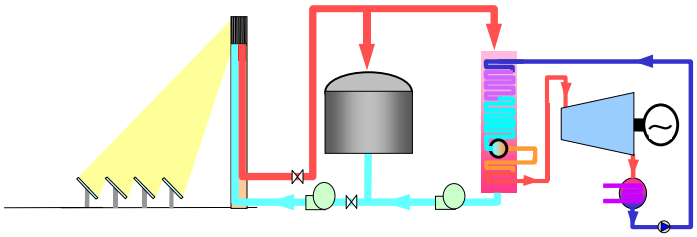
IEA SolarPACES Task I Experts Meeting
Cologne, 20 June 2001

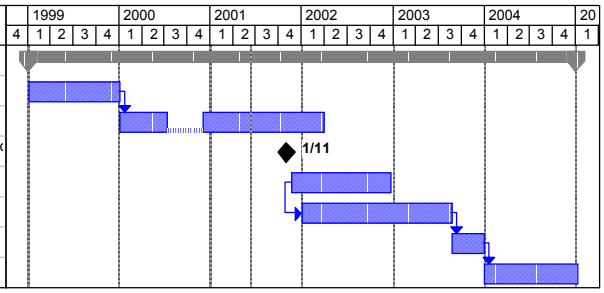


Status of PS10 Project Development

Manuel Romero
CIEMAT/PSA

PS10: Review of project planning

Id	Nombre de tarea
0	**CHRONOGRAM PS10**
1	1 BASIC ENGINEERING
2	2 DETAILED ENGINEERING
3	Permits and environmental study cleare
4	3 MANUFACTURING COMPONENTS
5	4 SHIPMENT AND ASSEMBLING
6	5 ACCEPTANCE TESTS
7	6 OPERATION AND EVALUATION

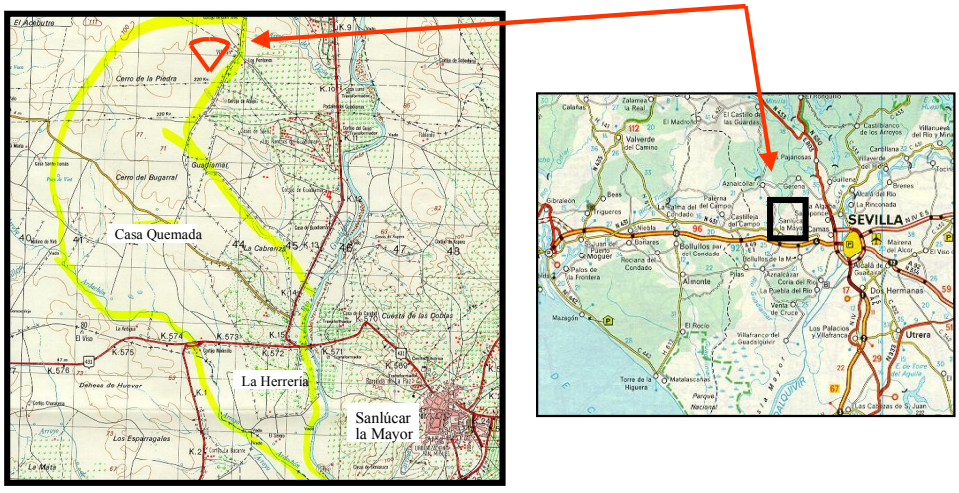


* The project got frozen by June 2000 because of legal constraints.
* After informal confirmation of 12 cents of Euro/kWh activities re-started early this year.

PS10 status

- ☺ The "Sanlúcar Solar S.A." PS10 IPP Consortium has been formed by ABENGOA (90%) and IDAE (10%).
- ☺ Information about project status has been sent to the EC to apply for time schedule update approval.
- ☺ Permits and environmental impact study should be ready by October 2001.
- ☺ Civil works starting by November 2001 provided premium is eventually published (Milestone).
- ☺ Bank loans are being re-negotiated for new premium expected of 12 EURO cents/kWh.

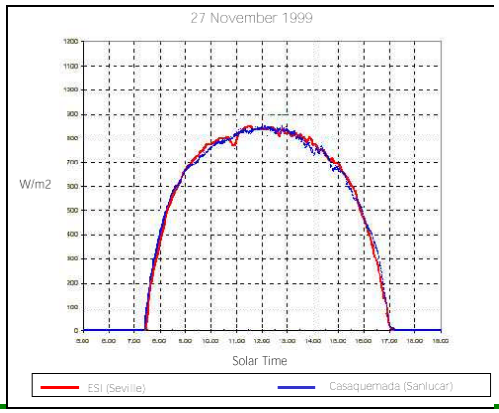
PS10 SITE IN SANLÚCAR LA MAYOR



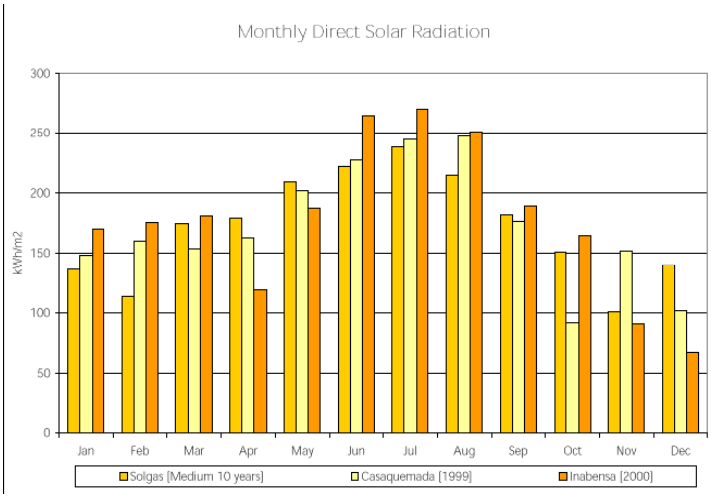
SolarPACES
IEA SolarPACES Task I Meeting
Cologne, Germany, 20 June 2001
Ciemat PSA

Site characterization

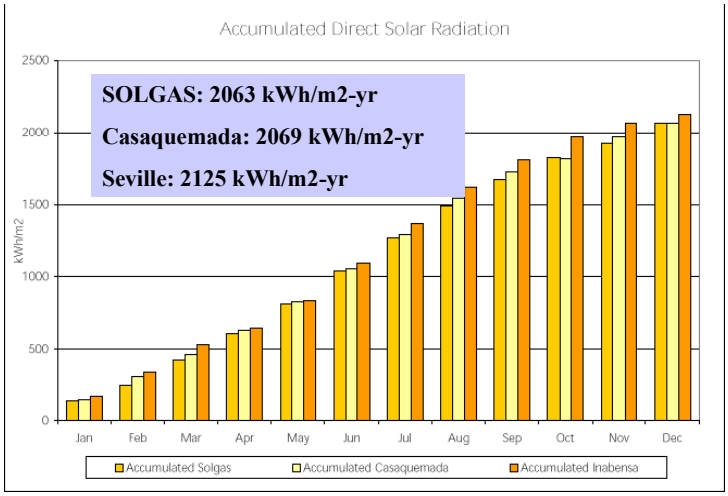
- ☺ Solar radiation resource measurements continued since February 1999.
- ☺ A second meteo station has been installed at Inabensa premises.
- ☺ Good correlations between Sanlúcar site and Seville.



Site characterization



Site characterization



Heat storage system

- ☺ Size and configuration has been refined (H. Fricker).
- ☺ Heat storage and air blowers proved excellent to stabilize TSA during cloudy and transients
  - ☺but..... Allumina pebbles revealed expensive.
- ☺ For PS10 the heat storage material and charging/discharging modes have been optimized to reduce costs.
  - ☺Materials: Allumina, cordierite, rock, clay and steel tubes filled with sand.
  - ☺Geometry: Spheres, rings, plates, saddles, rods and bricks.
- ☺ Al2O3 ceramic saddles selected for the storage core material

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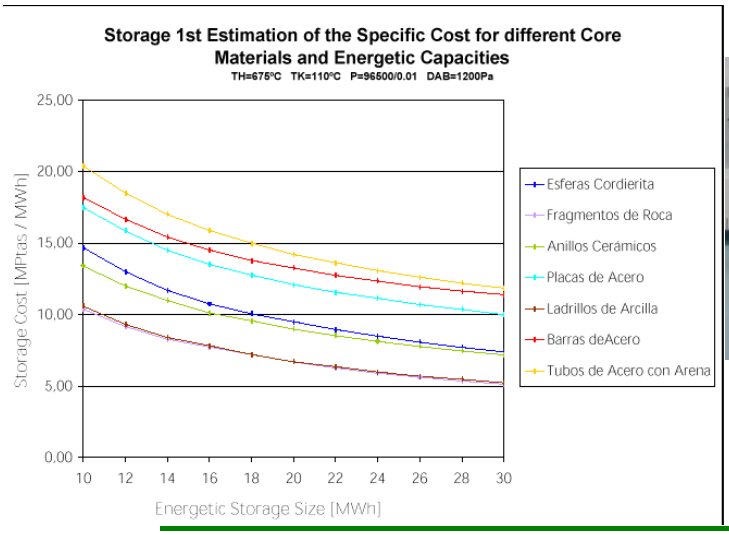
Heat storage system



Heat storage system

- Size of heat storage reduced to half an hour (18 MWh total capacity with a useful storage capacity of 14.4 MWh)
- Running from storage at a reduced air mass flow rate corresponding to approximately 70 % of the nominal value.
- Air temperature during discharging was fixed to 649ºC.

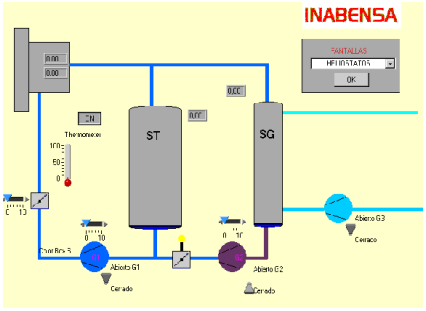
	GNT	GMT	GET	BWT	BMT	BET
Spring	123	135	121	132	148	116
Summer	226	185	183	212	216	255
Autumn	282	269	350	309	291	272
Winter	365	74	32	362	3	54

GNT: Good Day with No Transitories
GMT: Good Day with Morning Transitories
GET: Good Day with Evening Transitories
BWT: Bad Day, Whole Transitories
BMT: Bad Day with Morning Transitories
BET: Bad Day with Evening Transitories

18 MWh is enough in all strategies and seasons

Other components

- Steam generator, power block and master control already defined and ready to place purchasing orders.
- Heliostat selected---->Sanlúcar-90.
- Critical component is solar receiver---> Steinmüller should be contacted soon to re-start activity.



EURODISH- Cost Reduction of Dish/Stirling Systems

Peter Heller (DLR-PSA), Diego Martinez (Ciemat)

IEA/SolarPACES Task I, Köln, June 20, 2001

EURODISH- Cost Reduction of Dish/Stirling Systems

Partners and Contributions:

Schlaich, Bergermann & Partner (D):	Design
MERO Raumsysteme (D) :	Concentrator
SOLO Kleinmotoren (D)	PCU
Klein +Stekl (D):	Control
Inabensa (E):	Foundations, Turntable, Switchboards
DLR (E):	Test and Evaluation
Ciemat (E):	Test and Evaluation

Project co-funded by EU under contract JOR3-CT-98-0242

EuroDish- Project Goals

- ❑ System cost goal of 5500 Euro/kW
- ❑ Development of tools for small series production
- ❑ Automated and remote controlled operation

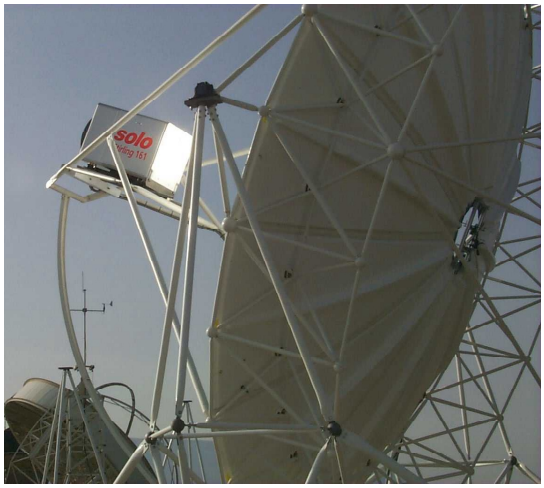
Foundations

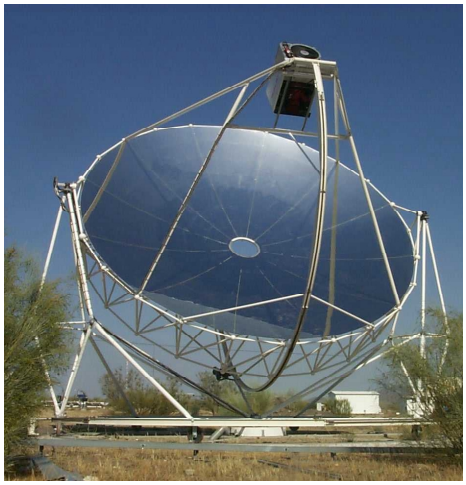
Concentrator Shell

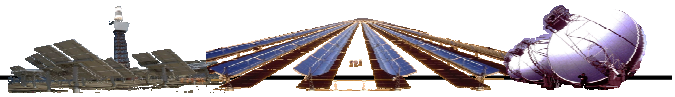
Mounting of Concentrator and Drives

Alignment and Flux Measurement

Putting into operation

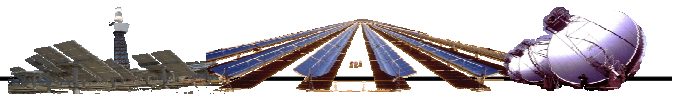






EuroDish- Project Status

- ❑ System cost goal of 5500 Euro/kW will be reached
- ❑ Tools for small series production developed and built
- ❑ Erection procedure simplified for unskilled personnel
- ❑ Automated and remote controlled operation
- ❑ Put into operation not yet finished
- ❑ Further cost reduction potential had been identified



Next Steps

- ❑ New Component test in Distal II still going on
  - ⇨ Cavity
  - ⇨ Beam control system and drives
  - ⇨ Engine components
- ❑ Start of system erection at PSA in April 2000 (2 units)
- ❑ Flux measurement
- ❑ 8 month system test and evaluation
- ❑ Closed loop control test
- ❑ Reproducibility tests of encoderless drives

Boeing/SES DECC Project

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Sandia National Laboratories, Albuquerque, NM
National Renewable Energy Laboratory, Golden CO

Boeing/Stirling Energy Systems (SES)

Dish Engine Critical Components (DECC) Project

by

Tom Mancini

June 20, 2001

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Boeing/SES DECC Project

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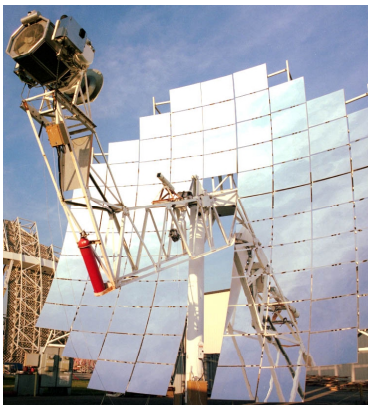
Background



- Phase I completed July 99: Build on MDA design; Test engine at Kockums
- Phase II contr placed Dec 00: Design/build new system
- Phase III deploy systems in pre-commercial application (potentially in Nevada)

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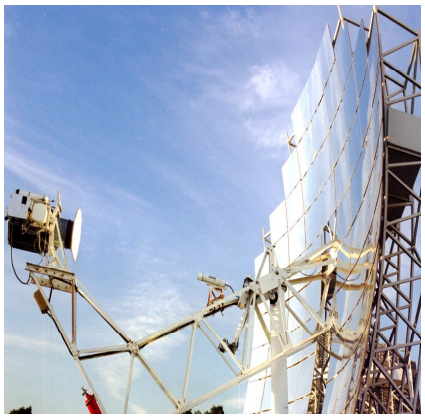
Background



Phase I Results

- 1 System, 1 engine
- 3134 hours on sun
- 42,042 kWhrs generated
- 96% Availability
- > 4500 hrs on test cell engine
- 23.5 kW Peak Power

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Phase II Status

- Two systems operating at HBeach Test Site
- New engine components running (regenerators, coolers, heater heads, piston assemblies)
- New engine blocks fabricated – first article
- Concentrator redesign near completion (parts ordered – drives, facet components)
- New generator under test
- Control system redesign in progress
- Operating/Incident data collected (not yet entered in reliability data base)

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Phases I and II Cumulative to date

11,281 Test Cell Hours on engines (206, 209, 212)

9,789 On-Sun Hours on engines (206, 209, 213)

Peak On-Sun performance 24.9 kW

Total Power produced 132.8 MWhrs

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Schedule for Phase II

Build 5 new engines

- **Assembled Aug/Sep**

Build Two concentrators

- **Assembled Dec**

Assemble and test two next-generation systems

- **Starting in Jan 2002**

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SAIC Dish/Stirling O&M and Engineering Development

Solar PACES

June 19-21, 2001

Cologne, Germany

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National Renewable Energy Laboratory, Golden CO

FY01 Approach - Phase 1

- Subcontract to SAIC/STM for additional O&M and engineering of four dish/Stirling systems
  - extension of existing NREL subcontract with SAIC
  - three Arizona-based systems (APS and SRP)
  - one NREL-based system
- SunLab support
  - continue tracking system reliability through SunLab developed reliability database (developed in FY00)
  - provide laboratory support as requested (optical materials, optical characterization, manufacturing assistance)

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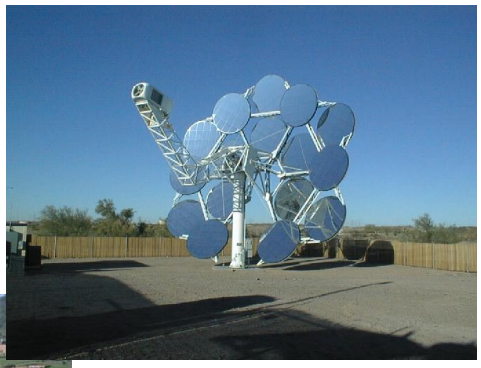
APS STAR Facility
Tempe, AZ



SRP Landfill Site
Tempe, AZ

NREL Mesa Test Site
Golden, CO

Current Status

- 4020 hours of on-sun solar operation on all three Arizona-based systems
- Hybrid operation on all three systems (25 kW demonstrated on APS West)
  - APS East (natural gas)
  - APS West (natural gas and hydrogen)
  - SRP (landfill gas)
- Much improved availability over prior years

Status of Systems (cont.)

System Operation (through April 30, 2001)

	On-Sun Hours	kW-hr Solar	Hybrid Hours	kW-hr Hybrid
APS West	1870	22136	99	1759
APS East	991	11986	56	1082
SRP	1159	14724	82	1484
Total	4020	48846	237	4325

- improvement in system availability
  - all systems operating
- improvement in system performance
  - more stable dish structure
  - reduced hydrogen leakage
- limited hours of hybrid operation
  - shutter assembly
  - gas control problems (flow and calibration)

Reliability

- Incident Level Definitions
  - Level 1: minor incident in which system or component can be reset from control console
  - Level 2: incident requiring minor physical intervention at a sub-component level (i.e. < 1/2 day)
  - Level 3: incident requiring a major overhaul or physical intervention at a component level
  - Level 4: catastrophic incident requiring replacement of component or resulting in a significant safety or environmental consequence

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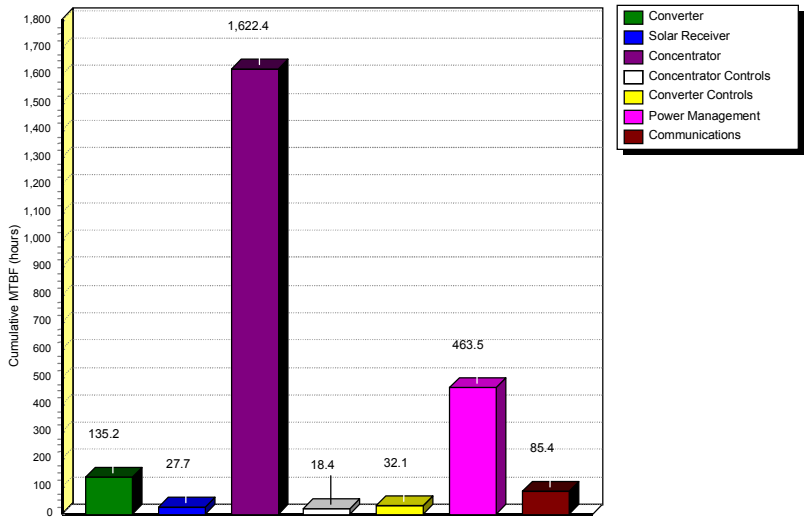
Reliability of System Components
All Systems, Levels 1-4



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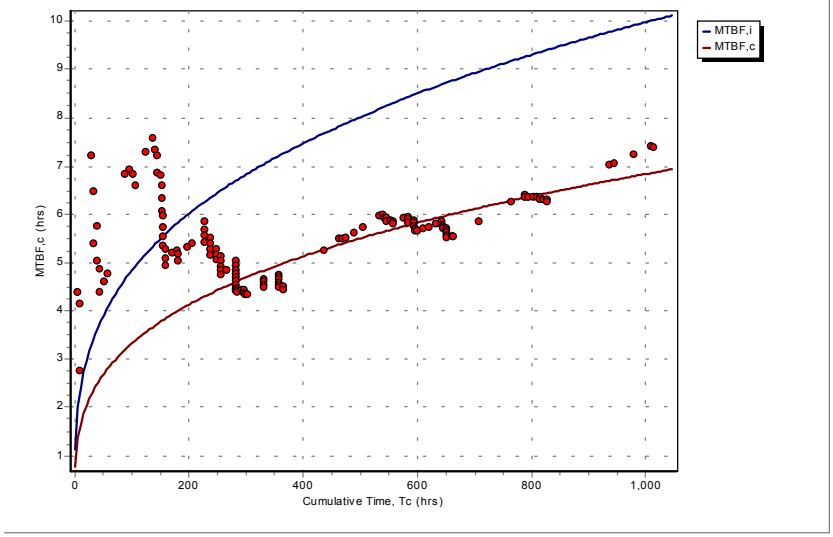
Cumulative & Instantaneous MTBF
SRP System, Incident Levels 1-4



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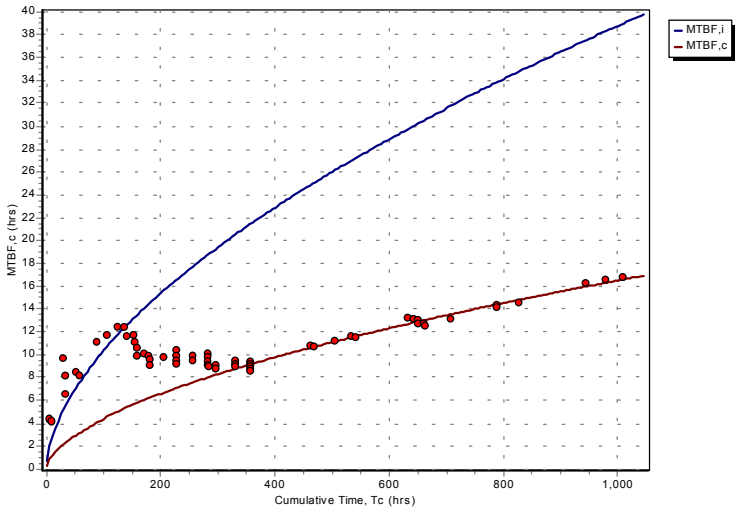
Cumulative & Instantaneous MTBF
SRP System, Incident Levels 2-4



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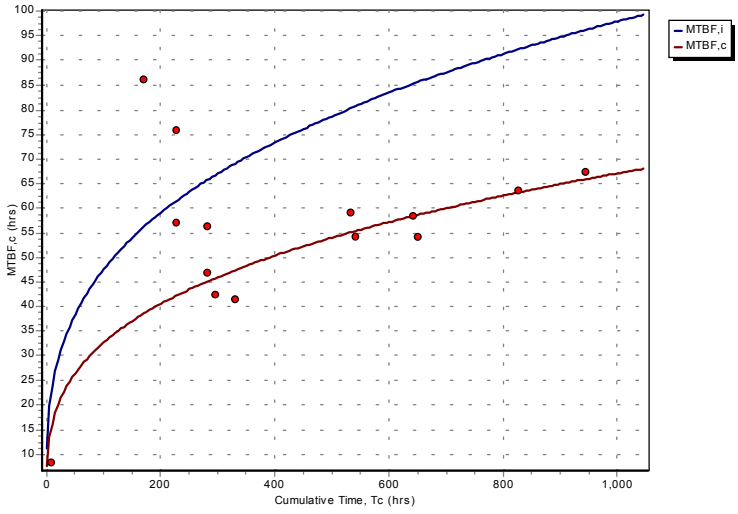
Cumulative & Instantaneous MTBF
SRP System, Incident Levels 3-4



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FY01 Approach - Phase 2

- UNLV demonstration
  - transport one APS-based system to Las Vegas, Nevada
  - hybrid Stirling PCS converted to solar only operation
  - SAIC to provide on-site O&M support through FY01
  - potential for additional systems in FY02, FY03 (competitive solicitation)
- Alternative converter development
  - investigate use of CPV converter as alternative to Stirling engine

Summary

- Hours on Systems
  - 4020 hours (48846 kWh) of operation on all three systems
  - key element of reliability growth program
- System Reliability
  - improved availability over past years
  - reliability growth curves show positive trend (but growth needs to be much faster)
  - receiver/engine and concentrator controls most problematic components
  - CPV converter may provide near-term alternative if converter reliability targets can't be achieved
- Project Opportunities
  - Nevada may provide opportunity for system installations (reliability growth)

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