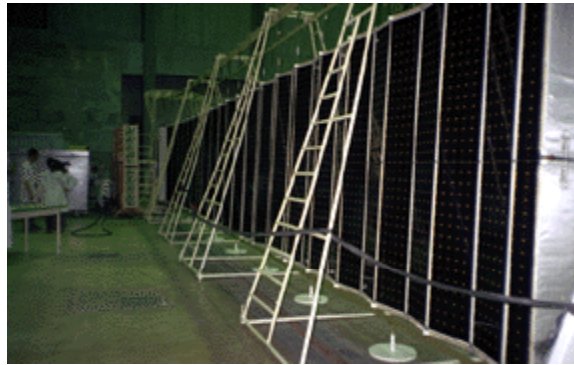


# Mir Cooperative Solar Array

The Mir Cooperative Solar Array (MCSA), produced jointly by the United States and Russia, was deployed on the Mir Russian space station on May 25, 1996. The MCSA is a photovoltaic electrical power system that can generate up to 6 kW. The power from the MCSA is needed to extend Mir's lifetime and to support experiments conducted there by visiting U.S. astronauts. The MCSA was brought to Mir via the Space Shuttle Atlantis on the STS-74 mission, launched November 12, 1995.

This cooperative venture combined the best technology of both countries: the United States provided high-efficiency, lightweight photovoltaic panel modules, whereas Russia provided the array structure and deployment mechanism. Technology developed in the Space Station Freedom Program, and now being used in the International Space Station, was used to develop MCSA's photovoltaic panel. Performance data obtained from MCSA operation on Mir will help engineers better understand the performance of the photovoltaic panel modules in orbit. This information will be used to more accurately predict the performance of the International Space Station solar arrays. Managed by the NASA Lewis Research Center for NASA's International Space Station Program Office in Houston, Texas, the MCSA Project was completed on time and under budget despite a very aggressive schedule.



*MCSA deployment test in Russia.*

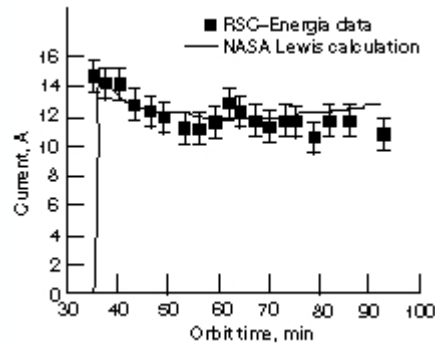
The MCSA (see the photo) has 42 panels hinged like an accordion and is about 2.7-m (9-ft) wide and 18-m (59-ft) long when deployed. Each panel consists of two photovoltaic panel modules (PPM's) mounted side by side. A PPM is a collection of 80 large-area silicon solar cells in a 5- by 16-cell matrix. The entire solar array contains 6720 solar cells, which are mounted on a flexible film and wired in series via a flat printed copper circuit. Each PPM is secured to a Russian-built support structure at fastening points on the corner of each cell. To fit the PPM into existing frames, we shortened the row of cells at each end of the PPM by 0.5 cm (0.2 in.). A support ring was placed on the back of each cell to increase the stiffness of the flexible solar cell substrate and help reduce the acceleration, or g-loads, experienced during their launch on the space shuttle.

To assure that no problems would occur when the U.S. PPM was integrated with the Russian composite frame, we performed an accelerated-life thermal cycle test. For this test, a U.S.-made 15-solar-cell coupon was integrated with a Russian-made structure

frame to form a "minipanel" that was subjected to 24,000 temperature cycles alternating between 80 and -100 °C. At about 90 min per orbit, 24,000 such cycles correspond to a 4-year life.

Taking advantage of NASA Lewis' unique expertise in space photovoltaic power systems, a team from Lewis performed a "dark" electrical test on the MCSA's flight unit (ref. 1) while it was stowed and awaiting launch in the Space Station Processing Facility at the NASA Kennedy Space Center. The primary objective of the test was to assess the overall electrical performance condition of the flight array, after handling and shipment from Russia to Kennedy, without having to deploy and illuminate it (hence, the "dark" test designation). The successful application of the dark test technique indicated that the MCSA's condition was nominal and was ready for launch.

The MCSA has been producing electrical power since its deployment on Space Station Mir. Currently, approximately half of the MCSA (38 of 84 PPM's) is providing electrical power to Mir. In June 1996, the Russians obtained estimates on a number of operating MCSA segments; they provided the preliminary MCSA performance data to NASA Lewis. This preliminary data compares well with Lewis' state-of-the-art space power computer model (see the graph).



*Comparison of NASA Lewis' electrical performance prediction with on-orbit measurements made by RSC-Energia for a segment of the MCSA known as "GS10."*

The Russians will measure the MCSA's performance again in the fall of 1996, after the remainder of the MCSA is connected, and once more in the fall of 1997. In this way, the performance of the MCSA over time in the space environment can be measured and compared with analytical models. The models can then be refined on the basis of actual on-orbit data from a large space vehicle.

## Reference

Kerslake, T.W.; Scheiman, D.A.; and Hoffman, D.J.: Dark Forward Electrical Testing on the Mir Cooperative Solar Array. Research & Technology 1996. NASA TM-107350, 1997, pp. 157-158. Available WWW:

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