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Biological Effects of Microwaves: Future Research Directions

Special Panel Discussion

Lt Col Alvin M. Burner, USAF, MC, Chairman

Transcript and Supplementary Materials

Held on the Occasion of the

1968 SYMPOSIUM ON MICROWAVE POWER

International Microwave Power Institute

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PREFACE

The Special Panel Discussion of which this report presents a transcript derives indirectly from the research programs on the biological effects of microwave and other nonionizing radiation that were carried out at a number of institutions (mainly universities) during approximately 10 years beginning in about 1955 under the sponsorship of various agencies of the Department of Defense. Participants in these programs were called together periodically in a series of Tri-Service Conferences, which met at Rome, N.Y., in 1957 and 1958; in Berkeley, California, in 1959; and in New York City in 1960. Proceedings of each Tri-Service Conference were printed; the last was published in book form (M. F. Peyton, ed., "Biological Effects of Microwave Radiation," Plenum Press, New York, 1961).

Department of Defense interest in the subject was motivated in the first instance by the desire to establish safety criteria; as they were established and gradually accepted, the Department of Defense (mainly Air Force) research programs were progressively phased out. The last in this group of contracts was between the U.S. Air Force Systems Command and a group centered at the Department of Radiation Biology and Biophysics in the University of Rochester School of Medicine and Dentistry. While the final report on that contract was being readied in late 1967, Lt. Col. A. M. Burner, USAF, MC, at the Headquarters of the AFSC's Aerospace Medical Division, wrote to many of the participants in the earlier research programs proposing that the publication of the report should serve as the occasion for another meeting. The undersigned (one of those to whom an invitation was addressed) had just been asked to serve as chairman of a session on the biological effects of microwave energy during the annual Symposium on Microwave Power organized by the International Microwave Power Institute (IMPI) in Boston on 20-23 March 1968, and suggested that the regular session might be conveniently followed by a panel discussion under Col. Burner's chairmanship. The suggestion proved to be acceptable and invitations were issued to a list of nearly 100 research workers whose names appear at the end of the present report. Not a few attended or sent representatives; in addition, about 100 participants in the IMPI Symposium stayed for the panel discussion.



The panel was to consist, in addition to Col. Burner and the undersigned, of Dr. R. L. Carpenter (Tufts University), Dr. J. W. Howland (University of Rochester), Dr. H. P. Schwan (University of Pennsylvania), and Dr. M. M. Zaret (Zaret Foundation). Unfortunately, the last two were prevented from attending, so that the panel membership was reduced to four.

At the regular session preceding the Special Panel Discussion, the following four papers were presented:

"Microwave techniques in biophysical measurements," P. O. Vogelhut, University of California, Berkeley.

"Effects of microwave radiation on the lens epithelium in the rabbit eye," F. C. Cogan and C. A. Van Ummersen, Tufts University.

"Biochemical effects of microwave fields," V. T. Tomberg, New York Medical College.

"Control of grain insects by microwave power," M. A. Hamid, C. S. Kashyap, and R. Van Cauwenberghe, University of Manitoba.

It is hoped that these papers will find their way into the Journal of Microwave Power published by IMPI.

Research workers who have followed U.S. government involvement in research on the biological effects of nonionizing electromagnetic radiation over the years have noted a perceptible increase in such interest recently, arising in part from the adverse publicity associated with the discovery that some models of color-television receivers were producing X radiation above acceptable levels. The legislation being introduced to deal with such problems has been broadened to include not only ionizing but also nonionizing, particulate, sonic, and ultrasonic radiation. Three separate bills were introduced in the 90th Congress. Representatives Rogers and Jarman submitted H.R. 10790 on 13 June 1967 in the House; Senator Bartlett and others submitted S. 2067 on 10 July 1967 in the Senate; and Senator Hill submitted S. 3211 on behalf of the Administration on 21 March 1968 in the Senate, which referred the bill to its Committee on Labor and Public Welfare.

Hearings were held in the House during August, September, and October, 1967; a transcript was issued by the U.S. Government Printing Office ("Electronic Products Radiation Control," Hearings before the Subcommittee on Public Health and Welfare, House Committee on Interstate and Foreign

Commerce, Serial No. 90-11, 1967). Hearings were likewise held in the Senate during August 1967 ("Radiation Control for Health and Safety Act of 1967," Hearings before the Senate Committee on Commerce, Serial No. 90-49, 1967). A report to accompany H.R. 10790 (Report No. 1166) was submitted by the House Committee on Interstate and Foreign Commerce on 12 March 1968; an amended version of H.R. 10790 was passed by the House on 20 March 1968 (two days before the discussion reported in the present report took place) and sent to the Senate.

Because of the importance of the proposed legislation to readers of the present report, the amended version of H.R. 10790 as passed by the House is included as an Appendix. Also included is a section-by-section comparison of the three bills (i.e., S. 3211, the Administration bill; S. 2067, the Bartlett bill; and H.R. 10790, the House-passed bill) prepared by Mary Anne Lipford, research assistant in the Science Policy Research Division, Legislative Reference Service, Library of Congress. We are grateful to Miss Lipford and to the Library of Congress for permitting us to reproduce the draft version of this comparison, which was completed on 15 April 1968. Hearings by the Senate Committee on Commerce are to be held on four days in May 1968.

The above-mentioned Report No. 1166 by the House Committee on Interstate and Foreign Commerce amplifies the language of the bill somewhat, making clear that "all types of radiation are included if emitted from an electronic product." The report goes on to enumerate specific instances:

Examples of sources of the ionizing radiation which is usually classified as electromagnetic radiation are--X-ray machines used for the diagnosis and treatment in the healing arts, as well as X-ray machines used in research, education, and industrial applications; cyclotron, betatron, pulsed or flash X-ray spectrographs; electron microprobes; electron microscopes; electron beam welders; X-ray level gauges; klystron tubes, cathode ray tubes; and high voltage vacuum tubes. Examples of sources of nonionizing electromagnetic radiation are--microwave ovens, radar, diathermy units, lasers, computing systems, resonant transformers, communication equipment (broadcast relay), and illumination systems. Some sources of radiation commonly referred to as particulate radiation are linear accelerators and Van de Graaff accelerators. Finally, examples of sources of the sonic and ultrasonic (that is, above the audible range) vibrations included in the definition are those that are produced by sonar systems and those produced by ultrasonic generators for medical diagnosis and treatment and for industrial cleaning.

Each source described above could be made subject to a performance



standard set by the Secretary of Health, Education, and Welfare if he found that the radiation emitted from the source was a danger to the public health and safety.

Prof. CHARLES SUSSKIND

Berkeley, California

30 April 1968

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The Special Panel Discussion on "Biological Effects of Microwaves: Future Research Directions" convened in the Stanbro Room of the Hotel Statler, Boston, Massachusetts, on Friday, 22 March 1968, at 3:55 p.m., Lt. Col. A. M. Burner, USAF, MC (Aerospace Medical Division, Brooks AFB, Texas), presiding.

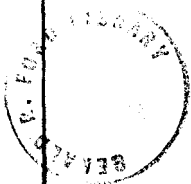
DR. CHARLES SUSSKIND (University of California, Berkeley): This begins the special discussion on "Biological effects of microwaves: Future research directions." The panel members are Dr. Carpenter, Dr. Howland, Colonel Burner, and myself. The format that we shall follow is that each panel member will make a brief presentation, after which the meeting will be open to discussion. The discussion may take the form of individual contributions or short statements or questions asked of panel members, directed at individual panel members or at the entire panel. I shall start by introducing Colonel Burner as our chairman and the first speaker.

COL. BURNER: Thank you, Dr. Susskind. As the Chief of the Radiobiology Division, Directorate of Research and Development, Aerospace Medical Division, U.S. Air Force, I am charged with the technical management of the field of radiobiology, the subspecialty of Occupational Medicine.

I have often heard technical management likened to a log plunging down a turbulent mountain stream with three hundred ants as riders, each of which is convinced that he is steering.

Although radiobiology is most closely associated with the problems of ionizing radiation, a field with which I am most familiar, it also serves to shelter other, somewhat related fields, of which the area of microwave effects is a good example. Therefore, I have ex officio responsibility in this field.

For several years, Air Force-sponsored research in this field has pined as a result of several factors, not the least of which is budget austerity, certainly a fact of life to an increasing degree. Another factor is that our research has reached a point of evaluation when a good hard look must be taken to assess technical progress to date, to determine the meaning of the results so painstakingly achieved, to study their effects on the operational parameters of existing systems, to



evaluate the results of possible selective relaxation or tightening of limits on systems vital to our nation's welfare, and, perhaps most importantly, to consider, in the light of rather extensive work done by other scientific communities, whether, as they suggest, nonthermal effects may place tighter (by orders of magnitude) constraints on our exposure guides.

Most of the work in this field has been done in the range from 100 to 3000 MHz. It is possible that future systems may operate at other frequencies, above or below these limits. Next to no biological work has been done in these areas. Can we say on the basis of theoretical considerations that these ranges represent no hazard, or must we actively investigate these frequencies for possible effects?

In an effort to obtain some answers to these and other problems, when Dr. Michaelson's report was in final preparation I prepared an admittedly incomplete list of those with active interest in the field and proposed that they should use the report as a springboard for discussion to this end. Among them was Dr. Susskind, who felt that a discussion could be held fruitfully in connection with this Symposium. Today's session is the result of that expression of interest.

When I was approached by Dr. Susskind, I felt I was not as well versed technically in the field as others might be and suggested that I co-chair the session, asking another with greater experience to sit in this place. To that end we prevailed upon Dr. Schwan of the University of Pennsylvania to serve; unfortunately, commitments have prevented his attendance, so for better or worse, in sickness or in health, I go on alone.

As Dr. Susskind and I organized the session we suggested several names of those to join the panel. Nature has shown that our technology is still no match for her wiles, so that which we propose she disposes; some of those experts have been unable to join us because of poor flying conditions. Among them is Dr. Milton Zaret, whose absence I strongly regret.

We shall start the panel with Dr. Howland discussing his report, and develop the discussion from that point.

DR. J. W. HOWLAND (University of Rochester): Thank you, Col. Burner and Prof. Susskind. To summarize this large report on the biological effects of microwave exposure within a limited period of time is almost an impossible task. It includes some thirteen publications in the open

literature, twenty-six presentations, and four military reports from this Laboratory alone. The major portion of the work carried out at the Rochester Laboratory and the associated Verona Test Site (Griffiss Air Force Base, N. Y.) consisted of studies at two specific frequencies: 2800 MHz pulsed, and 1280 MHz pulsed. A few studies were carried out at the University of Buffalo using a 200-MHz cw generator.

This report, RADC-TR-67-461, summarizes results of our findings previously reported or presented and also includes some additional information not presented before. (Federal government agencies may order this document directly from the Defense Documentation Center, Cameron Station, Alexandria, VA 22314, under number AD 824 242L. Others must route their request through Headquarters AMD, Brooks AFB, TX 78235.) It contains a current bibliography of pertinent work carried out in this country as well as the reported literature of the many Russian laboratories. A few recent French papers are noted. It would appear that the Russians with their phenomenal interest in "nervism" may have adopted microwave technology as a discipline to exploit.

A review of the presented literature shows that most available information is on the frequencies from 1000 to 3000 MHz. A small amount is available on 3000-6000 MHz and a few studies are reported on the 6000- to 10 000-MHz range. The range 10 000 to 30 000 MHz is represented largely by work from one laboratory at the higher frequency. Variations in observed biologic effect occur which are characteristic of the wavelength, pulse, frequency, pulse height, average as contrasted to peak power, and the like. Homogeneity of field conditions is important. Simultaneous exposure to a variety of frequencies, a not unusual happening in field conditions, could result in variable but no less significant biological effect. If one could visualize all of the radiations passing through this room at this moment, he would find it illuminating. In turn, he might well be more concerned as to potential biologic interactions of certain energies.

In simple summary of the report, certain findings or events of biologic significance occur following microwave exposure. The first type is the direct or immediate effect. This may be instantaneous or consist of pulses of peak power over short intervals of time. The primary example would be cataract of the lens. The energy may also be

protracted over a period of minutes to hours. (It should be mentioned that simple immediate coagulation of lens is not classified as cataract, which requires a latent period following the initial injury for its development.) Very high peak power administered over a few microseconds to seconds may end in cataract formation but not at levels reported in these experiments. Superficial heating of the testis can result in injury.

Indirect effects due to microwave exposure are caused by the reaction of the animal body to the heating stimulus. These effects may appear as the accumulation of a series of small injuries which occur over days or even months. Examples include cataract, cardiovascular changes, neuroendocrine alteration (thyroid), and effects on skin receptors. Secondary effects of uncompensated effect of thermal regulation are the most common. They include fluid loss, hemoconcentration leading to shock, local loss of circulation with resulting burns, local vascular degeneration (testes), specific regional cooking, or coagulation (bone necrosis).

A third type of change may be classified as adaptive and consists of an alteration in the response of the animal to the thermal stress, or, in other words, learning to get along with it. This adaptation would include reduction in tissue reserve, general or local, or reduction in vascular reserve, general or local. In turn, a change could occur in the adaptive process resulting in better accommodation in the young and healthy, or poor accommodation in the older individual (particularly those with the specific vascular pathology of aging). At one time it was felt that stimulation of the circulation by microwave exposure might result in a form of vascular exercise. There is little question that overall thermal heating does cause increased activity of specific cardiopulmonary functions related to heat loss. One might conclude that employment in areas subject to microwave exposure should be limited to young, healthy individuals.

The changes produced by microwave exposure in turn may be additive when joined with other physical, chemical, infectious, or environmental stresses. There is little question that the total amount of microwave exposure in urban areas has risen in parallel with other forms of atmospheric changes. One might be curious as to whether microwave might be as dangerous as tobacco in the causation of cancer.

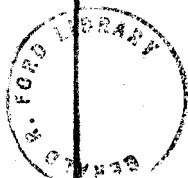
The final and perhaps most important of effects, at least for hazard

evaluation, are the so-called nonthermal or athermal effects, or those from changes not associated with generalized heating of the animal. They may be vibrational or rotational, alterations in orientation of molecules, or other unknown changes. Consideration as to whether a thermal reaction occurs does, however, vary with the species. Dogs show no change at exposures of 20 mW/cm^2 (at 1200 MHz) but mice show specific reaction at 10 mW/cm^2 because of an inefficient thermoregulatory apparatus. Man has one of the best of heat-regulating mechanisms because of the efficient nature of heat loss by evaporative cooling of his entire skin. Hence the human should tolerate microwave exposure at a level of 10-20 mW/cm^2 without alteration of thermal equilibrium. Subtle pathophysiologic changes, however, may not be apparent at these power levels. What is important to know is whether nonthermal effects occur particularly at the frequencies of 15-400 MHz in which the highest power densities are transmitted.

Despite the large amount of work that has been carried out, analyses indicate tremendous gaps in our information. In the Rochester studies, we have basic information at 2800-MHz pulsed microwave at 50, 100, and 165 mW/cm^2 , and 1200-MHz pulsed microwave at 20 and 100 mW/cm^2 . A few studies were conducted using 200 MHz cw at 100 and 165 mW/cm^2 . From these studies we can make certain conclusions concerning characteristics of wavelengths and power density. We have no information on variations in pulse, pulse frequency, or duration. The comparable effects of average and peak power are not clear. The effect of changing pulse shape (i.e., to square waves or sine waves) on biologic effect is unknown. The comparable effects of homogeneous or inhomogeneous fields requires consideration.

Modification of the effects of ionizing radiation by previous microwave exposure has been shown in some of the Rochester experiments, in which a decrease in mortality from X-ray exposure has followed microwave conditioning in both dog and mouse. This result raises certain curious questions as to possible effects of nonthermal microwave exposure on ionizing radiation tolerance.

The microwave literature, and popular writing as well, are filled with numerous curiosities. The howling of dogs near transmitters, peculiar actions of birds, fatigue and headaches in workers, and other



psychosomatic complaints have been reported. The exact nature of such phenomena should be investigated and not merely ignored.

The entire area of environmental contamination is at present being considered in the Jarman-Rogers bill, which proposes control of all forms of electromagnetic energy. Numerous supporting documents are included in the publication of the hearings. One of them, by Prof. Hans Neuberger of the Department of Meteorology at Pennsylvania State University, states: "In view of the continuously increasing number of Radar, TV, AM and FM Radio transmitters in our environment, a concerted effort would be worthwhile in investigating the long-range effects of these artificial electromagnetic radiations on people. Particularly the urban population is exposed to increasing dosages of electromagnetic radiations from the multitude of communication channels. Who knows, the general unrest among people may well be a direct result of electromagnetic insults to their nervous system?" ("Electronic Products Radiation Control," Hearings before the subcommittee on Public Health and Welfare of the Committee on Interstate and Foreign Commerce, House of Representatives, 90th Congress, First Session, on H.R. 10790; Serial No. 90-11; 1967.) Similar comments have been raised in my own conversations with other scientists.

I have dashed through this report hitting only the high spots on the way. Most can see the nature of the problem, much of which is concerned with the production of carefully standardized information so that results from one laboratory can be compared to others. In this way, we can prevent the "mish-mash" which constitutes so much of our present information.

In closing, I must emphasize that as in the field of ionizing radiation, microwave research demands a merging of disciplines. This merger requires that the engineer, the physicist, and the biologist (and in particular the radiobiologist) join forces. Absolute control of experiments and experimental techniques is a prerequisite since so many of the observations will be of a borderline nature, particularly within the low-exposure groups ($1-10 \text{ mW/cm}^2$). Need exists for better dosimetry. The effects of multiple exposures with differing frequencies deserves attention. It is encouraging that interest in this complex problem is returning. I know that the scientific rewards will be great.

COL. BURNER: Thank you, Dr. Howland. Our next speaker this afternoon will be Dr. Carpenter.

DR. R. L. CARPENTER (Tufts University): I am very grateful to Dr. Howland for having explained why I have had that tired feeling for so long. I thought it was spring and I welcomed it. Now I know it was just microwaves!

I would like to compliment Drs. Michaelson, Thomson, and Howland on the thoroughness of their report. Not only have they reported experiments done in their laboratory but they have very concisely summarized some of the work that has been done in other laboratories. I agree with Dr. Howland that much more remains to be done and many more unanswered questions must be answered. I think that we should be grateful to the U.S. Air Force which, through its program initiated in 1955, supported research in this field. Out of it came two things I consider of particular value. First, there were original findings. Second, during the years the program was in operation, annual conferences were sponsored at which the workers in the field could take their hair down and talk over and criticize work in progress and argue various points. I think these were most stimulating sessions and I think the work has suffered for their lack. I am grateful to the International Microwave Power Institute for providing us with a forum at this annual Symposium.

The early work, the biological experimental work for the last 20 years--since about 1947 or 1948--involved answering the question: does microwave energy do something to biological systems? Parenthetically, I suppose we should remind ourselves that it is the engineers who are polluting the atmosphere with their application of microwave radiation to commercial and industrial purposes. We get crisper potato chips, the chickens are fried better, and the paint is dried more rapidly. More and more achievements useful to man are being brought about through the application of microwave radiation, but at the same time the hazard to man is increasing as we add this one more factor in our ecology.

In the past twenty years, as I have already remarked, the bulk of the work has been devoted to finding out whether something happened. If you put an animal in a microwave field, you ask whether he becomes any different as a result. The literature which has been summarized in the report by Drs. Michaelson, Thomson, and Howland, as well as in a recently published volume on environmental biology, certainly shows that microwave radiation does have a biological effect. (P. L. Altman and D. S. Dittmer,



eds., "Environmental Biology," Federation of American Societies for Experimental Biology, Bethesda, Maryland, 1966; see esp. R. L. Carpenter and V. A. Clark, "Response to radio-frequency radiation," Table 31.)

One of the questions that was raised during this period was: is this merely a heating effect? Are we only cooking things? I think we have come to the conclusion, as Dr. Tomberg so well summarized in the earlier session today, that with all microwave radiation, there is a thermal effect. You can cook with it. But you can also, with careful planning of experiments, reduce the thermal factor or take it into account and still find effects that cannot be explained on the basis of microwave heating. Dr. Howland has reviewed this point. Whether accomplished by a change in the rotation of molecules or of certain radicals, there is an effect that is not due solely to heating of living tissues.

It seems to me that future efforts should be directed toward finding the biological site of action of microwave radiation and learning what is going on in a living tissue when it is in a microwave field. This is not going to be an easy problem to solve.

A point to which Dr. Howland referred, and which I think is still in great need of an answer because of its importance in determining what we are going to call "safe" levels of power density, is the question of pulsed-wave vs cw radiation. Are the biological effects always proportional to the average power? Certainly the thermal effect--microwave heating--appears to be but there is some suggestion that high peak powers may perhaps have a biological effect different from thermal action and that with high peak powers a biological effect can be produced at an average power which would yield no effect under cw conditions. I am not ready to be comfortable in a microwave field when I am told that the average power is safely below 10 mW/cm^2 but where I am being subjected to peak power many times that figure. I would prefer not to be there.

That brings up another point and one which I am not sure is susceptible of solution. We talk about power levels. What are we going to say about power levels and safe power levels? The Department of Defense has set up what is called a maximum safe power level of 10 mW/cm^2 , which is a power level measured by an instrument placed at a certain position in the field. Now take the instrument out of the field and put an animal in its place and the field is no longer the one which was measured; it is a

different field. We have found that we have to be very careful during experiments as to how we hold the animal in position for irradiation. We have found in an anechoic room that if the experimental animal is held in position by a Plexiglas support, for example, then the Plexiglas can bend or distort or even concentrate the radiant energy sufficiently to cause burning of tissue in a localized area. Anything that perturbs the microwave field can affect the field pattern and hence the radiation incident on the animal. You may have an apparently healthy experimental animal which has been irradiated; and a week or two later, suddenly an area of its facial skin falls off, revealing a sterile subcutaneous burn. Drs. Howland and Michaelson have described burns of this nature occurring in irradiated dogs, especially over the rib cage.

In our laboratory, Mr. Leslie Fisher has performed experiments which help explain the occurrence of facial burns in some of our rabbits. Using a scatter technique and employing as the scatterer a dipole of infinitesimal dimension and hence so small as not to perturb the field at 10 GHz, Fisher plotted power distribution under "free-space" conditions in our anechoic room and found it to be fairly uniform. He then placed a rabbit in the room with its right eye at the center of the field and upon again plotting the power distribution, found the pattern to be greatly distorted, with a zone of particularly high intensity directly over the animal's cheek. This was the site where microwave burns had most frequently occurred. The presence of the rabbit in the microwave field had changed the conditions of irradiation to such an extent that the power distribution was not predictable.

So I do not place much faith in statements regarding the power level because you cannot compare the power level given for one experiment with that given for another experiment, and I include our own levels in that statement.

If only an engineer would come up with an all-purpose power densimeter, accurate at all frequencies! Even then, you would have to measure the field strength with the animal and the instrument both in the field and you ought to keep the instrument in the field all the time to realize that during the course of an experiment, you may well have neither a uniform power distribution nor a constant one.

But I think the most important problem is to examine what is going



on at the cellular level when microwave radiation affects living tissue and I suspect this will mean that we will have to go to the biochemical or molecular levels to find out what is happening within the cells.

So far as possible, then, we can attempt to control the radiation field and its uniformity in the laboratory but I think Dr. Howland is absolutely right in saying that when we get out in the environment in which man walks and works and plays, we cannot control that environment and there are so many factors to mess it up that I do not see how we can ever say we are really safe. But that may be just one of the risks of living and they all seem to increase year after year.

COL. BURNER: Thank you, Dr. Carpenter. Next I would like to invite a couple of comments from members of the audience. As he is the senior author of the University of Rochester report, I would like to call first on Dr. Michaelson.

DR. S. M. MICHAELSON (University of Rochester): I would like to talk to you about some observations on the Soviet approach to investigation of the biological effects of microwaves. For those of you who are interested, Christopher Dodge at the Library of Congress has done an extensive translation of the Soviet literature in this area. (C. H. Dodge, "Biological effects of microwaves," Compilation of abstracts, Library of Congress, Washington, D.C., ATD P 65-68, 1965; 93 pp.) Of all the translations from various sources that I have read (and there are quite a few) I found his to be the most accurate. Most of what I am going to present is taken from the report by Christopher Dodge and Simon Kassel entitled "Soviet research on the neural effects of microwaves" (Library of Congress, Washington, D.C., ATD 66-133, 1966; 33 pp.). I would like to discuss some of the points that are made in this report and interject some of my own thoughts on the subject.

In general, Soviet and United States interest in biological effect of microwaves has increased since 1950. Although some Soviet investigators emphasize the thermal characteristics of microwaves, most of them discuss nonthermal aspects or specific microwave effects. Most recently the concept of microthermal effect has come into the picture. So apparently there is a dichotomy here even in the Soviet literature. The extensive amount of work on the biological effects of microwave exposure

that has been done in the Soviet Union is manifested by involvement of distinct Institutes that have assumed the leadership in this area and have developed a systematic approach to these investigations.

One of the striking things in reviewing the Soviet literature is that the functional changes due to microwaves are mostly referable to effects on the nervous, cardiovascular, and endocrine systems.

A. S. Presman is doing the most important research in the area of effects of microwaves on living organisms in the Soviet Union. Presman apparently is the leading interpreter of the effects of microwaves for the Soviets. In general, he believes that the stress stimulus from microwaves, no matter what the frequency or power level, comes not only from thermal receptors in the skin but also from other sensory skin receptors. In his reviews he usually discusses the impulses that flow from the skin receptors to the cortical areas of the brain and then to specific target organs or systems. This, in general, is the Soviet view of the effect of microwaves. [A. S. Presman, "Problems of the mechanism of the biological effect of microwaves," *Uspekhi sovremennoy biologii* (USSR) 5:161-179, 1963; see also Dodge, loc. cit.]

Another leading investigator is Yu. A. Kholodov, who emphasizes the neural effects of microwaves, most recently in his book "The Effects of Electromagnetic and Magnetic Fields on the Central Nervous System" (see National Aeronautics and Space Administration report NASA TT F-465, 1967), which is a very comprehensive review of the Soviet investigations in this area.

In reviewing the Soviet approach to this problem, one notes that it was not until about 1957 or 1958, when N. N. Livshits wrote two critical reviews of the effects of electromagnetic waves on the nervous system, that Soviet research in this area started expanding. ("The role of the nervous system in reactions to uhf electromagnetic waves," *Biofizika* 2: 378-379, 1957, Pergamon Press; and "The effect of an ultrahigh-frequency field on the functions of the nervous system," *ibid.* 3: 426-436, 1958.) It was about this time also that we became interested. In general he pointed out that Soviet research on neural effects of electromagnetic fields falls into the following categories.

- (1) Comparison on denervated and intact organs.
- (2) Use of neurotropic drugs or stimulants to amplify the neural

effect of the electromagnetic field.

(3) Comparison of the effects of electromagnetic fields with effects of stimuli such as heat and cold to demonstrate specific mechanisms of electromagnetic exposure.

The same basic approach is still true today among Soviet investigators.

In the last few years there has been a tremendous increase in research in this area which is mainly due, more or less, to refinement of some of the radioelectronic equipment and techniques that are now available.

One of the interesting things that has come out in the Russian literature within the last few years is the difference of opinion concerning the question of thermal vs nonthermal effects of microwaves. Yu. A. Osipov reviewed data as far back as 1933 relative to the effect of microwave energy on biologic systems. ["The health of workers exposed to radio-frequency radiation," in "Gigiyena truda i vliyaniye na rabotayuschikh elektromagnitnykh poley radiochastot" (Occupational hygiene and the effects of radiofrequency electromagnetic fields on workers), Leningrad: Izd. Meditsina, 1965; pp. 104-144.] He discusses well-known syndromes that the Soviets have frequently reported; namely loss of memory, headaches, insomnia, etc., all of which are related to cortical stimulation. Although one cannot measure temperature rise in individuals that have these symptoms which apparently are related to working in an electromagnetic field, Osipov feels that this is a reflection of the lack of precise instrumentation and he prefers to consider these changes as due to microthermal rather than nonthermal effects.

We thus have Presman, on the one hand, who still feels these symptoms are of nonthermal origin or specific effects of microwaves, and on the other, Osipov who introduces the concept of microthermal effects. Both Presman and Osipov interject a fair amount of objectivity into their reports. This makes the discussion more interesting.

Also of significance in reviewing the Soviet literature is that the Soviet military service regards the neural effects of microwaves no less seriously than does the civilian community. This has actually been reported in the Soviet journal of military medicine (I. R. Petrov and A. G. Subbota, "The influence of electromagnetic irradiation in the uhf range on the organism," *Voyennomeditsinskiy Zhurnal* 2: 16-21, 1966). So apparently



there is a unanimity of opinion as to the feeling that microwave-range electromagnetic fields above 10 mW/cm^2 constitute an occupational hazard and can affect the human central nervous system.

One thing I would like to emphasize in regard to the Soviet literature is that we have to be aware of Soviet biological research in general. Biological research in the Soviet Union is oriented towards the Pavlovian conditional response concept in which all biological activity is related to stimulation of the central nervous system. This is commonly known as nervism or higher cortical activity. Although many people in this country feel that there is a lack of reliability or validity in the Soviet investigations because of limited statistical analysis, inadequate controls, and difficulty in objective interpretation of the findings, it would be most unfortunate to dismiss the Soviet approach to these effects ipso facto. Although a lot of the findings are obscured by this concept of nervism, although there may be poor statistical interpretation of results, and although there may be a lack of objectivity in interpretation that makes the results questionable, I feel very strongly that the concepts the Soviets have developed should be investigated, either for refutation or for corroboration.

COL. BURNER: Thank you, Dr. Michaelson. In the interest of everyone wanting to speak we must move along. Dr. Heller, have you some comments that you would like to make?

DR. J. H. HELLER (New England Institute for Medical Research): I agree that the most vital thing is to try to find out what is going on. Certainly we do not know. In the last 5 years we have been constantly working to try and find out what is going on. I do not know that we are very much wiser now. During that period we have been working exclusively between 0.5 and 100 MHz. So there is one body of data in that frequency range and it is rather extensive.

The first thing I can say is that our experiments are nonthermal in terms of anything we have been able to measure either physically or biologically. We often set up an experiment where we place organisms in the field in addition to the material with which we wish to experiment. These organisms are quite heat sensitive. If there is micro-heating in one organism and not in the others there must be a peculiar dielectric structure which is going to be different from all the rest. However, we seem

to be well below any "biological" heating of significance, and in so far as we can measure, this is the nonthermal range.

In addition, one thing I must emphasize is that the concept of a simple calculation for safety on the basis of milliwatts per square centimeter is completely invalid, for in the range we are measuring, effects are frequency specific. We have shown frequency specificity in polystyrene colloids where there is an acute specificity. We found by accident that if we have a physical-chemical effect at 15 MHz, one that does not occur at 16 MHz, if we sweep to 16 MHz the effect is immediately obliterated. In other words, what we see at 15 MHz can then be changed in a colloid when we go above or below the critical frequency. I have not a clue as to whether those events we observed in physical or chemical or physical-chemical systems are analogous to those things we have seen in biological systems.

Here are some of the phenomena we have seen in biology. At very low field strengths, radio-frequency energy is mutagenetic. We have produced in vegetable, animal and human cells every type of chromosomal aberration that is seen with ionizing radiation and with several chemicals which also induce such changes. Radio frequency also produces mutations. We have collections of mutations between the 35 and 40 generations old in which there are dominant and recessive mutations, again similar to those induced by ionizing radiation. However, some induced mutations have never been seen before, so far as we know.

We see the same types of aberrations in animal and vegetable cells. Consequently we suspect we are looking at a physical interaction of some kind with material in a manner not dissimilar from other physical interactions.

Some of the effects we have seen, such as Dr. Howland mentioned, which are weird and which could fill many volumes of journals for nonreproducible data, have changed our mind as to how to approach these problems. Originally, when we began and found "nonreproducible" results we would drop it. Now we do not. We chase it to find out what we did right by mistake. However, effects of rf at relatively low energies in our systems work pulsed as well as cw. Frequency specificity seems to be extremely important. I would urge people to think about this seriously. Of course, when you get in the gigahertz range the frequency



flexibility is rather much. But if changes do occur so dramatically at 20 or 21 or 36 or 40 MHz, I think the burden of proof that nonthermal changes do not occur elsewhere in the microwave range must be carefully studied. These studies are time consuming, particularly when you study mutation. Though the mutation rate is 30 or 40 times normal, this means a tremendous number of animals--e.g., fruit flies--to be looked at. The types of changes that we see seem to be similar in animals, e.g., mice and rats, and in human, plant, and insect material. We have found that the needed energy and time in the field varies from one species to the next. But we do see changes. There seems to be some degree of frequency specificity. I submit that is a rather frightening concept as far as rf energy is concerned. However, I think these are some of the areas that need to be explored.



COL. BURNER: Thank you. I would next like to throw open the meeting to comment or discussion from the floor.

MR. DAVID THOMPSON (University of Puerto Rico): The first thing I would like to say is that there seems to be somewhat better balance in the Soviet program than in ours, Colonel. For some reason they do not seem to be ashamed of spinning off useful possible results from the application of microwaves. In other words, there are positive and there are negative types of things that you could get and it would be nice to be looking for both the positive ones and the negative ones.

There are two exceptions. One would be Professor Howland working on the observation of ionizing-radiation interactions with microwaves, which I think is a perfect example of a useful possibility. The other is the enhancement of the learning response which some of you may remember hearing about last year, the work of A. H. Frey. This was a learning response in rats--microwave irradiation resulting in the better retention of the behavior that was learned. In this case, the animal was shocked. If we can smarten up animals with microwaves I think this is a positive type of result.

So there are two ways of looking at the radiobiological effect. I wish we had certain aspects of the Soviet program ourselves. I do not think we should be ashamed talking about radio narcosis or any of these other things as though they were really weird but maybe should try to derive some benefits from them.

COL. BURNER: Thank you very much, sir. Dr. Susskind.

DR. SUSSKIND: I merely wanted to mention that Dr. Frey, who presented this paper last year, could not come to this conference. He has written me to say that he continues to be active in the field at Pennsylvania State College and I note that his most recent paper appeared in the Journal of Applied Psychology (23: 984, 1967), so we need not always restrict our reading to the medical and engineering literature. My own most recent report has to do with a case of burns received during a routine EEG procedure that were possibly caused by microwave interference (Medical Research Engineering 6, no. 4: 32, 1967).

MR. S. W. ROSENTHAL (Brooklyn Polytechnic Institute): Just a very short comment. Dr. Carpenter mentioned something about peak versus cw effect. We have been doing intensive work on the cataract genetic effects



on rabbit eyes. This has included a good amount of peak power and cw. To date, although we have only tried one value of power, namely 5 kW, we have found no difference at all. We tried to do something further with high peak and we had some difficulty with the equipment but we hope in the future to try again.

One other comment is that we have also done a very short experiment at 70 GHz. (That is a wavelength of about 4.3 mm.) We did produce quite an opacity at that frequency with some vascularization. We have not produced much at this frequency but we hope to do more.

I also want to comment on reviewing the Russian literature. Presman mentions millimeter work and I wondered if there were any comments.

DR. MICHAELSON: Presman does discuss it and he finds very definite neurological effects.

DR. HOWLAND: He attributes them entirely to nerve-end stimulation.

MR. ROSENTHAL: The only problem is that we have not very much power at the present time. But we are coming up from the other end with lasers.

MR. W. E. PACE (U.S. Atomic Energy Commission): One brief question to Dr. Heller. You stated you got an indication of specificity in your studies of mutagenetic effects. I wondered if you investigated the effect of the specificity on the suspending medium?

DR. HELLER: The suspending medium in all of these cases is air. We have done a large series of two studies with ionizing radiation and rf, one with ⁶⁰Cobalt and one with conventional X rays. In one case we found a synergistic effect and in another case a subtractive effect.

COL. BURNER: I think that is a good example of the way the field is confused.

MR. G. M. WILKENING (Bell Telephone Laboratories): I just want to make sure I have quoted Dr. Howland correctly. It is a number that I am not completely familiar with. He says you can produce cataracts using 400-mW/cm^2 pulses a few microseconds long. I would like to know a little more about that and whether it has special relevance for the proposed standard as an exposure criterion.

DR. HOWLAND: To the best of my knowledge--and Dr. Carpenter can correct as the eye is his province--the single dose required to produce cataracts is approximately 400 mW/cm^2 . The cataracts have been produced

following exposures at above 700 or 750 mW/cm² of total power. I think there are two cases of that order of magnitude.

MR. WILKENING: I do not understand that. I thought you mentioned the 100-mW/cm² power density with a pulse of a few microseconds, for what repetition rate or duration I do not know.

DR. HOWLAND: I do not recall the specific exposure duration.

DR. MICHAELSON: The early lenticular changes that subsequently regress which are reported by many investigators should not be called cataracts, as they are most likely due to tumescence of the lens. True cataracts are those lenticular opacities which do not regress in time. The designation of these early and transient changes as cataracts has resulted in considerable confusion regarding the effects of microwaves on the eye.

In our experiments with 2800-MHz pulsed (360 pps, 2-μsec pulse width), minimal power level for cataract production in the dog was 700 mW/cm², 20 minutes exposure. With 2800 MHz cw, cataracts were produced in rabbits at 160-170 mW/cm² exposure for 1 hr. These were permanent changes. Shorter exposures resulted in transient changes which regressed.

DR. CARPENTER: I would like to comment. Certainly one can produce an effect on the lens with a high amount of power in a brief time but, as Dr. Michaelson says, that is not a cataract; it is coagulation of the lens proteins. With enough power you can very quickly produce a white lens. That is not a cataract. It is an opaque lens certainly but a cataract is something that arises as an abnormality of the developmental process. These cataracts can be produced at various powers depending on the duration of exposure. We have produced, at low powers but long exposures such as an hour, repeated daily, very apparent localized cataracts. I would suspect that brief exposure at a high power such as has been mentioned produces a protein coagulation and not a cataract.

MR. ROSENTHAL: We have drawn up a whole set of these exposures and it runs from 1 watt for 3 or 4 min down to possibly 600 mW, which may be kept on for long periods of time without results.

MR. F. W. WAINWRIGHT (Canada Packers, Ltd.): Some of the papers report some effects as thermal and some as athermal. I wonder if Dr. Heller has any comment on which frequency would be most effective.

DR. HELLER: My comments are really preliminary because most of this



work was done by people in industry who wanted to use our gear to see if they could use our gear to kill their bugs. They claimed that different types of organisms could be eliminated from food samples at different frequencies. The only data I feel comfortable about is where there is no question a certain strain of staph. was killed. Ten degree temperature rise did not affect them and with the three degree rise it did not make a significant dent in their population.

COL. BURNER: How was the temperature measured?

DR. HELLER: By means of a thermistor, with the radiation temporarily cut off. These frequency ranges were somewhere between 35 to 50 MHz.

MR. T. L. WILSON (Chemetron Corp.): I am with an equipment manufacturer and somewhat out of my field here. As a matter of experience several of us in the audience have been working with radiofrequencies for years. I started in with a 50-kW transmitter at 19, unshielded and not very far from the antenna. Apart from losing my hair I feel pretty good. I wonder how or what you have been injecting into the organisms so you get these effects?

COL. BURNER: This is somewhat akin to the fact that some of us would like to die at 93 at the hands of an irate husband. That does not mean that all of us so engaged will be that fortunate.

DR. MICHAELSON: I was not going to address myself to the question of loss of hair [laughter] but interestingly enough the Russian work points out baldness as one of the manifestations of working in an rf field.

I would like to say something about this frequency specificity that Dr. Heller mentioned. We have seen this in the total animal. There is a very definite difference in the response between two frequencies at the same power level. It is hard to say which is more detrimental. It depends on which system you are looking at but there are very definite differences in total animal response.

DR. VICTOR TOMBERG (New York Medical College): First I would like to say to Dr. Heller's comment that these specific effects are frequency dependent, so frequency dependence does not mean you are necessarily seeing an athermal effect. You have to prove it is not thermal.

Then a general comment on Professor Howland's comment as to which areas we should work in. Even if we restrict ourselves to one area, the

very cosmetic!



area of biological hazards, I see it as a two-sided affair. The radiation has an undesirable effect but at the same time it can be a desirable effect when you use the same method to kill sickness, particularly cancer cells. The same destructive effect for normal persons can be curative for persons who are not healthy and have to be cured.

DR. CARPENTER: Mr. Wilson spoke about being exposed from early youth. At what frequencies?

MR. WILSON: It started out about 1 MHz, and in the last 25 or 30 years from 6 to 30 MHz.

DR. CARPENTER: I would not worry about a cataract at that frequency. Certainly at 400 MHz no cataracts have been reported and this frequency has been investigated considerably. The cataract range we have seen has been around 2 to 3 GHz.

DR. SUSSKIND: I think this points up a need for research on lower frequencies. We have all been preoccupied with microwaves and yet there is a problem right down to the broadcast band of 1 MHz. It is interesting to note that House Bill H.R. 10790 by Congressman Rogers of Florida declares that "the public health and safety must be protected from the dangers of radiation from electronic products." In other words, in this bill we are going to see some interest on the part of the Federal government in electromagnetic radiation. This is spelled out as follows: "the term radiation means any electromagnetic radiation including but not limited to ionizing radiation and sound radiation which can be generated in the operation of electronic products or devices." In other words, there is interest on the part of the Federal government in all this frequency range. [Note added in proof: the bill passed the House on 20 March 1968 and is now before the Senate in a slightly amended version sponsored by Senator E. L. Bartlett of Alaska, a copy of which appears as an Appendix.]

Furthermore, we are told that the National Institutes of Health are concerned with the possibility of extending their radiological work to nonionizing radiation. So I think we shall see in the very near future, in addition to this very good support that we have received from agencies of the Department of Defense and notably the United States Air Force in the past, also interest on the part of agencies such as the AEC and the NIH.

DR. CARPENTER: Could I say that the NIH is already supporting this

work? We have a grant from them purely for microwave work.

MR. L. A. MOE (Peavey Co.): I am a representative of industry, the grain and flour milling business, Minneapolis. During the past few years we have done considerable work on infestation control. I just wanted to take this chance to make a comment. A friend of mine is in the television manufacturing business and is slowly going mad over this term radiation. We have particle radiation supposedly, if you own a color television set, where we are going to be in trouble, fellows, and I think as an industry we have to get this clarified before we disturb our members out of their trousers. Many of them are attending meetings like this and do not understand these technical details.

Now the television industry has been given a maximum soft x-ray limitation of 0.5 millirem/hr and I think we have to be very careful we do not get apples and oranges in the same barrel. I do think we have to exercise judgment and be prepared not to scare the people. I agree with the man in the radio station who lived with a transmitter and a lot of ham operators have done the same. I have had a burn on my chin from that for many years.

COL. BURNER: I think this points up the fact that Mr. Rogers's bill is really an umbrella. Some of us who have an influence on the direction this might take would be well advised to exercise it. Any other comments?

COL. O. P. SNYDER (University of Massachusetts): I am formerly of the U.S. Army's Natick Laboratories. While I was there we became interested in finding out whether there would be a synergistic effect on microorganisms when they are subjected simultaneously to microwave and ionizing radiation. We had a device built by Raytheon that enabled me to get about 2 MW of peak power at 2 MHz into a sample. We stuck this in front of a linac and tested it. This was about 5 μ sec pulse time. We tested in conjunction and separately to see if we could get synergism. We never found any thermal effect or any kill effect other than simple ionization. The spores were inactive, dormant, and everything else when exposed. This is a very typical food situation where you are required to kill the microorganisms. So that means that it is not so good under these circumstances. It may be that the organism has to be viable or growing.

MR. M. R. PHARR, JR. (Gulf South Research Institute): We are doing



equipment experiments in the 24-GHz region and using the 10-mW/cm² microwave safety criterion. Is there evidence that this criterion no longer holds? Is there a better number and what is it?

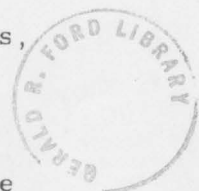
DR. HOWLAND: As far as we can tell we would not want to raise it above 10 mW/cm² in the present state of information.

DR. C. M. OLSEN (Varian Associates): I represent the manufacturer's side again. Much of the work we have been doing has to do with the treatment of various materials for industrial purposes. This work may involve drying, heating, cooking, and what not, of (very often) food products. One of the areas in which we are extremely interested, of course, has to do with bacteria or fungus control. Our work shows no special or deleterious effects; nothing particularly distinct or different from conventional thermal treatments. Most frequently we find temperature differentials between microwave and conventional heat treatments. In other words, we can kill an organism at a lower microwave-treatment temperature than with conventional means. Often this depends on the moisture content of the product or the food material itself. Moreover, one can carry out literature searches and find that the energy very often depends somewhat on size: the larger the microorganism, the greater the temperature differential between the microwave process and the conventional process.

So to sum up, our work shows nothing particularly mysterious in microwave processing other than a phenomenon we might call "preferential heating," i.e., heating to a higher temperature than the matrix. This result has been substantiated in studies on respiration and the coagulation or the state of coagulation in various organisms and correlating the degree of coagulation with things like water-bath treatments and so on. We find that the same amount of coagulation is present but the indicated temperature is much lower.

COL. BURNER: Thank you very much. I would like to carry the discussion on ad infinitum but unfortunately the room is required for others, so I would like to sum up.

Please remember I said initially that budgetary limitations are increasingly more severe. However, I think we all recognize that there are future directions which microwave research (and I include in this term lower frequencies as well) must address itself to, and we at the Aerospace Medical Division are anxious to find out from you people what these



standard

directions should be. Now unfortunately I am constrained here to say that in order to entertain suggestions for research there are definite procedures that must be followed. These are included in the pamphlet, "AFSC Guide For Unsolicited Proposals," a copy of which may be obtained from this office. My address is: Hq AMD (AMRB), Brooks Air Force Base, Texas 78235; I will be very happy to entertain correspondence from any of you. I welcome the opportunity to consider and discuss with you any such efforts which may advance our knowledge in this field.

There are future areas of effort which I think are very important. We are asking you people both in industry and in research to aid us in addressing ourselves to the problem.

Dr. Susskind, have you anything to say in closing?

DR. SUSSKIND: I want to thank the International Microwave Power Institute for this opportunity to hold this session here. In conclusion I shall call on the Chairman of the Symposium, Dr. Olsen.

DR. OLSEN: Thank you very much. Thank you all, gentlemen, for your contribution to our program. We appreciate it very much.

(The panel discussion adjourned at 5:30 P.M.)





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A Section-by-Section Comparison of

S.2311 S.2067 H.R. 10790

Three bills to provide for the protection of the public from radiation emissions from electronic products

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15 April 1968

Contents

Table with 2 columns: Section of bill, Page of Analysis. Rows include Short title, Congressional declaration, Definitions, Research, studies, information, Electronic product radiation control program, Standards, Performance standards, Imports, Inspection, records, and reports, Notification of defect in product and recall, Prohibited acts, Enforcement, Federal-State cooperation, Effect on State standards, Noninterference with other Federal agencies.





Three bills to provide for the protection of the public from radiation emissions from electronic products

(1)

S. 3211

Amends the Public Health Service Act to provide for the protection of the public health from radiation emissions from electronic products

Provides that the Act may be cited as the "Hazardous Radiation Act of 1968"

Sec. 2 amends Part F of title III of the Public Health Service Act by striking out the heading for that part and inserting:

"PART F-LICENSING AND PRODUCT REGULATION

Subpart 1-Biological Products"; and by inserting above the heading of section 353 the following:

"Subpart 2-Clinical Laboratories" and by adding at the end of part F: "Subpart 3-Electronic Products"

CONGRESSIONAL DECLARATION

Sec. 354 declares that the public health and safety must be protected from the dangers of radiation from electronic products and directs the Secretary to:

- (1) undertake and provide support and assistance for research and investigations relating to the biological effects and the control of radiation hazards
- (2) cooperate with public and private organizations
- (3) develop and enforce standards
- (4) otherwise carry out the provisions of this subpart

S. 2067

Provides for the protection of the public health from radiation emissions from electronic products which are in commerce or are imported into the United States

SHORT TITLE

Sec. 1 provides that the Act may be cited as the "Radiation Control for Health and Safety Act of 1967"

CONGRESSIONAL DECLARATION

Sec. 2 same as Administration, with the substitution of "administer" for "enforce"; (4) of S. 3211 omitted

H.R. 10790

Same as Administration

SHORT TITLE

Sec. 1 same as Bartlett, with exception of date, 1968

AMENDMENTS TO PUBLIC HEALTH SERVICE ACT

Sec. 2 amends Part F of title III by striking out the heading for that part and inserting:

"PART F-LICENSING OF BIOLOGICAL PRODUCTS AND CLINICAL LABORATORIES AND CONTROL OF RADIATION" and same subparts (1) and (2) as Administration; adds at the end of part F: "Subpart 3-Electronic Product Control

DECLARATION OF PURPOSE

Sec. 354 reiterates declaration of Administration bill, and directs the Secretary to:

- (1) establish an electronic product radiation control program to include
- (2) development and administration of performance standards and
- (3) undertaking by public and private organizations of research and investigation into effects and control of radiation emissions

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S. 3211

DEFINITIONS

[see page 23 of this analysis]

Sec. 355 (1) defines "radiation" as:

(A) any electromagnetic radiation, including but not limited to ionizing radiation, or

(B) any sound radiation generated or emitted during the operation of electronic products or devices;

Sec. 355 (2) defines "electronic product" as any manufactured product or device with an electronic circuit which during operation can generate or emit a physical field of electromagnetic or sound radiation;

Sec. 355 (3) defines "new electronic product" as an electronic product the equitable or legal title to which has never been transferred to an ultimate purchaser;

Sec. 355 (4) defines "manufacturer" as any person engaged in the manufacturing or assembling or electronic products, or importing such products for resale, or who acts for and is under control of any such person in connection with electronic product distribution;

Sec. 355 (5) defines "dealer" as any person engaged in the sale or distribution of new electronic products to the ultimate purchaser;

Sec. 355 (6) defines "distributor" as any person engaged in the sale and distribution of new electronic products to dealers either directly or through other distributors;

Sec. 355 (7) defines "ultimate purchaser" as the first person who in good faith purchases such product for purposes other than resale

S. 2067

DEFINITIONS

Sec. 3 (1) defines "Secretary" as the Secretary of Health, Education, and Welfare

Sec. 3 (2) defines "radiation" identically to Administration, with the omission of "or emitted"

Sec. 3 (3) defines "electronic product" identically to Administration, with addition of any X-ray device

H.R. 10790

DEFINITIONS

[see page 23 of this analysis]

Sec. 355 (1) defines "electronic product radiation" as:

(A) any ionizing or non-ionizing electromagnetic or particulate radiation, or

(B) any sonic or ultrasonic wave emitted as the result of electronic circuit operation

Sec. 355 (2) defines "electronic product" as any manufactured or assembled product which contains an electronic circuit and which emits electronic product radiation;

Sec. 355 (3) defines "manufacturer" with underlined portion of Administration definition; adds business of before "manufacturing"



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S. 3211

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H.R. 10790

Sec. 355 (8) defines "sale" to include a lease, lease-purchase, or equivalent arrangement under which an electronic product is made available to another user; also defines "purchase" and "purchaser"

Sec. 3 (4) same

Sec. 355 (4) same

Sec. 355 (9) defines "commerce" as (a) commerce between any place in any State and any place outside (b) commerce wholly within the District of Columbia

Sec. 3 (5) defines "State" to include the District of Columbia, Puerto Rico, the Virgin Islands, Guam, and American Samoa

Sec. 355 (5) same as Bartlett bill, with addition of Commonwealth of before Puerto Rico

[elsewhere in bill, defines "State" same as Bartlett bill; see page 23 of this analysis]

RESEARCH, STUDIES, INFORMATION

RESEARCH, STUDIES, INFORMATION

ELECTRONIC PRODUCT RADIATION CONTROL PROGRAM

Sec. 356 (a) same as House bill, with omission of underlined parts of that bill

Sec. 4 (a) same as Administration bill

Sec. 356 (a) directs Secretary to establish and carry out an electronic product radiation control program to protect the public health and safety and to:

(1) plan, conduct, coordinate, and support research, development, training, demonstrations, surveys, and other activities

(1) same as Administration bill, with omission of underlined words and substitution of and operational activities

(1) develop and administer performance standards

(2) maintain liaison with and receive information from industry, industry associations, and other organizations on present and future potential emissions

(2) same

(2) same as Bartlett

(3) same



S. 3211

Sec. 356 directs Secretary to:

(3) study and evaluate emissions and conditions and effects of exposure and their relation to control activities

(4) develop, test, and evaluate the effectiveness of procedures and techniques for minimizing radiation exposure

Sec. 356 (b) authorizes Secretary to:

(1) collect and make available the results of, and other information concerning, research and studies on nature, extent, and control of radiation hazards, including appropriate recommendations

(2) makes grants to public and private agencies, organizations, and institutions, and to individuals for purposes in (1), (3), and (4) of (a) above

(3) contract with public or private agencies, institutions, and organizations, and with individuals, without regard to sections 3648 and 3709 of the Revised Statutes (31 U.S.C. 529, 41 U.S.C. 5)

S. 2067

Sec. 4 directs Secretary to:

(3) essentially same as Administration bill, with omission of underlined words and substitution of epidemiological and bioeffects studies

(4) identical to Administration

Sec. 4 (b) authorizes Secretary to:

(1) identical to Administration

(2) same as Administration, with addition of nonprofit organizations and omission of (1) and (3)

(3) identical to Administration

H.R. 10790

Sec. 356 directs Secretary to:

(4) same as Administration, omitting and effects and control activities

(5) same, with addition of electronic product radiation

(6) consult and maintain liaison with Secretary of Commerce on (A) techniques, equipment, and programs for testing and evaluating radiation (B) development of performance standards

Sec. 356 (b) authorizes Secretary to

(1) essentially same as Administration, with addition of electronic product radiation hazards; adds more specific mandate for him to make such recommendations relating to such hazards and control as he considers appropriate

(2) same as Administration; for purposes of corresponding paragraphs (2), (4), and (5)

(3) identical to Administration



(5)

S. 3211

S. 2067

Sec. 356 authorizes Secretary to:

(4) procure (by negotiation or otherwise) electronic products for research and testing purposes, and sell or otherwise dispose of such products

STANDARDS

Sec. 357 (a) directs Secretary to by regulation prescribe such standards applicable to the emission of radiation from electronic products as he determines to be necessary to protect public health and safety. In the development of such standards, shall consult with appropriate interested persons, including representatives of industries which would be affected by such standards and including Federal agencies having related responsibilities or interests

STANDARDS

Sec. 5 (a) differs from Administration in use of rule for "regulation" and in omission of underlined words

H.R. 10790

Sec. 356 authorizes Secretary to:

(4) identical to Administration

PERFORMANCE STANDARDS

Sec. 357 (a) (1) essentially same as Administration, with addition of performance standards and substitution of if for "as"; omits underlined words of S. 3211 and requires that Secretary give consideration to:

(A) the latest available scientific and medical data in the field of electronic product radiation;

(B) the standards currently recommended by (i) other Federal agencies having responsibilities relating to the control and measurement of electronic product radiation, and (ii) public or private groups having an expertise in the field of such radiation

(C) the technical and economic feasibility of such standards as applied to a particular electronic product: and

S. 3211

S. 2067

H.R. 10790

Sec. 357 (a) (1) requires that the Secretary give consideration to:

(D) the adaptability of such standards to the need for uniformity and reliability of testing and measuring procedures and equipment

Sec. 357 (a) (2) provides that the Secretary may prescribe different and individual performance standards to recognize different operating characteristics and uses of different products

(3) exempts from performance standards prescribed here any electronic product intended solely for export if (A) labeled to so indicate, and (B) such product meets all applicable requirements of recipient country

(4) provides that Secretary may by regulation amend or revoke any performance standard prescribed under this section

Sec. 357 (b) provides that the provisions of section 553 of title 5, United States Code (re administrative procedure for rulemaking), and of chapter 7 of title 5 (re judicial review), shall apply with respect to any regulation prescribing, amending, or revoking any such standard

Sec. 5 (b) same

Sec. 357 (b) same





S. 3211

Sec. 357 (c) provides that each regulation prescribing, amending, or revoking such standard shall specify the effective date. Effective date of a regulation prescribing or amending may not be sooner than the 180th day or not later than one year after the day such regulation is issued, unless the Secretary finds, for good cause shown, that an earlier or later date is in the public interest and publishes his reason for such finding, in which such case such earlier or later date shall apply.

S. 2067

Sec. 5 (c) same as Administration, with rule replacing "regulation" and any preceding second "rule"

H.R. 10790

Sec. 357 (c) same as Administration, with difference in effective dates: not sooner than one year or not later than two years after date regulation is issued. Adds mention of Federal Register re publication of reason

Sec. 357 (d)(1) provides for filing of a petition with the U.S. court of appeals in appropriate circuit, for a judicial review of a regulation whose validity is controverted by any person who will be adversely affected by such regulation.

(2) provides for adducement of additional evidence by petitioner

(3) provides that upon the filing of the petition referred to in (1) that the court shall have jurisdiction to review the regulation in accordance with chapter 7 of title 5 of the U.S. Code and to grant relief as provided

(4) states that the judgment of the court affirming or setting aside any such regulation of the Secretary shall be final, subject to review by the Supreme Court



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Sec. 357 (d) (5) provides that any action instituted under this subsection shall survive, notwithstanding change in person occupying office of Secretary or vacancy

(6) states that remedies in this subsection shall be in addition to and not in substitution for any other remedies provided by law

Sec. 357 (e) provides for access to certified copy of transcript of record and administrative proceedings to any interested party and for its admissibility as evidence in proceedings arising under this subpart

Sec. 357 (f)(1) directs the Secretary to appoint a National Advisory Committee on Electronic Product Radiation Standards, to be consulted before prescribing any performance standard under this section (A)-(D) prescribes composition of the Committee

(2) prescribes compensation of Committee members

Sec. 357 (g) identical to S.2067

Sec. 357 (d) essentially same, with omission of underlined words and insertion there of to assure the adequacy of safeguards against hazardous radiation and

Sec. 5 (d) Directs the Secretary to review and evaluate on a continuing basis testing programs carried out by industry which are intended to assure that electronic products comply with standards prescribed under this section.



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Sec. 357 (e) requires every manufacturer of an electronic product to which a standard in effect under this section is applicable, furnish to the distributor or dealer at the time of delivery the certification that each product conforms to all applicable standards and has been tested in compliance with such standards. Such certification shall be in the form of a label or tag permanently affixed to the product.

IMPORTS

Sec. 358 (a) differs considerably from other two bills; first, in the omission of underlined provisions of S. 2067; other differences or additions are underlined in the following provisions of this bill:

provides that a new electronic product offered for importation into the U.S. which fails to comply with an applicable standard of this subpart, or to which is not affixed a certification as provided above, shall be refused admission into the United States;

if an electronic product is finally refused admission, the Secretary of the Treasury shall cause disposition thereof in accordance with the customs laws unless it is exported within ninety days, or such additional time as may be permitted under regulations prescribed by the Secretary, except that disposition in accordance with customs laws may not be made in such manner as may result, directly or indirectly, in the sale to an ultimate purchaser of a new electronic product that fails to comply with applicable standards;

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IMPORTS

Sec. 6 (a) directs the Secretary of the Treasury to deliver to the Secretary of HEW, upon the latter's request, samples of electronic products which are being imported or offered for import into the U.S., giving notice thereof to the owner or consignee, who may have a hearing before the Secretary of HEW; provides that if it appears from an examination of such samples or otherwise that any electronic product fails to comply with applicable standards, unless subsection (b) of this section is complied with, such product (1) shall be refused admission, and

(2) the Secretary of the Treasury shall cause the destruction of such product unless exported within ninety days, or within such additional time as may be permitted by regulations prescribed by the Secretary;

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Sec. 359 (a) identical to Bartlett bill

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Sec. 358 (a) states that a joint regulation of the Secretaries of HEW and the Treasury may provide for deferring final determination as to admission and authorizing delivery as may appear to them appropriate to insure that such product will be brought into conformity with applicable standards;

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Sec. 6 (b) provides that if it appears to the Secretary of HEW that any electronic product refused admission under above provisions can be brought into compliance with applicable standards, final determination as to admission may be deferred upon filing of timely written application by the owner or consignee and the execution of a good and sufficient bond providing for the payment of such liquidated damages in the event of default as the Secretary may be rule prescribe.

Sec. 6 (c) provides for expenses in connection with destruction, supervision of operations, and storage, cartage, or labor (re product refused admission) to be paid by the owner or consignee. In the event of default, these expenses shall constitute a lien against future importations

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Sec. 359 (b) identical to Bartlett bill

Sec. 359 (c) identical to Bartlett bill

Sec. 358 (b) requires that every manufacturer offering a new electronic product for importation designate in writing an agent who is served all administrative and judicial processes, notices, orders, decisions, and requirements in behalf of a manufacturer; such designation is filed with the Secretary. In default of such designation, processes, notices, orders, etc., may be posted in the Office of the Secretary or in a place designated by him.

INSPECTION, RECORDS, AND REPORTS

Sec. 359 (a) authorizes the Secretary to conduct inspections and investigations





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INSPECTION, RECORDS, AND REPORTS

Sec. 359 (b) authorizes officers of employees designated by the Secretary, upon presenting credentials and a written notice to the owner, operator, or agent in charge,

(1) to enter, at reasonable times, any factory, warehouse, or establishment manufacturing electronic products or holding them for introduction into commerce or for sale after introduction, and

(2) to inspect such factory, warehouse, or establishment with reasonable promptness;

Sec. 359 (c) same as Bartlett bill, with omission of underlined portions of that bill, substitution of electronic products for first portion and substitution of the following portion for "Act" :

this subpart and standards prescribed pursuant to this subpart, and shall, upon request of an officer or employee duly designated by the Secretary, permit such officer or employee to inspect appropriate books, papers, records, and documents relevant to determining whether such manufacturer has acted or is acting in compliance with standards prescribed pursuant to this subpart.

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RECORDS AND REPORTS

Sec. 7 requires that every manufacturer of any electronic product which is subject to standards prescribed under section 5 establish and maintain such testing records, make such reports, and provide such information as the Secretary may by rule reasonably require to enable him to determine whether such manufacturer has acted or is acting in compliance with this Act.

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RECORDS AND REPORTS

Sec. 360 (a) same as Bartlett, with regulation substituted for "rule" in S.2067, and with subpart substituted for "Act"

Sec. 360 (b) states that the Secretary may by regulation

(1) require retailers of color-television receivers, to which there is applicable a stand-



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and prescribed pursuant to section 357, to furnish manufacturers of such receivers such information as may be necessary to identify and locate the first purchasers for purposes other than resale, and

(2) require manufacturers to preserve such information

Sec. 359 (d) requires every manufacturer of electronic products to provide to the Secretary such performance data and other technical data related to performance and safety as may be required;

authorizes the Secretary to require the manufacturer to give such notification of performance and technical data at the time of original purchase to the ultimate purchaser as he determines necessary.

Sec. 359 (e) assures that all information reported pursuant to subsection (b) or (c) which contains or relates to a trade secret shall be considered confidential, except that such information may be disclosed to other officers or employees when relevant to any proceeding under this subpart;

states that nothing in this section shall authorize the withholding of information by the Secretary, or any officers or employee under his control, from the duly authorized committees of the Congress

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