

SATELLITE POWER SYSTEM TOTAL PROOF-OF-CONCEPT PROGRAM

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INTRODUCTION

During the past years of Satellite Power Systems (SPS) studies, major emphasis has been placed on identifying and resolving technical, environmental, societal, and economic issues which could seriously impact the feasibility, viability, and acceptability of an SPS program. Two years ago, sufficient effort had been conducted to show that the vast majority (e.g., 70%-85%) of these issues could be resolved by ground-based testing. To achieve this end, a relatively low-cost¹, four- to six-year Ground Based Exploratory Development (GBED) program was evolved to be conducted during the first half of the 1980's. From the mid-80's until the guideline year 2000 for IOC of the first SPS, study of the remaining development program objectives centered around ensuring that hardware and manufacturing capability development schedules could be met and integrated within the time remaining before IOC. Upon review of these schedules and estimated funding demands within the context of decision-making requirements, it became obvious that a major conflict would ultimately surface. Basically, the problem encountered was that within the schedule constraints, a total program commitment needed to be made by the year 1990, yet adequate SPS proof-of-concept might not be accomplished until the mid-1990's. In an effort to resolve this conflict, Rockwell International undertook a brief in-house study to develop a program concept responsive to the needs of the decision-maker.

STUDY OBJECTIVES

The objectives of the Rockwell study were as follows:

- To define requirements for an early SPS orbital demonstration that could provide a system proof-of-concept within the 1980 decade sufficient to allow an SPS program commitment to be made in the year 1990.
- To develop a conceptual approach which would satisfy the defined requirements.

GUIDELINES AND CONSTRAINTS

The following guidelines and constraints were observed:

- Maximum use will be made of anticipated GBED program results.
- Earth launch system will be Space Shuttle Vehicle with current payload cargo bay limits and appropriate mass-to-orbit capabilities.

¹ If the development of every new hardware element required for the SPS were charged against the SPS programs, then the GBED phase would cost less than 1% of the overall development program costs.

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SYSTEM DEMONSTRATION REQUIREMENTS

Fundamentally, a total system proof-of-concept entails component manufacturing, launch to orbit, space construction, and system operation measurable to a performance specification. More specifically, it must involve validation from orbit of key technology issues such as:

- Construction of large space structures
- Solar array performance
- Power amplifier performance
- Phase control system
- System pointing control
- Key subsystems interface performance
- Microwave beam forming
- Microwave environmental interactions
- Rectenna system performance
- Replication of system efficiency chain

Where deemed necessary, full scale system elements are to be employed. Note, however, that operational SPS system efficiencies are not required for all components in order to provide total system proof-of-concept. Funding for the demonstration must meet two basic requirements: First, the overall funding level must be reasonably low, and achieve results commensurate with the desired goals. Second, funding commitments must be very small during the early time frame of the GBED programs, and compatible with the GBED schedule.

DEMONSTRATION CONCEPT FINDINGS

The Rockwell effort, conducted within the bounds of demonstration objectives, guidelines, constraints and requirements, yielded a number of significant findings.

- System total proof-of-concept can be demonstrated with a satellite at low earth orbit.
- A microwave antenna structure of full SPS scale can be constructed on orbit.
- The concept shown in Figure 1 will duplicate all key interfaces of the operational SPS efficiency chain.
- Power collection can be demonstrated by a transportable rectenna farm of approximately half an acre in area (half the playing area of a football field).
- First-order cost estimates of the proof-of-concept demonstration at low earth orbit - including launch systems, space support systems, satellite systems, ground systems, and production facilities - might be achieved at a cost of ~\$800 M (in 1979 dollars). Major funding for the demonstration is not required until the late 1980's, i.e., until after completion of the GBED program.

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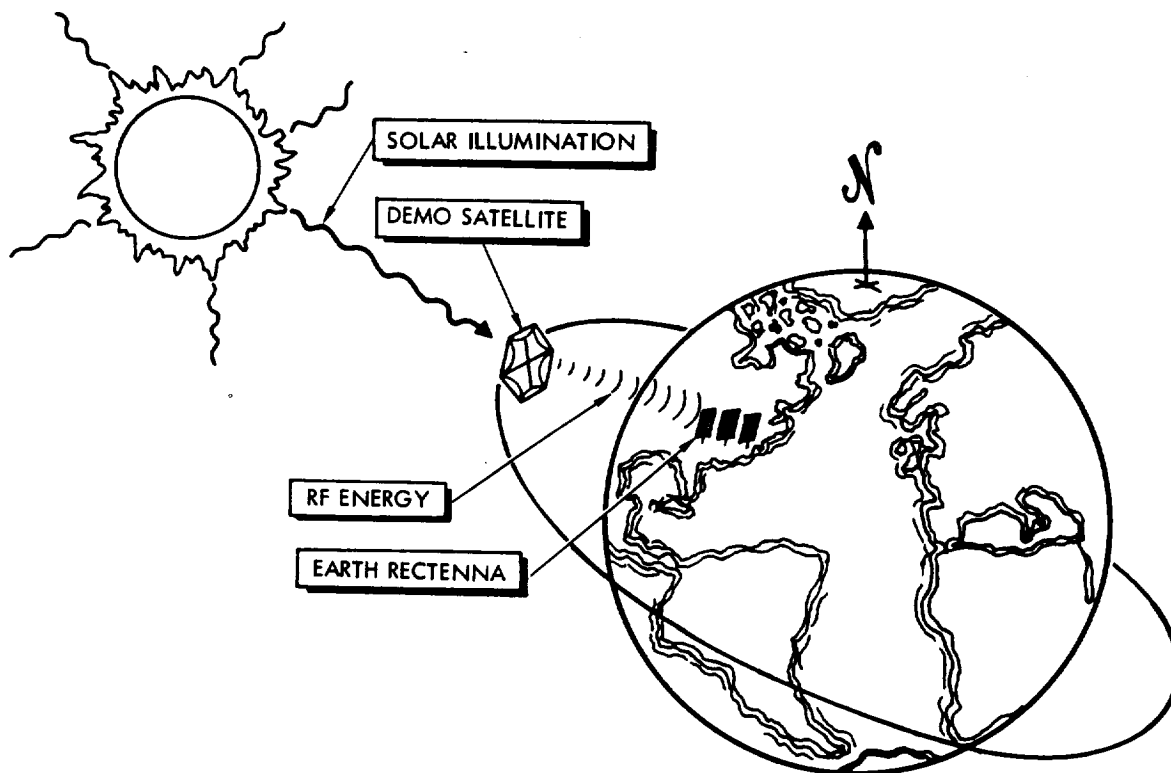


Figure 1. SPS Total Proof-of-Concept Demonstration

- As conceived, the demonstration system can be upgraded in stages to an operational system providing from one-half to a full GW of power at a utility interface.

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