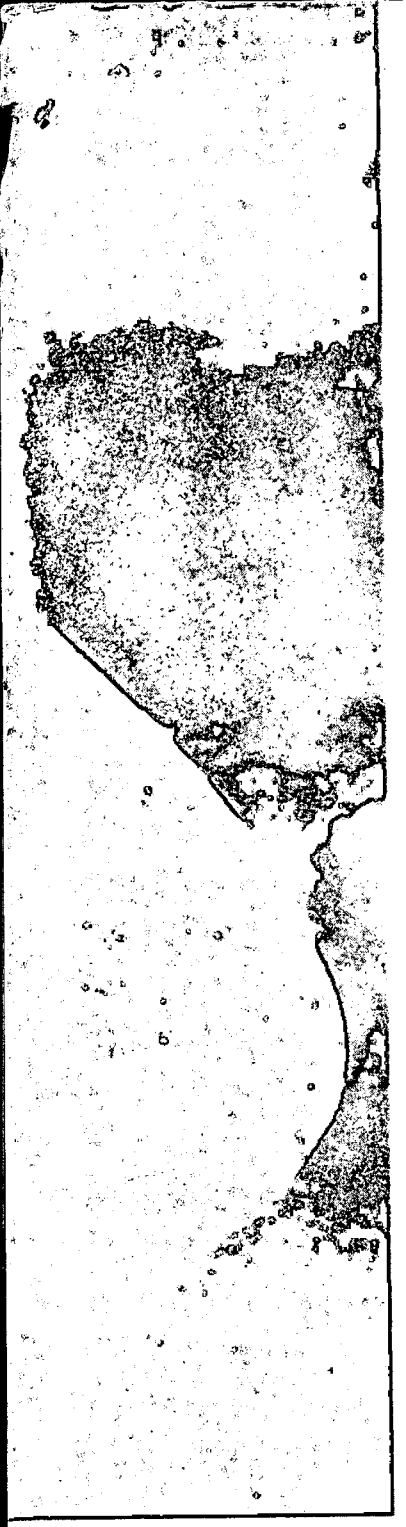
"Microwave Radiation Hazards" by Morgan

Invisible microwaves, such as radar, can . . .
Ignite steel wool,
Set off photo-flash bulbs,
Ignite fuel vapors.
Do they affect the human body too?

This is an age of man-made scientific phenomena. Articles on atomic energy, satelites, supersonic aircraft, and electronic wonders seem to fill our newspapers and journals.

Whenever man does not understand the working of these scientific advances, he tends to place them in a supernatural category. In this atmosphere of miracles and mystery, reports and rumors of fearsome side effects on persons exposed to microwave radiation from radar beams have more than once found an interested audience. Then, like most rumors, it is passed on a little larger and blacker and soon all radar beams have become death rays. To eliminate this type of rumor, a basic understanding of microwave radiation is needed by personnel in the field of health protection.

Microwaves originate as electromagnetic impulses in a high frequency oscillator tube. The wave length of the impulses are relatively short, thus the term "micro." The waves are carried through a wave guide to a transmitting antenna which ejects them into space at the speed of light. When these waves strike an object which they cannot



Microwave Radiation Hazards

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penetrate, the waves are reflected back to the antenna.

Microwaves are classed in a band of the electromagnetic spectrum just above the radio wave. This means that the microwave has a shorter wave length than the radio waves.

Energy from microwave radiation can be either absorbed or reflected by an object in the direct path of the microwave beam. The total amount absorbed or reflected depends on the material being bombarded and the frequency and power density of the bombarding microwave.

Airborne radar equipment employs several different wave lengths. S-band radiation—which contains longer wave lengths (10 cm), lower frequency (3000 megacycles), and high power density—is used for general search type work. The X- and C-bands are shorter (3 and 5 cm, respectively), with higher frequency (10,000 megacycles and 5,000 megacycles, respectively), and are used for weather radar and height finders which require less power density.

Some startling effects are produced by airborne radar. For example, **under some conditions** dry steel wool may be ignited. Photo flash bulbs have been set off at distances up to 350 feet. Ignition of this type of material is possible due to the fine wires being heated to a point of incandescence when excited by microwaves. Fuel vapors can also be ignited by a microwave beam if there are metal chips or wires in close proximity. An electric potential is built up between two metal particles and if a discharge takes place, the resulting arc ignites the fuel. This type of occurrence is uncommon, however, and normal precaution should eliminate the problem.

Effects on the Human Body

The biological effects of microwave radiation are to a great extent dependent on the frequency or wave length and the average field density (power). When microwaves are absorbed by matter, they produce localized heating. It is the nature of microwaves that the shorter X- and C-band wave lengths cause maximum heating effects at the skin level, where it is most easily felt and dissipated. The longer wave lengths of the S-band induce greater heating in the tissue below the skin. For the purpose of examining the effect of radiation, the body can be represented by a triple layer arrangement. Microwave radiation at frequencies of 3000 megacycles and above is usually reflected or absorbed by the outer layers of skin only and seldom penetrates the deeper layers. When radiation is absorbed, it causes heating of the tissue. The skin layer contains most of the body's nerve endings or sensory elements and when this layer absorbs the energy and overheats, warning is immediately sent to the brain. Of course, the brain tells the man he is getting too warm and to move; thus there is no overexposure.

Radiation in the range between 1000 and 3000 megacycles is capable of penetrating the skin and heating the fat layer. The amount of radiation absorbed in this layer is dependent on the thickness of skin and fat; this thickness varies with each individual.

Frequencies of less than 1000 megacycles are more serious than the high frequencies because they

penetrate both the skin and fat layers and heat the deep tissues of the body. This area of the body has less sensory elements and a possible overheating could occur before an adequate warning is sent to the brain.

The general consensus of medical investigators is that the primary hazard to the body from microwave is due to the heating effect. Injury does not occur instantaneously; however, chronic exposure to high levels may cause tissue damage.

Tests have been conducted on small fur-bearing animals to determine the effects of microwaves. The first test revealed potential health hazards. These tests were highly publicized and gained the attention of persons in all walks of life. The tests themselves do not necessarily apply to man for many important reasons. The small furry animal does not have efficient heat regulating mechanisms and it is quite easy to elevate its body temperature to a critical point. In the experiments, the animals were anesthetized, which eliminated their sense of feeling heat.

Man is a relatively large subject with a very efficient heat regulating system which can resist the effect of microwave heat more effectively. Also, man is usually working in open areas where it is easy to lose body heat to the surrounding cooler air. Another important factor is that the animals were exposed to a stationary beam, whereas most humans are exposed to beams from rotating antennas, which give the person exposed a chance to lose heat to the surrounding air between exposure intervals.

Direct tests and experiments were not possible with human beings, but complete physical examinations have been given to personnel occupationally exposed to microwave radiation. The history of personnel exposure varied from a few days to greater than 10 years. The results of these examinations showed no significant evidence of any temporary or permanent body changes or injury which could be attributed to microwave radiation. It is known, however, that powerful microwave emmissions do produce a heating effect on the body.

Control of Possible Hazards

Because of the potential danger of high powered radar, man has put into effect certain controls to minimize the hazards of radiation. At present, the main stem of these controls is a U. S. Air Force maximum permissible power density level of 10 mw/cm^2. The 10 mw/cm^2 is the line drawn between a hazardous and a non-hazardous microwave radiation area. Due to a lack of knowledge of the exact relationship between time of exposure, frequency of the wave, and the average power density, a large safety factor was placed in the maximum permissible power density.

The determination of free space power density at microwave frequencies can be accomplished with a minimum of equipment. Basically, the determination of power density involves probing the microwave field with a calibrated wave guide horn, half-wave dipoles or some other structure of known properties and measuring the received power flowing through a point at the end of the transmission line.*

In practice, an instrument made of four components, a calibrated wave guide horn, a detector mount, an attenuator, and a microwave power meter, is used. All the components are standard or stock devices and are easily obtained By adjustment and calibration of the various component parts, a direct reading of power density in mw/cm^2 can be obtained. When probing a microwave field, the monitor performs the initial measurements at some practical distance from the radiation and gradually works in toward the source, thus safely guarding the man and the instrument. When measuring a high radiation field, the monitor is protected by a microwave-absorbing material: This synthetic material resembles pig hair matted together with a rubber-like material.

The controls of the microwave radiation hazard given in Table 1 are necessarily of a general nature because of the great variety of radar sets and their designs for

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TABLE 1: Safety Rules For Microwave Radiations

1. Avoid any exposure to radio-frequency energy having a power density of 10 mw/cm^2 or greater. Areas accessible to transit personnel and having a power density equal to or greater than 10 mw/cm^2 will be posted with a caution sign and flashing light, and should not be occupied for any length of time.
2. Do not make detailed visual examination of any microwave radiator, reflector, wave guide opening, wave guide horn, or magnetron during periods of transmission.
3. Limit the number of personnel having access to areas immediately adjacent to test stands or benches containing equipment radiating energy of hazardous power. Only those required to perform specific tests should be present.
4. Use dummy loads, water loads, or other absorbent materials whenever possible to absorb the energy output of the transmitter while being operated or tested.
5. When this cannot be complied with, provide absorbent screening to isolate test stands from each other or from adjacent administrative areas which may be affected by the microwave radiation.

* From this measurement the power density can be calculated using the following formula:

$$Po = \frac{4\pi Pr}{\lambda^2 Gr}$$

where Po = power density in watts/cm^2
Pr = received power in watts
Gr = absolute gain of receiving probe
λ = wave length in cm

troit, Michigan, has been announced by *Howard J. Mather,* general manager of industrial finishes and plastics for the firm's paint division. Prior to his appointment, Mr. Calhoun had served as manager of industrial sales for Houston, Texas, paint factory since 1953.

UNIVERSAL MFG. CORP. has announced the election of *Robert L. Carbeau* as president. He succeds *J. A. Kirkpatrick* who recently resigned from the scaffolding manufacturing corporation. Mr. Carbeau has been employed by the company since 1950 and has been manager of its Pittsburgh office, assistant to the president, and most recently served as Vice President of Sales and Finance.

Appointment of *Martin B. Jaeger* to the newly created post of advertising manager for *KOEHRING CO.*, was recently announced by E. B. Hill, vice president-marketing. The new position carries responsibility for directing the product advertising and publicity programs for all Koehring divisions and subsidiaries. *E. J. Goes,* publicity manager for Koehring, will continue in that position.

DELTA FIRE & SAFETY, INC., of Lafayette, Louisiana, has been appointed a stocking distributor for Pacific Mercury electric plants and flasher warning lights. Well-known distributors of fire and safety equipment, Delta will maintain a complete parts and service department, according to manager *W. F. Dunlap.*

KLEMP INTERNATIONAL, a new division of the Klemp Metal Grating Corporation, has been established to handle all aspects of Klemp's International-Foreign trade. The new division will be located at 1379 N. North Branch Street, Chicago.

New Atlanta sales and service facilities have been opened by *WALTER KIDDE & CO., INC.* The new building is located at 1882 Marietta Boulevard, N. W.

The modern one-story, red brick structure has loading docks for two trucks, 4,000 square feet of warehouse area, and 800 square feet devoted to service facilities. The remainder of the building is occupied by offices for the Southeastern Regional headquarters of Kidde's Industrial and Marine Division. Complete service facilities permit the repair, recharge, and hydrostatic testing of high pressure cylinders and extinguishers. In charge of the operation is *W. K. Winstead,* District Manager.

James A. Main has been named to manage the newly aligned Industrial Division of *THE FLINTKOTE CO.* The new Division will handle the sale of products for the automotive, railway, paving and industrial products for the building industry—those products which are normally sold in bulk quantities and which are distributed through industrial converters, contractors and industrial distributors.

F. E. Diefendorf has been appointed manager of hospital bed sales for the *AMERICAN METAL PRODUCTS CO.*, it was announced by *E. Wright Yount,* vice president in charge of sales. Diefendorf will supervise sales of AMP's new all-electric hospital bed which AMP developed with the cooperation of engineers, nurses and technicians at the University of Michigan Medical Center.

Safety Appointments

The appointment of a staff director of industrial relations for the Bridgeport Brass company has been announced by *Joseph P. McNamara,* vice president, personnel. Named to this position is *Clarence E. Wynn,* formerly industrial relations director at the Company's Indianapolis (Ind.) plant. Mr. Wynn will be in charge of employee benefits, labor relations and safety programs for all plants of the Bridgeport Brass company.

Mr. McNamara also announced that a new post, that of staff director of accident prevention, has been established in the department of Industrial Relations and *Donald E. Cogswell,* formerly cost reduction supervisor for the Company's Housatonic plant in Bridgeport, has been named to this position. Mr. Cogswell will be in charge of physical demands analysis, industrial hygiene, and safety equipment and practices for all of the Company's plants.

Radiation Hazards

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different conditions and power output. Specific controls would be out of proportion for hazards involved with another type of radar.

In conclusion, it is believed that repeated exposure to radar waves while observing proper precaution does not lead to any cumulative or chronic effects on the body. This seems to be proven by the lack of any evidence showing that anyone has been seriously injured by working with radar equipment. A few reports have been published in newspapers and magazines in past years concerning alleged injury, but it is the opinion of most medical scientists that the reported disorders were not caused by radar. This does not imply that there is no potential risk or hazard associated with microwaves, however. To guarantee the safety of persons who work with radar, additional and extensive medical research should be provided. In the meantime, all radar equipment should be treated with full respect and in accordance with the necessary hazards control information.

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Picture: Official U. S. Navy Photo.

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the future shows

Minneapolis, Minn. *August 13–15*

Twelfth Annual Convention of the International Rescue and First Aid Association (Pick-Nicollet Hotel). Max L. Spray, Executive Director, IRFAA, 101 North Alfred St., Alexandria, Va.

Chicago, Ill. *September 21–25*

Fourteenth Annual Instrument-Automation Conference & Exhibit, (International Amphitheatre). Fred J. Tabery, 3443 S. Hill St., Los Angeles 7, Calif.

Atlantic City, N. J. *October 19–23*

Eighty-seventh Annual Meeting of the American Public Health Association (Convention Hall). American Public Health Association, 1790 Broadway, New York, N. Y.

Chicago, Ill. *October 19–23*

Forty-seventh Annual National Safety Congress and Exposition (Conrad-Hilton Hotel). R. L. Forney, Secretary, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Fort Wayne, Ind. *March 15–16*

1960 Northeastern Indiana Safety Conference and Exhibit. Ivan A. Martin, Safety Council Manager, Chamber of Commerce Building, Fort Wayne, Ind.