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IEA SMALL SOLAR POWER SYSTEMS PROJECT

TASK I FINAL REPORT

STAGE 3

JANUARY 1987

OPERATING AGENT

INSTITUTO DE ENERGIAS RENOVABLES

CENTRO DE INVESTIGACIONES ENERGETICAS MEDIOAMBIENTALES Y TECNOLOGICAS

TABLE OF CONTENTS

TASK I REPORT

PREFACE

In 1985, the Stage 3 of the SSPS Project began. In this stage different tasks were set up, being Tasks I and II the ones related to the PTSA. Task I consisted of the O + M of the Project SSPS facilities in Almería, while Task II -"Technical Improvements"- deals with new projects intended to diversify the works and experiments carried out up to then.

This report shows the activities related to Task I during the two years in which Annex I of the Implementing Agreement, that is, 1985 and 1986, when CIEMAT-IER has been the Operating Agent of the SSPS Project for Tasks I and II.

Annex I ended on January, 1st, 1987, after the process of the transference to Spain of all the facilities of the SSPS Project, a process which culminated in the XXXII E.C. Meeting held in Madrid on October, 16th, 1986.

With the transference of the SSPS Project facilities to Spain, a new phase for the PTSA has begun, and the PTSA has become a big experimentation and and test center for all kinds of applications of solar thermal energy.

We would like to make a special reference to the former PTSA Director, Dr. Ricardo Carmona, who died in December 1987. Without his enthusiasm, dedication, capabilities and creativeness, the works carried out in the PTSA would not have been possible. All the team working for the PTSA consider ourselves lucky to have worked with him, and we want to express our gratitude and admiration for him.

Finally, we would like to thank the SSPS Executive Committee their support and cooperation during the last phase of the project, summarized here.

Almería, January 1987

Fernando Sánchez Sudón

SSPS Operating Agent for TAsks I and II

2. STATUS SUMMARY

2.1.General: The Stage 3 that commenced on 1 January 1985 with the Annexes I and II has been contemplating the following objectives proposed to the Executive Committee in the 27th meeting and adopted in the 28th Executive Committee in Paris:

Task I - SSPS Plants Technical Preservation

Task II - Operational optimization of DCS and DCS2

- High Flux testing with the Advanced Sodium Receiver

where Spain would be the Operating Agent. At the same time, new fields were proposed for investigation which should be studied for their proposal to the Executive Committee.

- The International Test and Evaluation Team ceased its activities as such as the site. However, some of its former members continued in Tabernas, working for the Task II experiments.

- DFVLR was appointed as the Executive Committee Secretary to carry out such functions as the Executive Committee requested it to perform.

TASK II Preparatory Work Accomplished during the period from 1 January 1985 to 31 August 1985.

Subtask 1; DCS: The tests under Task II had started. An oil cooler with its instrumentation procured for the "Wide Temperature Range" test, installed, and ready for operation.

For the ACUREX field automation, an HP scanner was purchased, and a contract with the Automation Department of the University of Sevilla was established.

For the DMST test, the buffer tank was eliminated from the ACUREX field, and the corresponding by-pass pipe was installed.

Subtask 2; CRS: The tower protection and ASR receiver works were carried out.

The MMC and MBB (GAST) heliostats were hand-washed, and the realignment of the MMC heliostats accomplished.

During the second half of 1985, much effort was made to complete the Program of Work established for 1985 relating to Task II, both for the DCS and the CRS.

In fact, the first phase of the test campaign, the ASR High Flux Experiment of the CRS, has been performed and a report is being written separately. Flux densities of up to 2.5 MW/m^2 were achieved on a few occasions, and after the test phase no damage was visibly appreciated on the receiver surface.

At the same time, various tests were carried out with the DCS in the following areas:

- wide temperature range of operation
- plant automation and operation strategies
- dual medium storage tank (DMST) evaluation
- reflectivity measurements

Reports concerning the wide temperature range operation as well as the DMST evaluation have been written within the TASK II scope.

During the first half of 1986, the operation of the plants has been devoted to the accomplishment of the Program of Work approved at the 30th Executive Committee meeting.

Some tasks were completed during the period:

- Convective loss experiments in the ASR
- Absorptance measurements
- Metallurgic analyses of the ASR and Sulzer receiver
- Installation and testing of a fiber optical flux measuring systems (FOS)
- Automation ACUREX field

Other tasks were in progress at that time:

- ASR routine operation
- DCS fields in a wide range of temperatures

From June to August 1986, plant operation was aimed at accomplishing the Program of Work approved at the 30th Executive Committee meeting.

On August 18, an uncontrolled gush of sodium from the hot tank caused extensive damage to the Sodium Hall and completely destroyed the Computer Hall and Control Room.

Some tasks were completed prior to this accident:

- Convective loss experiments in the ASR
- Testing of a fiber optical flux measuring system (FOS)
- Fine-tuning of the ACUREX field automation

Other tasks are not yet finished, because of the sodium fire:

- ASR routine operation
- DCS fields in a wide range of temperatures

The second phase of the ASR Hihg Flux Experiment has been cancelled, due to the above mentioned fire.

In the 32nd Executive Committee held in October in Madrid, the transfer of the SSPS properties to SPAIN (CIEMAT-IER) was decided, becoming effective on 1st January 1987.

At the same time, a cooperation agreement for the use of the whole Plataforma Solar was signed between DFVLR and CIEMAT.

2.2 Operation and maintenance

The new Operating Agent, CIEMAT-IER, continued the contract of Sevillana de Electricidad for the operation of the SSPS Plants during 1985. Contracting was based on previous years' reduced operation basis.

In spite of the comprehensive technical inspection made by the POA Sevillana of the two SSPS Plants in December 1985, and in spite of the fact that these plants have practically not been operated during the period from January to August 1985, major failures were detected and required important maintenance work.

DCS: Failure of the UPS.

Failure of the KSB triple pump.

Failure in the ASEA generator.

CRS: Failure in the trace heating system of the downcomer pipe.

Two more failures in the trace heating system of the sodium receiver.

Failure of the chromotograph, which consequently had to be sent to Germany for repairing.

Failure of the PCS flow automatic control.

The departure of the Compañía Sevillana was scheduled effective on January 1st, 1986.

During the last two months of 1985, a major effort was devoted to the substitution of the responsible personnel of the Sevillana Team by personnel of MOMPRESA, pertaining to staff of the CESA-1. The Operation Head, Shift Heads, and Maintenance Head were substituted: the operators, watchmen, and maintenance personnel continued as before, as part of the pesonnel integrated in MOMPRESA.

The stage dedicated to transition and know-how acquisition by the new persons responsible for the operation and maintenance was carried out successfully thanks to the excellent collaboration of the Sevillana Team, and the previous experience of the new key persons in the operation of CESA-1.

At the end of 1985 the two plants were being operated routinely by the new Operating Team.

As of January 1st, 1986, the SSPS plants have been operated five days per week by the new operation team, composed of MOMPRESA personnel, until the fire on August, 18th.

Since this date they have been devoted exclusively to the cleaning and reconstructing of the zones affected by the fire.

2.3. Organization of the Plataform

The latest organization of the Plataforma solar was as described in Figure 1.

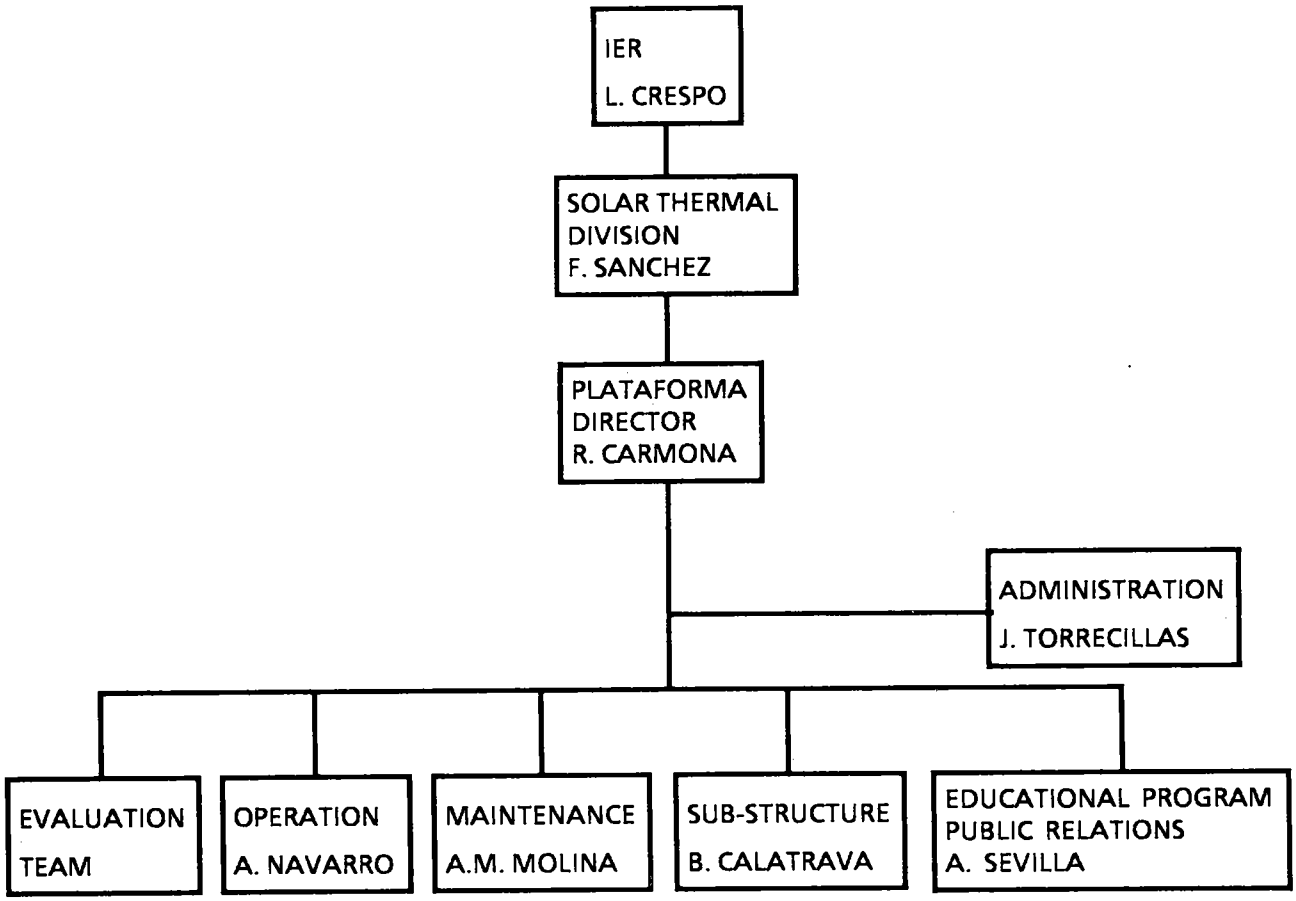


FIGURE 1

3. DCS OPERATION STATUS

The DCS activities during 1985 and 1986 aimed to complete the program of work defined and approved under the Task I Annex for which the IER has been the Operating Agent. After adoption of the Task II Annex by the Executive Committee, the different substasks specified below have been carried out with the participation of Germany and Spain, this last country being the O.A.

- Plant automation (Spain)
- Dual Medium Storage Tank (Germany and Spain)
- Wide Temperature Range (Germany and Spain)
- Reflectivity Measurements (Germany and Spain)
- Intercept Factor (Germany and Spain)
- Absorptance and Emittance (Germany and Spain)
- Transient Response (Germany and Spain)
- Operation Strategies (Germany and Spain)
- Reliability - Availability (Germany and Spain)

In 1986, ACUREX and MAN-East fields have been mainly devoted to operation in a wide range of temperatures.

In June, 1986 a parabollic trough collector made in Spain, GESA, was installed for testing at the Plataforma Solar.

The unfortunate sodium fire on August 18, caused a halt to these activities.

The most relevant activities are highlighted below.

3.1. Collector Fields

ACUREX

1985: - The ACUREX oil flow transmitter presented the same problems than the MAN-I field. As the trouble had and intermittent nature, it was difficult to locate.

- Maintenance work, including revision and repair of the thermal insulation, control of the oil level in motors and gear boxes, and greasing of all bearings was accomplished.

- Glaverbel made a new inspection of the delamination of the thin glass mirrors. Results are not yet available. No replacement of facets was made in 1985, and no significant delamination progress was detected during that period.

- Before starting the low temperature tests, the ACUREX field was hand-washed. The washing took three days, beginning on September 11; the reflectivity rose to 0.903.

- The hardware needed for Task I, Substask 1, "Automation" was installed.

- The PT-100 of Loop #6 was calibrated and flow transmitters of the ACUREX and MAN-W were repaired.

1986: -To obtain the highest possible levels in mirror reflectivity, the field was hand-washed on January 11.

- On January 13, Glaverbel personnel were on site to perform the semestral revision of the ACUREX field mirrors.

- On March 20, the automatic control program was modified.

- In July, the automation of the ACUREX field centered on data output on the plotter, and fine-tuning the program.

- On August 6, a cable control feedline to the ACUREX field pump burned. This ocurred during a constant flow test of 100% flow, with an oil inlet temperature of 110°C.

MAN-WEST

1985: - Thirty-six facets had to be replaced.

- In order to avoid further facets falling on the glass tubes, it was suggested to install clips as it had been done in the MAN-East Field.

- The flow transmitter of the MAN-I Field continued giving problems. Due to the intermitent nature of the failure, it was difficult to locate the problem.

- Loop #14, progressively taken out of service as its electronic boxes were used as spares, was put into operation again with the exception of module A-14, after receiving a set of repaired electronic boxes form Germany.

- The collector field was hand-washed during October 3, 4 and 5; the reflectivity rose to 0.888.

- The pyrheliometer that failed on November 5, was repaired and calibrated.

1986: - On June 26, the VALUTROL thyristors of the MAN-West pump were replaced, and operability of the field was restored.

- On July 7, module D-7 presented a leak in the flexible oulet tube. The loop was closed and this defective part was replaced.

MAN-East

1985: - Twenty-six facets with loose supports were replaced . To avoid the continuous falling of facets, MAN sent approximately 9,000 steel/plastic clips that, once fastened to the facet, impede the loosing of mirrors.

- Module D-6 electrical wiring was torn out as a consequence of the mechanical stops not being sufficiently strong to limit the azimut displacement after a failure in one limit switch.

- The collector field was hand-washed on September 16-20; the reflectivity rose to 0.884.

- A small oil leak was detected and repaired in helioman C-8. The repair required the substitution of the oil inlet flexible hose.

- Due to a fault in its electric motor, the Transfer Pump from the DMST to Tank I was unable to supply its rated oil flow. While the motor was under reparation, the pump was put in service using other motors with similar electrical and mechanical characteristics.

1986: - Mechanical stops have been installed on the modules to avoid breakage of the cabling due to uncontrolled movements.

- Several electronic boxes have been repaired.

- Helioman D-2 was put out of service due to failures in the azimuth motor.

GESA

- The GESA collector was mounted and installed for testing; power is supplied by LCB-1 of the MAN-West field.

- The GESA collector was filled on June 26.

- On July 17, while circulating oil at 200°C, numerous leaks were observed in the collector where the collector tubes joined.

- Finaly the collector loop was tested.

3.2. Storage system

1985: - As a preparation of the DMST evaluaton campaign, all the instruments were calibrated.

- A new oil cooler was installed in the DCS plant to allow the evaluation of the collectors at a wide temperature range.

- Automation of the oil cooler installed for wide range temperature tests was completed.

- A cabling overhaul was completed.

- Due to the low temperature tests, the oil levels in the storage tank were too low. An amount of 15m^3 necessary to recover the level was purchased.

1986: - The oil levels in the storage tank has become too low due to the low temperature tests. 15 m^3 were purchased, and added to the storage tank to recover the correct level.

- On June 17, a method to avoid temperature transient in the field inlet where the oil from Tank-1 was cooled by the oil-cooler was tested. Oil from the oil-cooler outlet was mixed with oil directed to the lower part of the tank from the MAN-East field. This procedure maintained the oil temperature constant, thus maintaining the temperature of the oil entering the pumps. In this way, the temperaure of all the oil coming from the MAN-East field remains

constant in the bottom of the tank by regulating of the flow in the oil cooler and employing the three-way valve in the ACUREX field.

- On July 30, work to change the oil-cooler couple commenced; new holes for the support screws had to be made in the head before it could be remounted.

3.3. Power conversion system

1985: - The PCS was submitted to a general overhaul, cleaning all the steam generator tubes and condenser tubes.

- The feedwater pump had a breakdown of the lubricating oil pump.

The Uninterruptable Power Supply unit broke down. After changing several thyristors the unit was put again into service.

- The ASEA generator broke down as a consequence of a false maneuver. It has been out of service until december, when repairs arrived from Sweden.

- The hydraulic system was revised.

1986: - The spare parts required for reparation of the electric generator arrived from Sweden and were installed. After this, the electric generator was operated for 8.2 hours.

- On June 20, the Diesel Motor tripped the high temperature alarm after operating under full charge for 1/2 hour. This was apparently due to a dirty radiator.

- The filter box of the raw water treatment plant broke on July 24, and had to be replaced.

3.4. Data acquisition system

1985: - The ducts of the air conditioning system in the Control Room were modified to provide better cooling for the unit.

- The Analog Input Definition Table of the Data Base was modified after the calibration of the ACUREX field flow transmitter.

- The eight channel analog input card corresponding to Loops # 9, 10, 11,12,13 and 14, and to the flow and pressure signals failed. It was substituted by a spare and the problem was solved.

- A new measurement point in the DAS was created. It corresponds to a T between the inlet and outlet temperatures of the oil cooler.

1986: - The flow transmitter FE903, located in the transfer line between the two tanks, was connected to channel 35 of the DAS.

- The DAS suffered a failure in one of the disks. Reparation required a visit by a technician from Hewlett-Packard.

- On June 16, the relay card indicating the outlet temperatures of the MAN-West loops was changed in the DCS-DAS closet.

- Verification continued of the PT-100's and signals which go to the DAS.

3.5. Operation Time and Performance

	TOTAL 1985	TOTAL AS OF AUGUST 1986
Irradiation	2755.4	1704.2
ACUREX operation (hours)	463.1	613.9
MAN-W operation (hours)	268.5	70.4
MAN-E operation (hours)	517.3	760.0
PCS operation (hours)	132.1	211.3
Grid synchronization (hours)	67.5	8.2
Gross output MWh_e	31.6	3.3

4. CRS OPERATON STATUS

During the first semester of 1985, the CRS Plant activities were minimal due to breakdowns in the Sodium Heat Transfer System Trace Heating, and also to the installation of the tower and ASR with the thermal protection. Afterwards, all the activities carried out were devoted to the ASR High Flux Experiment: Performance of convective losses tests and routine operation of the receiver from sunrise to sunset. Also in 1986, the ASINEL heliostats were installed and tested.

The unfortunate sodium fire on August 18 caused an untimely halt to these activities.

4.1. Heliostats field

1985:
- The power lines feeding the HAC computer and the heliostat field provided surprises. The erratic behaviour of the Power Failure Recovery Sequence had to be investigated in order to detect the causes of the intermittent failure.
- An external inspection of the heliostat motors showed that 42 had oil leaks in the flange connection betwen the motor and the gear box. After contacts with the maintenance supervisor of Solar One, it had been found that this was caused by a design error in the thickness of the oil seals installed. It was decided to proceed with the repair using new, thicker seals.
- A revision of the heliostat images was carried out. Some 14 modules (the more defective ones) were realigned. This was the first time that this was performed since their installation in 1981.
- Due to failures in the heliostat limit switches, the gears of two heliostats were damaged. Modifying some damaged components, it has been possible to put them again in service.
- A general revision of the heliostat field was accomplished in order to have maximum availability of the field during the ASR High Flux test campaign.
- Up to 14 heliostat motors were changed and repaired.
- Up to 8 heliostat controllers were repaired.
- The MMC heliostat field was hand-washed on October 25 and 28.
- The aiming accuracy of the heliostat field was verified.

- One drive mechanism was repaired.

1986: - A Spanish company, Electrónica Digital, S.A. modified a heliostat to improve the lightning protection. After testing and approving the behaviour of the heliostat, the work will be extended to the rest of the heliostat field.

- A photographic study of the heliostats' images was carried out on March 24.

- On June 5, specialized personnel came to test the heliostat field lightning protection.

- Acceptance tests were made of the ASINEL heliostats and their control system on June 18 and 19.

- On June 26, the mechanical stops of the heliostats' runs were checked.

- On July 14, the grid failed, due to opening the interruptor BF01-GJ-QO1 of the general power inlet to the CRS. Consequently, the HAC failed and HFC-2 remained focused on the diesel inlet.

  As the sun moved, this group of heliostats burned the eastern part of the receiver and receiver doors.

- On August 5, a technician from INORMA checked the MODCOMP computers and observed that the disc unit heads were in poor condition. The discs were inspected and most were found to be scratched. He proposed that the Control Room be cleaned and more care be taken in this area.

4.2. Advanced sodium receiver

1985: - The receiver was drained on April 24. All the sodium was stored in the tanks and the trace heating switched off. The complete shutdown of the CRS took place on April 29.

- The cromotograph was sent to Germany (Siemens) for repair due to erratic readings. It was reinstalled on August 8.

- The ASR was filled and put in service on July 24. However, a new failure in the ASR Flux Control device when the system was in automatic operation originated a sudden drop of flux for no apparent reason. After several tests, and in accordance with suggestions of Estudio de Informática, a motherboard

card replaced, to no avail. The High Flux Tests performed under Task II were conducted manually for safety reasons.

- The HFD cooling system was modified establishing a closed circuit that permited a saving of 2 to 3 m^3 of water for every reading.

- As stated above, new thermal protection was installed in the ASR tower and also in the ASR itself to take care of the increased spillage due to the MBB heliostats.

- The control and alarm devices of the ASR were modified to take care of extreme operating conditions that would be encountered in the course of the Task II, High Flux Experiment.

1986: - Sunrise-sunset operation tests still displayed an increase in temperature during the first and last hours of operation, as indicated by the thermocouples on the reciever frame.

- Repair of the ASR automatic control continued the first half of June, due to the constant value indicated by the signal converter card located at the outlet of the microcomputer to the SIMATIC.

- On July 29, an HFD run was carried out; the measurements were incorrect, due to the poor condition of the radiometers. The HFD bar was dismounted and the radiometers were repaired.

4.3. Sodium Heat Transfer System

1985: - The trace heating has been the weakest part of the CRS Plant. Four consecutive failures have ocurred in sections 5, 53, 63 and 103.

- The Hot Sodium Pump DC tachometer was replaced.

- After intensive work, the ASR flow controller had been repaired and was capable of performing its functions in automatic mode.

- Some tests were performed to evaluate the accuracy of the receiver sodium flow transmitter.

- Some controllers had been modified to enable operation of the steam generator with lower inlet and outlet temperatures, needed for the High Flux Experiment.

- The accuracy of the level transducers of the two sodium storage tanks had been verified. The data base had been changed to adopt a new calibration curve.

- The sodium leakage detector of the receiver was repaired.

- The sodium was purified from a plugging temperature of 120°C to 100°C.

1986: - Failure of the power supply units of the trace heating system, made drainage of the receiver necessary.

- Valves VS1-9 of the ASR opened in February 6, while circulating the sodium with the doors closed and the heliostat field out of track. Vent valves VS5-9 and drain valves VS1-4 opened of their own accord.

- The argon valves were checked for leakages on March 5.

- The receiver was drained on March 26 for the metallurgic analysis of the ASR panels.

- Leakage in the steam generator rupture disk. In the late afternoon after a day of PCS operation on April 21, a small sodium leakage was detected. After draining the steam generator, it was observed that the leak was in the welding of the rupture disk. After replacing the disk for a new one, the steam generator was filled.

- Mixing of oil and sodium in the cold pump. On May 3 (Saturday), the chromotographic analysis of the argon in the cold pump showed an increase in H_2 and CH_4 concentrations. It was assumed that there was an oil leakage through the gasket leading into the sodium. After increasing the pressure in the cold tank from 4.3 to 5 bar and decreasing the pressure of nitrogen from 8 to 7 bar in the oil side, the problem dissapeared.

- A significant increase in the concentrations of H_2 and CH_4 in the cold pump were noted in the chromatographic measurements.

- On June 25, the pressure transmitter of the cold tank indicated less pressure than taht of the hot tank, even tough both tanks are connected. This was readjusted.

- On August 11, a leak was detected in the bellows of valve LK01-AA06. It was decided to change the valve.

- On August 18, after making all the necessary preparations to change the valve LK01-AA06, the uncontrollable sodium leak ensued. The Sodium Hall was partially damaged, and the Control Room was completely destroyed. A complete, detailed report covering of this unfortunate incident was presented to the E.C. on October 1987.

4.4. Power Conversion System

1985 - In April, a grid failure while the CRS generator was producing electricity in Power Control Mode caused a PCS trip due to overspeed of the motor. It was the first time that a grid failure occurred with the CRS generating electricity. This system had no provision to switch automatically to Speed Control upon loss of grid power.

- The PCS was subject to a general revision and reconditioning. During the performance of the tests, it was operated smoothly and without failures.

- In accordance with the minimum operation policy of Task II, the Spilling motor was operated 10 hours in May. This was the first and only time that the CRS generated electricity since September 1984. After the first three hours of operation, the seals of the cylinder and valve of the first stage had to be retightened.

- After those incidents, and according to the policy established with respect to the Spilling Motor, it has not been operated.

- Apart from reparations accompanying these systems, work has been done with the steam generator, to adapt it to the low temperature conditions, required for some tests of the High Flux Experiment.

1986: - As agreed in the policy established regarding the Spilling motor, this has not been operated.

- The start-up of the PCS has been problematic, causing trips in the system. One of the valves of the hydraulic oil circuit of the PCS control did not function properly, and was replaced with a spare valve.

- On July 21, the feedwater pump to the steam generator blocked during operation. It had to be dismantled and the sockets changed and the pistons corrected.

4.5. Operation Time and Performance

The most relevant data are listed below.

	TOTAL 1985
Irradiation ≥ 300 W/m² (hours)	2756
HP standby (hours)	725
HF in track (hours)	336
PCS operation (hours)	269
Grid synchronization (hours)	10.4
Energy gain in the receiver MWh	390
Gross output MWh_e	4

	TOTAL as of August 1986
Irradiation ≥ 300 W/m² (hours)	1704.2
HP standby (hours)	438.3
HF in track (hours)	554.8
PCS operation (hours)	368.2
Grid synchronization (hours)	0.0
Energy gain in the receiver MWh	687.4
Gross output MWh_e	0.0

5. GAST

1985: - In the period of January to August 1985, the GAST heliostats have been submitted to extensive life cycle tests with satisfactory results.

- The SSPS-CRS plant was taking advantage of these MBB heliostats, using them to preheat the ASR after prolonged plant shutdown. Also, these heliostats were used for the High Flux Experiment that has been conducted in Almería.

- The GAST Consortium test using the ASR as a cooled target have been accomplished after 53.8 hours of experiments.

- Since October 1985, once the GAST Technological Program had finished their test campaign of the MBB heliostats, the operation and maintenance of this heliostat field was transferred to the SSPS Project.

- Likewise, at the end of 1985 work commenced to install the ten ASINEL heliostats, also pertaining to the GAST Technological Program. These heliostats were located behind the MMC heliostat field. A test campaign was planned for 1986.

1986: -Testing of the Fiber Optical Flux Measuring System (FOS)

Fiber optical sensors were installed on the HFD bar. Their signals were sent through optical fibers to the electronic sensors installed at the top of the receiver. Some demage was observed in the head of the fiber due to the high temperatures reached at the terminals.

- MBB Field

Due to electronic failures in the control unit, the MBB field has been out of service for 20 days. The cause of this failure was found in the EPROM memories of the HEDU system.

- ASINEL Field

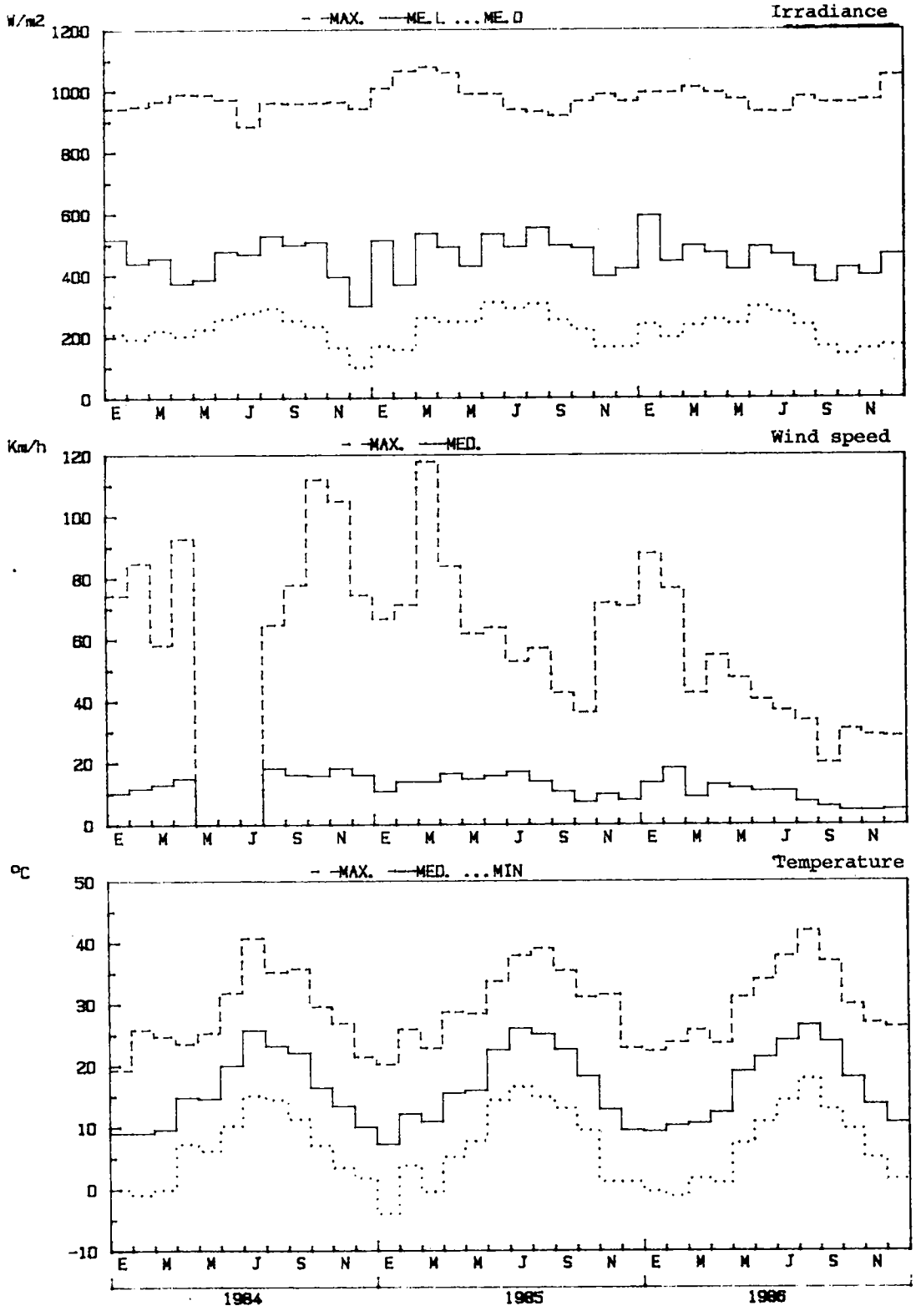
Installation of the ASINEL heliostats and their control system was finished in July 1986. The test campaign for this group of heliostats was scheduled to

start at the beginning of September; however, the HP-1000 computer used to control the field was destroyed in the CRS fire.

Activities of the GAST Project have been limited to testing individual heliostat images and solving small shift problems encountered during the control installation.

6. METEO DATA SUMMARY

A graphic display of the most significant meteorological parameters since 1984 is shown below.



7. EDUCATIONAL PROGRAM

Objectives

The objectives of this Program are to demonstrate the Plataforma Solar's capabilities to carry out educational activities and to implement a channel through which our knowledge could be spread to those groups of society most receptive to our technology.

1985 Educational Program

Just one course was offered during this first year: "HIGH TEMPERATURE SOLAR CONVERSION COURSE".

Schedule: September 22-27, 1985.

The main topics covered the theoretical and practical aspects of medium and high temperature solar conversion technology.

Solar radiation physiscs, concentration geometry, design factors for DCS and CRS plants, control systems, storage mediums, and heat flux measurements were among the theoretical points.

Operation strategies and maintenance problems composed the practical aspects. Specific practices were done in control rooms during routine operation.

Teachers

All the subjects were taught by personnel involved in the design, operation, maintenance, evaluation, and direction of the Plataforma Solar Projects.

Alumnae

A total of twenty-two persons attended the course with the following backgrounds:

- 5 University professors
- 4 Engineers from industrial and engineering companies
- 6 investigators
- 7 University students in the last year of studies

Conclusions

The general opinion expressed by the alumnae was that the course was helpful and interesting, and that further courses should be scheduled.

1986 Educational Course

Three courses were scheduled for 1986, and together represent the Educational Program of the Plataforma Solar in its first year, 1986.

1. Solar Radiation.
2. Applied Solar Thermology.
3. Electricity Production through Renewable Energies.

1. Solar Radiation Course

The first course of the 1986 Educational Program was offered on April 28, 29 and 30, 1986.

The course provided theoretical and practical information regarding methods of measuring and calculating solar radiation.

The teachers came from the Universities of Seville and Cordoba, the Consejo Superior de Investigaciones Científicas, Portugal (LNTI) and members of the Plataforma Solar staff.

The twenty-two attendants to the course came mainly form universities, altough there were some representatives form industry.

Once again, as inthe 1985 course, the students' general opinion was positive.

2. Applied Solar Thermology Course

From July 7 to 11, the Educational Program held the second course scheduled for this year. The topic dealt with the technology employed at the Plataforma Solar, covering the main aspects of design, operation, and maintenance of Distributed Collector Systems and Central Receiver Systems.

A total of 32 students from Universities (students and professors) and industry attended this course, lectured by Plataforma Solar staff, members of the former Plant Operation Authority, Instituto de Energías Renovables, and the DFVLR.

Compared with former courses, there was remarkable interest displayed on behalf of local institutions to support the Program, and a marked increase in students, this time surpassing the stipulates limit of 30.

3. Electricity production through Renewable Energy

This course is aimed for the Educational Program to reach the international frame. The subjects' plan contains those technologies which development is, at present, closest to the commercial level, and it has been designed from a practical point of view, making a detailed analysis od the daily problems of the world's most relevant facilities. This aspect was shown by international experts.

The 1st International Course took place on November, 17 to 28, with a number of 25 teachers; 8 were foreigners; 8 belonging to the IER; and the rest were hired through the IER from universities and different companies.

30 asisstants from Spain, Germany, Mexico, Argentina, Sweden, Israel, Egypt, Turkey, Argelia and Yugoslavia attended the course.

We must note the contacts with the following organisms for the celebration of this course:

- PNUMA
- ENHER
- ISPRA
- CEE (DG XII)
- Renault Automation
- Commisariat de la Recherche (Argelia)
- Egyptian Enviroment Affairs Agency
- Enviromental Protection Agency (Israel)

8.VISITORS TO THE SITE

Resumé of 1985

No. of visits	170
No. of visitors	7329
No. of technical visits	27
% of total	15.8
No. Of school visits	124
% of total	72.9
Tourists et al.	29
% of total	17

The data processed since last August, corresponding to the last report is as follows:

Month	No. visits	No. visitors	Tech. visits No.	% total	School visits No.	% total	Tourist et al. No.	% total
January		375						
February		723						
March		1498						
April		981						
May		1505						
June		424						
July		171						
August		46						
September		130	4	33	2	17	6	50
October		400	6	46	2	14	5	38
November		414	3	37.5	4	50	1	12.5
December		566	0	0	8	80	2	20

Resumé of 1986 (up to November 30, 1986)

No. of visits	159
No. of visitors	7171
No. of technical visits	33
% of total	21
No. Of school visits	85
% of total	53
Tourists et al.	41
% of total	26

Month	No. visits	No. visitors	Tech. visits No.	% total	School visits No.	% total	Tourist et al. No.	% total
January	8	230	1	13	4	50	3	37
February	21	1336	3	14	12	57	6	29
March	25	801	8	32	10	40	7	28
April	28	1729	3	10	19	68	6	11
May	25	1121	3	12	16	64	6	24
June	12	593	2	16	10	84		
July	7	229	3	43	1	14	3	43
August	4	40	3	75			1	25
September	5	39	3	60	1	20	1	20
October	11	393	4	9	6	54	4	36
November	13	665	4	31	6	46	3	23

9. LIST OF REPORTS

Attached is a list of SSPS reports 1985 and 1986, complete up to -and including- November 1986.

In addition to these reports, there are:

- Monthly Data, compiled in red covers.
- Raw Data Tapes, which will be mailed on request.

All reports, manuals, technical descriptions, data tapes, software programs, etc., generated in the course of the SSPS Project are available in the Project's on-site reference Room.

SSPS TECHNICAL REPORTS

Report No.	Title	Author	Date
TR-1/85	Proceedings of the IEA-SSPS Experts Meeting on "High temperature Technology and Applications". Atlanta, USA, Downtown Marriot Hotel, June 18-21, 1985	M. Becker A. Skinrood	June 1985
TR-1/86	Performance of the DCS Fields in a Wide Temperature Range. Present Status of Test Campaigns and Preliminary Results.	M. Sánchez R. Carmona E. Zarza	July 1986

SSPS INCIDENT REPORTS

IEA/SSPS PROJECT — INCIDENT REPORT - INDEX — C S E

REF. NUMBER	DATE	SUBJECT
1/85 CRS	12.2.85	Receiver Drainage
2/85 DCS	9.1.85	Fire in MAN facets storage boxes
3/85 CRS	21.3.85	Failure in Trace Heating Element 053
4/85 CRS	7.3.85	Trace Heating Failure
5/85 CRS	21.3.85	PCS/CRS Hydraulic Pump Failure
6/85 DCS	21.3.85	PCS/DCS Feedwater Pump Breakdown
7/85 CRS	21.3.85	Failure of Trace Heating Element 103
8/85 CRS	6.5.85	Failure of Elevation Limit Switch in Heliostat 79
9/85 DCS	21.6.85	Failure to Generator Exciter
9.b/85 DCS	2.8.85	Addendum to Incident Report
10/85 CRS	24.6.85	Drive Mechanism Damaged in Heliostat #86
11/85 DCS	19.7.85	U.P.S. Failure
12/85	19.8.85	Failure of HAC Disk Drive
		IER-JEN MMPSA
1/86 CRS	1.6.86	Failure of the 5V and 24V power Supply Units of the Trace Heating System Control
2/86 DCS	31.1.86	Breakage of the Cabling of Module D-6: MAN-E Field
3/86 CRS	6.2.86	Opening of Valves VS1-9 of the ASR Receiver
4/86 CRS	19.2.86	Strong Fluctuation of the Flowmeter during a Reverse Flow Test
5/86 GENERAL	21.2.86	Failure of the HFD System
6/86 CRS	21.4.86	Leakage in the Steam Generator Rupture Disk (LK02 CB02)
7/86 CRS	3.5.86	Mixing of Oil and Sodium in the Cold Pump
8/86 CRS	5.5.86	Failure in the Trace Heating System Control: BN01 GJ06

SSPS SYNOPTICAL REPORTS

Report no.	Title	Author	Date
SSPS-SR7	SSPS Results of Test and Operation 1981-1984	W. Grasse	May 1985

SSPS CRS/DCS INTERNAL REPORTS - 1985/1986

Report No.	Title	Author	Date
R-56/85	HELIOS Calculations to determine the Heliostat field capability with the addition of the MBB + ASINEL Heliostats	M. Blanco	March 1985
R-57/85	Absorptance Measurements of the ASR	M. Sánchez R. Carmona	March 1985
R-1/85	Improvements of HELIOS Facilities on Site	M. Sánchez	March 1985
R-2/85	Estimation of Average Reflectivity in the DCS Collector Field	M. Sánchez	March 1985
R-3/85	Operating Conditions for the ASR	R. Carmona	April 1985
R-4/85	Draft- "Evaluation of DCS Fields in a Wide Temperature Range"	R. Carmona	April 1985
R-5/85	Operating Conditions for the ASR Campaign	M. Blanco R. Carmona	May 1985
R-8/85	A User's Guide to THERESA	M. Blanco	May 1985
R-10/85	Evaluation Program for the DMST	M. Geyer	Mar.1985
R-12/85	Sunlight Hours Considering Geographical Conditions	A. Cuadrado	May.1985
R-13/85	DCS Thermal Evaluation: Work Plan	M. Sánchez	May.1985
R-14/85	Report of Trip made by R. Carmona to Stuttgart and Livermore	R. Carmona	Jun.1985
R-15/85	Software Development for the Han-ling of Operational Data - SSPS -	A. Cuadrado	Jun.1985
R-16/85	Modification of the HFD Cooling System	C. López	Jun.1985
R-17/85	Installation to Detect the Existence of Homopolar Tension	C. López	Jun.1985
R-20/85	Irradiance Forecast for Cloudless Days	A. Cuadrado	Jun.1985
R-23/85	Reconditioing of the Raw Water Station	C. López	Jul.1985
R-24/85	Control of the Power Sent to the Receiver	M. Blanco M. Sánchez	Jul.1985
R-25/85	Proposed Operating Points for the ASR High Flux Experiment	R. Carmona	Jul.1985

SSPS CRS/DCS INTERNAL REPORTS - 1985/1986

Report No.	Title	Author	Date
R-26/85	Thermal Shield Protection Against Spillage	F. Ruiz	Aug.1985
R-27/85	Heliostat Field Focalization	J. Ramos	Aug.1985
R-28/85	Test Matrix for Phase I of the ASR High Flux Experiment	W. Schiel	Jul.1985
R-29/85	VAX - HP-85 Communication	A. Cuadrado	Aug.1985
R-31/85	Heliostat Flux Distribution (31/85)	A. Cuadrado	Jul.1985
R-32/85	Evaluation of DCS Fields in a Wide Range of Temperatures. Test Campaign. Final Version.	M. Sánchex R. Carmona	Aug.1985
R-33/85	Heliostat Flux Distribution (32/85)	A. Cuadrado	Aug.1985
R-34/85	Geometrical Factors for Parabolic Collectors which Track the Sun Around and East-West Axis Applied to the ACUREX Field	M. Sánchez A. Delgado	Aug.1985

SSPS CRS/DCS INTERNAL REPORTS

Report N°.	Title	Author	Date
R-35/85	Heliostat Flux Distribution (33/85)	A. Cuadrado	Aug.1985
R-36/85	Heliostat Flux Distribution (34/85)	A. Cuadrado	Aug.1985
R-37/85	Coordination of DMST Tests with the Evaluation of the DCS Fields in a Wide Range of Temperatures	M. Geyer	Sep.1985
R-38/85	Examination of the Important Measurement Devices used for the ASR High Flux Experiment	A. Brinner	Sep.1985
R-39/85	Calibration of the Measutement Level in the Sodium Storage Tnak	R. Carmona F. Blanco J.M. Aranda	Sep.1985
R-40/85	Heliostat Flux Distribution (35/85)	A. Cuadrado	Sep.1985
R-40/85	Heliostat Flux Distribution (36/85)	A. Cuadrado	Sep.1985
R-42/85	Heliostat Flux Distribution (37/85)	F. Blanco	Aug.1985
R-43/85	Receiver Thermal Energy Loss Experiment	A. Brinner	Sep.1985
R-44/85	DCS Partial Inspection	D. Jaeger	Oct.1985
R-45/85	Solar Availability of the ACUREX Field	M. Sánchez S. Gracia	Oct.1985
R-46/85	Calibration of the DCS-MAN 2 Field Pyrheliometer of 4.10.85	D. Jaeger	Oct.1985
R-47/85	Present Status of DCS Evaluation	R. Carmona	Oct.1985
R-48/85	Heliostat Flux Distribution (39/85)	A. Cuadrado	Oct.85
R-49/85	Heliostat Flux Distribution (40/85)	A. Cuadrado	Oct.1985
R-50/85	Heliostat Flux Distribution (41/85)	A. Cuadrado	Oct.1985
R-51/85	ASR Test Statics - 1 Aug.- 1 Oct.	H. Jacobs	Oct.1985
R-52/85	Heliostat Flux Distribution (42/85)	A. Cuadrado	Oct.1985
R-53/85	DCS Test and Evaluation Highligts 1985	R. Carmona	Oct.1985
R-52a/85	Continuation of Heliostat Flux Distribution (42/85)	A. Cuadrado	Oct.1985
R-58/85	Replacement of Radiometer # 7-Bar	M. Sánchez	Nov.1985

SSPS CRS/DCS INTERNAL REPORTS

Report N°.	Title	Author	Date
R-59/85	Energy of Solar Radiation. Application to the ACUREX Field	R. Carmona V. Ruiz	Nov.1985
R-60/85	Heliostat Flux Distribution (45/85)	F. Blanco	Nov.1985
R-61/85	Statistical Characterization of Direct Normal Solar Irradance Data on Site. Preliminary Results.	M. Blanco C.G. Camacho	Nov.1985
R-62/85	The Shadow Factor of the MAN-East and MAN-West Fields	M. Sánchez M. Blanco	Nov.1985
R-63/85	Heliostat Flux Distribution (47, 48, 49/85)	F. Blanco	Dec.1985
R-64/85	'ADQUISI FOR', A Computer Code to Read SSPS-DCS Tapes	E. Zarza	Dec.1985
R-1/86	Production of the Data Base for ASR Tests	H. Jacobs	Jan.1986
R-2/86	Manual of Processing and Storage of CRS Five-Minute Data Average	H. Jacobs	Jan.1986
R-3/86	CRS Evaluation Subroutines	H. Jacobs	Jan.1986
R-4/86	Systems Manager's Report	H. Jacobs	Jan.1986
R-5/86	Calibration of MAN I Pyrheliometer and Coverter 4-20 mA	J.M. Aranda	Feb.1986

SSPS CRS/DCS INTERNAL REPORTS

Report N°	Title	Author	Date
R-6/86	Checking of Drain and Vent Valves of the ASR and Emergency Defocus Modifications	J.M. Aranda	Feb.1986
R-7/86	Flux Distribution on the Sulzer Volu-Receiver	M. Silva	Feb.1986
R-8/86	Analisis del Polvo Sedimentable	J.M.Andújar	Feb.1986
R-9/86	Análisis del Polvo Sedimentable	J.M.Andújar	Mar.1986
R-10/86	Heliostat Flux Distribution (10/86)	A. Navarro	Mar.1986
R-11/86	Heliostat Flux Distribution (11/86)	A. Navarro	Mar.1986
R-12/86	Evaluation and Qualification of the HDF Bar	M. Silva	Mar.1986
R-13/86	Heliostat Flux Distribution (12/86)	A. Navarro	Mar.1986
R-14/86	Heliostat Flux Distribution (13/86)	A. Navarro	Mar.1986
R-15/86	HFD Modification for Connection to Fiberoptical Flux Measurement System (FOS)	J.M. Aranda	Apr.1986
R-16/86	Analisis del Polvo Sedimentable	J.M.Andújar	May.1986
R-17/86	Heliostat Flux Distribution (17/86)	A. Navarro	May.1986
R-18/86	Distance Measurements between the ASR and Three Reference Lines	M. Silva	May.1986
R-19/86	Maximum Daily Energy Collection by the ASR	M. Silva	May.1986
R-20/86	Mirror Corrosion and Heliostat Status	A. Valverde G. García	May.1986
R-21/86	Evaluation of Advanced Sodium Receiver Losses	R. Carmona	May.1986
R-22/86	Analisis del Polvo Sedimentable	J.M.Andújar	Jun.1986
R-23/86	Modifications of the Programs 'POLFIT' and 'GRAFI2' to Create 'POLGRA'	J.M.Aranda	Jun.1986
R-24/86	Data Recovery from HP-85 Data Cartridgs on Storage on the VAX	J.M.Aranda	Jun.1986
R-25/86	Flux Distributions for Different Beam Diameters of the Sulzer Volumetric Receiver	R. Carmona	Jun.1986

SSPS CRS/DCS INTERNAL REPORTS

Report N°	Title	Author	Date
R-26/86	Análisis del Polvo Sedimentable	J.M.Andújar	Jul.1986
R-27/86	Análisis del Polvo Sedimentable	J.M.Andújar	Jul.1986
R-28/86	Determinación de las causas del bloqueo en las líneas HC del CRS, en los cortes de red	J.M. Aranda J.A. Gonzá-lez	Aug.1986
R-29/86	Heliostat Flux Distribution (20/86)	A. Navarro	Aug.1986
R-30/86	Heliostat Flux Distribution (22/86)	A. Navarro	Aug.1986
TN-31/86	Improvement of the Absorptivity Measurement Procedure for Central Receiver Tubes		
R-32/86	Análisis del Polvo Sedimentable	J.M.Andújar	Aug.1986
R-33/86	Análisis del Polvo Sedimentable	J.M.Andújar	Sep.1986

SSPS CRS/DCS INTERNAL REPORTS

Report N°	Title	Author	Date
R-34/86	Location of the Wire Back Volumetric Receiver on the CRS Tower. Flux Distribution at the Aperture	M. Silva R. Carmona	Oct.1986
R-35/86	Colector GESA. Instalación, Ensayos y Evaluación	C. Peguero J.M. Aranda E. Zarza	Oct.1986
R-36/86	Thermodynamic Simulation of the ASR Using 'THERESA'	F. Rosa	Nov.1986
R-37/86	Calibration of Relevant Thermoelements in the DCS Fields	E. Zarza	Nov.1986
R-38/86	Status of DCS-DAS Analog Input Cards	E. Zarza	Nov.1986
R-39/86	IEA-SSPS Loss Tests by Complementary Heliostat Field Configurations	A. Becker	Nov.1986
R-40/86	Análisis del Polvo Sedimentable	J.M.Andújar	Nov.1986
R-41/86	Análisis del Polvo Sedimentable	J.M.Andújar	Nov.1986

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