

SPECIFIC SPS CONSTRUCTION STUDIES: OPERATIONS AND MAINTENANCE

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The overall scope of the Solar Power Satellite program operations is depicted in Figure 1. These operations involve many surface as well as in-space operations. In this discussion, we will take a look at these operations using the 12th year of commercial operations as a model. During this time period, the primary end products of SPS industrial enterprise are the following: 1) operation and maintenance of 20 satellites, 2) completion of a new SPS and its ground receiving antenna every 6 months, and 3) construction of electric cargo orbital transfer vehicles (EOTV's) at the rate of one vehicle every 45 days. EOTV's are not constructed every year of SPS operations; we have selected a year including EOTV construction for completeness.

During the 12th year of commercial SPS operations, the industrial infrastructure will be producing the materials and components required to support the space construction and ground receiving station construction operations. Studies have shown that the production of photovoltaic cells and blankets will be the most significant new industrial enterprise. Certain other subsystems will require the development of significant new industrial capacity, but the SPS demand seems reasonably comparable with projected capacity to serve other markets. Most of the components can be shipped by rail or truck. A couple of very large components will have to be shipped by barge or ship.

Each ground receiving station includes the land area, rectenna, utility interface equipment, and control and communications systems. The land sites are 13.2 x 18.7 km (nominal at 35° latitude) and each rectenna is 9.9 x 14 km. Each ground receiving station would be constructed over a 24 month period. Four of these sites would be in work simultaneously so that the receiving stations are brought on-line at the rate of one every 6 months (the same as the SPS construction rate).

Satellite components and propellants are delivered to the launch site at the Kennedy Space Center. Heavy lift launch vehicles are loaded with 1 million pound payloads. There will be 1 or 2 launches each day from three off-shore launch pads. Space crews are launched by a dedicated vehicle.

The cargo and crews are delivered to a low Earth orbit staging base (the LEO Base shown in Figure 2). Some of the cargo and crew remain at this base where electric orbital transfer vehicles (EOTV's) will be constructed at the rate of one vehicle every 45 days. The majority of cargo is transferred to an EOTV which is flying in formation with the base. The EOTV's will deliver the cargo to the geosynchronous Earth orbit base (the GEO Base). Crews will be delivered to GEO by dedicated personnel orbit transfer vehicles (POTV's). There will be approximately 230 people at this base.

The GEO base is shown in Figure 3. This base is used to construct the solar power satellites, and to support the SPS maintenance operations. The SPS construction operations are conducted at a rate to produce a new satellite every 6 months. The solar array portion of the satellite and the antenna are constructed simultaneously in the two main construction areas on the base.

The satellite maintenance operations include two primary sub-operations: 1) The

maintenance that is performed at the satellites, and 2) the refurbishment of defective satellite components at a maintenance depot on the GEO Base.

A crew of maintenance workers are delivered to the GEO Base twice a year. These crew members are then delivered to an operational satellite along with some maintenance equipment and some replacement parts. Over a 3½ day period, defective components are removed and replaced with new ones. The defective components are returned to the GEO Base. The crew, mobile maintenance equipment, and replacement parts move on to the next satellite. They repeat these maintenance operations as they visit 20 satellites over a 90 day period. The crew and equipment are returned to the GEO Base at the end of their tour and the crew is returned to Earth.

At the GEO Base, the defective components are delivered to maintenance modules. These parts are individually tested to diagnose their fault conditions and then they are sent through a production line where they are torn down to the extent required to replace the defective components. The components are then reassembled and tested. They are then returned to storage for eventual delivery to the satellites for reuse.

The space crews work on a 6-day-per-week, 10-hours-per-day work schedule. They are returned to Earth after 90 days and are replaced by crew members who have been on Earth for 90 days.

Each of the operational satellites beam power back to its ground receiving station where the microwave energy is converted to electrical energy which is then delivered into the utility power grid.

All of these operations are coordinated and controlled by operations control people, facilities, and systems.

Table 1 shows our estimate of the total number of people who will be directly involved in the SPS program during this 12th year of production.

Reference: Solar Power Satellite System Definition Study, Vol. III, Phase II Final Report, Operations and Systems Synthesis, (Contract NAS9-15636), The Boeing Aerospace Company, D180-25461-3, December 1979.

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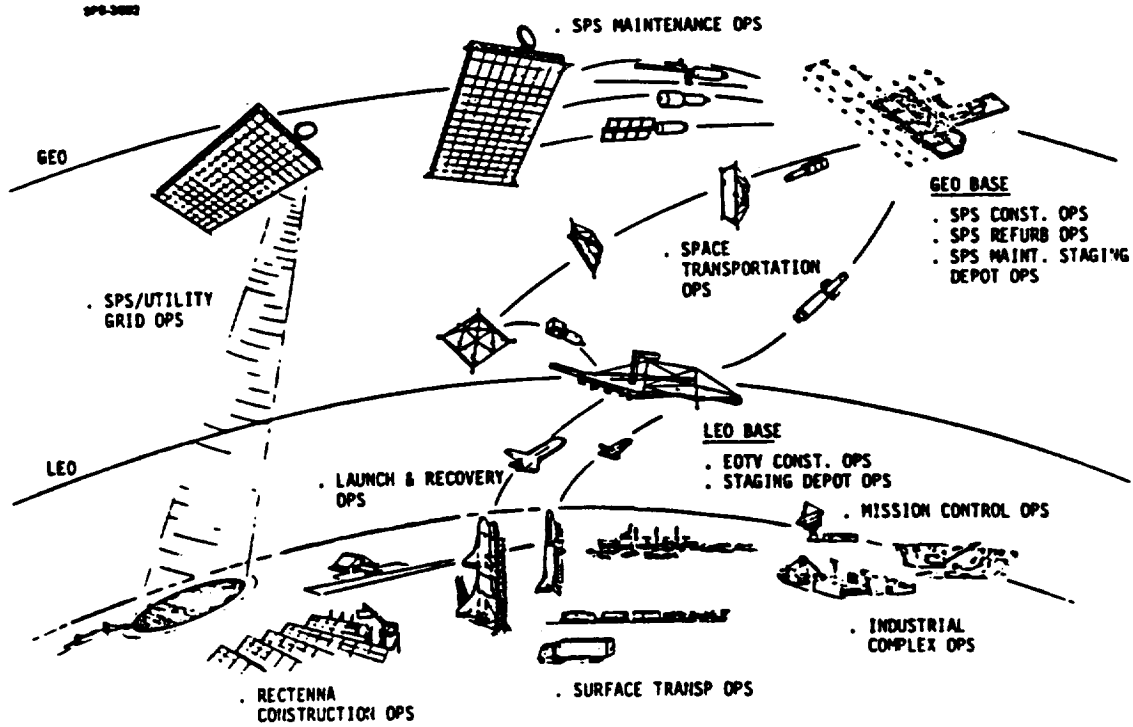


Figure 1 - Integrated SPS Program Operations

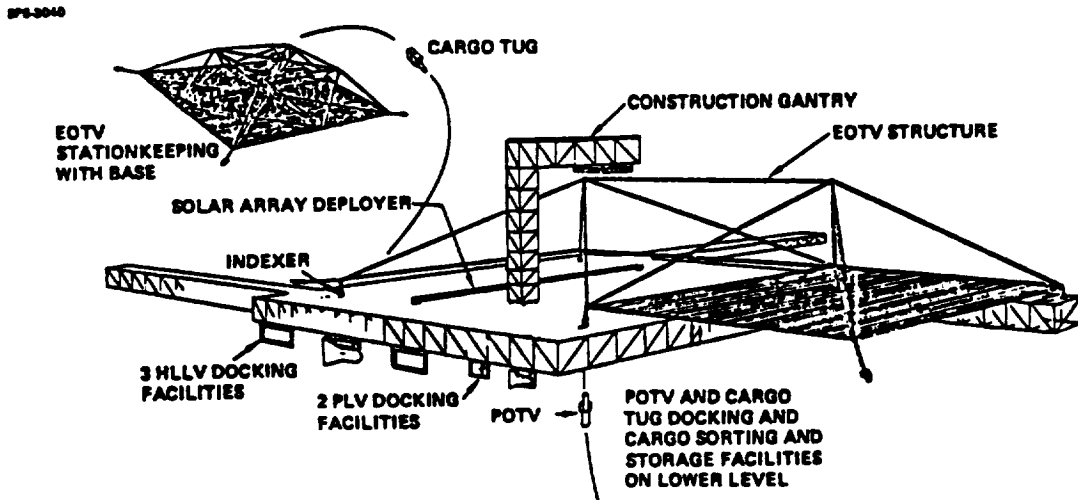


Figure 2 - LEO Base

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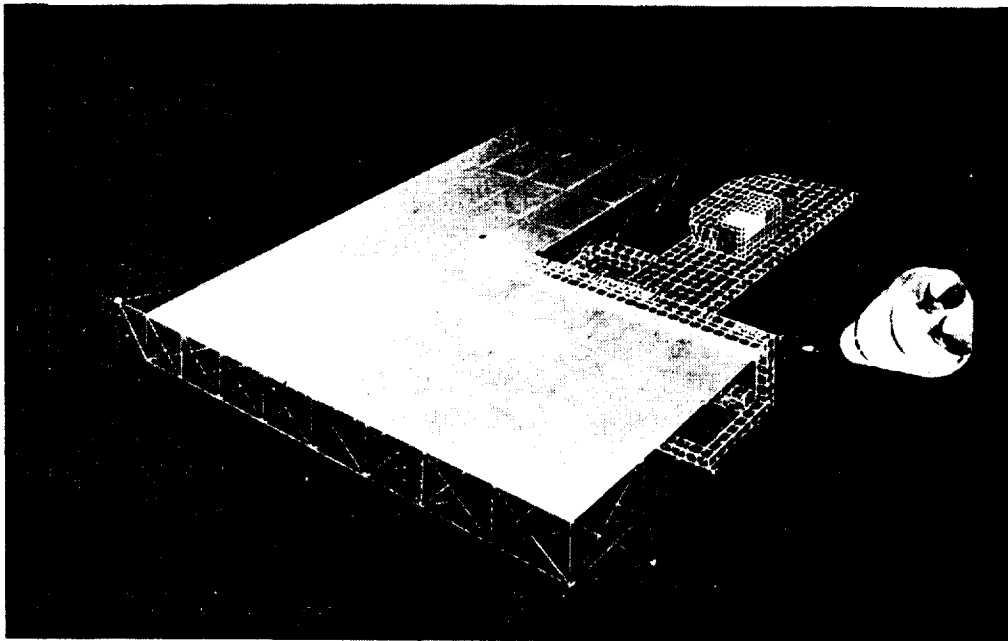


Figure 3 — GEO Base

TABLE 1
SPS PROGRAM MANPOWER ESTIMATE

	Estimated Number of People Req'd During 12th Year of Commercial Operations (20 SPS's in operation)
o Industrial Complex/Surface Transportation Operations	500,000
o Rectenna Construction Operations	2,100
o Launch and Recovery Site Operations	6,425
o LEO Base Operations	
o Space Crews	460*
o Ground Support Crews	4,600
o GEO Base Operations	
o Space Crews	888*
o Ground Support Crews	8,880
o SPS Maintenance Operations	
o GEO Base Crews	600*
o Mobile Crew	85
o Ground Support Crews	6,850
o SPS/Rectenna/Utility Grid Operations	7,700
o Operations Control	<u>2,996</u>
Total	542,000 (approx.)

* Half of these crewmembers will be in space at any point in time. The other half is on the Earth on vacation, receiving training, preparing for next tour of duty, etc.