SPACE STATION DEVELOPMENT WORK

SOLAR DYNAMIC SYSTEMS

BY

MILES O. DUSTIN

LEWIS RESEARCH CENTER

NOVEMBER 13, 1984
SOLAR DYNAMIC SYSTEMS

WHAT IS IT?

WHY ARE WE INTERESTED?

WHAT ARE THE BENEFITS?

WHAT IS THE SOLAR DYNAMIC DEVELOPMENT PROGRAM?
|-------------|----------------|--------------|-----------------------------------------------|----------------------|

**SYSTEM CONCEPT**

- **SUN**
- **MIRROR**
- **RECEIVER WITH STORAGE MATL.**
- **BRAYTON, RANKINE OR STIRLING HEAT ENGINE W/ALT.**
- **SPACE RADIATOR**

**Diagram:**

- **SUN**
- **MIRROR**
- **RECEIVER**
- **RADIATOR W/ALTERNATOR**

**Legend:**

- **SUN**
- **MIRROR**
- **RECEIVER**
- **RADIATOR**
- **BRAYTON, RANKINE OR STIRLING ENGINE W/ALTERNATOR**
Organic Rankine Cycle
BRAYTON CYCLE SPACE POWER SYSTEM

HEAT SINK EXCHANGER

RADIATOR

PUMP

RECUPERATOR

COMPRESSOR

TURBINE

GENERATOR

HEAT REJECTION

CS-66872
## SOLAR DYNAMIC RADIATOR REQUIREMENTS

**20 kW<sub>e</sub>**

<table>
<thead>
<tr>
<th></th>
<th>ORGANIC RANKINE</th>
<th>BRAYTON</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TURBINE INLET TEMP</strong></td>
<td>670K (750F)</td>
<td>730K (855F)</td>
</tr>
<tr>
<td><strong>CONCENTRATOR DIA. AREA</strong></td>
<td>14.6m</td>
<td>14.8m</td>
</tr>
<tr>
<td></td>
<td>167m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>170m&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>HEAT REJECTION RATE</strong></td>
<td>105 kW</td>
<td>115 kW</td>
</tr>
<tr>
<td><strong>PRIME RADIATOR AREA</strong></td>
<td>150m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>220m&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>RADIATOR TEMP</strong></td>
<td>355K (180F)</td>
<td>376K (220F)</td>
</tr>
<tr>
<td></td>
<td>344K (160F)</td>
<td>296K (70F)</td>
</tr>
</tbody>
</table>
BENEFITS OF SOLAR DYNAMIC SYSTEMS OVER PV SYSTEMS

PRIMARY

- SMALLER AREA
- DRAG
- ORBIT ALTITUDE
- VIEW ANGLE
- STABILITY AND CONTROL
- ACCESSIBILITY

SECONDARY

- LOWER MASS
- LOWER COST
- HIGHER RELIABILITY
75 kW SPACE STATION
PHOTOVOLTAIC
75 kW SPACE STATION
SOLAR DYNAMIC
300 kW SPACE STATION
PHOTOVOLTAIC
300 KW SPACE STATION
SOLAR DYNAMIC
SPECIFIC MASS AND AREA OF SEVERAL
SPACE STATION POWER SYSTEMS
Net Power Output = 75 kWe

LeRC Space Systems Office
SOLAR DYNAMIC DEVELOPMENT HISTORY

- SEVERAL SPACE CONCEPTS ACTIVELY PURSUED BY NASA AND USAF IN 1960's AND 70's
  - RANKINE
  - BRAYTON 1 - 15 kW_e LEVELS
  - KINEMATIC STIRLING
- GREATEST EFFORT EXPENDED ON RANKINE AND BRAYTON POWER CONVERSION SUBSYSTEMS
- LESS EFFORT EXPENDED ON CONCENTRATORS AND RECEIVERS
- SYSTEMS DESIGNED FOR EXPENDABLE BOOSTER LAUNCH
- NO SYSTEMS HAVE FLOWN
- DEVELOPMENT DISCONTINUED IN EARLY 70's FOR LACK OF SUITABLE MISSIONS
- DOE DEVELOPING LOW COST CONCEPTS FOR TERRESTRIAL APPLICATIONS SINCE APPROX. 1977
SOLAR DYNAMIC ADVANCED DEVELOPMENT

PURPOSE:

PROVIDE A BASE OF DATA ON THE CRITICAL TECHNOLOGY OF SOLAR
DYNAMIC SYSTEMS FOR SPACE STATION
- TO ASSESS VIABILITY OF THE SOLAR DYNAMIC OPTION FOR IOC
- TO PROVIDE BASIS FOR SYSTEM DESIGN

APPROACH:

o ADDRESS PRIMARY CRITICAL TECHNOLOGY AREAS
  - RECEIVER/STORAGE
  - CONCENTRATOR
  - SOLAR DYNAMIC SYSTEM INTEGRATION WITH SPACE STATION

o EMPLOY CONSERVATIVE DESIGN APPROACHES

o FABRICATE AND TEST CRITICAL COMPONENT FUNCTIONS
SOLAR DYNAMIC ADVANCED DEVELOPMENT

CRITICAL CONCENTRATOR TECHNOLOGY

CENTERS: LERC, JPL

0 DEFINE CONCENTRATOR REQUIREMENTS

0 DEVELOP SEVERAL DESIGN CONCEPTS FOR 12-18 M. DIAMETER CONCENTRATORS
  - FAB TECHNIQUES
  - ACCURACY
  - DISTORTION
  - SINGLE VS. CASSEGRAINIAN
  - COATINGS
  - POINTING REQUIREMENTS
  - SHUTTLE REQUIREMENTS
  - STOWAGE
  - DEPLOYMENT/ERECTION

0 FABRICATE AND TEST ELEMENTS OF SELECTED DESIGNS

0 TEST REFLECTIVE SURFACE SAMPLES IN SPACE
SOLAR DYNAMIC ADVANCED DEVELOPMENT

CRITICAL HEAT RECEIVER TECHNOLOGY

CENTER: LERC

- Define heat receiver requirements
- Develop several design concepts for receivers in the range of 75-160 kW and temperature near 700K and perhaps to 1100K
  - Thermal storage material
  - Containment of storage material
  - Movement of storage material
  - Heat pipes
  - Temperature control
  - Fabrication methods
- Fabricate and test designs of alternate approaches
- Capsule tests of storage and containment materials