THERMAL ENERGY STORAGE EFFORT AT JPL

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OUTLINE OF THE PRESENTATION

- JPL INTEREST IN THERMAL ENERGY STORAGE
- IMMEDIATE APPLICATIONS
- METHODOLOGY FOR JPL EFFORT
- TASKS FOR JPL SUPPORT TO SLL
- JPL IN-HOUSE WORK
- PLANNED PROCUREMENTS
- SCHEDULE

JPL PARABOLIC DISH PROGRAM

OBJECTIVES

- TO ESTABLISH TECHNICAL, OPERATIONAL & ECONOMIC READINESS OF PARABOLIC DISH SYSTEMS FOR ELECTRIC AND THERMAL APPLICATIONS

- TO DEVELOP PARABOLIC DISH SYSTEMS TO THE POINT AT WHICH SUBSEQUENT COMMERCIALIZATION ACTIVITIES CAN LEAD TO SUCCESSFUL MARKET PENETRATION
JPL INTEREST IN THERMAL ENERGY STORAGE

- PROVIDE TECHNICAL SUPPORT TO THE THERMAL ENERGY STORAGE FOR SOLAR THERMAL APPLICATIONS (TESSTA) PROGRAM

- IDENTIFY CONCEPTS, ASSESS THEIR FEASIBILITY, AND DEVELOP ENGINEERING DESIGNS OF PARABOLIC DISH LATENT THERMAL ENERGY STORAGE ELEMENTS

- PLAN AND CONDUCT SUBSYSTEM RESEARCH EXPERIMENTS AT PARABOLIC DISH TEST SITE (PDTS, EDWARD) TO DEMONSTRATE THE READINESS OF THE LATENT HEAT ENERGY STORAGE

- IDENTIFY CONCEPTS AND ASSESS THEIR FEASIBILITY FOR ADVANCED, HIGH TEMPERATURE (1500-2800°F) THERMAL STORAGE

CURRENT APPLICATIONS

- SMALL COMMUNITY SOLAR THERMAL POWER EXPERIMENT (EE-1)
- ISOLATED LOAD EXPERIMENTS SERIES (EE-2 ETC)
- THERMAL APPLICATIONS EXPERIMENTS SERIES (EE-3)
- ADVANCED DISH STIRLING

ENERGY STORAGE REQUIRED TO BUFFER THE ENERGY CONVERSION SYSTEM FROM HARMFUL TRANSIENTS & PROVIDE BETTER SYSTEM CONTROL
CURRENT APPLICATIONS

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>ECS/SIZE</th>
<th>STORAGE TEMP RANGE</th>
<th>APPLICATION/TIME PERIOD</th>
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<tbody>
<tr>
<td>EE-1</td>
<td>RANKINE/15 KWe</td>
<td>800→1300°F</td>
<td>GRID CONNECTED, SMALL COMMUNITY/1981</td>
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<td>EE-2</td>
<td>BRAYTON/15 KWe</td>
<td>1200→1700°F</td>
<td>ISOLATED/1981</td>
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<td>EE-3</td>
<td>THERMAL LOADS</td>
<td>TBD</td>
<td>ISOLATED/1982</td>
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<td>STIRLING</td>
<td>STIRLING/20 KWe</td>
<td>1500→1600°F</td>
<td>ENGINEERING EXPERIMENTS 1981 SYSTEM TESTS 1984</td>
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BRIEF DESCRIPTION OF PLANT

- 1 MW PLANT USING NEAR TERM TECHNOLOGY
- APPROXIMATELY 10 ACRE SITE WITH 65 PARABOLIC CONCENTRATORS, EACH 11 METERS IN DIAMETER AND EACH HAVING ITS OWN:
  - RECEIVER
  - ENGINE
  - GENERATOR

THE ELECTRICAL OUTPUT OF THE INDIVIDUAL GENERATORS IS COMBINED AND CONNECTED TO A SMALL COMMUNITY DISTRIBUTION SYSTEM
STEAM-RANKINE SOLAR RECEIVER

PRIMARY

RE-HEAT

MOUNTING FLANGE

BACKPLATE

RE-HEAT

PRIMARY

SHELL

APERTURE

SOLAR FLUX
PLATE FIN BRAYTON SOLAR RECEIVER

FUTURE APPLICATIONS

- ADVANCED BRAYTON ENGINE (2300-2700°F)
- FUELS AND CHEMICAL APPLICATIONS (1500-3500°F)
- INDUSTRIAL PROCESS HEAT APPLICATIONS (1000-2500°F)
- COMBINED CYCLE (BRAYTON/RANKINE) ENGINES (1000-2700°F)
PRESSURIZED MATRIX
HIGH TEMPERATURE SOLAR THERMAL RECEIVER

CERAFORM® FORMED INSULATION
STORAGE MEDIA
CARBON STEEL HOUSING
QUARTZ WINDOW
CPC TERMINAL CONCENTRATOR

ADVANCED GAS TURBINE POWERTRAIN
METHODOLOGY FOR THE JPL EFFORT

TASKS FOR JPL SUPPORT TO SLL

TASK NO. 1: PRELIMINARY DESIGNS
- SYSTEM APPLICATION REQUIREMENTS
- LATENT HEAT BUFFER AND ENERGY STORAGE CONCEPTS
- PERFORMANCE AND COST ESTIMATES

TASK NO. 2: SMALL SCALE EXPERIMENTS
- CANDIDATE MATERIALS & CONTAINMENT
- HEAT TRANSFER CHARACTERISTICS
- DEGRADATION, DECOMPOSITION, CORROSION & PERFORMANCE
- SOLIDIFICATION CONTROL

TASK NO. 3: SUBSYSTEM RESEARCH EXPERIMENT DESIGN
- TEST OBJECTIVES
- TEST PROCEDURES
- TEST EVALUATION

TASK NO. 4: PROGRAM MANAGEMENT
- CONTRACTS PREPARATION & MONITORING
- COORDINATE JPL INHOUSE EFFORT WITH CONTRACTED EFFORT
- REPORTS
JPL IN-HOUSE EFFORT

PURPOSE: TO DEVELOP THE NECESSARY BACKGROUND, DATA BASE, AND
CAPABILITY TO WRITE AND MANAGE INDUSTRIAL CONTRACTS
FOR THE DEVELOPMENT OF THERMAL ENERGY STORAGE FOR
DISH-APPLICATIONS.

PLANNED EFFORT IN:

- APPLICATION REQUIREMENTS
- CONCEPTS SELECTION OF ~50 KWHT TES USING PCM FOR
  800-2400°F TEMPERATURE RANGE
- NOVEL IDEAS OF HEAT TRANSFER AT HIGH TEMPERATURES
- STORAGE MEDIA SCREENING & SELECTION
- CONTAINMENT MATERIALS, CORROSION, AND STABILITY
  OF PCM
- DEVELOPMENT OF COMPUTER CODES FOR THE TRANSIENT
  ANALYSES OF LATENT HEAT STORAGE SYSTEMS
- DEFINE AND PLAN SUBSYSTEM RESEARCH EXPERIMENTS

A LIST OF PRELIMINARY THERMAL ENERGY
STORAGE COMPONENTS

1. PHASE CHANGE MATERIALS
   - NaF (~1810°F)
   - NaF + MgF₂ (~1526°F)
   - NaF + KF + MgF₂ (~1265°F)
   - K₂CO₃ + Li₂CO₃ + LiOH (~800°F)

2. HEAT EXCHANGER CONCEPTS
   - FLEXING SURFACES
   - HEAT PIPES
   - FLUIDIZED BEDS
   - TUBE & SHELL WITH SCRAPING

3. CONTAINMENT
   - RECEIVER INTEGRATED
   - ENGINE INTEGRATED
   - SEPARATE TANK

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PLANNED PROCUREMENTS

1. DEFINITION OF REQUIREMENTS FOR DISH MOUNTED LATENT HEAT BUFFER ENERGY STORAGE FOR THE FOLLOWING ENERGY CONVERSION SYSTEMS:
   - RANKINE
   - BRAYTON
   - STIRLING

2. NOVEL CONCEPTS OF LATENT HEAT STORAGE OF SMALL SIZES

3. MEASUREMENT OF THERMAL PROPERTIES OF SELECTED PHASE CHANGE MATERIALS

4. DEGRADATION AND DECOMPOSITION OF THE SELECTED PHASE CHANGE MATERIALS FOR CYCLIC THERMAL LOADING

5. SOLIDIFICATION CONTROL OF THE SELECTED PHASE CHANGE MATERIALS

6. CORROSION CONTROL OF THE SELECTED HIGH TEMPERATURE PHASE CHANGE MATERIALS

7. SUBSYSTEM RESEARCH EXPERIMENT DESIGN

SCHEDULE

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