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Project Summary

Radiofrequency Radiation Exposure Facilities for Bio-Effects Research

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This report describes the multi-user radiofrequency radiation exposure facilities for bio-effects research in use at the Health Effects Research Laboratory, Research Triangle Park, NC. Four facilities are described: (1) a 100 MHz CW exposure system, (2) a 2450 MHz CW exposure system, (3) a 2450 MHz AM exposure system, and (4) an X-band pulsed RF exposure system. In the final report, the individual facility descriptions include construction details, specifications, photographs, circuit drawings and block diagrams. All of the facilities incorporate environmental control systems, and three have RF power-level regulation.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

One of the missions of the Environmental Protection Agency (EPA) is to investigate the effects of radiofrequency radiation (RFR) exposure on biological organisms. The EPA has been involved in this effort since its creation in 1970. This report focuses on the major RFR exposure facilities in use by the Health Effects Research Laboratory at the Research Triangle Park, N.C.

The operating frequency of an exposure system determines to a large degree the types of exposure systems that can be employed. For example, transverse electromagnetic mode transmission lines (TEM cells) are generally not useful above approximately 1 GHz because of the small size required to prevent the propagation of unwanted higher order modes. Likewise, anechoic chambers become impractical and expensive below about 400 MHz because of the large size of the anechoic material and the chamber itself. Selection of the operating frequency generally results from one of two motives: (1) a facility is designed to simulate some environmentally occurring exposure situation over some narrow portion of the RF spectrum, or (2) an exposure system is designed which maximizes the chance of observing an effect based on a theoretical model and therefore the research leads to a better understanding of the mechanisms of interaction.

Four exposure facilities are described in this report. Each is a large, multi-animal exposure system available to all the research staff who quite frequently design multidisciplinary studies with these facilities. All of these systems are located in the same "high-bay" room which has been equipped with an auxilliary air conditioning system to precondition the air. The first facility constructed was the 2450 MHz CW exposure system. 2450 MHz has become the defacto reference frequency in biologic effects research. Probably more work has been done at this frequency than at any other, and most laboratories involved in the research have had a facility at this frequency. This happened largely for three reasons: (1) the availability of relatively low cost, high power RF sources since 2450 MHz is an

ISM band frequency (an ISM band frequency is one of a number of frequencies reserved for use by the industrial, scientific, and medical communities by the F.C.C.); (2) the excellent coupling of this frequency to laboratory animals and (3) the projected explosive growth in sales of microwave ovens, possibly leading to the exposure of a significant portion of the population to low-level radiation.

The X-band exposure facility, which became operational in 1974, was designed to simulate the RFR generated by radar systems. Acquisition, naval ship, aircraft and small marine radars all operate in the 8.5 to 9.6 GHz range covered by our system. The first from the list above was the primary consideration motivating the design of this facility. At this high frequency, depth of penetration of the RF energy into a biological target is poor; however, these frequencies are in extensive use in the environment and the system provides a tool to investigate the effects of high peak to average power ratio fields on biological organisms.

The 100 MHz exposure facility was designed to provide an irradiation facility in the environmentally significant FM band of radio frequencies. Radiation from these sources is deliberately beamed toward population centers for use in FM radiobroadcasting and is one of the more significant sources of manmade RFR in human exposures[1]. This, coupled with research studies showing the resonance of the human body lies in the FM band[2], were strong arguments for EPA to examine frequencies in this band for potential biologic effects.

The 2450 MHz AM facility was constructed for several purposes: (1) EPA agreed to investigate for the Department of Energy the biological impact of the use of solar power satellites which would collect solar energy using satellites in geosymchronous orbit, convert this energy to microwave energy at a frequency of 2450 MHz and beam it down to earth to be collected by large arrays of antennas, (2) studies were published reporting effects with low-level amplitude modulated RFR. Because virtually all of the U.S. population is exposed to low-level amplitude modulated RFR, the EPA has been interested in these reports.

The systems used for RFR biologic effects studies are largely custom designed to tailor the system characteristics for the special needs of biological effects research. A prime example of this is the power level stability of RF sources. In most commercial medium and high power RF generators and amplifiers, the RF power output is seldom regulated. The usefulness of an airport radar or an industrial microwave oven is not seriously compromised if the RF power output drifts by 10% to 20%. However, such a drift is of obvious concern in biologic effects studies since the absorbed energy is directly related to the stability of the RF source. Other features that are important in the design of RFR exposure facilities are: (1) provisions for environmental control, (2) spectral purity of the RF source, (3) personnel safety, (4) provision for automatically timed exposures and (5) RF field uniformity. The latter has become less important in recent years as the state of the art has advanced both in the determination of whole-body specific absorption rate (SAR) and localized SAR. As more becomes known about the effects of low-level amplitude modulated RFR, control of the spectral purity of test generators may grow in importance. For this reason, we have tried to characterize the spectral content of the sources used here where possible.

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The complete report, entitled "Radiofrequency Radiation Exposure Facilities for Bio-Effects Research," (Order No. PB 83-229 591; Cost: $10.00, subject to change) will be available only from:

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