

# UNLV

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## **Nevada Solar Dish Project**

### **DOE Subcontract #DE-FC04-01AL67286**

## Final Report

## Summary of All Activities

Submitted by  
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Date submitted  
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UNLV Dish System  
Quarterly Technical Report  
First Quarter, Ending 6/30/01  
Submitted by  
R. Boehm

From the start of the project, several items of advanced planning took place. Included was working closely with UNLV officials to secure a site that would meet the requirements of all parties. Also, early in the work, contact was made with Nevada Power to have them involved in the project. They pledged their commitment and assigned a contact person for us.

A planning meeting was scheduled at UNLV on April 17 for people directly related to the project. This took place with 14 people in attendance and was quite valuable to all involved. General project strategies were discussed.

On April 18 a general informational meeting took place at the UNLV Library. 33 people attended this, including most of the people from the meeting the day before and a number for Nevada Power. The latter people were not present the day before.

After much deliberation (not recounted here), a site on Flamingo Road, which offers both high visibility to the public as well as access to Taylor Hall for operations, was selected. This was a complicated situation because the campus has little open space on it. It was noted by project participants that the assigned space would cause some shading during the early and late parts of typical days, but that was taken as a limitation to live with.

Work started on site on 5/14. At this point the site being measured for drawings, including the location of, and distances to, surrounding buildings. As part of this effort UNLV site facilities drawings were reviewed. From all inputs, AutoCAD drawings of the details of the site were produced and sent to all participants.

During the next week the location for a temporary fence was sketched out. Also the site was measured for sewer pipe locations. This included some holes to be dug and verified by university maintenance.

A contact was let by the University to Western Technologies to drill core holes. Sandy Doty of SAIC was contacted to perform the geotechnical work related to bases construction for the two systems to be installed.

During the week of 5/28, Western Technologies core drilled two pedestal locations. Each site was drilled to 30 feet. The core was checked onsite by Sandy Doty of SAIC and Western Technologies' geologist. Fencing contractors came to the site and the location for the temporary fence was marked off. With this information in mind, modified site drawings were prepared.

Some uncertainty about the location of a sewer pipe traverse of site was expressed UNLV facilities people during the week of 5/4. A backhoe was brought in to verify location by university maintenance. In accomplishing this, the pipe was cracked by the backhoe and repaired immediately. The corrected sewer pipe locations were added to the AutoCAD drawings. During this week, temporary fencing was installed around the site.

During the next week, several aspects were resurveyed. This included the measuring and relocation of the core drill locations. Sewer locations were marked on the surface. Clearances for dishes were measured and marked.

Mid-month found the underground work for Nevada Power Company initiated. Trenching was performed. Conduit from the vault in parking lot was laid to the site transformer pad. Then the transformer pad was set. The lithology report from Western Technologies was submitted to SAIC for engineering design of the pedestal piers.

The final week of June found the underground work for Nevada Power Company completed. A temporary asphalt patch was installed in parking lot to be replaced at a later date. We then rechecked and remarked pedestal locations on our site maps.

UNLV Dish System  
Quarterly Technical Report  
Second Quarter, Ending 9/30/01  
Submitted by  
R. Boehm

The quarter started out with a minor lull at the site while the base designs were completed and arrangements for construction were being finalized. At this point the temporary fence had been installed, but the room in Taylor Hall had not yet been occupied by the project, although that was promised soon.

During the week of July 17 the construction company selected by SAIC was on the site. This company was Caliente Construction from Arizona. Prior to their arrival, all of the necessary formal arrangements to work on campus were satisfied..

At about the same time, the pier holes were placed by Allen Drilling. Caliche was anticipated in the pier locations because of the bore logs performed previously. The situation proved to be quite difficult. At about the same time, the grid protection panel support structure was installed. Reinforcement steel needed for the supports was delivered to site. A variety of construction equipment was delivered to site. A permanent asphalt patch was completed in the parking lot where Nevada Power had run the line to disconnect box. This replaced the temporary patch.

The week of July 23 found the site extremely busy with activity. The pier drilling was completed. Several bits were ruined because of some particularly stubborn caliche. After the completion of the drilling, the excavated material was removed from the site. The pier locations were again surveyed and reinforcement steel was installed in the pier holes. Electrical stub-outs to the piers were installed at this point and the pier concrete was poured. Following that housekeeping pads were formed and poured. The first of the actual dish hardware appeared on site when SAIC components were delivered. Assembly work on that unit started almost immediately. University electricians were contracted to run the underground electrical wiring to the piers. The grid protection panel and its associated equipment were installed at this point.

SES components were delivered to the site during the week of July 30. Both systems' pedestals were installed and the corresponding dishes were lifted onto the pedestals. Because of a need for 480 V power, UNLV electricians were secured to install a temporary generator. Nevada Power completed the installation of the transformer and the meter during this week. Conduit piping to Taylor Hall for the various control functions was completed. The weather station and control stations were assembled. Both dish assemblies were completed during this week. BCS testing for SAIC started by a contractor secured by them. At this point it was discovered that some of the radiators on the SES system were damaged during transporting to Las Vegas. The engine was removed and taken to the UNLV mechanical engineering shop. After removal of the radiator assembly, it was sent out for repair. Rick Hurt and Chris Halford, students who had been involved with the project through a undergraduate research grant (non-DOE funding), joined the project.

SAIC completed BCS alignment and focus testing, and calorimeter testing during the week of August 6. The PCS on the SAIC system was installed and tested "on sun." This was followed shortly there after by SAIC system being calibrated. Internet availability to the building was checked. It was found that a main line to the building had been installed, but the switching equipment was not present. This was ordered. With the use of Taylor Hall now being a reality, we acquired and assembled furnishings.

During the second week of August, we worked out bugs related to operations. The permanent fence was installed at this point. The fence contractor hit an unmarked Nevada Power cable hit at the northeast corner of the site causing power failure for a portion of the campus. This problem was repaired immediately. After the permanent fence was completed, we had the temporary fence removed. On-sun operation by SAIC occurred during this period. SES engine radiator was replaced and the PCU was mounted on the dish structure. The SES dish was run on-sun. A SAIC PCS failure occurred during this week. This PCS was removed and replaced with a spare PCS delivered to site. Disassembly of the faulty PCS took place in the mechanical engineering shop and the engine was sent to STM. At about this point in time, problems developed with the SES elevation drives. These were repaired. We continued to furnish Taylor Hall. A person from UNLV System Computing Services visited the site and outlined what would be required for internet connection. An order was initiated on that.

Both systems were on-sun and generating power during the next week (starting 8/20). Several preparations were carried out in anticipation of the dedication ceremony (held 8/24). The mirrors for both systems were cleaned.. Taylor Hall was cleaned and prepared. On Friday morning a planning meeting was held with participants from all of the organizations represented on the project. In the afternoon, the dedication ceremony was held. A large crowd attended this event. Things went well during the ceremony.

Fall semester began at UNLV on 8/27. On-sun operation continued by SAIC that week. Work continued to outfit Taylor Hall. Word was put out to students that the project was looking for operator trainees.

During the first full week of September 9 total students (including the two hired earlier) were lined up for training. On-sun operation by SAIC continued. The next week found both systems in operation. A student operator orientation and scheduling meeting was held, with all nine students in attendance. Objectives of the student positions and concerns were outlined to all attendees. Tilt measurements were taken by SES. SES shipping skids and pallets were removed from the site. It was noted that the SAIC PCS had very low power output and operation of this unit was stopped..

Student training took place for the remainder of the month. Special group sessions were set up with SES (two times) and SAIC (one time). During the bulk of this time the SES system was in operation. Problems with the SAIC PCS were addressed with the mounting of a replacement unit. SAIC experienced a facet failure during the final week of the quarter. Work was directed toward scoping-out a 7-day-operational week.

As of 10/4, the SAIC dish system had generated 1734.94 kWh, while the total energy reading on the grid protection panel was 3919 kWh. Throughout the quarter teleconferences between representatives of all of the organizations took place approximately every week.

**Quarterly Technical Report**  
**UNLV Solar Dish Project**  
**Submitted 01/23/02**

Work continued on the UNLV Solar Dish Project. This quarter found the project becoming much more “standard” in operation. By this we mean that it has generally moved from the construction phase to operations and enhancement roles.

Midway through the quarter completion of the arrangements needed for seven-day-a-week operation of the systems were accomplished. These included the training of students in virtually all aspects of the operation and having the manufacturers develop a conclusion that this was done. Also included was the line up of the necessary student availability to make this a reality.

In addition, work has continued in outfitting Taylor Hall with the necessary equipment and capabilities to satisfy the needs of the project. Among other things, fax capability was added to the enhanced ability of the computer system. Computer speakers have been purchased so that we are now able to play CDs related to system performance, engine operation, and other items of possible interest to visitors. We are still dealing with the necessary e-mail connections and the development of the dedicated web site.

Work has proceeded on the illuminated sign for the outside of Taylor Hall to indicate the total energy generated. We are now attempting to receive the necessary approval from the Campus Architect to install this.

Assignments have been made for a variety of tasks, including some of those noted above, to the student operators to assist with items that need to be accomplished for the improvement of the project. These range from basic R&D on the dish systems to general improvements in operations.

Chief among these additional aspects of the project has been one, initiated this quarter, to bring the instrumentation system up to some uniformly modern standards. This is viewed as critical for us to be able to operate the systems comprehensively and report their outputs. A longer-term issue is the possible development of an automated control operation for the systems.

We have numerous visitors over the quarter. The most notable of these groups was one from the Environmental Protection Agency and another from the Environmental Studies Department at UNLV. Several tours have been arranged for lessor numbers of visitors scheduled in advance as well as several drop-ins.

Three other sets of information are included in this report. Two of these that follow are virtually day-by-day reports of actions and incidents related to each of the systems. Each of these is followed by a glossary to enable the reader to understand some terminology used. Additionally, there is a summary set of information related to operations and output.

## **Incidents and Procedures (SAIC)**

### **10-01-01**

Patched 1/8" hole in Facet "Mid 5" with RTV "blue" silicone. Puncture caused by small rock.  
Minimum sun angle changed from 20 degrees to 30 degrees to prevent flashing apartment complex to the east of the site.

### **10-02-01**

Adjustments made to tracking matrix throughout day as required to minimize receiver temperature gradient.

### **10-03-01**

Hydrogen bottle exchanged.  
Adjustments made to tracking matrix throughout day as required to minimize receiver temperature gradient.  
Noticed presence of small airborne insulation particles at receiver aperture.  
"Hot fill" performed on PCS as advised by STM representative.

### **10-04-01**

Student operator training continued.  
Adjustments made to tracking matrix.

### **10-05-01**

Student operator training continued.

### **10-08-01**

Student operator training continued.

### **10-09-01**

Student operator training continued.

### **10-10-01**

Student operator training continued.  
Minor adjustments made to made to tracking matrix throughout day.

### **10-11-01**

Student operator training continued.  
Replaced NIP sensor board in network controller with new unit.  
Noticed lower than normal cycle pressures prior to morning cold fill.  
Focus enable shuts off intermittently throughout day when engine is at max stroke to prevent receiver from overheating. This is a normal occurrence.  
PCS fault "Minimum operating RPM". Reset grid protection panel to clear PCS fault. Enabled solar and commenced normal operation.

### **10-12-01**

Student operator training continued.  
Focus enable on and off intermittently throughout day.

### **10-15-01**

Student operator training continued.  
Minor adjustments made to tracking matrix throughout day.

### **10-16-01**

Student operator training continued.  
Washed mirrors using tap water as de-ionization system had not yet been installed.

**10-17-01**

Student operator training continued.  
Adjustments made to tracking matrix.  
Focus enable on and off intermittently throughout day.

**10-18-01**

Student operator training continued.

**10-19-01**

SAIC representative on site for group training session.  
Low cycle pressures on first cold fill. Restart PCS and attempt 2<sup>nd</sup> cold fill. 2<sup>nd</sup> cold fill successful.  
Reset dish computer.  
Minor adjustments made to made to tracking matrix throughout day.  
“Max operating temperature” fault.  
Dish moved manually to inspect PCS for cause of fault. Fault believed to be caused by low cycle pressure.  
Inspected mirrors for cracks and other damage.  
Noticed insulation build-up behind receiver tubes.  
Noticed cycle pressures falling after cold fill.  
Aperture plug patched.

**10-20-01**

SAIC representative on site for group training session.  
Student operator training continued.  
Installed tension spring on over-limit switch.

**10-22-01**

“Max operating temperature” fault.  
Cycle pressures falling.  
Aperture plug patched.  
Notified SAIC and STM of problems with PCS.  
Operation discontinued for remainder of the day.

**10-23-01**

PCS checked for hydrogen leaks.  
Whistling sound noticed when cold fill is attempted.  
Maximum cold fill pressure is 3.5 MPa (very low). This bleeds down to .3 MPa after about 3 min.  
No operation.

**10-24-01**

“Minimum cycle pressure” fault.  
Fault cleared and PCS is cold filled to check for leaks.  
No operation, which continued for several days.

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**10-28-01**

STM representatives on site to remove and inspect top end of PCS.  
Top end removed and inspected. Receiver tubes were found to have small holes in the outer walls. Receiver is shipped back to STM to determine the cause of failure. Suspected cause is chemical reaction between inconel heater tubes and insulation material.  
Camera installed to monitor incident flux pattern on receiver aperture.  
Purge valve installed at hydrogen bottle to remove air from system after changing bottles.  
No operation until 11-19-01. During this time a new receiver is being installed by STM.

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**11-19-01**

Work completed on PCS.  
Hydrogen bottle changed out.  
An attempt is made to go on sun but is aborted after a “Dish comm error” fault.



Fault is cleared and system is put on sun for a short time.  
Solar disabled due to very low power output.  
While system is off sun, a new camera lens is installed.  
No further operation on this day.

**11-20-01**

“PCS response” fault.  
SAIC contacted to determine cause of fault. Attempted to remedy by restarting both the dish and the PCS computers but this was unsuccessful.  
No further operation on this day and for several days following.

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**11-26-01**

SAIC on site to troubleshoot comm lines.  
“PCS response” fault still present.  
No operation on this day.

**11-29-01**

Communication with dish lost.  
Notified STM and SAIC.  
No operation on this day, and for several days following.

**12-05-01**

STM representative on site to troubleshoot system.  
PCS comm line disconnected at pedestal and PCS computer cycled. This re-established communication with dish and cleared “PCS response” fault.  
No operation on this day and for several days following.

**12-09-01**

Modifications made to insulation on receiver.  
No operation on this day.

**12-10-01**

“PCS not ready” fault. Fault cleared after cold fill.  
Solar enabled, positive power produced.  
Tracking adjustments made.

**12-11-01**

Changed NIP scale values using the terminal emulator.  
Dish communication lost again.  
Dish communication restored after closing terminal emulator.  
Solar enabled, positive power produced.  
Adjustments made to tracking matrix.

**12-12-01**

Solar enabled, positive power produced.  
Adjustments made to tracking matrix  
Noticed presence of small airborne insulation particles at receiver aperture.

**12-13-01**

Inspection performed on receiver by STM representative.  
Communication with dish lost again. Dish computer restarted, communication re-established.  
“PCS not ready” and “Focus power” faults. Cycle 480 volt power at pedestal and restart computer clears both faults.  
Azimuth limit lamp on dish computer lit but no fault.  
Solar enabled , positive power produced.

**12-14-01**

Student operator training continued.  
Cloudy skies.

**12-17-01**

Student operator training continued.

High wind stow.

Solar enabled, Positive power produced.

“Actuator stall” fault. STM notified.

Engine fault cleared with authorization by STM.

Solar enabled, Positive power produced.

Tracking adjustments made.

Noticed higher than normal (130 degrees c) receiver temperature spreads.

**12-18-01**

Student operator training continued.

Changed hydrogen bottle.

Solar enabled and disabled throughout day due to large receiver temperature spreads.

Mirrors cleaned (de-ionization system now installed at site.)

**12-19-01**

Student operator training continued.

Changed high wind stow parameters.

Solar enabled, Positive power produced.

Adjustments made to tracking matrix.

**12-20-01**

Student operator training continued.

Cloudy , tracked with focus blower off all day.

**12-21-01**

Student operator training continued.

Solar enabled, positive power produced.

Noticed presence of small airborne insulation particles at receiver aperture.

“Position motion timeout” fault.

SAIC and STM notified.

Dish operation halted per request of STM.

No further operation for this quarter.

## SAIC Glossary of Terms

**Actuator Stall Fault-** A fault which occurs when the engine stroke is set to a certain value but the actuator does not move.

**Aperture Plug-** An insulated shield which is used to protect the heater head in the event of an engine stoppage.

**Cold Fill-** Initial pressurization of the Stirling engine before start-up.

**Cycle Pressures-** The pressure in each of the four cylinders of the engine.

**De-ionization System-** A device for removing minerals from tap water. De-ionized water is used to clean the mirrors to prevent spotting.

**Dish Comm Error Fault-** A fault which occurs when the dish stops communicating with the control computer.

**Fault-** Any abnormal operating condition for the PCS or dish.

**Focus Enable-** A dish condition where the focus blower is “on”

**Hot Fill-** Pressurizing the Stirling engine while it is running.

**Limit Switch-** A device which prevents the dish from moving past a predetermined position.

**Max Operating Temperature Fault-** A fault which occurs when the working gas in any one of the four cylinders exceeds 800 degrees C.

**Min Cycle Pressure Fault-** A fault which occurs when the pressure of the working gas in any one of the four cylinders drops below 2.5 MPa.

**Min RPM Fault-** A fault which occurs when the engine RPM drops below 2150.

**NIP-** Short for “normal incident pyroheliometer” a device for measuring solar flux.

**PCS-** Short for “Power conversion system”. The PCU includes the engine, heater head and generator.

**PCS Response Fault-** A fault which occurs when the PCS stops communicating with the dish.

**Receiver Temperature Gradient-** Difference between highest and lowest temperature quadrants in the heater head.

**Tracking Matrix-** A matrix of numerical values which determine the amount of offset from the calculated sun position.

**Position Motion Timeout Fault-** A fault which occurs when the engine stroke is set to a certain value but the actuator cannot set the stroke to this value.

## **Incidents and Procedures (SES)**

### **10-01-01**

SES representative on site.  
Student operator training continued.  
Calibration of new elevation drive completed.  
Normal operation.

### **10-02-01**

SES representative on site.  
Student operator training continued.  
Tightened generator fan bolt.  
Normal operation.  
Took deflection measurements at different elevation positions. These measurements are used to determine offsets from calculated sun position.

### **10-03-01**

SES representative on site.  
Student operator training continued.  
Normal operation.

### **10-04-01**

SES representative on site.  
Student operator training continued.  
Normal operation.  
Changed damaged generator fan.  
Set gravitational deflection offsets to zero.

### **10-05-01**

SES representative on site.  
Student operator training continued.  
Checked new generator fan. Fan O.K.  
Normal operation.

### **10-08-01**

Student operator training continued.  
Made several attempts to go on sun, but temperature gradient very high.  
F3 and ID4 adjustments maxed out so adjustment not possible.  
"Pressure problem in compressor circuit" warning on PCU control console.  
No operation.

### **10-09-01**

SES representative on site.  
Student operator training continued.  
Dish operated but requires constant adjustments to maintain acceptable temperature spreads.

### **10-11-01**

SES representative on site.  
Reset F3 offset.  
Changed maximum dish adjustment limits.  
Some operation.  
Power loss at grid protection panel. Dish went to face up stow.  
Control panel reset and reference update performed.

### **10-12-01**

SES representative on site.  
Student operator training continued.

Tested new dish adjustment limits. New limits seem to solve tracking problems. Good power made throughout remainder of the day.

“Supply” fault. Reset system to clear fault. No further problems.

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#### **10-16-01**

SES representative on site.

Student operator training continued.

Power loss. System went to face up stow. Performed reference update.

Low solar insolation. Little power generated.

#### **10-17-01**

SES representative on site.

Student operator training continued.

Normal operation.

“Pressure problem in compressor circuit” warning. Most likely due to pressure spike caused by intermittent cloud cover. Operation commenced.

Good power produced.

#### **10-18-01**

SES representative on site.

Student operator training continued.

Normal operation.

#### **10-19-01**

SES representative on site.

Student operator training continued.

Normal operation.

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#### **10-23-01**

Student operator training continued.

De-track due to supply fault.

Fault cleared per phone conversation with SES rep.

Normal operation.

Changed gravitational deflection settings.

#### **10-24-01**

SES representative on site.

Student operator training continued.

Error while going to stand-by. “Wrong start pressure” fault. Reset PCU and ran “wake-up” to clear fault.

Normal operation.

#### **10-25-01**

SES representative on site.

Student operator training continued.

Normal operation.

#### **10-26-01**

SES representative on site.

Student operator training continued.

“Pressure problem in compressor circuit” warning

De-track due to “wrong start pressure” fault. Fault cleared.

De-track due to "wrong start pressure" occurs again.  
No further operation on this day.

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#### **10-29-01**

Student operator training continued.  
System will not track. Cycled power at grid protection panel. Reference update performed. Tracking problem solved.  
"Wrong start pressure" fault causes de-track while going to stand-by. Fault cleared. Dish taken to night stow position.  
No power generated on this day.

#### **10-30-01**

Student operator training continued.  
Low solar insolation.  
Tracked in standby all day.  
No power generated on this day.

#### **10-31-01**

Student operator training continued.  
Normal operation.  
Mirrors washed.

#### **11-01-01**

Student operator training continued.  
Supply fault while going from standby to track.  
"Wrong start pressure" fault  
Dish taken to night stow.  
No power generated on this day.

#### **11-02-01**

SES on site.  
Student operator training continued.  
Removed compressor valve. Found that spring had jammed sideways. Installed new "Herion" valve and went on sun.  
"Reference pressure very low" warning, due to low pressure in external hydrogen bottle.  
De-track due to supply fault. Supply fault cleared.  
"Pressure problem in compressor circuit" warning occurred when on sun operation is commenced.  
Dish taken to night stow.  
No further operation on this day.

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#### **11-05-01**

Student operator training continued.  
Attempted to go on sun. Supply fault caused de-track.  
"Reference pressure very low" warning.  
On sun operation attempted again  
Supply fault and "Reference pressure very low" warning again  
Dish taken to night stow.  
No power produced on this day.

#### **11-06-01**

SES on site.  
Student operator training continued.  
Cut power and installed new dump valve.  
Turned power back on and performed reference update.  
System taken on sun.  
System de-track.  
Dish taken back on sun.

Washed mirrors.

**11-07-01**

SES on site.

Student operator training continued.

Normal operation.

**11-08-01**

Student operator training continued.

Normal operation.

**11-09-01**

Student operator training continued.

Normal operation.

**11-12-01**

Student operator training continued.

Normal operation.

“Pressure problem in compressor circuit” warning.

False de-track.

System taken back on sun and operated normally for the rest of the day.

**11-13-01**

Student operator training continued.

Normal operation all day.

**11-14-01**

Student operator training continued.

Normal operation all day.

**11-15-01**

Student operator training continued.

Normal operation all day.

**11-16-01**

Student operator training continued.

Normal operation all day.

**11-19-01**

Student operator training continued.

Normal operation all day.

Washed mirrors.

**11-20-01**

Student operator training continued.

Normal operation throughout most of the day

“High engine pressure” warning, and de-track due to dump fault late in the day.

System taken to night stow.

**11-21-01**

Student operator training continued.

Cloudy conditions.

Some power produced.

Tracked in stand-by for most of day.

**11-27-01 to 12-06-01**

Mirror alignment performed. No operation

**12-07-01**

Student operator training continued.

Mirror alignment complete.

System taken on sun. High temperature spread. Noticed heater head quadrant 4 always hot, and quadrant 2 always cold.

System taken off sun and put into night stow.

No further operation on this day.

#### **12-09-01**

Mirrors washed.

No operation on this day.

#### **12-10-01**

Student operator training continued.

Attempted to go on sun but aborted when high temperature spreads were observed.

No operation on this day.

#### **12-11-01**

SES on site.

Student operator training continued.

Attempted to remedy high temperature spreads by moving PCU back 1 inch on support arm.

Attempted to go on sun but aborted due to high temperature spreads.

Moved PCU back another 2 inches. This produced low power and excessive spillage.

PCU moved forward 1 inch.

Noticed significant oil leakage near reservoir. Oil possibly leaking from oil nozzle plug for cylinder 4.

Taped rag over plug to monitor leak.

Added 1 quart of oil to engine.

No further operation on this day.

#### **12-12-01**

SES on site.

Adjusted F3 to raise the beam slightly.

Took system on sun. Power very low.

Moved PCU several more times attempting to fix high temperature spread problem.

Temperature spreads still high.

Dish shut down for remainder of the day.

#### **12-13-01**

SES on site.

Moved PCU several more times attempting to fix high temperature spread problem. Problem appears to be fixed.

Noticed compressor valve was sticking closed during operation.

Some power produced on this day.

#### **12-14-01**

Student operator training continued.

Cloudy skies. No power produced.

#### **12-15-01**

Student operator training continued.

Power produced.

#### **12-16-01**

Student operator training continued.

Normal operation.

"Pressure problem in compressor circuit" warning.

Warning cleared and operation commenced.

#### **12-17-01**

Student operator training continued.

Normal operation.

"Pressure problem in compressor circuit" warning.



Warning cleared and operation commenced.

#### **12-18-01**

Student operator training continued.

Normal operation.

System shut down early due to cloudy conditions.

#### **12-19-01**

Student operator training continued.

“Pressure problem in compressor circuit” warning.

Changed compressor valve.

Commenced on sun operation. Compressor valve cycling o.k.

Checked fast slew system. System checked out o.k.

Performed reference update after cutting power.

System shut down for the night.

#### **12-20-01**

Student operator training continued.

No power produced due to overcast conditions.

Tracked in stand-by for entire day.

#### **12-21-01**

Student operator training continued.

No power produced due to computer problems.

Computer problems resolved by end of day.

#### **12-22-01**

Student operator training continued.

System taken on sun.

High temperature spread due to sudden cloud cover

System taken back on sun after clouds cleared.

De-track due to supply fault. Fault caused by compressor valve sticking.

System shut down for remainder of the day.

#### **12-23-01**

Student operator training continued.

System on and off all day due to clouds.

#### **12-24-01**

Student operator training continued.

Normal operation all day.

#### **12-26-01**

Student operator training continued.

Several false de-tracks throughout day.

“Cannot dump completely” warning.

System shut down for the evening.

#### **12-27-01**

Student operator training continued.

“Cannot dump completely” warning.

De-track due to “wrong start pressure fault” while attempting to go on sun.

Fault cleared and on sun operation attempted again.

De-track due to dump fault. “High engine pressure” warning.

Fault cleared and on sun operation attempted again.

De-track due to “wrong start pressure” fault.

No power produced on this day.

Dish shut down for the remainder of the day.

#### **12-28-01**

Student operator training continued.

System controller error. Error cleared by re-booting dish control computer.  
Cloudy conditions. No power produced on this day.  
Receiver camera adjusted.

**12-29-01**

Student operator training continued.  
No power produced due to cloudy conditions.

**12-30-01**

Student operator training continued.  
De-track due to "wrong start pressure fault" while attempting to go on sun.  
Fault cleared.  
2<sup>nd</sup> attempt to go on sun made.  
System de-track due to same fault.  
System shut down for remainder of day.  
No power produced.

**12-31-01**

Student operator training continued.  
De-track due to dump fault while attempting to go on sun. "High engine pressure" warning.  
2<sup>nd</sup> attempt to go on sun made.  
De-track due to "wrong start pressure" fault.  
System shut down per SES request.

## SES Glossary of Terms

**De-track-** A condition in which the dish moves from track mode to standby.

**“Dump” Fault-** A fault which occurs when the compressor dump valve is not operating correctly.

**F3-** A parameter which may be changed by the operator as needed to adjust the beam in elevation.

**Gravitational Deflection Offsets-** Offset values added to the calculated sun position to compensate for the deflection of the engine support arm at various elevation settings.

**ID4-** A parameter which may be changed by the operator as needed to adjust the beam in azimuth.

**PCU-** Short for “Power conversion unit”. The PCU includes the engine, heater head and generator.

**“Pressure Problem in Compressor Circuit” Warning-** A warning which occurs when the gas pressure in the compressor circuit is either too high or too low while the engine is idling.

**Receiver Temperature Gradient-** Difference between highest and lowest temperature quadrants in the heater head.

**“Reference Pressure Very Low” Warning-** A warning which occurs when the external hydrogen tank pressure is low.

**Reference Update-** A procedure performed after a power loss which takes the dish to a reference position to allow the elevation and azimuth position sensors to become re-oriented.

**Stand-by-** In this mode the dish tracks the sun while keeping its centerline pointed 10 degrees above the sun elevation. In this mode incident solar flux is not concentrated on the receiver.

**“Supply” Fault-** A fault which occurs when the gas pressure in the engine does not come up when the microprocessor sends a request.

**Track-** In this mode the dish moves to keep its centerline aligned with the sun.

**“Wrong Start Pressure” Fault-** A fault which occurs when the engine is leaking gas. This fault is triggered when the engine pressure drops below 20 bar.

**Quarterly Technical Report**  
**UNLV Solar Dish Project**  
**Submitted 04/21/02**

Work continued on the UNLV Solar Dish Project. This quarter found the project personnel dealing with general operations, defining research topics to investigate, and completing the installation of some of the final aspects of the overall system.

Routine maintenance and operation has been fairly well defined. The student operators are quite capable for handling both aspects. As started last quarter, we have two students on duty during all daylight hours, seven days a week. These students carefully adjust the controls on the system as may be needed to optimize performance. They also record and report the performance data. They regularly handle such tasks as cleaning of the reflective surfaces, making sure that sufficient hydrogen is available, meeting with visitors and leading tours, interacting with the manufacturers for corrections to operations as well as minor system repairs, and developing computer-related items (more on this latter is given below).

During the quarter we began posting a web site for the system. This can be seen at the location:

<http://www.egr.unlv.edu/solar/main.html>

We are currently completing the installation of two major aspects of this site. One of these is the setting up of a live web cam to show how the systems appear at any time of interest to the browser. Another is arranging so that readings of the current system output, as well as the total energy generated, can be seen.

Work continues on the development of an illuminated sign for the outside of Taylor Hall to indicate the total energy generated so that people who pass by can see it. It will be of sufficient size that passengers in cars traveling on Flamingo Road should have no trouble reading the information. During the quarter we have gone through an extensive delay in the purchasing of the LED heart for the system, as well as getting a professional engineer's analysis of the loads to be incurred with mounting the unit on the roof. We anticipate the unit will be installed early this next semester.

Two identical power meters (one for each system) have been purchased and installed. They are currently undergoing comparison testing to the original methods of inferring power generated.

Chief among additional aspects of the project has been one, initiated last quarter, to bring the instrumentation system up to some uniformly modern standards. As noted in the last quarter report, this is viewed as critical for us to be able to operate the systems comprehensively and report their outputs. A longer-term issue is the possible development of an automated control operation for the systems. Arranging with one of the manufacturers to have access to the logic, protocols, and other aspects in their control/instrumentation system has taken great effort this quarter.

We have been asked by SES to monitor the temperature in the support structure because of the electronic elements housed there. We are preparing to do this when the weather moves more into typical summertime situations. Also, we have been asked to make design improvements to the reflector cleaning system nozzles. We have just begun this effort.

We continue to have numerous visitors to the site. In addition to several groups brought by each of the manufacturers as well as walk-ins, we have had visits by the Western Governors' Conference and several news organizations.

Two other sets of information are included in this report. One is a set of information for each system that outlines day-by-day reports of actions and incidents. Additionally, included is a summary set of information related to operations and output.

## **Incidents and Procedures (SAIC)**

### **01-01-02**

No operation per instruction from STM representative

### **01-02-02**

No operation per instruction from STM representative

### **01-03-02**

No operation per instruction from STM representative

### **01-04-02**

No operation per instruction from STM representative

### **01-05-02**

STM and SAIC representatives on site. Adjusted network NIP to match SES readings. New PCS installed. Facet focus adjusted.

### **01-06-02**

STM and SAIC representatives on site. Performed virus scan on control computer. New version (v 2.0.67) of dish controller software installed. Cold filled engine. System put on sun and then immediately taken off due to high receiver temperature spread. Facet focus readjusted. System put on sun and run normally (temp spreads normal) System stowed due to poor flux.

### **01-07-02**

STM and SAIC representatives on site. Dish control software updated to version 2.0.69 PCS software updated System produced positive power until incident flux dropped off due to cloud cover. (Temp spreads about 100 C). System shut down when shadow from SES system begins to shade lower facets.

### **01-08-02**

Normal operation throughout day.

### **01-09-02**

Normal operation throughout day.

### **01-10-02**

System brought on sun. Temp spreads higher than normal due to high winds. Wind speed declines around noon and temp spreads are reduced. Wind increases again and the system is defocused. Per instruction from STM representative, system tracks defocused for remainder of the day.

### **01-11-02**

System tracks defocused for early part of day due to high wind. Winds die down around noon and focus is enabled. System operated normally for remainder of day.

### **01-12-02**

Poor flux due to cloud cover. Tracked defocused for entire day.

### **01-13-02**

Normal operation throughout day.

### **01-14-02**

Minimum cycle pressure fault. Engine receiver head checked for leaks. Hydrogen leak detected and system shut down until STM representative arrives on site.

### **01-15-02**

STM representative arrives on site. Receiver head pulled revealing damaged cylinder head o-ring.

### **01-16-02**

STM representative on site. Damaged o-rings replaced. Receiver head re-installed. Engine filled and left to sit overnight to determine if leak has been fixed.

### **01-17-02**

STM representative on site. Engine pressure still good indicating that the leak has been fixed. System put on sun about noon and operated normally throughout remainder of the day.

### **01-18-02**

STM representative on site. Normal operation throughout most of the day. Timeout fault late in afternoon. Fault cleared and system is stowed for the evening. Aperture shutter patched.

### **01-19-02**

System operated normally for early part of the day. Focus enable lamp on and off intermittently. SAIC notified. Sun tracker calibration adjusted per instruction from SAIC representative. Incident report was filed. Dish stowed for remainder of day.

### **01-20-02**

Normal operation throughout day.

### **01-21-02**

Facets washed. System put on sun at about 10:00. Normal operation for remainder of the day.

### **01-22-02**

Poor solar conditions. Dish tracked defocused for most of the day.

### **01-23-02**

System put on sun at 9:00. Good isolation but high winds cause large temperature spreads. Focus disabled until winds subside. High winds throughout most of day. Dish stowed for the night.

**01-24-02**

Normal operation throughout day.

**01-25-02**

Normal operation throughout day.

**01-26-02**

Cloudy conditions. System tracked defocused for most of the day.

**01-27-02**

Cloudy conditions. System tracked defocused for most of the day.

**01-28-02**

Normal operation throughout day.

**01-29-02**

Normal operation throughout day.

**01-30-02**

Extremely windy conditions causing high receiver temperature spreads. System shut down for remainder of the day.

**01-31-02**

Normal operation throughout most of the day. Control computer locks up towards the end of the day. Power to control PC is cycled fixing the problem.

**02-01-02**

Normal operation throughout most of the day.

**02-02-02**

Normal operation throughout the day.

**02-03-02**

Maximum cycle pressure difference fault immediately after startup. STM notified and system shut down for the remainder of the day.

**02-04-02**

System put on sun per instruction of STM representative. Normal operation throughout day.

**02-05-02**

System put on sun. Maximum cycle pressure difference fault immediately after startup. Fault cleared and system put on sun per instruction from STM representative. System functions normally for remainder of the day.

**02-06-02**

System put on sun. Maximum cycle pressure difference fault immediately after startup. Fault cleared and system put on sun per instruction from STM representative. System functions normally for remainder of the day.

**02-07-02**

System put on sun. Normal operation throughout day.

**02-08-02**

System put on sun. Normal operation throughout day.

**02-09-02**

System put on sun. High receiver temperature spreads possibly due to gusting winds. System shut down for remainder of the day.

**02-10-02**

System put on sun. Focus disabled due to high temp spreads. Tracking matrix adjusted. System brought back up and power is made for most of the day.

**02-11-02**

Normal operation throughout day.

**02-12-02**

Normal operation throughout day.

**02-13-02**

Mirror mounts inspected. All check out OK. Normal operation throughout day.

**02-14-02**

Normal operation throughout day.

**02-15-02**

Aperture shutter fault immediately after startup. Fault cleared but reoccurs. STM notified. Shutter switch assembly suspected as likely cause of problem. No operation today.

**02-16-02**

No operation today per instructions from STM representative.

**02-17-02**

STM representative on site to inspect shutter switch. Switch repaired. Normal operation for latter part of the day. High wind fault at shutdown.

**02-18-02**

Normal operation throughout day.

**02-19-02**

Main breaker tripped overnight. Breaker reset. "PCS not ready" fault at startup. Chip swapped in network controller per SAIC instructions. Fault not clearing No further operation on this day.

**02-20-02**

"PCS not ready" fault at startup. Fault cleared. System produced power throughout latter half of the day. Problem with PCS computer monitor at shutdown.

**02-21-02**

New PCS monitor installed. Normal operation throughout remainder of the day.

**02-22-02**

Normal operation throughout day.

**02-23-02**

Normal operation throughout early part of day. High wind alarm. Elevation motor fault. System shut down for remainder of the day.

**02-24-02**

Normal operation throughout day. Changed hydrogen bottle at the end of the day.

**02-25-02**

Normal operation throughout day.

**02-26-02**

Normal operation throughout day.

**02-27-02**

Normal operation throughout day.

**02-28-02**

"PCS not ready" fault soon after startup. "Max operating temp" fault. STM notified. Hydrogen leak suspected as cause of problem. Engine cold filled and allowed to sit overnight.

**03-01-02**

Pressures low. Checked engine for hydrogen leak. Leak found in receiver head area. STM and SAIC notified. Engine cold filled again and allowed to sit overnight.

**03-02-02**

No operation.

**03-03-02**

No operation.

**03-04-02**

No operation.

**03-05-02**

Checked engine pressure. Pressures very low. No operation. Engine refilled.

**03-06-02**

No operation.

**03-07-02**

No operation.

**03-08-02**

No operation.

**03-09-02**

No operation.

**03-10-02**

No operation.

**03-11-02**

SAIC and STM representatives on site to repair system. PCS removed from dish. BCS target installed on system.

**03-12-02**

SAIC and STM representatives on site. PCS moved to UNLV mechanical engineering shop for disassembly and inspection. Cracked receiver head found to be causing hydrogen leak. Head replaced with new unit.

**03-13-02**

SAIC and STM representatives on site. Sent PCS back to STM.

**03-14-02**

SAIC and STM representatives on site. Began BCS testing and mirror adjustments. These adjustments are designed to improve the image quality on the receiver head and increase engine reliability.

**03-15-02**

SAIC and STM representatives on site. Continued BCS testing and mirror adjustment.

**03-16-02**

SAIC and STM representatives on site. Continued BCS testing and mirror adjustment.

**03-17-02**

SAIC and STM representatives on site. Continued BCS testing and mirror adjustment.

**03-18-02**

BCS testing and mirror adjustment discontinued due to poor weather.

**03-19-02**

BCS testing and mirror adjustment discontinued due to poor weather.

**03-20-02**

BCS testing and mirror adjustment discontinued due to poor weather.

**03-21-02**

SAIC and STM representatives on site. New PCS arrives on site. Continued BCS testing and mirror adjustment.

**03-22-02**

SAIC and STM representatives on site. Continued BCS testing and mirror adjustment.

**03-23-02**

SAIC and STM representatives on site. Poor weather prevents BCS testing and mirror adjustments. Installed new PCS package. Engine cold filled again and allowed to sit overnight.

**03-24-02**

SAIC and STM representatives on site. Engine pressure still good. Poor weather prevents BCS testing and mirror adjustments. SAIC and STM representatives depart until weather improves.

**03-25-02**

Poor weather prevents BCS testing and mirror adjustments.

**03-26-02**

Poor weather prevents BCS testing and mirror adjustments.

**03-27-02**

SAIC and STM representatives on site. Repaired thermocouple junction in heater head. "Max operating temp fault" immediately after startup. Intermittent tracking problems encountered. Aperture shutter closing and reopening. No further operation today.

**03-28-02**

SAIC and STM representatives on site. Amprobe power meter connected and power output monitored throughout the day.

**03-29-02**

Continued problems with aperture shutter. No operation today.

**03-30-02**

Continued problems with aperture shutter. No operation today.

**03-31-02**

Continued problems with aperture shutter. STM suggests replacing limit switch. No operation today.



## SAIC Glossary of Terms

**Actuator Stall Fault-** A fault which occurs when the engine stroke is set to a certain value but the actuator does not move.

**Aperture Plug-** An insulated shield which is used to protect the heater head in the event of an engine stoppage.

**BCS-** Short for beam characterization system. A method of measuring and adjusting the solar flux reflected by the facets.

**Cold Fill-** Initial pressurization of the Stirling engine before start-up.

**Cycle Pressures-** The pressure in each of the four cylinders of the engine.

**De-ionization System-** A device for removing minerals from tap water. De-ionized water is used to clean the mirrors to prevent spotting.

**Dish Comm Error Fault-** A fault which occurs when the dish stops communicating with the control computer.

**Fault-** Any abnormal operating condition for the PCS or dish.

**Focus Enable-** A dish condition where the focus blower is “on”

**Hot Fill-** Pressurizing the Stirling engine while it is running.

**Limit Switch-** A device which prevents the dish from moving past a predetermined position.

**Maximum cycle pressure difference fault-** A fault which occurs when the pressure difference between cylinders exceeds 1.2 Mpa.

**Max Operating Temperature Fault-** A fault which occurs when the working gas in any one of the four cylinders exceeds 800 degrees C.

**Min Cycle Pressure Fault-** A fault which occurs when the pressure of the working gas in any one of the four cylinders drops below 2.5 MPa.

**Min RPM Fault-** A fault which occurs when the engine RPM drops below 2150.

**NIP-** Short for “normal incident pyroheliometer” a device for measuring solar flux.

**PCS-** Short for “Power conversion system”. The PCU includes the engine, heater head and generator.

**PCS Response Fault-** A fault which occurs when the PCS stops communicating with the dish.

**Receiver Temperature Gradient-** Difference between highest and lowest temperature quadrants in the heater head.

**Tracking Matrix-** A matrix of numerical values which determine the amount of offset from the calculated sun position.

**Position Motion Timeout Fault-** A fault which occurs when the engine stroke is set to a certain value but the actuator cannot set the stroke to this value.

## **Incidents and Procedures (SES)**

### **01-01-02**

No operation due to holiday.

### **01-02-02**

System de-track due to compressor dump fault immediately after startup. SES representative notified. Attempted to go back on sun per STM instruction. System de-track due to compressor dump fault immediately after startup. Tracked in standby for remainder of the day per STM instruction. Mirrors washed.

### **01-03-02**

Cloudy conditions early in the day. Tracked in standby. Attempted to go on sun around 10:30. De-track due to "wrong start pressure fault." Fault cleared and on sun operation attempted again. De-track due to "high engine pressure fault". Tracked in standby for remainder of the day.

### **01-04-02**

Rebuilt and reinstalled compressor valve. System taken on sun at about 10:30 "Cannot dump completely warning." Warning cleared. Normal operation for remainder of the day.

### **01-05-02**

Intermittent cloud cover throughout the day. System switched between track and standby. throughout the day. Several false de-tracks in later part of the day.

### **01-06-02**

Intermittent cloud cover throughout the day. System switched between track and standby.

"Cannot dump completely warning". Warning cleared. "Dump fault". Engine pressure high. Several attempts to go on sun made. "Dump faults" prevent on sun operation. System stowed early.

### **01-07-02**

SES representative on site. Problems encountered with tracking computer. Attempted to go on sun around noon. De-track due to compressor "dump fault". Attempted to remove compressor valves but these are seized in the compressor housing. Lubricant applied to valves and allowed to sit overnight.

### **01-08-02**

SES representative on site. One compressor valve could be removed but the other one was still seized. Replaced the compressor solenoid valve. Attempted to go on sun but several false de-tracks prevented this. Cleaned all electrical connections to PCU. On sun operation achieved. Some power produced. Compressor valve now stuck in the open position. Installed compressor valve from different PCU. System stowed for the evening.

### **01-09-02**

SES representative on site. Performed full system inspection. Attempted to go on sun. De-track due to "dump fault". Fault cleared and Compressor valve switched back to original unit. On sun operation achieved. Some power produced. System stowed for the evening. Checked for correct voltage at compressor solenoid. Voltage checks out OK.

### **01-10-02**

System on and off sun throughout the day due to high receiver temperature spreads. Gusting winds possible cause for high temperature difference. Some power produced.

### **01-11-02**

Normal operation throughout day. Noticed receiver camera image intermittently on and off.

### **01-12-02**

NIP required realignment. "Wrong start pressure" error at startup. Error cleared and system operated normally for the remainder of the day.

### **01-13-02**

NIP required realignment. System taken on sun. False de-track late in the day. System taken back on sun for the remainder of the day.

### **01-14-02**

NIP not working. Attempted to go on sun. De-track due to "wrong start pressure" fault. Fault cleared. Attempted to go on sun. De-track due to "water pump" fault. Fault cleared. On sun operation achieved. Some power produced. "Pressure problem in compressor circuit" warning occurred late in the day. Warning cleared. System stowed for the evening.

### **01-15-02**

Overcast conditions all day. Tracked in standby all day. No power produced.

### **01-16-02**

Problem encountered with elevation limit switch. SES representative contacted.

Power cut to system and reference update performed per SES instruction. On sun operation achieved. Some power produced. System stowed for the evening.

### **01-17-02**

Normal operation throughout the day. Inspected oil leak after system was shut down. Loose mounting bolts tightened to fix leak.

**01-18-02**

System taken on sun. "Pressure problem in compressor circuit" warning immediately after startup. System produced power for most of the day. Inspected compressor circuit and found broken check valve. System stowed for the evening.

**01-19-02**

Installed new check valve. System taken on sun and operated normally throughout the day.

**01-20-02**

Attempted to go on sun. De-track due to "supply" fault. De-track cleared. Attempted to go on sun. "Wrong start pressure" error. Error cleared and on sun operation commenced. Normal operation for the remainder of the day.

**01-21-02**

Normal operation throughout the day.

**01-22-02**

Windy and intermittently cloudy conditions all day. System switched between track and standby all day. Some power produced.

**01-23-02**

Changed hydrogen bottle. Windy conditions throughout the day. Winds causing high receiver temperature spreads. System switched between track and standby all day. Some power produced.

**01-24-02**

System taken on sun. False de-track late in the day. De-track cleared and the system taken back on sun.

**01-25-02**

NIP needs realignment. Partly cloudy conditions. Some power produced. Mirrors washed.

Topped off oil in engine reservoir. Checked system for oil leaks.

**01-26-02**

Cloudy conditions all day. Tracked in standby. No power produced.

**01-27-02**

Cloudy conditions all day. Tracked in standby. No power produced.

**01-28-02**

Partly cloudy conditions. System switched between track and standby all day. Noticed some oil leaking from engine.

**01-29-02**

Partly cloudy conditions. System operated normally for most of the day. "Cannot dump completely" warning late in the day. Warning cleared and system shut down for the evening.

**01-30-02**

Wind very high today. No operation per SES instructions.

**01-31-02**

NIP requires realignment. Normal operation throughout the day.

**02-01-02**

Normal operation throughout the day. Checked oil in engine.

**02-02-02**

Normal operation throughout the day. NIP requires realignment.

**02-03-02**

Normal operation throughout the day. NIP requires realignment.

**02-04-02**

NIP realignment performed. System taken on sun. De-track due to "supply" fault immediately after startup. 2nd attempt made to go on sun. De-track due to "supply" fault immediately after startup. 3<sup>rd</sup> attempt to go on sun successful. Normal operation for remainder of the day.

**02-05-02**

SES representative on site. Replaced gasket for oil reservoir. Installed rebuilt compressor valve. On sun operation. Compressor valve not opening properly. Installed newer style compressor valve. Brought system on sun. Normal operation for the remainder of the day.

**02-06-02**

SES representative on site. Some problems with "fast slew" at startup. Problems resolved. Normal operation throughout remainder of day. Mirrors washed.

**02-07-02**

NIP realignment performed. Normal operation throughout the day.

**02-08-02**

Normal operation throughout the day.

**02-09-02**

Windy conditions. "Reference pressure low" warning due to low bottle pressure. No full bottles available. Advised to go on sun but to put in standby if pressure drops below 150 psi. Commenced on sun operation. High receiver temperature spreads due to wind. System switched between track and standby throughout the day.

**02-10-02**

"Reference pressure low" warning due to low bottle pressure. No full bottles available. Attempted to go on sun but immediately went back to standby due to high receiver temperature spreads. Attempted on sun operation again. False de-track around noon. System taken back on sun. Normal operation for remainder of the day.

**02-11-02**

"Reference pressure low" warning due to low bottle pressure. Normal operation all day. Changed external hydrogen cylinder.

**02-12-02**

NIP realignment performed. Normal operation throughout the day.

**02-13-02**

Overcast conditions. Tracked in standby for entire day.

**02-14-02**

NIP realignment performed. Contacted NIP manufacturer for assistance. Normal operation throughout the day.

**02-15-02**

NIP taken down to repair azimuth clutch per manufacturers instruction. Cloudy conditions throughout the day. Tracked in standby for most of the day.

**02-16-02**

System taken on sun. "Pressure problem in compressor circuit" warning. Warning cleared and on sun operation commenced. "Pressure problem in compressor circuit" warning. Warning cleared and on sun operation commenced. Normal operation for remainder of the day. Noticed oil drops beneath the system.

**02-17-02**

Windy and cloudy conditions. Tracked in standby for entire day. No power produced

**02-18-02**

De-track due to "supply" fault immediately after startup. On sun operation attempted again. De-track due to "wrong start pressure" fault. Fault cleared and on sun operation attempted again. De-track due to "supply" fault. Fault cleared. System successfully taken on sun for the remainder of the day. Some power produced. NIP azimuth clutch motor tightened per manufacturers' instruction.

**02-19-02**

Cloudy conditions. Main breaker tripped overnight. Breaker reset and reference update performed. System switched between track and standby throughout the day due to intermittent cloud cover. Some power produced. "Pressure problem in compressor circuit" warning. System stowed for the evening. NIP reinstalled for testing and alignment.

**02-20-02**

System switched between track and standby throughout the day due to intermittent cloud cover. Some power produced. NIP still not working. Unit taken down from roof for further adjustments.

**02-21-02**

Normal operation throughout the day. NIP undergoing alignment per manufacturers' instruction.

**02-22-02**

System taken on sun. "Pressure problem in compressor circuit" warning soon after startup. Warning cleared and system taken back on sun. False de-track. System taken back on sun. False de-track. System taken back on sun. Switched between track and standby for the remainder of the day due to intermittent cloud cover. Some power produced.

**02-23-02**

System switched between track and standby for the remainder of the day due to intermittent cloud cover and gusting winds. Some power produced.

**02-24-02**

Normal operation throughout the day.

**02-25-02**

SES representative on site. System operated normally for the first half of the day. Shut down early to remove radiator. Radiator removed to gain access to a suspected oil leak.

**02-26-02**

SES representative on site. Replaced gaskets on front cover and reinstalled radiator assembly. Checked oil level.

**02-27-02**

SES representative on site. System taken on sun. "Pressure problem in compressor circuit" warning soon after startup. Warning cleared and system taken back on sun. Some power produced. System shut down early to wash mirrors.

**02-28-02**

High receiver temperature spreads due to dirty upper mirrors. System tracked in standby for most of the day. Washed mirrors.

**03-01-02**

System taken on sun. System taken to standby due to high receiver temperature spreads. System taken back on sun. "Cannot dump completely" warning. Warning cleared and on sun operation commenced. (SES notified.) System taken to standby due to high receiver temperature spreads. Normal operation for the remainder of the day. Some power produced.

**03-02-02**

De-track due to "dump fault" immediately after startup. Normal operation for the remainder of the day.

**03-03-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. "Wrong start pressure" warning. False de-track. De-track cleared and on sun operation attempted again. De-track due to "supply fault". De-track cleared and on sun operation attempted again. Normal operation for the remainder of the day.

**03-04-02**

De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. De-track due to "supply fault". De-track cleared and on sun operation attempted again. Normal operation. False de-track late in the day. De-track cleared and system stowed for the evening.

**03-05-02**

System taken on sun. System switched between standby and track throughout day due to variable cloud cover. "Pressure problem in compressor circuit" warning around noon. Warning cleared and on sun operation commenced. Normal operation for the remainder of the day.

**03-06-02**

Cloudy conditions all day. System tracked in standby. No power produced.

**03-07-02**

De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. Normal operation for the remainder of the day.

**03-08-02**

System in "comm loss mode" when operators arrived. Power reset and reference update performed. De-track due to "dump fault" immediately after startup. "Engine pressure too high" warning. "Wrong start pressure" error. On sun operation attempted again. "Pressure problem in compressor circuit" System stowed for the evening.

**03-09-02**

De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. Normal operation for the remainder of the day.

**03-10-02**

De-track due to "dump fault" soon after startup. Attempted unsuccessfully several times to go on sun. No further operation on this day.

**03-11-02**

De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. Normal operation for the remainder of the day. Washed mirrors again due to recent windstorm.

**03-12-02**

System taken on sun. De-track due to "dump fault" immediately after startup. No further operation. System stuck in night stow position due to sheared azimuth position sensor.

**03-13-02**

Replaced azimuth position sensor. No operation on this day.

**03-14-02**

Repositioned azimuth sensor. Still having problems. No operation on this day.

**03-15-02**

SES representative on site. System taken on sun. De-track due to "dump fault" immediately after startup. "High engine pressure" warning. Replaced compressor valve. Attempted to go back on sun. De-track due to "dump fault" immediately after startup. Replaced compressor valve again. Attempted to go back on sun. Compressor valve stuck closed but commenced on sun operation anyway. Some power produced.

**03-16-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. False de-track. De-track cleared and on sun operation attempted again. De-track due to "dump fault" immediately after startup. "High engine pressure" warning. SES advised to try again. De-track due to "dump fault" immediately after startup. No power produced.

**03-17-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. On sun operation achieved. Normal operation for the remainder of the day.

**03-18-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. De-track due to "wrong start pressure" fault. De-track cleared and on sun operation attempted again. De-track due to "dump fault" immediately after startup. Tracked in standby for the remainder of the day per SES instruction. No power produced.

**03-19-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. De-track due to "dump fault" immediately after startup. De-track cleared and on sun operation attempted again. On sun operation achieved. Some power produced.

**03-20-02**

De-track due to "dump fault" immediately after startup. "High engine pressure" warning. De-track cleared and on sun operation attempted again. On sun operation achieved. Some power produced.

**03-21-02**

De-track due to water pump fault immediately after startup. De-track cleared and on sun operation attempted again. De-track due to water pump fault. Power to system cycled on and off per SES instruction. Reference update performed. Attempted to go on sun. De-track due to "wrong start pressure" fault. De-track cleared and on sun operation attempted again. De-track due to "dump fault" System taken to night stow position to change compressor valve. No power produced.

**03-22-02**

De-track due to "dump fault" "High engine pressure" warning. De-track cleared and on sun operation attempted again. "Cannot dump completely" warning. Warning cleared. On sun operation achieved. Some power produced.

**03-23-02**

"Wrong start pressure" warning soon after startup. De-track due to "supply fault" De-track cleared and on sun operation attempted again. On sun operation achieved. Some power produced.

**03-24-02**

Cloudy conditions. Tracked in standby for half the day. Some power produced.

**03-25-02**

Normal operation throughout the day. "Pressure problem in compressor circuit" warning late in the day. Warning cleared and on sun operation commenced.

**03-26-02**

Normal operation throughout the day.

**03-27-02**

Normal operation throughout the day.

**03-28-02**

Cloudy conditions throughout the day. Tracked in standby.

**03-29-02**

Normal operation throughout the day.

**03-30-02**

Normal operation throughout the day.

**03-31-02**

Normal operation throughout the day.

## SES Glossary of Terms

**De-track-** A condition in which the dish moves from track mode to standby.

**“Dump” Fault-** A fault which occurs when the compressor dump valve is not operating correctly.

**F3-** A parameter which may be changed by the operator as needed to adjust the beam in elevation.

**Gravitational Deflection Offsets-** Offset values added to the calculated sun position to compensate for the deflection of the engine support arm at various elevation settings.

**ID4-** A parameter which may be changed by the operator as needed to adjust the beam in azimuth.

**PCU-** Short for “Power conversion unit”. The PCU includes the engine, heater head and generator.

**“Pressure Problem in Compressor Circuit” Warning-** A warning which occurs when the gas pressure in the compressor circuit is either too high or too low while the engine is idling.

**Receiver Temperature Gradient-** Difference between highest and lowest temperature quadrants in the heater head.

**“Reference Pressure Very Low” Warning-** A warning which occurs when the external hydrogen tank pressure is low.

**Reference Update-** A procedure performed after a power loss which takes the dish to a reference position to allow the elevation and azimuth position sensors to become re-oriented.

**Stand-by-** In this mode the dish tracks the sun while keeping its centerline pointed 10 degrees above the sun elevation. In this mode incident solar flux is not concentrated on the receiver.

**“Supply” Fault-** A fault which occurs when the gas pressure in the engine does not come up when the microprocessor sends a request.

**Track-** In this mode the dish moves to keep its centerline aligned with the sun.

**“Wrong Start Pressure” Fault-** A fault which occurs when the engine is leaking gas. This fault is triggered when the engine pressure drops below 20 bar.

## **Incidents and Procedures (SAIC)**

### **04-01-02**

Waiting for shutter actuator and switch to arrive on site. No operation on this day.

### **04-02-02**

Shutter actuator and switch arrives late in the day. No operation on this day.

### **04-03-02**

Shutter actuator arm and limit switches replaced. Shutter still inoperative. STM notified. No operation on this day.

### **04-04-02**

STM representative on site. Continued to troubleshoot shutter issue. No operation on this day.

### **04-05-02**

STM representative on site. Continued to troubleshoot shutter issue. No operation on this day.

### **04-06-02**

Continued to troubleshoot shutter issue. No operation on this day.

### **04-07-02**

Continued to troubleshoot shutter issue. No operation on this day.

### **04-08-02**

Replaced plug from shutter arm to engine. Shutter working properly. System brought on sun around noon and operated normally for the remainder of the day.

### **04-09-02**

“Dish comm” error while attempting to go on sun. Error cleared and on sun operation attempted again. “Several PCS” response faults throughout the morning. Power cycled and faults cleared. Tracked defocused for remainder of the day. No power generated.

### **04-10-02**

New engine software installed. “Dish comm” Error. No power generated.

### **04-11-02**

Attempted on sun operation. “Max temperature” fault. Changed engine fault parameters and attempted to go on sun again. Dish comm. error. Error cleared and on sun operation commenced. Some power produced.

### **04-12-02**

Difficulty cold filling engine. (incident report filed) On sun operation achieved after several attempts. Max temperature fault soon after startup. On sun operation achieved after several attempts. “Max temperature” fault soon after startup. Some power produced.

### **04-13-02**

On sun operation attempted. Actuator stall time out. Dish not responding to offset commands. System shut down for the remainder of the day.

### **04-14-02**

No operation on this day.

### **04-15-02**

High winds.

No operation on this day.

### **04-16-02**

STM representative on site. Leak down test performed on engine. Engine pressure dropped about 1 Mpa overnight. Attempted on sun operation. “Max temperature” fault. Stroke actuator suspected as cause of high temperature. Inspection revealed broken actuator. Broken actuator removed. No further operation today.

### **04-17-02**

STM representative on site. Blowing dust prevents completion of repairs. No operation today.



**04-18-02**

STM representative on site. Stroke actuator replaced. Normal operation for most of the day. "Azimuth motor" fault late in the day. System shut down for the evening.

**04-19-02**

Normal operation throughout the day. Focus on and off throughout the day due to intermittent clouds.

**04-20-02**

Normal operation throughout the day.

**04-21-02**

Tracking problems early in the day. Synchronized clocks and attempted on sun operation. Normal operation for the remainder of the day.

**04-22-02**

"Min cycle pressure" fault early in the day. Adjusted the engine fault parameters. On sun operation commenced. Normal operation for the remainder of the day.

**04-23-02**

Normal operation throughout the day. System run in optimized mode to check operation. Focus on and off throughout the day due to intermittent clouds.

**04-24-02**

Normal operation throughout the day.

**04-25-02**

Normal operation throughout most of the day. Actuator stall timeout late in the day. System shut down for the evening.

**04-26-02**

Actuator stall fault cleared. Changed engine parameters per STM request. Patched shutter. No operation today due to high winds.

**04-27-02**

Normal operation throughout the day. Focus on and off throughout the day due to intermittent clouds.

**04-28-02**

Normal operation throughout the day.

**04-29-02**

Normal operation throughout the first half of the day. System taken to face up stow due to high winds. Dish will not move from face up stow position after high wind alarm has been cleared. STM notified. No further operation today.

**04-30-02**

Normal operation for early part of the day.

High wind alarm and engine fault. No further operation today.

**05-01-02**

Normal operation throughout the day. Washed mirrors.

**05-02-02**

Attempted on sun operation. Elevation drive motor fault. Commenced on sun operation. Normal operation throughout the day.

**05-03-02**

Normal operation throughout the early part of the day. Elevation motor fault. Fault cleared and on sun operation commenced.

**05-04-02**

Normal operation throughout the day.

**05-05-02**

Normal operation throughout the day.

**05-06-02**

Normal operation throughout the day.

**05-07-02**

Normal operation throughout the day.

**05-08-02**

Normal operation throughout the day. High receiver temp spreads caused by gusting winds.

**05-09-02**

Normal operation throughout the day.

**05-10-02**

Normal operation throughout the early part of the day. Operation stopped due to high winds in the afternoon.

**05-11-02**

High receiver temp spreads caused by gusting winds. Tracked defocused for most of the day.

**05-12-02**

Normal operation throughout the day.

**05-13-02**

Normal operation throughout the day.

**05-14-02**

Normal operation throughout the day.

**05-15-02**

Normal operation throughout the early part of the day. "Maximum cycle pressure difference" fault around noon. No further operation today.

**05-16-02**

Normal operation throughout the day.

**05-17-02**

Normal operation throughout the early part of the day. "Minimum cycle pressure" fault late in the day.

**05-18-02**

Engine not holding pressure. Hydrogen leak detected in receiver area. No operation on this day.

**05-19-02**

No operation on this day.

**05-20-02**

No operation on this day.

**05-21-02**

STM representative on site. Engine disassembled. Found scarring on cylinder walls. Engine sent back to STM for rebuild.

**05-21-02 to 06-30-02**

Engine being rebuilt. No operation

## **Incidents and Procedures (SES)**

### **04-01-02**

Normal operation throughout day. Shut down early to wash mirrors.

### **04-02-02**

Normal operation throughout day.

### **04-03-02**

Normal operation throughout day.

### **04-04-02**

Normal operation throughout day.

### **04-05-02**

De-track due to "wrong start pressure" fault. Fault cleared. Attempted to go on sun. Overcast.

### **04-06-02**

De-track due to "supply" fault. Fault cleared and continued operation. System shut down to install new meters and change hydrogen bottles.

### **04-07-02**

Normal operation throughout day.

### **04-08-02**

De-track due to "supply" fault. Warning: pressure problem in compressor circuit. Warning cleared and resumed operation. Overcast.

### **04-09-02**

Normal operation throughout day.

### **04-10-02**

Normal operation throughout day.

### **04-11-02**

Normal operation throughout day.

### **04-12-02**

Normal operation throughout day. Overcast.

### **04-13-02**

Warning: pressure problem in compressor circuit. Cleared and resumed normal operation.

### **04-14-02**

Warning: pressure problem in compressor circuit. Cleared and continued normal operation.

### **04-15-02**

No operation due to high winds (peak at 58mph)

### **04-16-02**

Warning: pressure problem in compressor circuit. Cleared and continued normal operation.

### **04-17-02**

Gusting winds (peaks at 43mph) all day. System did not run.

### **04-18-02**

Compressor valve changed. Also adjusted camera on receiver. System resumed normal operation.

### **04-19-02**

De-track due to "dump" fault. Warning: engine pressure was high. Valve polished and re installed. Per instruction from SES representative, system restarted. Possible supply valve sticking.

### **04-20-02**

De-track due to "supply" fault. Cleared and continued normal operation.

### **04-21-02**

De-track due to "supply" fault and wrong starting pressure. Cleared and continued normal operation.

### **04-22-02**

Per instruction from SES representative, power killed and did reference update. NIP dusted off. Mirrors washed.

**04-23-02**

Removed and cleared tank valve, supply valve and two filters on supply block, then reinstalled. Partly cloudy.

**04-24-02**

Normal operation throughout day.

Light haze.

**04-25-02**

Normal operation throughout day.

**04-26-02**

Normal operation throughout day.

**04-27-02**

Warning: pressure problem in compressor circuit. Cleared and continued normal operation.

**04-28-02**

De-track due to "supply" fault and wrong starting pressure. Hydrogen tank replaced. Resumed operation.

**04-29-02**

Normal operation throughout day. High winds.

**04-30-02**

Normal operation throughout day.

**05-01-02**

Normal operation throughout day.

**05-02-02**

Normal operation throughout day.

**05-03-02**

Normal operation throughout day.

**05-04-02**

Normal operation throughout day.

**05-05-02**

Normal operation throughout day.

**05-06-02**

Normal operation throughout day.

**05-07-02**

De-track due to "supply" fault. Cleared and resumed normal operation.

**05-08-02**

Normal operation throughout day.

**05-09-02**

Normal operation throughout day. Mirrors washed.

**05-10-02**

Gusting winds (peaks at 40mph). De-track due to no oil pressure.

**05-11-02**

Warning: can not dump completely. De-track due to "supply" fault. Cleared and resumed normal operation.

**05-12-02**

High engine pressure and low tank pressure. Valve failure. Per instruction from SES representative, system shut down early.

**05-13-02**

Per instruction from SES representative, tank valve closed and released gas. Sent system to operate. De-track due to low tank pressure. Cleared and resumed operation.

**05-14-02**

De-track due to "supply" fault. Cleared and resumed normal operation.

**05-15-02**

Washed mirrors with acid (CB-120). Adjusted camera. De-track due to "supply" fault. Replaced supply valve. Polished compressor valve. Resumed normal operation.

**05-16-02**

De-track due to "supply" fault and wrong start pressure. Per instruction from SES representative, power killed and reference updated. Resumed normal operation.

**05-17-02**

Dish did not completed NST and was stuck on the process. Per instruction from SES representative, power killed and reference updated. Resumed normal operation.

**05-18-02**

De-track due to "supply" fault. De-track due to wrong start. Per instruction from SES representative, power killed and reference updated. Resumed operation.

**05-19-02**

De-track due to "supply" fault. De-track due to wrong start. Tracked in standby for the remainder of the day.

**05-20-02**

Wrong start pressure. Power killed and reference update done. De-track due to "supply" fault. Cleared de-track and resumed operation.

**05-21-02**

Dish did not completed NST and was stuck on the process. Per instruction from SES representative, power killed and reference updated. "Water pump" fault, "supply" fault and wrong start pressure. Fault cleared and resumed operation.

**05-22-02**

Dish moved too far west, power killed and reference updated. "Thermocouple tubes" fault. Power killed per SES representative request. System shut down for the day.

**05-23-02**

No operation while possible causes of persistent supply faults are analyzed

**05-24-02**

No operation while possible causes of persistent supply faults are analyzed

**05-25-02**

No operation while possible causes of persistent supply faults are analyzed

**05-26-02**

No operation while possible causes of persistent supply faults are analyzed

**05-27-02**

No operation while possible causes of persistent supply faults are analyzed

**05-28-02**

Azimuth magnet replaced and thermocouple number three and four rewired. De-track due to "supply" fault Wrong start pressure Faults cleared and resumed operation.

**05-29-02**

Wrong start pressure and "supply" fault. Power killed and reference update (RFU) performed. Continued normal operation for the rest of the day.

**05-30-02**

De-track due to "supply" fault. Power killed and reference update performed. Continued normal operation for the rest of the day.

**05-31-02**

Normal operation throughout day.

**06-01-02**

Communication loss error.

Reference update performed and resumed normal operation for the rest of the day.

**06-02-02**

De-track due to "dump" fault and wrong start pressure. Fault cleared and resumed operation. Overcast.

**06-03-02**

DIR alignment in progress. No operation.

**06-04-02**

DIR alignment in progress. No operation.

**06-05-02**

DIR alignment in progress. No operation.

**06-06-02**

Finished DIR alignment. PCU 213 installed. Resumed normal operation.

**06-07-02**

De-track due to high tank pressure (231). Bled excess pressure from supply tank on PCU. Kill power and perform reference update. Resumed normal operation.

**06-08-02**

Normal operation throughout day.

Windy.

**06-09-02**

Normal operation throughout day.

**06-10-02**

High temperature difference due to thermocouple fault. Fault fixed and resumed normal operation.

**06-11-02**

Normal operation throughout day.

**06-12-02**

Normal operation throughout day.

**06-13-02**

Normal operation throughout day.

**06-14-02**

Normal operation throughout day.

**06-15-02**

Normal operation throughout day.

**06-16-02**

Normal operation throughout day.

**06-17-02**

Normal operation throughout day.

**06-18-02**

Normal operation throughout day.

**06-19-02**

Normal operation throughout day.

**06-20-02**

Normal operation throughout day. Partly cloudy day.

**06-21-02**

Normal operation throughout day.

**06-22-02**

Normal operation throughout day.

**06-23-02**

De-track due to "supply" fault. Fault cleared and resumed normal operation.

**06-24-02**

Oil leaks noticed on mirrors. Notified SES representative and instructed to operate until further notice.

**06-25-02 to 06-30-02**

Tracked in standby until oil leaks could be repaired.

**Quarterly Technical Report  
UNLV Solar Dish Project  
Submitted 10/18/02**

Work continued on the UNLV Solar Dish Project. This quarter found the project personnel dealing with general operations, submitting proposals to the NREL Nevada Renewable Energy Program, and trying to make the production rate as high as possible. Decreased production rates that were experienced were due in part to the following:

- SES changed their control system, necessitating some down time.
- SES removed their control board for installation in another system on an emergency basis, again necessitating some down.
- SAIC/STM experienced a great deal of engine problems resulting in significant down time.

We had made a plea to STM to have two engines available for operations here so that we could change-out one if need be. At the end of the reporting period this was finally realized.

Several proposals were submitted to NREL for solar-related work. We were informed that we will be awarded funds to continue operations on the SES unit. We were also awarded funds to assist SAIC in converting their dish system to a fixed-facet, dish-concentrating-PV system.

Two students left the project and were not replaced, as our money (and DOE's) has been of concern. We still have nearly 100% capability of operations.

Below we list a day-by-day summary of operations. Tabular performance data is attached to this.

**Incidents and Procedures (SES)**

**07-01-02** Engine leaking oil. Tracked in standby throughout the day. SES repair crew still installing system in South Africa. No power produced.

**07-02-02** Checked oil engine oil level. Discovered oil leaking from check valve block. Tracked in standby throughout the day. No power produced.

**07-03-02** Tracked in standby throughout the day. No power produced.

**07-04-02** Tracked in standby throughout the day. No power produced.

**07-05-02** Tracked in standby throughout the day. No power produced.

**07-06-02** Tracked in standby throughout the day. No power produced.

**07-07-02** Tracked in standby throughout the day. No power produced.

**07-08-02** Tracked in standby throughout the day. No power produced.

**07-09-02** Tracked in standby throughout the day. No power produced.

**07-10-02** Communication with dish lost. Dish not tracking. Some glinting observed on generator. Killed power to system but fast slew malfunctioned. System driven to safe position using XMDI program per SES instructions. Performed reference update. System taken to night stow position and insulation at engine connector repaired. Fast slew battery tested.

**07-11-02** No operation on this day.

**07-12-02** System controller had shut down overnight. Controller started back up. No operation on this day.

**07-13-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-14-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-15-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-16-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-17-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-18-02** No operation on this day. Waiting for new fast slew battery and motor to arrive.

**07-19-02** Battery and motor arrived. Fast slew repaired. Attempted on sun operation. System de-tracked due to high temp difference. Faulty thermocouple suspected. Thermocouples checked per SES instruction.

**07-20-02** Dish began to move past elevation sensor. Main structural beam hit pedestal. No major damage to system.

**07-21-02** Waiting for new elevation sensor to arrive. No operation

**07-22-02** Waiting for new elevation sensor to arrive. No operation

**07-23-02** Elevation sensor arrives late in the day. Sensor installed and tested. No operation.

**07-24-02 to 08-12-02** Installation and testing of updated controller.

**08-13-02** Took dish on sun around noon. Dish taken off sun due to high controller circuit board temp.

**08-14-02** System put on sun for early part of the day. Some power generated. System taken to night stow to inspect grease leakage at elevation drive.

**08-15-02** System on sun for most of the day.

**08-16-02** System operated normally throughout the day.

**08-17-02** System operated normally throughout the day.

**08-18-02** System operated normally throughout the day.

**08-19-02** System operated normally throughout most of the day. Changed out external hydrogen bottle. New control board pulled and sent to South Africa for installation on new system.

**08-20-02 to 09-19-02** Waiting for fabrication of new control board. No operation.

**09-20-02** New controller installed. Normal operation throughout the day.

**09-21-02** Normal operation throughout the day.

**09-22-02** Normal operation throughout the day. "Pressure problem in compressor circuit" warning late in the day.

**09-23-02** Normal operation throughout the day.

**09-24-02** Normal operation throughout the day.

**09-25-02** Partly cloudy conditions. Switched between track and standby throughout the day. System taken to night stow to test fast slew system per SES instruction. Fast slew ok.

**09-26-02** Normal operation throughout the day.

**09-27-02** Normal operation throughout most of the day. Dump fault late in the day.

**09-28-02** No operation due to cloudy conditions.

**09-29-02** Normal operation throughout the day.

**09-30-02** Normal operation throughout the day.

### **Incidents and Procedures (SAIC)**

**07-01-02** Rebuilt PCS arrives at site. Began installation of PCS.

**07-02-02** Finished PCS installation. Pressurized engine for leak down test.

**07-03-02** System taken on sun with no incidents. Normal operation throughout the day.

**07-04-02** System taken on sun. Normal operation throughout the early part of the day. Maximum temp difference fault around solar noon. Shutter plug closed during fault and requires repair. Plug repaired. No further operation on this day.

**07-05-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-06-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-07-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-08-02** STM representative on site. PCS inspected. System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-09-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.



**07-10-02** Breather valves replaced on all facets. System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-11-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-12-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads. EI meter giving faulty reading.

**07-13-02** System taken on sun. "Max hard temp difference" fault. Shutter plug closed. STM notified and an incident report filed. No further operation on this day.

**07-14-02** SAIC representative on site. Shutter inspected. Checked out ok. STM suggests that faulty thermocouple could be causing temp faults. Recommends disconnecting one thermocouple. No operation on this day.

**07-15-02** System taken on sun. "Max hard temp difference" fault. Shutter plug closed. Disconnected thermocouple in heater head. Normal operation throughout the remainder of the day. EI meter disassembled for troubleshooting.

**07-16-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-17-02** System taken on sun. Focus blower must be switched off several times throughout the day due to the high temperature spreads.

**07-18-02** System taken on sun for early part of the day. Focus disabled due to high receiver temperature spread. Focus re-enabled and system run normally for the remainder of the day.

**07-19-02** System taken on sun for early part of the day. Max cycle pressure difference fault. Focus disabled due to high receiver temperature spread. PCS visually inspected by SAIC representative. System taken back on sun per STM instruction. Max cycle pressure difference fault. System tracked defocused for the remainder of the day.

**07-20-02** Normal operation throughout most of the day. Focus disabled for a short time around solar noon due to high temperature spreads.

**07-21-02** Normal operation throughout most of the day.

**07-22-02** Normal operation throughout most of the day.

**07-23-02** Normal operation throughout most of the day. Focus disabled for a short time around solar noon due to high temperature spreads.

**07-23-02** Attempted on sun operation. "Max hard temp diff" fault soon after startup. Engine found to be "cold pumping" STM representative notified. Tracked defocused for the remainder of the day.

**07-24-02** Attempted on sun operation. "Max hard temp diff" fault soon after startup. Engine found to be "cold pumping" STM representative notified. Tracked defocused for the remainder of the day.

**07-25-02** STM representative on site. Inspected mirror support structure. Tightened loose support strut. Noticed grease leakage from azimuth and elevation drives. Attempted on sun operation. High receiver temperature spread. Attempted adjustment of inner facets to reduce temp diff. Commenced on sun operation again.

**07-26-02** No operation.

**07-27-02** Normal operation throughout most of the day.

**07-28-02** Normal operation throughout most of the day.

**07-29-02** Normal operation throughout most of the day. STM representative arrives with image adjustment hardware (BCS).

**07-30-02** Installed BCS hardware. BCS computer not responding. New part ordered from Arizona. No operation.

**07-31-02** STM representative on site. Troubleshooting BCS equipment. BCS repaired.

**08-01-02 to 08-05-02** STM representative out of town. No operation.

**08-06-02** STM representative on site. Commenced BCS testing and adjustment.

**08-07-02** STM representative on site. PCS reinstalled. Attempted on sun operation. Focus disabled due to high temp spreads. STM advises no operation until further notice.

**08-08-02** STM representative on site. Some testing performed on system. No operation.

**08-08-02 to 08-15-02** Operation suspended until further notice from STM.

**08-16-02** STM notified site to commence operation until new PCS arrives. Normal operation throughout most of the day.

**08-17-02** Normal operation throughout most of the day.

**08-18-02** No operation.

**08-19-02** Normal operation during early part of the day. System stowed due to high winds.

**08-20-02** Normal operation throughout most of the day.

**08-21-02** Normal operation throughout most of the day.

**08-22-02** Normal operation throughout most of the day.

**08-23-02** Normal operation during early part of the day. System stowed due to high winds.

**08-24-02** Normal operation throughout most of the day.

**08-25-02** Normal operation throughout most of the day.

**08-26-02** Normal operation throughout most of the day.

**08-27-02** Normal operation throughout most of the day.

**08-28-02** Normal operation throughout most of the day.

**08-29-02** STM representative arrived on site with new engine. BCS equipment installed.

**08-30-02** STM representative on site. BCS testing completed. Installation of new engine started.

**08-31-02** STM representative on site. Installation of engine completed.

**09-01-02** STM representative out of town.

**09-02-02** STM representative out of town.

**09-03-02** STM representative out of town. System taken on sun. Tracking offsets adjusted throughout the day.

**09-04-02** Normal operation throughout most of the day.

**09-05-02** Cloudy conditions. No operation.

**09-06-02** Cloudy conditions. No operation.

**09-07-02** Cloudy conditions. No operation.

**09-08-02** Cloudy conditions. No operation.

**09-09-02** Normal operation throughout most of the day.

**09-10-02** Normal operation throughout most of the day.

**09-11-02** Cloudy conditions. No operation.

**09-12-02** Cloudy conditions. No operation.

**09-13-02** Normal operation throughout most of the day.

**09-14-02** Normal operation throughout early part of the day.

**09-15-02** Attempted on sun operation. "Max cycle pressure difference" fault. STM notified. No operation on this day.

**09-16-02** STM representative on site. Attempted on sun operation. "Max cycle pressure difference" fault. Operation suspended until PCS can be rebuilt.

**09-17-02 to 09-30-02** Waiting for new PCS No operation

**Final Technical Report**  
**Project DE-FC04-01AL67286**  
**4/10/03**

This report is the final one for this project. Here we summarize some the observations we made during the course of the work. These represent our opinions, and they have not been cleared by the companies involved.

1. The Site where the dishes were located offered several benefits sought in the original project definition. Included in these was a very visible location of the dishes that precipitated a great deal of interest from the general public. We welcomed people to tour any time during daylight hours (seven days a week), and we estimate approximately 300 people did over the duration of this project and learned more about concentrating solar power. In addition, the location of the Site on campus allowed easy access to the students who operated the system. At one point 11 students were employed in both operations and routine maintenance. A down side was that the visible location was a liability when the dishes were not operating. People would ask about what was the problem. Partially as a result of this project, UNLV has selected renewable energy as one of their "macrothemes," a term which is used to denote areas where the university will focus efforts in the years to come.
2. The systems operated with less reliability than had been hoped at the start of the project. Several elements contributed to this, and they differed somewhat between each of the two systems.
3. Engine problems greatly hindered the SAIC system operation. This was exacerbated by the attitude of STM in that they did not want anyone but their own technician performing work on the engine. Since this technician had more than one base to cover in various physical locations, that meant that turnaround on requests for service often were delayed. Of course this engine is an early design. At the end of the project period, STM had developed a beta version of this engine, and they were distributing it to several locations around the world as a combustion-fired distributive generation driver. The company appeared to lose whatever interest may have existed at one time in solar applications. Perhaps this will return at some future date.
4. An additional element of concern was the relatively large amount of time required for the stretched-membrane facets to focus and defocus in interrupted operation. This resulted in less generation time than was possible. We had a student consider some design alternatives for application of the stretched membrane concept, and he did propose a possible approach. At this point in the program, though, it was apparently clear to SAIC that they would not be utilizing the stretched membranes for their future work. Further effort was not expended by us in this direction.
5. SAIC did have a person at the Site throughout the project, and this person facilitated a great deal of the day-to-day maintenance issues (except for the STM engine).
6. The STM engine was removed from the dish system at about the turn of the calendar year. The dish has been at the stow position since that time. Efforts are currently underway to convert that system to dish-PV unit under funding through NREL.
7. Initially the SES system performed quite well. Maintenance and repair issues were dealt with in a very timely fashion. Since SES did not have a person at the Site on a regular basis, this led to their training several of our students for routine maintenance and other aspects. One of these students, Rick Hurt, was hired by SES to travel to South Africa to assist in installing their system there last summer.
8. SES then suffered from the loss of several people in their organization. They also lost their base of operations at the Boeing facility. Both of these circumstances had deleterious effects on their ability to service the UNLV system. Included was the fact that Boeing apparently

held a large cache of SES parts because of some financial issues between the two companies. This had very negative impacts on the availability of appropriate replacement seals. Only at the present time is SES starting to recoup from these problems.

9. We have found that we have some extremely talented students who learn quite quickly about the dish systems and their operation. They have recently been able to almost single-handedly overhaul an SES engine. In our continuation work through NREL we are attempting to have SES base their repair operations here, rather than California. We have a local engine manufacturer with incredible machining facilities and interests in unusual engines with whom we have a good working relationship. We hope that this company will be tapped by SES to perform necessary major repair aspects. When this is combined with our students' abilities, this promises to greatly shorten any down times required for repairs. We recently have seen this work on a major overhaul.

## **Incidents and Procedures (SAIC)**

**10/01/02 – 12/31/02**

**10-01-02** No operation per instruction from STM representative

**10-02-02** No operation per instruction from STM representative

**10-03-02** No operation per instruction from STM representative

**10-04-02** No operation per instruction from STM representative

**10-05-02** No operation per instruction from STM representative

**10-06-02** No operation per instruction from STM representative

**10-07-02** No operation per instruction from STM representative

**10-08-02** No operation per instruction from STM representative

**10-09-02** SAIC and STM representatives on site. Installed rebuilt PCS unit 003. Enabled solar in the late morning. System set to “optimized tracking” due to high clouds in mid-afternoon.

**10-10-02** Tracked defocused until early afternoon. “Max Hard Temp Diff” Fault in mid-afternoon. Engine Logs sent to STM. Solar enabled in mid-afternoon and system ran without faults until shutdown.

**10-11-02** Tracked defocused in AM. Dish brought down in late AM to replace shutter from previous day’s fault. Shutter replaced and dish tracked defocused for rest of day.

**10-12-02** Tracked defocused all day without incident.

**10-13-02** Tracked defocused in morning due to clouds. Focus blowers enabled in late morning. “Max Hard Temp Fault” occurs at noon. Engine Logs sent to STM. Dish brought down and shutter inspected. Tracked defocused for rest of day.

**10-14-02** Tracked defocused all day without incident.

**10-15-02** “Max Hard Temp Diff” fault 30 mins after positive power produced. Engine Logs sent to STM. Camera installed. Focus blowers disabled and dish tracked defocused for rest of day without incident.

**10-16-02** Normal operation for two hours in AM. “Max Hard Temp Diff” fault two hours after positive power produced. Pumping resonance noticed coming from PCS. Engine Logs sent to STM. Shutter inspected and patched. Dish sent back to track and produced positive power for a few minutes before focus blowers were disabled (due to cloud cover). Focus blowers enabled in late afternoon. “Max Hard Temp Diff” fault occurs 50 mins later. System shut down for the day.

**10-17-02** No operation (overcast skies).

**10-18-02** Per STM instructions, thermocouple HT2-2 disconnected and jumper HT3-1. Normal operation for rest of day without incident.

**10-19-02** No operation per instruction from STM representative

**10-20-02** No operation per instruction from STM representative

**10-21-02** No operation per instruction from STM representative Computer system crashes. Rebooted successfully.

**10-22-02** “Max Cycle Pressure Diff” fault one hour after positive power produced. Engine Logs sent to STM. Tracked defocused for rest of day without incident.

**10-23-02** PCS units swapped. Power restored. PCS not ready for operation (no shutter components).

**10-24-02** No operation per instruction from STM representative

**10-25-02** No operation per instruction from STM representative

**10-26-02** No operation per instruction from STM representative

**10-27-02** No operation per instruction from STM representative

**10-28-02** No operation per instruction from STM representative

**10-29-02** No operation per instruction from STM representative

**10-30-02** Quartz window installed.

**10-31-02** SAIC and STM representatives on site. Infrared photographs of aperture taken by STM representative. “Max Cycle Press Diff” fault occurs soon after positive power produced. STM representative reviews logs. Operation resumed after faults cleared. “Max Operating Speed” and “Max Temp” faults occur soon after. Tracked defocused for rest of day.

**11-01-02** No operation per instruction from STM representative

**11-02-02** No operation per instruction from STM representative

**11-03-02** No operation per instruction from STM representative

**11-04-02** Tracked defocused all day without incident.

**11-05-02** Tracked defocused all day without incident.

**11-06-02** Tracked defocused all day without incident.

**11-07-02 to 12-31-02** No operation per instruction from STM representative.

## **Incidents and Procedures (SES)**

**10/01/02–12/31/02**

- 10-01-02** Normal operation throughout day. Early shutdown due to cloud and high wind.
- 10-02-02** Tracked at standby due to cloud cover. On-sun for 32 minutes during a break in clouds.
- 10-03-02** Normal operation throughout day.
- 10-04-02** Late startup due to unavailable operators. Detrack: Low Water Temp, High Oil Temp
- 10-05-02** Detrack: Low Water Temp, High Oil Temp. Normal operation throughout day after clearing detrack.
- 10-06-02** Normal operation throughout day.
- 10-07-02** Normal operation throughout day.
- 10-08-02** Normal operation throughout day.
- 10-09-02** Normal operation in morning. System taken off-sun in early afternoon to install new tracking program.
- 10-10-02** Scattered cloud conditions throughout day resulting in dish being on-sun for short periods.
- 10-11-02** Tracked at standby due to cloud cover.
- 10-12-02** Host PC and PCU Monitor not functioning properly at startup. Dish manually driven to Night Stow until further instructions from SES. No operation.
- 10-13-02** No operation.
- 10-14-02** Tracked at standby due to hazy conditions.
- 10-15-02** Normal operation in morning. Warning: Tank Press. Low. Tracked at standby in afternoon due to cloud cover.
- 10-16-02** Normal operation throughout day. Warning: Refill Time Out. System shut down early to perform work on tracking program.
- 10-17-02** Detrack: Tank Pressure Low. No operation due to low tank pressure.
- 10-18-02** New hydrogen tank installed. Normal operation throughout day.
- 10-19-02** Warning: Refill Time Out, No More Ref.; Pressure Problem in Compressor Circuit  
Normal operation in morning. Tracked at standby in afternoon due to cloud cover.
- 10-20-02** Detrack: Low Water Temp, High Oil Temp (x2) Normal operation throughout day after clearing detrack.

**10-21-02** Detrack: Low Water Temp, High Oil Temp. Warning: Refill Time Out, No More Ref ; Pressure Problem in Compressor Circuit. Normal operation throughout day after clearing detrack and warning.

**10-22-02** Detrack: Low Water Temp, High Oil Temp (x2). Warning: Refill Time Out, No More Ref ; Pressure Problem in Compressor Circuit. Water temp sensor giving faulty readings. Tracked at standby.

**10-23-02** Normal operation throughout day.

**10-24-02** Normal operation throughout day.

**10-25-02** Tracked at standby in morning due to cloud cover. Normal operation in afternoon.

**10-26-02** Tracked at standby due to cloud cover.

**10-27-02** Tracked at standby due to cloud cover.

**10-28-02** Detrack: Low Water Temp, High Oil Temp (x3). Warning: Pressure Problem in Compressor Circuit. Normal operation throughout day after clearing detrack and warning.

**10-29-02** Detrack: Low Water Temp, High Oil Temp (x3). Water Temp sensor replaced. New hydrogen tank installed. Normal operation in late afternoon.

**10-30-02** Warnings: Tank Pressure Low; Refill Time Out, No More Ref,; Pressure Problem in Compressor Circuit, Can't Dump Completely Detrack: Low Water Temp, High Oil Temp (x2) Normal Operation after clearing detracks and warnings.

**10-31-02** Warnings: Refill Time Out, No More Ref ; Pressure Problem in Compressor Circuit Normal operation throughout day.

**11-01-02** Normal operation in morning. Detrack: Wrong Start Pressure (x2). Tracked at standby after clearing detrack.

**11-02-02** Detrack: Low Water Temp, High Oil Temp (x2). Warning: Pressure Problem in Compressor Circuit. Normal operation after clearing detrack and warning.

**11-03-02** Normal operation throughout day. Warning: Tubes Working Gas High. Normal operation after clearing warning.

**11-04-02** Warning: Pressure Problem in Compressor Circuit. Normal operation throughout day after clearing warning.

**11-05-02** Warning: Pressure Problem in Compressor Circuit. Normal operation throughout day after clearing warning.

**11-06-02** Warning: Pressure Problem in Compressor Circuit. Normal operation throughout day after clearing warning. Detrack: Wrong Start Pressure

**11-07-02 – 11-18-02** No operation per SES instructions.



**11-19-02** Temperature spread too high due to incorrect clock setting on Host PC. Tracking program reset after freezing up.

**11-20-02 – 12-01-02** No operation per SES instructions.

**12-02-02** Nevada Power Grid lost power. Reset grid and all computers.

**12-03-02 – 12-08-02** No operation per SES instructions.

**12-09-02** Tracked at standby for 2 hours in afternoon for tour purposes.

**12-10-02** No operation per SES instructions.

**12-11-02** Tracked at standby for 2 hours in afternoon for tour purposes.

**12-12-02 – 12-22-02** No operation per SES instructions.

**12-23-02** Removed PCU 209 from structure. Removed radiator from PCU 209 for use on PCU 213.

**12-24-02** PCU 213 installed to replace PCU 209.

**12-26-02** Attempted operation. Valve and sensor problems. Replaced interface board on PCU 213 with board from PCU 209.

**12-28-02** Manually filled supply tank from external tank to desired pressure. Leak checked system.  
Thermocouple problems.

**12-29-02-12-31-02** Troubleshooting problems with system with SES supervision.

### Stirling Energy Systems Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	49	18	105:05	86:38	791.91	9.14	4.81
Oct-Dec 01	92	48	318:32	245:00	3523.16	14.38	5.10
Jan-Mar 02	90	82	555:32	403:50	6148.99	15.23	4.92
Apr-Jun 02	91	76	698:08	568:22	7981.14	14.04	7.48
Jul-Sep 02	91	19	240:43	125:40	1832.00	14.58	6.61
Oct-Dec 02	92	34	257:00	162:48	2380.00	14.62	4.79
Totals:	<b>505</b>	<b>277</b>	<b>2175:00</b>	<b>1592:18</b>	<b>22657.2</b>	<b>14.23</b>	<b>5.75</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

### Science Applications International Corporation Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	55	20	N/A	100:00	1150.61	11.51	5.00
Oct-Dec 01	92	28	N/A	147:09	1704.92	11.59	5.26
Jan-Mar 02	90	51	N/A	254:50	2840.44	11.15	5.00
Apr-Jun 02	91	31	N/A	235:01	2903.83	12.36	7.58
Jul-Sep 02	91	21	349:22	167:28	1048.18	6.26	7.98
Oct-Dec 02	92	10	27:05	60:35	172.7	2.85	6.06
Totals:	<b>511</b>	<b>161</b>		<b>965:03</b>	<b>9820.68</b>	<b>10.18</b>	<b>5.99</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

### General Information

	SES:	SAIC:	Total:	NVP:	Error:
Quarter Power (7/02-9/02):	2380	172.7	2552.7	2510	-42.7
Total Power:	22657.2	9820.68	32477.88	32421	-56.88

\*Total Power found by adding Quarter Power to the Total Power found on 9/30/02

### Stirling Energy Systems Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	49	18	105:05	86:38	791.91	9.14	4.81
Oct-Dec 01	92	48	318:32	245:00	3523.16	14.38	5.10
Jan-Mar 02	90	82	555:32	403:50	6148.99	15.23	4.92
Apr-Jun 02	91	76	698:08	568:22	7981.14	14.04	7.48
Jul-Sep 02	91	19	240:43	125:40	1832.00	14.58	6.61
<b>Totals:</b>	<b>413</b>	<b>243</b>	<b>1918:00</b>	<b>1429:30</b>	<b>20277.2</b>	<b>14.18</b>	<b>5.88</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

### Science Applications International Corporation Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	55	20	N/A	100:00	1150.61	11.51	5.00
Oct-Dec 01	92	28	N/A	147:09	1704.92	11.59	5.26
Jan-Mar 02	90	51	N/A	254:50	2840.44	11.15	5.00
Apr-Jun 02	91	31	N/A	235:01	2903.83	12.36	7.58
Jul-Sep 02	91	21	349:22	167:28	1048.18	6.26	7.98
<b>Totals:</b>	<b>419</b>	<b>151</b>		<b>904:28</b>	<b>9647.98</b>	<b>10.67</b>	<b>5.99</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

### General Information

	SES:	SAIC:	Total:	NVP:	Error:
Quarter Power (7/02-9/02):	1832	1048.18	2880.18	2866	-14.18
Total Power:	20277.2	9647.98	29925.18	29911	-14.18

### Stirling Energy Systems Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	49	18	105:05	86:38	791.91	9.14	4.81
Oct-Dec 01	92	48	318:32	245:00	3523.16	14.38	5.10
Jan-Mar 02	90	82	555:32	403:50	6148.99	15.23	4.92
Apr-Jun 02	91	76	698:08	568:22	7981.14	14.04	7.48
<b>Totals:</b>	<b>322</b>	<b>224</b>	<b>1677:17</b>	<b>1303:50</b>	<b>18445.2</b>	<b>14.15</b>	<b>5.82</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

### Science Applications International Corporation Summary

Period	Total Days	Operational Days**	Hours Tracking	Hours Generating	Net Energy (kWh)	Average Power (Net/GenHours)	Average Hours (GenHours/OpDays)
Aug-Sep 01*	55	20	N/A	100:00	1150.61	11.51	5.00
Oct-Dec 01	92	28	N/A	147:09	1704.92	11.59	5.26
Jan-Mar 02	90	51	N/A	254:50	2840.44	11.15	5.00
Apr-Jun 02	91	31	N/A	235:01	2903.83	12.36	7.58
<b>Totals:</b>	<b>328</b>	<b>130</b>		<b>737:00</b>	<b>8599.8</b>	<b>11.67</b>	<b>5.67</b>

\*Values for this periods are estimated and fairly accurate.

\*\*Days are not operational days if there are high winds, holidays, or engine malfunctions.

## Stirling Energy Systems Daily Reports

	Peak Solar (W/m <sup>2</sup> )	Ops?	Start Time	End Time	Track Time (Hours)	Gen Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Oct 1	799	Yes	10:40	15:25	4:45	4.6	15.4	46.2
Oct 2	851	Yes	6:30	14:34	8:04	7.8	17	99.5
Oct 3	883	Yes	7:42	16:15	8:33	8.4	17.4	115.1
Oct 4	818	Yes	7:20	15:25	8:05	7.9	20.2	129.8
Oct 5	756	Yes	11:00	12:30	1:30	1.4	15.2	16
Oct 6		Off						
Oct 7		Off						
Oct 8	No Rec	No	0	0	0:00	0	0	0
Oct 9	933	Yes	9:40	15:10	5:30	5.47	19.5	85.58
Oct 10	No Rec	Tests	6:37	15:18	8:41	0	0	0
Oct 11	890	Yes	8:32	14:34	6:02	3.32	16.2	25.94
Oct 12	971	Yes	8:15	16:08	7:53	7.57	20.7	129.48
Oct 13		Off						
Oct 14		Off						
Oct 15	No Rec	No	0	0	0:00	0	0	0
Oct 16	835	Yes	11:03	16:14	5:11	4.98	15.4	39.09
Oct 17	936	Yes	8:30	16:15	7:45	7.75	17.8	110.03
Oct 18	899	Yes	7:51	15:53	8:02	7.6	17.1	112.94
Oct 19	914	Yes	8:12	14:58	6:46	6.33	20.5	105.43
Oct 20		Off						
Oct 21		Off						
Oct 22	940	No	0	0	0:00	0	0	0
Oct 23	810	Yes	8:55	16:08	7:13	6.95	18.3	113.47
Oct 24	1010	Yes	7:40	15:10	7:30	7.5	20	120.25
Oct 25	1001	Yes	8:00	15:09	7:09	7.1	19.3	125.75
Oct 26	970	Yes	8:56	14:39	5:43	4.7	18.4	58.22
Oct 27		Off						
Oct 28		Off						
Oct 29	No Rec	No	0	0	0:00	0	0	0
Oct 30	No Rec	Yes	8:25	15:05	6:40	0	0	0
Oct 31	949	Yes	8:41	15:27	6:46	6.52	17.1	100.46
Nov 1	No Rec	No	0	0	0:00	0	0	0
Nov 2	960	Yes	8:29	14:48	6:19	5.68	19	94.24
Nov 3		Off						
Nov 4		Off						
Nov 5	No Rec	No	0	0	0:00	0	0	0
Nov 6	808	Yes	9:09	15:32	6:23	6.33	17.3	91.77
Nov 7	869	Yes	8:17	15:44	7:27	7.05	18.6	99.86
Nov 8	971	Yes	8:59	15:56	6:57	6.95	19.8	117.44
Nov 9	930	Yes	8:35	16:00	7:25	7.18	19.3	112.16
Nov 10		Off						
Nov 11		Off						
Nov 12	919	Yes	10:19	15:41	5:22	4.8	17.3	54.35
Nov 13	935	Yes	8:45	15:42	6:57	5.28	17.2	62.78
Nov 14	955	Yes	8:45	15:47	7:02	6.77	19.7	93.63
Nov 15	957	Yes	8:41	15:55	7:14	7.23	18.1	108.73
Nov 16	954	Yes	8:41	15:33	6:52	6.82	17.9	95.95
Nov 17		Off						
Nov 18		Off						
Nov 19	889	Yes	8:40	15:15	6:35	6.45	17.5	97.01

Nov 20	843	Yes	8:43	14:31	5:48	5.03	20.2	83.84
Nov 21	No NIP	Yes	8:14	14:59	6:45	4.48	18.4	59.65
Nov 22		Off						
Nov 23		Off						
Nov 24		Off						
Nov 25		Off						
Nov 26	No Rec	No	0	0	0:00	0	0	0
Nov 27	No Rec	No	0	0	0:00	0	0	0
Nov 28	No Rec	No	0	0	0:00	0	0	0
Nov 29	No Rec	No	0	0	0:00	0	0	0
Nov 30	No Rec	No	0	0	0:00	0	0	0
Dec 1		Off						
Dec 2		Off						
Dec 3	No Rec	No	0	0	0:00	0	0	0
Dec 4	No Rec	No	0	0	0:00	0	0	0
Dec 5	No Rec	No	0	0	0:00	0	0	0
Dec 6	No Rec	No	0	0	0:00	0	0	0
Dec 7	930	Yes	11:20	12:33	1:13	0.8	14.2	10.17
Dec 8		Off						
Dec 9		Off						
Dec 10	890	No	0	0	0:00	0	0	0
Dec 11	1020	Yes	9:00	15:05	6:05	2.63	8.9	21.29
Dec 12	No Rec	No	0	0	0:00	0	0	0
Dec 13	950	Yes	8:24	15:30	7:06	5.28	17.3	70.11
Dec 14	0	Yes	8:24	13:15	4:51	0	0	0
Dec 15	No NIP	Yes	8:28	15:40	7:12	6.98	18.5	115.75
Dec 16	No NIP	Yes	8:29	14:49	6:20	5.92	18.7	93.04
Dec 17	1040	Yes	8:47	15:54	7:07	6.83	18.6	94.89
Dec 18	960	Yes	9:00	15:15	6:15	6.25	18	82.13
Dec 19	924	Yes	10:01	15:16	5:15	5.03	17	71.09
Dec 20	0	Yes	8:45	15:23	6:38	0	0	0
Dec 21	936	No	0	0	0:00	0	0	0
Dec 22	951	Yes	8:45	15:27	6:42	4.2	17.5	48.71
Dec 23	913	Yes	8:53	14:30	5:37	1.1	16.4	14.82
Dec 24	994	Yes	8:24	15:42	7:18	7.5	18.2	115.29
Dec 25		Off						
Dec 26	483	Yes	8:41	15:37	6:56	6.53	17.3	81.22
Dec 27	100	Yes	10:20	12:12	1:52	0	0	0
Dec 28	0	Yes	8:10	15:30	7:20	0	0	0
Dec 29	0	Yes	8:04	11:08	3:04	0	0	0
Dec 30	No Rec	No	8:13	14:12	5:59	0	0	0
Dec 31	No Rec	No	8:12	9:00	0:48	0	0	0

Totals: **318:32    244.99    3523.16**

For Ops: Yes - Operated  
No - Not functioning  
Off - Holiday or Weekend

[kylehalford@msn.com](mailto:kylehalford@msn.com)

## Science Applications International Corporation Daily Reports

		Peak Solar (W/m <sup>2</sup> )	Ops?	Start Time	End Time	Track Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Oct	1	799	Yes	8:44	16:10	7:26	15.75	62.10
Oct	2	851	Yes	9:03	15:54	6:51	16.90	99.14
Oct	3	883	Yes	8:46	16:15	7:29	18.00	115.44
Oct	4	818	Yes	8:52	16:08	7:16	17.96	110.83
Oct	5	756	Yes	8:53	15:44	6:51	17.14	77.88
Oct	6		Off					
Oct	7		Off					
Oct	8	No Rec	Yes	8:49	15:56	7:07	18.06	77.88
Oct	9	933	Yes	9:09	15:30	6:21	17.99	96.44
Oct	10	No Rec	Yes	9:12	15:46	6:34	19.77	89.71
Oct	11	890	Yes	9:12	15:09	5:57	14.54	23.27
Oct	12	971	Yes	9:21	15:27	6:06	19.98	102.78
Oct	13		Off					
Oct	14		Off					
Oct	15	No Rec	Yes	9:18	15:43	6:25	16.60	68.56
Oct	16	835	Yes	9:19	15:11	5:52	15.60	35.26
Oct	17	936	Yes	9:20	15:42	6:22	20.95	102.40
Oct	18	899	Yes	9:21	16:02	6:41	19.89	100.62
Oct	19	914	Yes	9:50	13:59	4:09	20.14	67.25
Oct	20		Yes	14:16	14:54	0:38	17.24	8.00
Oct	21		Off					
Oct	22	940	Yes	9:42	10:37	0:55	19.21	22.09
Oct	23	810	No			0:00		
Oct	24	1010	No			0:00		
Oct	25	1001	No			0:00		
Oct	26	970	No			0:00		
Oct	27		Off					
Oct	28		Off					
Oct	29	No Rec	No			0:00		
Oct	30	No Rec	No			0:00		
Oct	31	949	No			0:00		
Nov	1	No Rec	No			0:00		
Nov	2	960	No			0:00		
Nov	3		Off					
Nov	4		Off					
Nov	5	No Rec	No			0:00		
Nov	6	808	No			0:00		
Nov	7	869	No			0:00		
Nov	8	971	No			0:00		
Nov	9	930	No			0:00		
Nov	10		Off					
Nov	11		Off					
Nov	12	919	No			0:00		
Nov	13	935	No			0:00		
Nov	14	955	No			0:00		
Nov	15	957	No			0:00		
Nov	16	954	No			0:00		
Nov	17		Off					
Nov	18		Off					
Nov	19	889	Yes	14:30	15:30	1:00	13.26	8.75

Nov 20	843	No			0:00		
Nov 21	No NIP	No			0:00		
Nov 22		No			0:00		
Nov 23		No			0:00		
Nov 24		Off					
Nov 25		Off					
Nov 26	No Rec	No			0:00		
Nov 27	No Rec	No			0:00		
Nov 28	No Rec	No			0:00		
Nov 29	No Rec	No			0:00		
Nov 30	No Rec	No			0:00		
Dec 1		Off					
Dec 2		Off					
Dec 3	No Rec	No			0:00		
Dec 4	No Rec	No			0:00		
Dec 5	No Rec	No			0:00		
Dec 6	No Rec	No			0:00		
Dec 7	930	No			0:00		
Dec 8		Off					
Dec 9		Off					
Dec 10	890	Yes	9:44	13:50	4:06	10.78	8.52
Dec 11	1020	Yes	10:40	15:04	4:24	16.59	58.31
Dec 12	No Rec	Yes	9:29	14:39	5:10	19.01	87.55
Dec 13	950	Yes	10:01	15:30	5:29	18.69	73.36
Dec 14	0	Yes	9:34	13:01	3:27	0.00	0.00
Dec 15	No NIP	Off					
Dec 16	No NIP	Off					
Dec 17	1040	Yes	9:26	14:30	5:04	17.48	32.92
Dec 18	960	Yes	9:32	14:51	5:19	17.51	48.11
Dec 19	924	Yes	9:45	14:56	5:11	19.38	85.10
Dec 20	0	Yes	9:55	15:23	5:28	0.00	0.00
Dec 21	936	Yes	9:28	12:59	3:31	18.76	42.65
Dec 22	951	Off					
Dec 23	913	Off					
Dec 24	994	No			0:00		
Dec 25		Off			0:00		
Dec 26	483	No			0:00		
Dec 27	100	No			0:00		
Dec 28	0	No			0:00		
Dec 29	0	Off					
Dec 30	No Rec	Off					
Dec 31	No Rec	No			0:00		

Totals:

**147:09**

**1704.92**

For Ops: Yes - Operated  
No - Not functioning  
Off - Holiday or Weekend

## Stirling Energy Systems Daily Reports (Oct-Dec 02)

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Gen Time (Hours)	Net Pk Pwr (kW)	Net Energy (kWh)
Oct 1	Yes	MC	851.30	8:46	14:22	5.60	5.35	17.7	78.00
Oct 2	Yes	MC	782.50	7:21	15:04	7.72	0.53	16.8	7.00
Oct 3	Yes	CLR	897.50	7:21	16:16	8.90	8.68	21.3	150.00
Oct 4	Yes	CLR	840.00	14:02	16:32	2.50	0.55	16.3	8.00
Oct 5	Yes	CLR	908.80	7:25	16:08	8.72	8.57	20.9	146.00
Oct 6	Yes	CLR	908.80	7:25	16:31	9.10	9.10	20.5	152.00
Oct 7	Yes	CLR	900.00	7:20	16:20	9.00	8.50	20.7	150.00
Oct 8	Yes	CLR	870.00	7:16	16:19	9.02	8.55	20.7	147.00
Oct 9	Yes	CLR	812.50	7:07	12:39	5.53	5.35	20.1	92.00
Oct 10	Yes	PC	646.30	7:19	16:04	8.75	3.83	17.9	37.00
Oct 11	Yes	OVR	0.00	7:08	16:33	9.25	0.00	0.0	0.00
Oct 12	No						0.00	0.0	0.00
Oct 13	No						0.00	0.0	0.00
Oct 14	Yes	OVR	0.00	10:06	16:06	7.00	0.00	0.0	0.00
Oct 15	Yes	MC	933.80	8:02	16:01	7.99	1.97	17.9	18.00
Oct 16	Yes	CLR	955.00	7:23	14:47	7.40	5.83	18.6	88.00
Oct 17	No	Rain					0.00	0.0	0.00
Oct 18	Yes	CLR	933.80	8:28	16:34	8.10	6.27	20.0	92.00
Oct 19	Yes	MC	908.80	7:22	15:47	8.42	5.02	18.3	68.00
Oct 20	Yes	PC	943.80	7:25	16:03	8.57	7.43	19.4	101.00
Oct 21	Yes	CLR	886.30	7:07	16:04	8.95	7.02	18.0	97.00
Oct 22	Yes	CLR	803.80	7:20	16:29	9.15	0.72	13.3	5.00
Oct 23	Yes	PC	907.50	10:29	16:02	5.55	4.80	17.8	62.00
Oct 24	Yes	PC	863.80	7:43	15:31	7.80	7.72	16.8	99.00
Oct 25	Yes	MC	None	7:04	16:24	9.33	2.88	15.1	22.00
Oct 26	Yes	OVR	None	7:14	16:24	9.17	0.00	0.0	0.00
Oct 27	Yes	OVR	None	8:17	16:48	8.57	0.00	0.0	0.00
Oct 28	Yes	PC	871.30	8:10	16:50	7.67	4.83	16.4	60.00
Oct 29	Yes	CLR	862.50	8:16	16:31	3.97	1.57	9.8	11.00
Oct 30	Yes	PC	867.50	8:05	15:00	6.92	5.33	15.7	68.00
Oct 31	Yes	CLR	903.80	8:21	16:37	8.27	5.73	16.3	64.00
Nov 1	No						0.00	0.0	0.00
Nov 2	Yes	CLR	983.80	8:14	16:04	7.83	7.02	19.1	108.00
Nov 3	Yes	PC	1001.00	8:25	15:25	7.00	5.63	19.2	92.00
Nov 4	Yes	PC	961.50	8:09	16:30	8.35	8.17	18.0	115.00
Nov 5	Yes	CLR	1003.00	8:21	16:30	8.15	7.82	18.3	115.00
Nov 6	Yes	CLR	1006.00	8:06	15:04	6.97	6.75	18.2	106.00
Nov 7	No						0.00	0.0	0.00
Nov 8	No						0.00	0.0	0.00
Nov 9	No						0.00	0.0	0.00
Nov 10	No						0.00	0.0	0.00
Nov 11	No						0.00	0.0	0.00
Nov 12	No						0.00	0.0	0.00
Nov 13	No						0.00	0.00	0.00
Nov 14	No						0.00	0.00	0.00
Nov 15	No						0.00	0.00	0.00
Nov 16	No						0.00	0.00	0.00
Nov 17	No						0.00	0.00	0.00
Nov 18	No						0.00	0.00	0.00
Nov 19	Yes	CLR	710.00	13:43	15:30	1.78	1.28	10.4	9.00



Nov 20	No						0.00	0.00	0.00
Nov 21	No						0.00	0.00	0.00
Nov 22	No						0.00	0.00	0.00
Nov 23	No						0.00	0.00	0.00
Nov 24	No						0.00	0.00	0.00
Nov 25	No						0.00	0.00	0.00
Nov 26	No						0.00	0.00	0.00
Nov 27	No						0.00	0.00	0.00
Nov 28	No						0.00	0.00	0.00
Nov 29	No						0.00	0.00	0.00
Nov 30	No						0.00	0.00	0.00
Dec 1	No						0.00	0.00	0.00
Dec 2	No						0.00	0.00	0.00
Dec 3	No						0.00	0.00	0.00
Dec 4	No						0.00	0.00	0.00
Dec 5	No						0.00	0.00	0.00
Dec 6	No						0.00	0.00	0.00
Dec 7	No						0.00	0.00	0.00
Dec 8	No						0.00	0.00	0.00
Dec 9	No						0.00	0.00	0.00
Dec 10	No						0.00	0.00	0.00
Dec 11	No						0.00	0.00	0.00
Dec 12	No						0.00	0.00	0.00
Dec 13	No						0.00	0.00	0.00
Dec 14	No						0.00	0.00	0.00
Dec 15	No						0.00	0.00	0.00
Dec 16	No						0.00	0.00	0.00
Dec 17	No						0.00	0.00	0.00
Dec 18	No						0.00	0.00	0.00
Dec 19	No						0.00	0.00	0.00
Dec 20	No						0.00	0.00	0.00
Dec 21	No						0.00	0.00	0.00
Dec 22	No						0.00	0.00	0.00
Dec 23	No						0.00	0.00	0.00
Dec 24	No						0.00	0.00	0.00
Dec 25	No						0.00	0.00	0.00
Dec 26	No						0.00	0.00	0.00
Dec 27	No						0.00	0.00	0.00
Dec 28	No						0.00	0.00	0.00
Dec 29	No						0.00	0.00	0.00
Dec 30	No						0.00	0.00	0.00
Dec 31	No						0.00	0.00	0.00

Totals:

**257.00    162.80**

**2367.00**

Actual\*: **2380.00**

For Ops:

Yes - Generated  
Tra - Tracked, No Gen  
No - No Track, No Gen  
Off - Holiday or Weekend

For Weather:

CLR - Clear  
PC - Partly Cloudy  
MC - Mostly Cloudy  
OVR - Overcast  
Wind - Wind prevented ops

\*Actual kWh is determined from taking the value of the EI  
meter on 12/31/02 and subtracting the value on 9/30/02  
(11582 - 9202 = 2380)

## Science Applications International Corp Daily Reports (Jul-Sep 02)

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Oct 1	No	MC	851.30			0:00		
Oct 2	No	MC	782.50			0:00		
Oct 3	No	CLR	897.50			0:00		
Oct 4	No	CLR	840.00			0:00		
Oct 5	No	CLR	908.80			0:00		
Oct 6	No	CLR	908.80			0:00		
Oct 7	No	CLR	900.00			0:00		
Oct 8	No	CLR	870.00			0:00		
Oct 9	Yes	CLR	812.50	11:23	17:00	5:37	14.63	75.46
Oct 10	Yes	PC	646.30	8:23	16:45	8:22	11.74	28.00
Oct 11	Yes	OVR	0.00	8:25	16:00	7:35	7.75	0.00
Oct 12	Yes	MC	300.00	8:24	12:55	4:31	0.00	0.00
Oct 13	Yes	MC	987.00	8:59	17:00	8:01	15.20	23.00
Oct 14	Yes	OVR	0.00	8:43	17:06	8:23	0.00	0.00
Oct 15	Yes	MC	933.80	9:02	17:01	7:59	5.01	4.24
Oct 16	Yes	CLR	955.00	9:06	16:15	7:09	11.87	29.00
Oct 17	No	Rain	0.00			0:00		
Oct 18	Yes	CLR	933.80	10:28	12:10	1:42	10.75	13.00
Oct 19	No	MC	908.80			0:00		
Oct 20	No	PC	943.80			0:00		
Oct 21	No	CLR	886.30			0:00		
Oct 22	No	CLR	803.80			0:00		
Oct 23	No	PC	907.50			0:00		
Oct 24	No	PC	863.80			0:00		
Oct 25	No	MC	None			0:00		
Oct 26	No	OVR	None			0:00		
Oct 27	No	OVR	None			0:00		
Oct 28	No	PC	871.30			0:00		
Oct 29	No	CLR	862.50			0:00		
Oct 30	No	PC	867.50			0:00		
Oct 31	Yes	CLR	903.80	11:00	12:40	1:40	0.00	0.00
Nov 1	No					0:00		
Nov 2	No	CLR	983.80			0:00		
Nov 3	No	PC	1001.00			0:00		
Nov 4	Tra	PC	961.50	9:16	16:01	6:45	0.00	0.00
Nov 5	Tra	CLR	1003.00	8:37	15:27	6:50	0.00	0.00
Nov 6	Tra	CLR	1006.00	9:30	16:10	6:40	0.00	0.00
Nov 7	Tra	MC	None	8:51	15:41	6:50	0.00	0.00
Nov 8	No	Wind				0:00		
Nov 9	No					0:00		
Nov 10	No					0:00		
Nov 11	No					0:00		
Nov 12	No					0:00		
Nov 13	No					0:00		
Nov 14	No					0:00		
Nov 15	No					0:00		
Nov 16	No					0:00		
Nov 17	No					0:00		
Nov 18	No					0:00		
Nov 19	No	CLR	710.00			0:00		

Nov 20	No					0:00		
Nov 21	No					0:00		
Nov 22	No					0:00		
Nov 23	No					0:00		
Nov 24	No					0:00		
Nov 25	No					0:00		
Nov 26	No					0:00		
Nov 27	No					0:00		
Nov 28	No					0:00		
Nov 29	No					0:00		
Nov 30	No					0:00		
Dec 1	No					0:00		
Dec 2	No					0:00		
Dec 3	No					0:00		
Dec 4	No					0:00		
Dec 5	No					0:00		
Dec 6	No					0:00		
Dec 7	No					0:00		
Dec 8	No					0:00		
Dec 9	No					0:00		
Dec 10	No					0:00		
Dec 11	No					0:00		
Dec 12	No					0:00		
Dec 13	No					0:00		
Dec 14	No					0:00		
Dec 15	No					0:00		
Dec 16	No					0:00		
Dec 17	No					0:00		
Dec 18	No					0:00		
Dec 19	No					0:00		
Dec 20	No					0:00		
Dec 21	No					0:00		
Dec 22	No					0:00		
Dec 23	No					0:00		
Dec 24	No					0:00		
Dec 25	No					0:00		
Dec 26	No					0:00		
Dec 27	No					0:00		
Dec 28	No					0:00		
Dec 29	No					0:00		
Dec 30	No					0:00		
Dec 31	No					0:00		

Totals:

**88:04**

**172.70**

For Ops:

Yes - Generated  
Tra - Tracked, No Gen  
No - No Track, No Gen  
Off - Holiday or Weekend

For Weather:

CLR - Clear  
PC - Partly Cloudy  
MC - Mostly Cloudy  
OVR - Overcast  
Wind - Wind prevented ops

## Stirling Energy Systems Daily Reports

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Gen Time (Hours)	Net Pk Pwr (kW)	Net Energy (kWh)
Jan 1	Off								
Jan 2	Off								
Jan 3	Off								
Jan 4	Yes	CLR	973.75	10:02	15:49	5.78	5.70	19.3	91.75
Jan 5	Yes	PC	940.00	8:40	16:00	7.33	5.35	18.8	59.20
Jan 6	Yes	MC	862.50	8:15	10:59	2.73	0.05	12.9	5.41
Jan 7	No	PC	912.00						
Jan 8	Yes	PC	920.00	11:18	15:03	3.75	3.75	16.8	38.57
Jan 9	Yes	MC	862.50	12:22	15:25	3.05	1.72	14.3	21.41
Jan 10	Yes	CLR	845.00	8:59	15:50	6.85	4.93	18.1	74.02
Jan 11	Yes	CLR	980.00	8:39	16:16	7.62	6.48	18.3	101.51
Jan 12	Yes	OVR	20.00	8:58	15:07	6.15	0.00	0.0	0.00
Jan 13	Yes	CLR	1000.00	8:17	14:56	6.65	6.00	19.4	102.92
Jan 14	Yes	PC	No NIP	8:51	15:30	6.65	5.55	17.5	67.48
Jan 15	Yes	OVR	No NIP	8:50	15:00	6.17	0.00	0.0	0.00
Jan 16	Yes	CLR	911.25	13:19	15:02	1.72	1.67	15.7	24.14
Jan 17	Yes	CLR	1005.00	8:00	15:59	7.98	7.65	20.9	132.73
Jan 18	Yes	CLR	998.75	8:32	15:24	6.87	6.80	20.7	123.40
Jan 19	Yes	PC	960.00	13:07	16:02	3.23	2.92	17.6	26.70
Jan 20	Yes	CLR	983.75	8:11	15:23	6.33	6.08	19.9	102.46
Jan 21	Yes	CLR	930.00	8:35	16:05	7.55	7.32	18.3	111.30
Jan 22	Yes	MC	936.00	8:22	13:10	6.38	3.85	18.1	53.83
Jan 23	Yes	PC	971.00	9:08	16:13	7.08	5.23	18.7	77.72
Jan 24	Yes	CLR	980.00	8:48	16:09	7.55	7.32	19.8	122.35
Jan 25	Yes	PC	903.00	8:29	13:25	5.27	4.25	18.7	71.76
Jan 26	Yes	OVR	0.00	8:39	15:23	6.73	0.00	0.0	0.00
Jan 27	Yes	OVR	0.00	8:02	15:25	7.38	0.00	0.0	0.00
Jan 28	Yes	PC	989.00	8:36	15:22	6.77	6.55	20.0	109.20
Jan 29	Yes	MC	970.00	9:14	15:16	6.25	5.47	19.9	70.52
Jan 30	No	Wind	1050.00						
Jan 31	Yes	CLR	980.00	8:46	16:00	7.15	6.23	18.8	84.54
Feb 1	Yes	MC	943.75	8:31	15:48	7.47	6.05	18.8	71.04
Feb 2	Yes	CLR	No NIP	8:47	16:34	7.78	7.57	19.4	127.75
Feb 3	Yes	CLR	No NIP	8:32	16:30	7.97	7.95	20.3	136.09
Feb 4	Yes	CLR	1037.50	8:38	16:24	7.77	7.35	19.8	111.30
Feb 5	Yes	CLR	1030.00	10:07	16:06	6.37	5.35	20.2	92.63
Feb 6	Yes	CLR	976.00	9:27	15:02	5.58	5.38	19.1	95.15
Feb 7	Yes	PC	988.00	9:11	15:52	7.58	6.63	20.1	103.14
Feb 8	Yes	PC	881.25	8:47	16:32	7.97	7.88	16.7	99.04
Feb 9	Yes	CLR	781.25	8:06	16:02	7.08	6.22	20.4	104.35
Feb 10	Yes	CLR	1024.00	8:27	16:27	8.00	7.88	20.9	145.52
Feb 11	Yes	CLR	1030.00	8:39	15:49	7.17	6.97	21.1	118.42
Feb 12	Yes	PC	995.00	8:42	16:05	7.63	7.42	19.2	100.85
Feb 13	Yes	OVR	0.00	8:30	15:36	7.10	0.00	0.0	0.00
Feb 14	Yes	CLR	950.00	9:13	16:26	7.40	7.22	18.3	116.00
Feb 15	Yes	OVR	No NIP	8:21	16:00	7.65	1.60	13.4	12.74
Feb 16	Yes	MC	No NIP	8:45	16:10	7.72	5.47	16.0	48.38
Feb 17	Yes	OVR	No NIP	8:25	15:05	6.67	0.00	0.0	0.00
Feb 18	Yes	MC	No NIP	8:48	15:26	6.63	2.68	17.7	37.20
Feb 19	Yes	MC	No NIP	9:47	14:33	7.27	4.53	17.3	39.90

Feb 20	Yes	PC	No NIP	8:47	16:31	7.73	5.25	18.3	79.10
Feb 21	Yes	PC	No NIP	8:42	16:32	8.05	7.27	19.2	116.10
Feb 22	Yes	MC	No NIP	8:25	15:00	6.58	4.70	17.9	47.18
Feb 23	Yes	PC	No NIP	8:02	16:03	7.63	4.72	18.0	71.54
Feb 24	Yes	CLR	No NIP	8:20	16:25	7.92	7.88	19.4	136.13
Feb 25	Yes	CLR	No NIP	8:45	13:06	4.35	4.12	19.1	73.42
Feb 26	No	CLR	No NIP						
Feb 27	Yes	PC	No NIP	8:10	12:35	4.42	2.27	17.2	21.94
Feb 28	Yes	CLR	No NIP	8:22	10:22	1.12	0.92	18.3	14.87
Mar 1	Yes	CLR	No NIP	8:18	14:30	6.20	5.20	19.6	88.11
Mar 2	Yes	CLR	No NIP	8:43	16:07	7.40	7.02	21.8	138.07
Mar 3	Yes	CLR	No NIP	8:31	16:03	7.53	7.53	21.8	137.62
Mar 4	Yes	PC	No NIP	8:35	16:18	7.72	7.27	21.2	125.44
Mar 5	Yes	PC	No NIP	8:46	16:30	7.70	5.57	18.3	80.47
Mar 6	Yes	OVR	No NIP	8:44	16:00	7.27	0.00	0.0	0.00
Mar 7	Yes	PC	No NIP	8:28	15:25	6.93	6.57	18.8	101.60
Mar 8	Yes	CLR	833.75	13:55	16:12	2.28	1.67	14.5	17.84
Mar 9	Yes	PC	No NIP	8:15	16:35	8.00	7.78	19.1	91.10
Mar 10	Yes	MC	955.00	8:16	14:38	6.37	0.77	16.4	7.07
Mar 11	Yes	CLR	821.25	8:37	16:01	7.40	7.12	19.4	121.30
Mar 12	Yes	MC	866.25	8:37	15:45	7.13	6.75	14.0	13.72
Mar 13	No								
Mar 14	No	PC	960.00						
Mar 15	Yes	PC	1033.00	9:46	15:05	7.20	5.30	22.1	104.33
Mar 16	Yes	MC	No NIP	8:45	16:21	7.60	0.00	0.0	0.00
Mar 17	Yes	CLR	993.75	8:35	16:02	7.45	6.53	20.3	106.51
Mar 18	Yes	MC	937.50	8:39	16:28	7.82	0.00	0.0	0.00
Mar 19	Yes	CLR	1013.00	8:40	16:45	8.08	6.40	20.6	112.80
Mar 20	Yes	PC	993.75	8:33	16:32	7.98	4.47	19.5	56.75
Mar 21	Yes	OVR	300.00	8:33	16:30	7.95	0.00	0.0	0.00
Mar 22	Yes	PC	981.25	8:27	16:07	7.67	6.63	19.7	99.90
Mar 23	Yes	PC	1015.00	11:22	15:36	4.60	3.42	19.5	59.10
Mar 24	Yes	MC	932.50	10:58	15:27	4.75	2.33	18.4	22.39
Mar 25	Yes	CLR	995.00	8:23	17:00	8.62	8.45	20.8	120.12
Mar 26	Yes	CLR	981.25	8:24	16:56	8.53	8.37	20.7	145.80
Mar 27	Yes	CLR	980.00	7:23	17:15	9.87	9.72	20.4	162.82
Mar 28	Yes	MC	966.25	8:26	14:17	5.85	1.17	18.1	17.43
Mar 29	Yes	CLR	983.00	8:26	17:07	8.68	8.45	20.0	141.10
Mar 30	Yes	CLR	968.00	8:42	2:38	8.52	8.52	19.4	142.80
Mar 31	Yes	CLR	962.00	8:10	17:00	8.85	8.67	19.7	142.10

Totals:

**555.53    403.83**

**6148.99**

For Ops:

Yes - Operated  
No - Not functioning  
Off - Holiday or Weekend

For Weather:

CLR - Clear  
PC - Partly Cloudy  
MC - Mostly Cloudy  
OVR - Overcast  
Wind - Wind prevented ops

# Science Applications International Corporation Daily Reports

		Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Jan	1	Off							
Jan	2	Off							
Jan	3	Off							
Jan	4	No	CLR	973.75					
Jan	5	No	PC	940.00					
Jan	6	Yes	MC	862.50	9:30	14:00	4:30	13.10	0.00
Jan	7	Yes	PC	912.00	10:20	15:21	5:01	16.38	52.40
Jan	8	Yes	PC	920.00	9:25	15:16	5:51	16.64	59.45
Jan	9	Yes	MC	862.50	11:17	15:07	3:50	16.64	30.40
Jan	10	Yes	CLR	845.00	9:28	15:10	5:42	15.89	53.46
Jan	11	Yes	CLR	980.00	9:14	15:07	5:53	18.66	93.71
Jan	12	Yes	OVR	20.00	9:59	15:05	5:06	0.00	0.00
Jan	13	Yes	CLR	1000.00	8:28	14:56	6:28	18.86	188.68
Jan	14	No	PC	No NIP					
Jan	15	No	OVR	No NIP					
Jan	16	No	CLR	911.25					
Jan	17	Yes	CLR	1005.00	12:03	15:08	3:05	18.01	48.70
Jan	18	Yes	CLR	998.75	8:35	15:12	6:37	18.54	89.60
Jan	19	Yes	PC	960.00	9:35	14:41	5:06	17.47	38.76
Jan	20	Yes	CLR	983.75	9:30	15:00	5:30	18.33	82.55
Jan	21	Yes	CLR	930.00	9:35	15:05	5:30	17.29	79.88
Jan	22	Yes	MC	936.00	9:22	14:48	5:26	17.29	43.39
Jan	23	Yes	PC	971.00	9:37	15:08	5:31	16.30	11.16
Jan	24	Yes	CLR	980.00	9:39	15:13	5:34	18.42	87.07
Jan	25	Yes	PC	903.00	9:28	15:06	5:38	18.42	44.73
Jan	26	Yes	OVR	0.00	9:29	15:22	5:53	0.00	0.00
Jan	27	Yes	OVR	0.00	8:42	15:25	6:43	0.00	0.00
Jan	28	Yes	PC	989.00	9:30	15:03	5:33	18.28	86.71
Jan	29	Yes	MC	970.00	9:20	15:25	6:05	18.26	51.23
Jan	30	Yes	Wind	1050.00	9:07	9:43	0:36	18.26	2.57
Jan	31	Yes	CLR	980.00	9:27	15:15	5:48	17.72	64.86
Feb	1	Yes	MC	943.75	9:18	15:19	6:01	17.12	39.24
Feb	2	Yes	CLR	No NIP	9:21	16:05	6:44	18.70	104.51
Feb	3	Yes	CLR	No NIP	8:55	9:21	0:26	0.00	0.00
Feb	4	Yes	CLR	1037.50	11:07	15:46	4:39	19.01	73.42
Feb	5	Yes	CLR	1030.00	11:33	15:32	3:59	18.98	62.46
Feb	6	Yes	CLR	976.00	10:35	15:24	4:49	18.98	86.74
Feb	7	Yes	PC	988.00	9:14	15:13	5:59	17.54	85.60
Feb	8	Yes	PC	881.25	9:06	15:30	6:24	17.54	67.46
Feb	9	Yes	CLR	781.25	9:02	11:08	2:06	17.00	28.94
Feb	10	Yes	CLR	1024.00	8:47	15:16	6:29	19.16	100.10
Feb	11	Yes	CLR	1030.00	9:20	15:12	5:52	14.23	103.15
Feb	12	Yes	PC	995.00	9:32	15:15	5:43	17.99	63.80
Feb	13	Yes	OVR	0.00	10:02	15:36	5:34	12.82	67.57
Feb	14	Yes	CLR	950.00	11:07	15:35	4:28	16.93	66.02
Feb	15	Yes	OVR	No NIP	8:04	9:20	1:16	0.00	0.00
Feb	16	No	MC	No NIP					
Feb	17	Yes	OVR	No NIP	11:30	15:05	3:35	0.00	0.00
Feb	18	Yes	MC	No NIP	9:13	15:26	6:13	17.28	72.00
Feb	19	No	MC	No NIP					

Feb 20	Yes	PC	No NIP	9:31	15:48	6:17	12.04	65.63
Feb 21	Yes	PC	No NIP	10:06	15:44	5:38	17.89	78.40
Feb 22	Yes	MC	No NIP	9:25	15:00	5:35	17.89	35.78
Feb 23	Yes	PC	No NIP	8:44	8:45	0:01	0.00	0.00
Feb 24	Yes	CLR	No NIP	8:10	15:54	7:44	18.82	117.79
Feb 25	Yes	CLR	No NIP	9:03	15:55	6:52	18.28	113.71
Feb 26	Yes	CLR	No NIP	9:19	15:52	6:33	18.08	95.26
Feb 27	Yes	PC	No NIP	10:11	15:20	5:09	14.25	38.10
Feb 28	Yes	CLR	No NIP	8:46	9:33	0:47	0.00	0.00
Mar 1	No	CLR	No NIP					
Mar 2	No	CLR	No NIP					
Mar 3	No	CLR	No NIP					
Mar 4	No	PC	No NIP					
Mar 5	No	PC	No NIP					
Mar 6	No	OVR	No NIP					
Mar 7	No	PC	No NIP					
Mar 8	No	CLR	833.75					
Mar 9	No	PC	No NIP					
Mar 10	No	MC	955.00					
Mar 11	No	CLR	821.25					
Mar 12	No	MC	866.25					
Mar 13	No							
Mar 14	No	PC	960.00					
Mar 15	No	PC	1033.00					
Mar 16	No	MC	No NIP					
Mar 17	No	CLR	993.75					
Mar 18	No	MC	937.50					
Mar 19	No	CLR	1013.00					
Mar 20	No	PC	993.75					
Mar 21	No	OVR	300.00					
Mar 22	No	PC	981.25					
Mar 23	No	PC	1015.00					
Mar 24	No	MC	932.50					
Mar 25	No	CLR	995.00					
Mar 26	No	CLR	981.25					
Mar 27	Yes	CLR	980.00	13:13	16:40	3:27	17.30	54.65
Mar 28	Yes	MC	966.25	8:43	14:17	5:34	15.54	10.80
Mar 29	No	CLR	983.00					
Mar 30	No	CLR	968.00					
Mar 31	No	CLR	962.00					

Totals:

**254:50**

**2840.44**

For Ops:

Yes - Operated

No - Not functioning

Off - Holiday or Weekend

## Stirling Energy Systems Daily Reports (Apr-Jun 02)

		Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Gen Time (Hours)	Net Pk Pwr (kW)	Net Energy (kWh)
Apr	1	Yes	CLR	970.00	8:39	16:51	8.20	7.97	19.2	123.39
Apr	2	Yes	CLR	971.00	8:26	17:00	8.57	8.37	19.7	141.10
Apr	3	Yes	CLR	912.50	8:52	17:09	8.28	8.08	18.7	121.99
Apr	4	Yes	CLR	950.00	7:57	17:12	9.23	9.07	19.8	142.71
Apr	5	Yes	OVR	848.75	8:29	16:50	8.35	2.47	16.7	23.94
Apr	6	Yes	PC	906.00	8:22	16:25	6.71	5.75	18.2	66.18
Apr	7	Yes	PC	935.00	9:04	15:04	6.02	5.77	18.7	92.98
Apr	8	Yes	PC	920.00	8:14	17:55	9.68	8.00	17.8	77.00
Apr	9	Yes	MC	893.00	8:34	14:29	5.92	5.70	17.0	48.67
Apr	10	Yes	PC	871.00	8:37	17:06	8.48	7.98	16.8	108.08
Apr	11	Yes	PC	893.00	8:11	17:00	8.82	8.58	18.0	103.40
Apr	12	Yes	PC	910.00	8:30	17:31	9.03	8.05	17.5	114.28
Apr	13	Yes	PC	944.00	8:19	17:30	9.15	8.82	18.0	126.38
Apr	14	Yes	MC	943.75	8:32	17:36	9.07	6.97	16.5	73.54
Apr	15	Yes	Wind							
Apr	16	Yes	PC	849.00	8:50	17:54	8.73	7.87	18.1	98.65
Apr	17	Yes	Wind							
Apr	18	Yes	CLR	906.00	8:27	17:00	8.55	8.37	18.7	128.52
Apr	19	Yes	MC	900.00	8:34	17:00	8.43	2.73	17.9	20.23
Apr	20	Yes	CLR	898.00	8:05	17:24	8.43	7.97	19.4	121.00
Apr	21	Yes	CLR	876.25	8:41	17:32	8.85	8.05	18.8	103.29
Apr	22	Yes	CLR	962.50	8:55	16:32	7.62	7.48	18.6	119.46
Apr	23	Yes	PC	934.00	11:15	16:50	4.62	3.30	16.9	51.53
Apr	24	Yes	MC	721.00	8:16	15:48	6.53	5.15	12.6	34.27
Apr	25	Yes	PC	960.00	8:09	18:02	9.88	9.72	18.8	124.75
Apr	26	Yes	PC	977.50	8:19	16:42	8.38	8.12	18.4	116.13
Apr	27	Yes	PC	925.00	9:13	18:00	8.80	6.08	17.1	82.65
Apr	28	Yes	CLR	993.00	8:42	18:01	9.32	9.18	18.9	132.73
Apr	29	Yes	PC	958.75	8:39	17:58	9.32	8.02	17.4	118.83
Apr	30	Yes	CLR	999.00	8:43	13:18	4.58	4.33	17.5	67.46
May	1	Yes	CLR	973.75	8:35	17:34	8.98	8.80	18.4	142.00
May	2	Yes	CLR	958.00	8:35	18:00	9.47	9.22	17.1	129.00
May	3	Yes	CLR	922.50	8:21	17:32	9.18	9.02	16.9	125.00
May	4	Yes	CLR	916.30	8:27	17:33	9.10	8.88	17.2	124.00
May	5	Yes	CLR	901.25	8:48	17:35	8.78	8.77	16.3	121.00
May	6	Yes	CLR	918.75	8:31	18:01	9.5	9.32	15.8	127.00
May	7	Yes	CLR	955.00	8:22	18:00	9.58	9.27	16.9	131.00
May	8	Yes	PC	951.00	10:11	16:24	6.20	5.37	18.0	79.00
May	9	Yes	PC	951.00	10:11	16:24	6.20	5.37	18.0	79.00
May	10	Yes	CLR	947.50	8:32	14:09	5.62	5.43	16.5	80.00
May	11	Yes	PC	953.80	7:59	17:09	8.78	8.60	15.8	100.00
May	12	No	CLR	975.00						
May	13	Yes	MC	847.50	11:28	18:32	7.07	6.12	14.2	24.00
May	14	Yes	CLR	951.00	7:59	18:00	10.03	9.75	16.4	136.00
May	15	Yes	CLR	953.75	11:26	16:17	4.85	2.83	18.0	43.00
May	16	Yes	CLR	898.75	8:02	18:01	9.98	7.85	17.1	113.00



May 17	Yes	CLR	956.30	9:22	18:02	8.67	8.40	17.9	130.00
May 18	Yes	CLR	955.00	12:38	19:03	6.42	5.98	17.9	84.00
May 19	Yes	PC	900.00	10:20	18:50	8.50	0.00	0.0	0.00
May 20	Yes	CLR	963.80	7:33	13:27	5.90	3.40	17.0	48.00
May 21	Yes	PC	941.25	9:06	19:02	9.93	4.55	16.3	53.00
May 22	Yes	CLR	970.00	8:27	15:51	7.40	6.97	18.1	114.00
May 23	No								
May 24	No								
May 25	No								
May 26	No								
May 27	No								
May 28	Yes	CLR	915.00	13:20	18:29	5.12	4.18	14.9	53.00
May 29	No	CLR	968.38	7:23	18:35	11.20	7.70	17.1	108.00
May 30	Yes	CLR	927.50	7:10	18:32	11.55	8.30	16.0	111.00
May 31	Yes	OVR	818.00	9:30	18:06	10.32	1.63	11.6	14.00
Jun 1	Yes	CLR	961.30	7:37	19:02	11.40	10.93	15.6	133.00
Jun 2	Yes	MC	898.00	7:40	18:30	10.67	6.28	14.0	45.00
Jun 3	No								
Jun 4	No								
Jun 5	No								
Jun 6	Yes	CLR	958.00	13:02	18:30	5.47	5.10	18.1	83.00
Jun 7	Yes	CLR	882.50	7:47	17:32	9.75	7.63	16.3	103.00
Jun 8	Yes	CLR	975.00	7:21	18:22	11.02	9.12	16.3	144.00
Jun 9	Yes	CLR	948.00	7:32	18:32	11.00	10.43	17.1	152.00
Jun 10	Yes	CLR	1008.80	7:13	18:17	11.07	8.37	19.6	141.00
Jun 11	Yes	CLR	973.50	7:07	18:32	11.42	11.20	18.7	184.00
Jun 12	Yes	CLR	973.75	7:17	18:53	11.60	11.57	19.0	188.00
Jun 13	Yes	CLR	978.75	7:30	18:11	10.68	10.50	18.0	172.00
Jun 14	Yes	CLR	957.50	6:55	18:32	11.62	11.42	17.5	181.00
Jun 15	Yes	CLR	981.25	7:17	18:31	10.77	10.58	18.6	177.00
Jun 16	Yes	CLR	974.00	7:38	18:30	10.88	10.87	18.4	179.00
Jun 17	Yes	CLR	950.00	7:36	19:00	11.43	11.23	17.5	170.00
Jun 18	Yes	CLR	950.00	7:09	18:32	11.37	11.33	17.2	166.00
Jun 19	Yes	CLR	918.75	7:10	18:15	11.08	10.90	16.7	158.00
Jun 20	Yes	PC	861.00	7:15	18:31	10.88	10.68	15.3	124.00
Jun 21	Yes	OVR	801.00	7:22	18:00	10.63	2.87	14.7	33.00
Jun 22	Yes	CLR	958.75	7:00	19:28	12.05	11.90	17.9	177.00
Jun 23	Yes	CLR	933.75	7:20	18:31	11.18	11.13	17.3	159.00
Jun 24	No								
Jun 25	No	CLR	933.75	13:34	17:23	3.89	0.00	0.0	0.00
Jun 26	No	CLR	N/A	8:06	17:00	8.90	0.00	0.0	0.00
Jun 27	Yes	CLR	916.25	7:25	18:32	11.12	8.45	17.8	127.00
Jun 28	Yes	CLR	926.30	7:48	14:25	6.67	2.22	18.1	34.00
Jun 29	No	CLR	N/A	7:06	18:00	10.50	0.00	0.0	0.00
Jun 30	No	CLR	N/A	13:21	18:00	5.21	0.00	0.0	0.00

Totals: **698.14    568.37    7981.14**

For Ops:

Yes - Operated  
No - No Generation  
Off - Holiday or Weekend

For Weather:

CLR - Clear  
PC - Partly Cloudy  
MC - Mostly Cloudy  
OVR - Overcast  
Wind - Wind prevented ops

## Science Applications International Corp Daily Reports (Apr-Jun 02)

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Apr 1	No	CLR	970.00					
Apr 2	No	CLR	971.00					
Apr 3	No	CLR	912.50					
Apr 4	No	CLR	950.00					
Apr 5	No	OVR	848.75					
Apr 6	No	PC	906.00					
Apr 7	No	PC	935.00					
Apr 8	No	PC	920.00					
Apr 9	No	MC	893.00					
Apr 10	No	PC	871.00					
Apr 11	No	PC	893.00					
Apr 12	No	PC	910.00					
Apr 13	No	PC	944.00					
Apr 14	No	MC	943.75					
Apr 15	No	Wind						
Apr 16	Yes	PC	849.00	9:13	11:22	2:09	17.39	34.38
Apr 17	No	Wind						
Apr 18	Yes	CLR	906.00	10:30	17:00	6:30	18.60	108.48
Apr 19	Yes	MC	900.00	8:19	17:00	8:41	18.60	78.94
Apr 20	Yes	CLR	898.00	8:05	17:24	9:19	18.71	126.20
Apr 21	Yes	CLR	876.25	11:17	17:30	6:13	18.35	88.57
Apr 22	Yes	CLR	962.50	9:08	18:07	8:59	18.23	140.36
Apr 23	Yes	PC	934.00	8:42	18:00	9:18	16.64	76.90
Apr 24	Yes	MC	721.00	8:59	15:48	6:49	10.03	20.63
Apr 25	Yes	PC	960.00	8:35	14:00	5:25	17.70	77.52
Apr 26	No	PC	977.50					
Apr 27	Yes	PC	925.00	13:00	17:31	4:31	17.30	61.35
Apr 28	Yes	CLR	993.00	8:35	17:39	9:04	18.13	144.26
Apr 29	Yes	PC	958.75	8:59	13:22	4:23	17.17	71.97
Apr 30	Yes	CLR	999.00	8:35	14:36	6:01	17.41	64.27
May 1	Yes	CLR	973.75	9:20	17:00	7:40		132.00
May 2	Yes	CLR	958.00	8:33	17:45	9:12		124.00
May 3	Yes	CLR	922.50	8:22	17:30	9:08	16.95	132.00
May 4	Yes	CLR	916.30	8:11	17:31	9:20	16.97	135.00
May 5	Yes	CLR	901.25	8:41	17:38	8:57	16.60	127.00
May 6	Yes	CLR	918.75	9:20	18:00	8:40	16.71	129.00
May 7	Yes	CLR	955.00	8:01	17:45	9:44	17.34	140.00
May 8	Yes	PC	951.00	8:40	16:23	7:43	17.91	104.00
May 9	Yes	PC	951.00	8:40	16:23	7:43	17.91	104.00
May 10	Yes	CLR	947.50	8:32	13:50	5:18	16.10	73.00
May 11	Yes	PC	953.80	8:15	17:06	8:51	16.42	54.00
May 12	Yes	CLR	975.00	9:31	17:57	8:26	18.53	116.00
May 13	Yes	MC	847.50	8:21	18:30	10:09	17.35	74.00
May 14	Yes	CLR	951.00	7:36	17:55	10:19		85.00
May 15	Yes	CLR	953.75	9:22	16:00	6:38	16.10	99.00
May 16	Yes	CLR	898.75	7:43	17:49	10:06	13.34	105.00
May 17	Yes	CLR	956.30	7:53	17:38	9:45	11.64	77.00
May 18	No	CLR	955.00					
May 19	No	PC	900.00					
May 20	No	CLR	963.80					

May 21	No	PC	941.25					
May 22	No	CLR	970.00					
May 23	No							
May 24	No							
May 25	No							
May 26	No							
May 27	No							
May 28	No	CLR	915.00					
May 29	No	CLR	968.38					
May 30	No	CLR	927.50					
May 31	No	OVR	818.00					
Jun 1	No	CLR	961.30					
Jun 2	No	MC	898.00					
Jun 3	No							
Jun 4	No							
Jun 5	No							
Jun 6	No	CLR	958.00					
Jun 7	No	CLR	882.50					
Jun 8	No	CLR	975.00					
Jun 9	No	CLR	948.00					
Jun 10	No	CLR	1008.80					
Jun 11	No	CLR	973.50					
Jun 12	No	CLR	973.75					
Jun 13	No	CLR	978.75					
Jun 14	No	CLR	957.50					
Jun 15	No	CLR	981.25					
Jun 16	No	CLR	974.00					
Jun 17	No	CLR	950.00					
Jun 18	No	CLR	950.00					
Jun 19	No	CLR	918.75					
Jun 20	No	PC	861.00					
Jun 21	No	OVR	801.00					
Jun 22	No	CLR	958.75					
Jun 23	No	CLR	933.75					
Jun 24	No							
Jun 25	No	CLR	933.75					
Jun 26	No	CLR	N/A					
Jun 27	No	CLR	916.25					
Jun 28	No	CLR	926.30					
Jun 29	No	CLR	N/A					
Jun 30	No	CLR	N/A					

Totals:

**235:01**

**2903.83**

For Ops:

Yes - Operated  
No - Not functioning  
Off - Holiday or Weekend

For Weather:

CLR - Clear  
PC - Partly Cloudy  
MC - Mostly Cloudy  
OVR - Overcast  
Wind - Wind prevented ops

## Stirling Energy Systems Daily Reports (Jul-Sep 02)

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Gen Time (Hours)	Net Pk Pwr (kW)	Net Energy (kWh)
Jul 1	Tra	CLR	None	7:08	18:16	11.13	0.00	0.0	0.00
Jul 2	Tra	CLR	None	7:38	18:00	10.37	0.00	0.0	0.00
Jul 3	Tra	PC	None	8:47	18:00	9.53	0.00	0.0	0.00
Jul 4	Tra	CLR	None	8:01	18:00	7.59	0.00	0.0	0.00
Jul 5	Tra	CLR	None	7:05	18:28	11.23	0.00	0.0	0.00
Jul 6	Tra	MC	920.00	7:31	18:34	11.05	0.00	0.0	0.00
Jul 7	Tra	PC	920.00	7:26	18:30	11.04	0.00	0.0	0.00
Jul 8	Tra	CLR	1010.00	6:57	18:19	11.37	0.00	0.0	0.00
Jul 9	Tra	CLR	1010.00	7:14	18:26	11.12	0.00	0.0	0.00
Jul 10	No	CLR	913.00			0.00	0.00	0.0	0.00
Jul 11	No	MC	846.00			0.00	0.00	0.0	0.00
Jul 12	No	PC	846.00			0.00	0.00	0.0	0.00
Jul 13	No	OVR	None			0.00	0.00	0.0	0.00
Jul 14	No	OVR	None			0.00	0.00	0.0	0.00
Jul 15	No	MC	None			0.00	0.00	0.0	0.00
Jul 16	No	OVR	None			0.00	0.00	0.0	0.00
Jul 17	No	OVR	None			0.00	0.00	0.0	0.00
Jul 18	No	PC	935.00			0.00	0.00	0.0	0.00
Jul 19	Tra	CLR	935.00	16:15	16:53	0.38	0.00	0.0	0.00
Jul 20	No	CLR	None			0.00	0.00	0.0	0.00
Jul 21	No	CLR	None			0.00	0.00	0.0	0.00
Jul 22	No	PC	894.00			0.00	0.00	0.0	0.00
Jul 23	No	CLR	None			0.00	0.00	0.0	0.00
Jul 24	No	OVR	None			0.00	0.00	0.0	0.00
Jul 25	No	CLR	972.00			0.00	0.00	0.0	0.00
Jul 26	No	CLR	972.00			0.00	0.00	0.0	0.00
Jul 27	No	CLR	972.00			0.00	0.00	0.0	0.00
Jul 28	No	CLR	1040.00			0.00	0.00	0.0	0.00
Jul 29	No	CLR	1117.00			0.00	0.00	0.0	0.00
Jul 30	No	CLR	None			0.00	0.00	0.0	0.00
Jul 31	No	CLR	None			0.00	0.00	0.0	0.00
Aug 1	No	CLR	None			0.00	0.00	0.0	0.00
Aug 2	No	CLR	None			0.00	0.00	0.0	0.00
Aug 3	No	CLR	None			0.00	0.00	0.0	0.00
Aug 4	No	PC	None			0.00	0.00	0.0	0.00
Aug 5	No	PC	None			0.00	0.00	0.0	0.00
Aug 6	No	CLR	None			0.00	0.00	0.0	0.00
Aug 7	No	CLR	None			0.00	0.00	0.0	0.00
Aug 8	No	PC	None			0.00	0.00	0.0	0.00
Aug 9	No	CLR	None			0.00	0.00	0.0	0.00
Aug 10	No	CLR	None			0.00	0.00	0.0	0.00
Aug 11	No	CLR	None			0.00	0.00	0.0	0.00
Aug 12	No	CLR	None			0.00	0.00	0.0	0.00
Aug 13	Yes	CLR	None	14:10	15:34	1.40	1.40	16.1	20.00
Aug 14	Yes	CLR	877.50	8:04	14:52	6.80	5.25	18.8	94.48
Aug 15	Yes	CLR	798.75	13:15	16:46	3.52	3.02	16.4	33.00
Aug 16	Yes	CLR	725.00	8:57	18:00	9.28	9.08	15.5	101.00
Aug 17	Yes	CLR	725.00	6:39	16:45	10.10	10.03	15.5	127.00
Aug 18	Yes	CLR	783.00	6:32	15:45	9.22	9.02	18.6	115.00
Aug 19	Yes	CLR	687.50	6:11	11:45	5.47	5.33	12.8	45.00

Aug 20	No	CLR	827.00			0.00	0.00	0.00	0.00
Aug 21	No	CLR	None			0.00	0.00	0.00	0.00
Aug 22	No	CLR	None			0.00	0.00	0.00	0.00
Aug 23	No	CLR	None			0.00	0.00	0.00	0.00
Aug 24	No	CLR	None			0.00	0.00	0.00	0.00
Aug 25	No	CLR	None			0.00	0.00	0.00	0.00
Aug 26	No	CLR	None			0.00	0.00	0.00	0.00
Aug 27	No	CLR	None			0.00	0.00	0.00	0.00
Aug 28	No	CLR	None			0.00	0.00	0.00	0.00
Aug 29	No	CLR	None			0.00	0.00	0.00	0.00
Aug 30	No	CLR	None			0.00	0.00	0.00	0.00
Sep 1	No	CLR	None			0.00	0.00	0.00	0.00
Sep 2	No	CLR	None			0.00	0.00	0.00	0.00
Sep 3	No	CLR	850.00			0.00	0.00	0.00	0.00
Sep 4	No	PC	860.00			0.00	0.00	0.00	0.00
Sep 5	No	Rain	None			0.00	0.00	0.00	0.00
Sep 6	No	CLR	None			0.00	0.00	0.00	0.00
Sep 7	No	CLR	None			0.00	0.00	0.00	0.00
Sep 8	No	CLR	None			0.00	0.00	0.00	0.00
Sep 9	No	CLR	None			0.00	0.00	0.00	0.00
Sep 10	No	CLR	None			0.00	0.00	0.00	0.00
Sep 11	No	CLR	None			0.00	0.00	0.00	0.00
Sep 12	No	CLR	None			0.00	0.00	0.00	0.00
Sep 13	No	CLR	None			0.00	0.00	0.00	0.00
Sep 14	No	CLR	None			0.00	0.00	0.00	0.00
Sep 15	No	CLR	None			0.00	0.00	0.00	0.00
Sep 16	No	CLR	None			0.00	0.00	0.00	0.00
Sep 17	No	PC	None			0.00	0.00	0.00	0.00
Sep 18	No	CLR	None			0.00	0.00	0.00	0.00
Sep 19	Yes	CLR	946.25	13:41	15:42	2.02	2.02	20.7	34.00
Sep 20	Yes	CLR	963.00	7:26	16:28	9.03	8.95	23.0	161.00
Sep 21	Yes	CLR	965.00	7:22	15:05	7.75	7.70	22.8	142.00
Sep 22	Yes	CLR	966.25	7:03	16:32	9.48	9.32	21.7	166.00
Sep 23	Yes	CLR	965.00	7:10	16:45	9.58	9.37	21.6	158.00
Sep 24	Yes	PC	931.30	7:24	15:21	7.95	7.70	19.9	100.00
Sep 25	Yes	PC	856.30	8:05	16:48	8.72	6.63	17.8	77.00
Sep 26	Yes	CLR	931.30	7:35	16:48	9.23	8.48	21.1	134.00
Sep 27	Yes	PC	872.50	7:07	8:36	9.45	4.12	17.1	53.00
Sep 28	Yes	MC	793.80	7:17	16:00	8.60	0.28	13.6	2.00
Sep 29	Yes	CLR	926.30	7:32	16:37	9.08	8.92	20.8	146.00
Sep 30	Yes	CLR	901.30	7:19	16:33	9.23	9.05	19.8	141.00

For Ops:

Yes - Generated  
 Tra - Tracked, No Gen  
 No - No Track, No Gen  
 Off - Holiday or Weekend

For Weather:

CLR - Clear  
 PC - Partly Cloudy  
 MC - Mostly Cloudy  
 OVR - Overcast  
 Wind - Wind prevented ops

\*Actual kWh is determined from taking the value of the EI meter on 9/30/02 and subtracting the value on 6/30/02

Totals:

**240.72    125.67**

**1849.48**

**1832.00** :Actual\*

## Science Applications International Corp Daily Reports (Jul-Sep 02)

	Ops?	Weather	Peak Solar (W/m <sup>2</sup> )	Start Time	End Time	Track Time (Hours)	Peak Power (kW)	Net Energy (kWh)
Jul 1	No	CLR	None			0:00	0.00	0.00
Jul 2	No	CLR	None			0:00	0.00	0.00
Jul 3	Yes	PC	None	16:30	18:51	2:21	11.10	16.00
Jul 4	Yes	CLR	None	8:01	18:00	9:59	18.80	49.00
Jul 5	Yes	CLR	None	8:31	18:26	9:55	16.45	46.00
Jul 6	Yes	MC	920.00	9:29	17:34	8:05	15.59	81.00
Jul 7	Yes	PC	920.00	7:13	17:34	10:21	15.82	96.00
Jul 8	Yes	CLR	1010.00	11:06	18:03	6:57	15.96	106.00
Jul 9	Yes	CLR	1010.00	8:15	18:02	9:47	15.75	90.00
Jul 10	Yes	CLR	913.00	8:38	18:30	9:52	13.69	59.00
Jul 11	Yes	MC	846.00	7:31	17:03	9:32	9.03	4.00
Jul 12	Yes	PC	846.00	7:18	18:03	10:45	14.15	89.14
Jul 13	Yes	OVR	None	7:23	9:36	2:13	11.08	18.55
Jul 14	No	OVR	None			0:00	0.00	0.00
Jul 15	Tra	MC	None	8:40	16:26	7:46	0.00	0.00
Jul 16	Yes	MC	None	8:03	18:06	10:03	13.70	27.48
Jul 17	Yes	OVR	None	8:33	13:44	5:11	0.00	1.53
Jul 18	Yes	PC	935.00	7:52	17:47	9:55	14.13	87.67
Jul 19	Tra	CLR	935.00	7:41	11:52	4:11	0.00	0.00
Jul 20	Tra	CLR	None	8:19	16:42	8:23	11.26	0.00
Jul 21	Tra	CLR	None	7:51	18:00	10:09	0.00	0.00
Jul 22	Tra	PC	894.00	7:20	17:58	10:38	0.00	0.00
Jul 23	Yes	CLR	None	9:12	18:01	8:49	13.89	27.04
Jul 24	Tra	OVR	None	7:50	17:52	10:02	0.00	0.00
Jul 25	Tra	CLR	972.00	8:00	17:46	9:46	7.17	6.00
Jul 26	Tra	CLR	972.00	7:43	18:00	10:17	0.00	0.00
Jul 27	Tra	CLR	972.00	7:43	18:00	10:17	0.00	0.00
Jul 28	Tra	CLR	1040.00	7:57	17:40	9:43	0.00	0.00
Jul 29	Tra	CLR	1117.00	8:26	17:30	9:04	0.00	0.00
Jul 30	No	CLR	None			0:00	0.00	0.00
Jul 31	No	CLR	None			0:00	0.00	0.00
Aug 1	No	CLR	None			0:00	0.00	0.00
Aug 2	No	CLR	None			0:00	0.00	0.00
Aug 3	No	CLR	None			0:00	0.00	0.00
Aug 4	No	PC	None			0:00	0.00	0.00
Aug 5	No	PC	None			0:00	0.00	0.00
Aug 6	No	CLR	None			0:00	0.00	0.00
Aug 7	Tra	CLR	None	13:08	13:45	0:37	9.94	3.00
Aug 8	Tra	PC	None	9:28	10:09	0:41	10.50	1.00
Aug 9	No	CLR	None			0:00	0.00	0.00
Aug 10	No	CLR	None			0:00	0.00	0.00
Aug 11	No	CLR	None			0:00	0.00	0.00
Aug 12	No	CLR	None			0:00	0.00	0.00
Aug 13	No	CLR	None			0:00	0.00	0.00
Aug 14	No	CLR	877.50			0:00	0.00	0.00
Aug 15	No	CLR	798.75			0:00	0.00	0.00
Aug 16	Tra	CLR	725.00	8:29	17:32	9:03	0.00	0.00
Aug 17	Tra	CLR	725.00	7:05	17:00	9:55	0.00	0.00
Aug 18	No	CLR	783.00			0:00	0.00	0.00
Aug 19	No	CLR	687.50			0:00	0.00	0.00

For Ops:

Yes - Generated  
 Tra - Tracked, No Gen  
 No - No Track, No Gen  
 Off - Holiday or Weekend

For Weather:

CLR - Clear  
 PC - Partly Cloudy  
 MC - Mostly Cloudy  
 OVR - Overcast  
 Wind - Wind prevented ops

Aug 20	Tra	CLR	827.00	8:59	17:11	8:12	0.00	0.00
Aug 21	Tra	CLR	None	8:05	17:03	8:58	0.00	0.00
Aug 22	Tra	CLR	None	10:50	17:00	6:10	0.00	0.00
Aug 23	No	CLR	None			0:00	0.00	0.00
Aug 24	Tra	CLR	None	7:19	16:19	9:00	0.00	0.00
Aug 25	Tra	CLR	None	12:50	18:00	5:10	0.00	0.00
Aug 26	Tra	CLR	None	8:27	18:00	9:33	0.00	0.00
Aug 27	Tra	CLR	None	8:17	17:55	9:38	0.00	0.00
Aug 28	Tra	CLR	None	8:47	18:11	9:24	0.00	0.00
Aug 29	No	CLR	None			0:00	0.00	0.00
Aug 30	No	CLR	None			0:00	0.00	0.00
Sep 1	No	CLR	None			0:00	0.00	0.00
Sep 2	No	CLR	None			0:00	0.00	0.00
Sep 3	Yes	CLR	850.00	10:36	18:00	7:24	13.61	81.16
Sep 4	Yes	PC	860.00	9:12	16:35	7:23	12.81	72.14
Sep 5	No	Rain	None			0:00	0.00	0.00
Sep 6	No	CLR	None			0:00	0.00	0.00
Sep 7	No	CLR	None			0:00	0.00	0.00
Sep 8	No	CLR	None			0:00	0.00	0.00
Sep 9	Yes	CLR	None	9:01	15:30	6:29	15.15	86.47
Sep 10	Tra	CLR	None	9:16	17:00	7:44	0.00	0.00
Sep 11	No	CLR	None			0:00	0.00	0.00
Sep 12	No	CLR	None			0:00	0.00	0.00
Sep 13	Tra	CLR	None	9:25	12:25	3:00	0.00	0.00
Sep 14	No	CLR	None			0:00	0.00	0.00
Sep 15	No	CLR	None			0:00	0.00	0.00
Sep 16	No	CLR	None			0:00	0.00	0.00
Sep 17	Tra	PC	None	9:24	16:24	7:00	0.00	0.00
Sep 18	No	CLR	None			0:00	0.00	0.00
Sep 19	No	CLR	946.25			0:00	0.00	0.00
Sep 20	No	CLR	963.00			0:00	0.00	0.00
Sep 21	No	CLR	965.00			0:00	0.00	0.00
Sep 22	No	CLR	966.25			0:00	0.00	0.00
Sep 23	No	CLR	965.00			0:00	0.00	0.00
Sep 24	No	PC	931.30			0:00	0.00	0.00
Sep 25	No	PC	856.30			0:00	0.00	0.00
Sep 26	No	CLR	931.30			0:00	0.00	0.00
Sep 27	No	PC	872.50			0:00	0.00	0.00
Sep 28	No	MC	793.80			0:00	0.00	0.00
Sep 29	No	CLR	926.30			0:00	0.00	0.00
Sep 30	No	CLR	901.30			0:00	0.00	0.00

Totals:

**349:22**

**1048.18**