SPACE STATION DEVELOPMENT WORK

SOLAR DYNAMIC SYSTEMS

BY

MILES O. DUSTIN

LEWIS RESEARCH CENTER

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SOLAR DYNAMIC SYSTEMS

WHAT IS IT?

WHY ARE WE INTERESTED?

WHAT ARE THE BENEFITS?

WHAT IS THE SOLAR DYNAMIC DEVELOPMENT PROGRAM?
<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Heat Collector</th>
<th>Heat Storage</th>
<th>Brayton, Rankine or Stirling Heat Engine w/ALT.</th>
<th>Waste Heat Rejection</th>
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</table>

**SYSTEM CONCEPT**

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

**Diagram:**
- **SUN**
- **RADIATOR**
- **RECEIVER**
- **MIRROR**
- **BRAYTON, RANKINE OR STIRLING ENGINE W/ALTERNATOR**
Organic Rankine Cycle
BRAYTON CYCLE SPACE POWER SYSTEM
## SOLAR DYNAMIC RADIATOR REQUIREMENTS

### $20 \text{ kW}_e$

<table>
<thead>
<tr>
<th></th>
<th>ORGANIC RANKINE</th>
<th>BRAYTON</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURBINE INLET TEMP</td>
<td>670K (750F)</td>
<td>730K (855F)</td>
</tr>
<tr>
<td>CONCENTRATOR DIA. AREA</td>
<td>14.6m</td>
<td>14.8m</td>
</tr>
<tr>
<td></td>
<td>167m$^2$</td>
<td>170m$^2$</td>
</tr>
<tr>
<td>HEAT REJECTION RATE</td>
<td>105 KW</td>
<td>115 KW</td>
</tr>
<tr>
<td>PRIME RADIATOR AREA</td>
<td>150m$^2$</td>
<td>220m$^2$</td>
</tr>
<tr>
<td>RADIATOR TEMP</td>
<td>355K (180F)</td>
<td>376K (220F)</td>
</tr>
<tr>
<td></td>
<td>344K (160F)</td>
<td>296K (70F)</td>
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</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
SOLAR DYNAMIC

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SPECIFIC MASS AND AREA OF SEVERAL SPACE STATION POWER SYSTEMS
Net Power Output = 75 kW

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:

- ADDRESS PRIMARY CRITICAL TECHNOLOGY AREAS
  - RECEIVER/STORAGE
  - CONCENTRATOR
  - SOLAR DYNAMIC SYSTEM INTEGRATION WITH SPACE STATION
- EMPLOY CONSERVATIVE DESIGN APPROACHES
- FABRICATE AND TEST CRITICAL COMPONENT FUNCTIONS
SOLAR DYNAMIC ADVANCED DEVELOPMENT

CRITICAL CONCENTRATOR TECHNOLOGY

CENTERS: LERC, JPL

- DEFINE CONCENTRATOR REQUIREMENTS
- 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
- FABRICATE AND TEST ELEMENTS OF SELECTED DESIGNS
- 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_T 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