EVOLUTION of THERMAL CYCLING TECHNIQUES for AEROSPACE SOLAR PANELS

ROBERT W. FRANCIS,[1] CHARLES SVE[2] and TIMOTHY S. WALL[3]

[1]THE AEROSPACE CORPORATION
Mail Station M4-986
2350 E. El SEGUNDO Blvd.
El SEGUNDO, CA 90245-4691
USA

[2]THE AEROSPACE CORPORATION
2350 E. El SEGUNDO Blvd.
El SEGUNDO, CA 90245-4691
USA

[3]THE AEROSPACE CORPORATION
2350 E. El SEGUNDO Blvd.
El SEGUNDO, CA 90245-4691
USA

Over the past fifteen years spacecraft for weather, navigation, reconnaissance, surveillance, and communication have grown in payload capability and mission life. A primary factor for these enhancements is a direct result of technical advances made over this time frame in power source efficiency and energy density, as well as, energy component conversion and system design improvements. Present day communication satellites have primary power capacity of 20 kilowatts; whereas, a decade ago less than 5 kilowatt spacecraft were available. Photovoltaic solar arrays are the primary power source for earth orbiting spacecraft. Over the last fifteen years electrochemical and solid-state science and technology has enabled solar arrays to be designed with areal power densities of over 300 Watts/M2 and specific powers greater than 150 Watts/Kg. The specific performance enhancements depend on the solar cell efficiency, structural materials, and deployment mechanisms incorporated into the solar array design to meet mission requirements. The evolution and production availability of advanced high-efficiency semiconductor solar cell devices, strong and lightweight substrates, and durable adhesive and bonding materials have enabled these high power solar arrays. The production of high performance power subsystems requires new processes and integration techniques for these solar array components to withstand the rigors of the space thermal environments. This paper describes a new solar panel thermal cycle test and evaluation facility which accurately demonstrates, verifies, and simulates spacecraft thermal conditions by uniquely controlling temperature uniformity and thermal transfer. Chamber designs, in-situ measurement capabilities, and their evolution to timely meet the thermal stress life cycle qualification testing and production schedules imposed in todays cost conscious environment for 10 and 15 year mission military, civilian, and commercial satellites are presented.