AN OVERVIEW OF SATELLITE POWER SYSTEMS--MICROWAVE HEALTH AND ECOLOGY PROGRAM

INVITED PAPER

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ABSTRACT

The Satellite Power System (SPS) is a concept under consideration by the Department of Energy (DOE) for its potential as an alternative source of energy. In the basic system design for SPS, solar energy will be converted to microwave energy and transmitted to receiving antennae on earth. The microwave power transmission system presently under consideration would employ continuous (CW) 2450 MHz radiation. The main beam power densities within a control exclusion zone at a rectenna site are anticipated to range up to 23 mW/cm^2. Scatter from the main beam, side lobe radiation, and antenna reradiation would also result in low level microwave exposures of the general public and the ecology outside of the controlled area. Many questions regarding health and ecological impacts of low to moderate exposures to microwaves must be addressed in assessing the feasibility of the SPS as an energy alternative. The overview will present the organization, philosophy, and program direction of the SPS microwave health and ecology program.

The Satellite Power System (SPS) is a concept under consideration by the Department of Energy (DOE) for its potential as a source of energy. The present system design envisions a satellite in geosynchronous orbit with a planar solar array of 55 square kilometers serving as a solar energy collector. The solar flux would be converted through photovoltaic processes to microwaves. A one kilometer diameter phased array microwave antenna, using klystrons as power amplifiers and slotted wave guides as radiating elements, would direct the energy to a rectenna site on earth. An operating frequency of 2450 MHz CW is considered optimum at this time for a microwave power transmission system because of the relatively low atmospheric transmission loss and its present allocation as an ISM frequency in the United States. The design calls for delivery of 5 Gigawatts of electrical energy at the utility interface.

The Department of Energy has organized the SPS Program along four major lines: Systems definition and environmental, societal, and comparative assessment. Within the environmental assessment area are research tasks focusing on the microwave and non-microwave health and ecological impacts, as well as the potential for RFI and EMI and atmospheric effects.

The necessity for considering the potential microwave health and ecological effects of the SPS is based on the anticipated power levels which the SPS antenna will radiate. It is expected that the maximum ground level power density would be 23 mW/cm^2 at the center of a 10 by 13 kilometer rectenna and 1 mW/cm^2 at the edge. Beyond the controlled area of the rectenna site the general public and the environment would be continuously exposed to low level 2450 MHz radiation ranging from nanowatts to tens of microwatts/cm^2. Based on the experience and expertise gained in operating a substantial intramural microwave health effects research program, the Environmental Protection Agency (EPA) was requested by the SPS Program Manager of DOE to oversee and direct the microwave health and ecology aspects of the environmental assessment.

In order to develop a comprehensive plan for assessing the effects of SPS-generated microwaves, we decided that expert advice from outside the EPA was required to discharge our responsibilities to DOE. A group of consultants has been assembled which both complements and supplements our own expertise, especially with respect to the ecological aspects.

Public acceptance of the SPS is crucial to the viability of the concept. This can only be gained if a number of important issues are addressed and satisfactorily answered. Some of the most basic questions revolve around the microwave health and ecology issues. In drafting a Program Plan we decided to focus on two general problems facing the SPS program. In essence, these are what we already know and what we don't yet know. Specifically, there is a need to investigate those apparently credible reports of certain biological effects occurring at 2450 MHz which have not yet been independently corroborated and in addition we need to examine the specific questions resulting from the operation of an SPS system. The Program Plan can be resolved into two general areas; the effects of intermittent, short term exposures at moderate-to-low power densities (1-23 mW/cm^2) as expected within the rectenna exclusion zone; and the effects of continuous, long term exposures at low-to-extremely low power densities.

At its earliest, the SPS is projected to become operational by the year 2000. Considerable commitments would be required in terms of time, money, manpower, and natural resources over the course of the transition from concept to reality. Estimates of the total dollar costs including the research and development to deploy the first satellite are on the order of 95 billion dollars. Thus, it is imperative that it be established as early as possible whether the SPS concept is a viable one.

In the microwave health and ecology area, the initial approach is to focus on short-term, moderate-to-low level exposures to 2450 MHz CW radiation and to attempt to define thresholds for effects on biological systems. Research proposals are being solicited in five key biological areas: The effects of SPS-specific microwaves on airborne biota and on behavioral, teratologic, immunologic, hematologic, and central nervous system endpoints in mammals. In addition, research on the relative biological effectiveness of unipath and multipath radiation exposure and a quality assurance task complete the initial phase of the microwave health and ecology program.

The data from these research projects is expected to have considerable bearing on the outcome of an assessment of the SPS concept to be conducted during 1980.

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