

HEALTH ASPECTS OF SOLAR POWER SATELLITE ASSOCIATED MICROWAVE POWER TRANSMISSION

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Abstract:

The concept of solar-power satellites (SPS) and wireless-power transmission (WPT) envisions the generation of electric power by solar energy in space for use on earth. The system would involve placing a constellation of solar power satellites in geostationary Earth orbits. Each satellite would provide 1-5 GW of power to the ground, using a 2.45 or 5.8 GHz microwave beam. The power-receiving rectenna on the ground would be a structure measuring several kilometers in diameter. The higher (5.8 GHz) frequency has been proposed since it has a similar atmospheric transparency, and would involve a reduced size for the transmitting and receiving antennas. The proposed limit for the "center-of-beam" power densities is up to 250 W/m^2 for microwave transmission. The power density is projected to be 1.0 W/m^2 at the perimeter of the rectenna. Beyond the perimeter of the rectenna or 15 km, the side lobe peaks would be less than 0.1 W/m^2 at 2.45 GHz. The ICNIRP guidelines are 50 or 10 W/m^2 for occupationally exposed vs. the general public, at either frequency. The corresponding limits for IEEE standards for maximum permissible human exposure to microwave radiation, at 2.45 or 5.8 GHz, are 81.6 or 100 W/m^2 as averaged over six min, and 16.3 or 38.7 W/m^2 as averaged over 30 min, respectively, for controlled and uncontrolled environments (occupational and general public). Clearly, beyond the perimeter of the rectenna, the potential exposure would be well below that currently permissible to the general public.

At the center of the microwave beam, power densities would be greater than the permissible level of exposure for controlled situations. Except for maintenance personnel, human exposure would normally not be allowed at this location. In the case of occupationally required presence, protective measures, such as glasses, gloves and garments could be used to reduce the exposure to a permissible level. However, above the rectenna, where the power density may be as high as 250 W/m^2 , research has shown that some birds exhibit evidence of detection of the microwave radiation. This suggests that migratory birds, flying above the rectenna, might suffer disruption in their flying paths. Moreover, at higher ambient temperatures, larger birds tend to experience more heat stress than smaller ones, during 30 min of exposure. This result is consistent with the knowledge that the larger birds, having a larger body mass, absorb a relatively greater quantity of microwave radiation than do the smaller birds. The additional heat, from microwave energy deposited inside the body, is stressing the thermal regulatory capacity of the larger birds.