliest changes observable by the slit lamp are the appearance of granules or vacuoles usually in the region of the lens suture at the posterior pole of the lens just under the capsule; however, these same changes may be found near the equator of the lens. Histopathologically this represents the migration of swollen epithelial cells posteriorly under the capsule, areas of degenerated lens fibers, and pockets of debris.

(2) Testicle. Testicular reaction to heat injury resulting from microwave radiation appears to be the same as the reaction to high fever associated with many illnesses. Although a condition of temporary sterility and damage to seminiferous tubules may occur, the condition does not appear to be of a permanent nature and will ultimately correct itself.

d. A good deal of discussion and controversy exists in the current literature regarding the question of "nonthermal" or "specific" effects; i. e., effects caused by mechanisms other than thermal action. These effects include disturbances of the central nervous system, sensory perception, and various cardiovascular changes. A variety of activity and behavioral changes have been noted, including changes in alertness and endurance. There have also been reports of general loss of strength, memory disturbance, tiredness, headache, irritability, and loss of appetite. A conclusive answer to the "nonthermal" effects question is not currently available.

e. There are two additional unexplained temporary responses of man to microwaves which have been reported. One of the responses is epigastric distress or nausea. The effect is purported to occur at intensities as low as 5-10 mw/cm² within the frequency range from 9-12 GHz. Also, certain people can perceive an auditory response in the form of a "buzz" when exposed to frequencies between 0.2 and 3.0 GHz which are in a pulse modulated format within the audio frequency range.

3. Action

a. Maximum Personnel Exposure Levels. In the frequency range between 100 megahertz and 100 gigahertz, personnel exposure shall not exceed the following:

(1) 10 milliwatts/cm² average incident power density for exposures greater than 30 seconds, (10 mw/cm²), or

(2) 300 millijoules/cm² for intermittent exposures between 3 and 30 seconds (300 mj/cm²/30 sec.) or (300 mj/cm²/3 sec.).

All areas in which the energy levels exceed the above limits shall be considered hazardous. Accordingly, admittance to areas where the exposure levels exceed the above limits shall be restricted and warning signs shall be posted (see references (a) and (b)). Minimum safe distances and exposure times for most naval radars are given in section 1.2 of reference (a) and table 4-4 of reference (b). For radars not listed in references (a) and (b), minimum safe distances and stay times should be calculated as shown in appendix B of reference (a).

b. Precautions to Insure the Safety of Personnel. The following precautions shall be taken to ensure that personnel are not exposed to power intensities exceeding the above limits:

(1) Personnel shall not look directly into the beam. Guidance should be sought from cognizant equipment personnel on locating the beam position for each antenna installation.

(2) Visual inspection of feed horns, open ends of wave guides, and any opening emitting high intensity electromagnetic energy shall not be made unless the equipment is definitely secured for the purpose of such an inspection.

(3) The use of dummy loads shall be employed where applicable as a load for equipment during testing or check-out rather than radiating the energy into the surrounding atmosphere.

(4) High power radar shall be directed so that the beam is emanating away from personnel working areas.

(5) Personnel shall observe "R-F HAZARDS" warning signs which point out the existence of microwave radiation hazards in a specific location or area.

c. Medical Surveillance. A specific preplacement and periodic medical examination program is required for individuals, both military and civilian, in close association with the development, calibration, or maintenance of microwave equipment emanating field intensities in excess of the limits specified in paragraph 3a.

(1) The preplacement medical examination shall consist of a routine preemployment physical examination plus a comprehensive

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ophthalmological examination. The ophthalmological examination shall include: evaluation of ocular motility, media and fundus, corrected visual acuity for near and far vision, and slit-lamp examination of the lens with the pupil widely dilated.

(2) The periodic surveillance examination, conducted at 3-year intervals, should include a careful review of eye symptomatology; a history of exposure since last examination, intervals between exposure, type of equipment, any unusual exposure; and performance of a physical examination. A comprehensive eye examination or additional laboratory procedures may also be indicated by the individual's history.

(3) Personnel exposed to power densities above 50 mw/cm^2 should be given a complete physical and ophthalmological examination immediately following the incident and at 2-week intervals thereafter for a minimum period of 4 weeks.

(4) Any individual who has been examined and found to have any evidence of secondary, other than congenital, lenticular opacities of the eyes, shall not be occupationally exposed to microwave radiation.

4. Overexposure Incident Reporting Requirements. If an individual is exposed in excess of the above stated limits, the commanding officer shall prepare a letter report, Microwave Overexposure Incident (Med 6470-11), and forward it via the chain of command to the Chief, Bureau of Medicine and Surgery (Code 74), within 30 days of the incident. As a minimum, the report shall contain a list of personnel exposed, a narrative description of the incident, an estimate of the level of exposure received, and a description of any untoward physiological affects. If the exposure is approximately an order of magnitude (factor of 10) greater than the above limits, an interim message report, Microwave Overexposure Incident (Med 6470-11, MIN:ETAUTH) should be forwarded to the Chief, Bureau of Medicine and Surgery, within 48 hours of the incident.

5. Reports. Report Symbol (Med 6470-11, MIN:ETAUTH) is assigned to the reporting requirement in paragraph 4 which has been approved by the Chief of Naval Operations.

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