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10 MWe Solar Central Receiver Pilot Plant Preoperational Readiness Review Meeting March 9-10, 1982 Barstow, California

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ABSTRACT

A Technical and Readiness Review Panel was convened in March 1982 to determine the readiness of the 10 MWe Pilot Plant for turbine roll and subsequent operational activities. On the basis of their review, the panel concluded that the Construction Phase is complete and that the plant is ready to begin the Test Operations Phase.

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10 MWe SOLAR CENTRAL RECEIVER PILOT PLANT
PREOPERATIONAL READINESS REVIEW MEETING

Executive Summary

The Department of Energy (DOE) and the Associates (composed of Southern California Edison Company which acts as principal, the Los Angeles Department of Water and Power, and the California Energy Commission) have entered into a Cooperative Agreement to design, construct, and operate a 10 MWe central receiver power plant near Barstow, California. The plant's purpose is to demonstrate the feasibility of an integrated solar thermal central receiver power plant as a viable source of renewable energy.

The Cooperative Agreement calls for a start-up and experimental test phase, which will provide operational experience in all the operational modes, measure plant performance, and establish stable, controlled operation of the Pilot Plant. This phase can be initiated after turbine roll has been safely achieved. "Turbine roll" refers to the generation from receiver steam of net electric power to the Southern California Edison (SCE) grid, in excess of the plant's parasitic load ($\sim$1.8 MWe).

The readiness of the 10 MWe Pilot Plant for turbine roll and for the initiation of the start-up and experimental test phase was reviewed and evaluated on March 9-10, 1982, by a Technical and Readiness Panel. Panel members represented the Department of Energy; the Associates; Sandia National Laboratories, Livermore, the lead laboratory for the project; and outside consultants having not only program experience but also technical experience in power plant construction, start-up, and operation. A list of panel members and invited observers is provided in Appendix A.

The review process covered the plant's physical and technical readiness to begin operations, SCE operator staffing and training, the DOE/SCE organization that will operate the plant, the test program, and the plan for test evaluation. (The meeting agenda is included in Appendix B.) The panel favorably noted the comprehensive acceptance testing that has taken place for the hardware and software of the subsystems and equipment; the extensive training of operators and maintenance personnel; the plans for the effective transition from construction activities to start-up to operation with (in many cases) the same experienced personnel; the detailed test planning documents; and the sound operational test management plan. On the basis of the presentations and subsequent discussions, the panel and observers unanimously reached the following conclusion:

> With the successful completion of the initial phase of the receiver steam generation test (Test 1030A), the 10 MWe Pilot Plant will be ready for safe turbine roll and initiation of the start-up and experimental test phase.

The panel cautioned, however, that achievement of turbine roll should not be interpreted to mean that the plant will be ready for routine power production. Considerable start-up testing and incorporation of additional control capabilities will remain to be done. A number of concerns were identified by the panel, but none was perceived to delay or prevent turbine roll. Section V, "Concerns," addresses these concerns and actions for their resolution.

This report presents an assessment of Pilot Plant readiness primarily "by exception"--following the summary of each presentation, the key questions that were raised by the panel members (and that were answered by the speakers) are listed. In the next section, the actions for resolving the major concerns are discussed. Finally, the report concludes with the panel's principal determination: with the completion of Test 1030A, the 10 MWe Pilot Plant will be ready to begin operation.

Introduction

The Department of Energy (DOE) convened a panel to assess the operational readiness of the 10 MWe Solar Central Receiver Pilot Plant on March 9-10, 1982, in Barstow, California. Located near Barstow in Daggett, the Pilot Plant will demonstrate the feasibility of an integrated solar thermal central receiver system as a viable source of renewable energy. Responsibility for the design, construction, and operation of the plant has been established through a Cooperative Agreement between DOE and the Associates (composed of the Southern California Edison Company, the Los Angeles Department of Water and Power, and the California Energy Commission).

The Pilot Plant consists of a field of 1818 computer-controlled mirrors (heliostats) that reflect the sun's energy to a tower-mounted receiver. At the receiver, water is converted into superheated steam. The plant is designed to generate 10 MWe net for delivery to the Southern California Edison (SCE) electric power grid with steam directly from the receiver (1465 psia and 950°F). When delivered to a thermal storage system, the steam is capable of driving the turbine-generator to produce 7 MWe net for a period of at least four hours.

By the end of September 1981, plant construction was essentially complete. Checkout of individual subsystems as well as correction of construction deficiencies have been underway since that time. A decision will now be made by DOE and the Associates to begin operational activities.

Panel Objective

The purpose of the panel was to assess and verify the readiness of the plant to begin operations. "Readiness" was defined as the capability of the physical plant, staffing, plans, management, and procedures to (1) achieve safe turbine roll for a limited time period, and (2) initiate the plant start-up and experimental test phase.

Panel Members and Responsibilities

The panel was composed of persons both from within and outside of the DOE Solar Central Receiver Program who have expertise in pertinent technical and management areas. Panelists were selected to represent many points of view. While some members had participated in the pilot plant project since its inception, others had been associated with it only during the early design phase. Several members were familiar with start-up procedures for conventional utility plants. Participants included mechanical design and control specialists, as well as people experienced with the start-up and operation of central receiver systems in the United States and Spain. A list of panel members appears in Appendix A.

Consisting of both a "technical" and a "readiness" (management) group, the panel deliberated and operated as a single body. Panel responsibilities were outlined as follows:

> Technical Group - "The Technical Group will assess the technical readiness of the plant for operation, emphasizing the completeness of construction, degree to which control systems have been checked out, and performance of the system and its components. The readiness of operating procedures, safety procedures, and thoroughness of test and evaluation plans will be assessed."
>
> Readiness Group - "The Readiness Group will assess the overall operational readiness of the 10 MWe Pilot Plant in terms of management, staffing, organizational interfaces, plans, procedures, policies, and schedules. In consultation with the Technical Group, the Readiness Group will prepare an advisory report to the management of DOE and SCE. The final DOE decision on operational readiness will be made by the DOE Under Secretary."

The panel reviewed detailed presentations of Pilot Plant objectives, construction activities, site checkouts, subsystem operations, operator training, staffing and training for operations and maintenance, DOE/SCE test organizations, operational testing plans, and safety plans. Issues relating to turbine roll, post-turbine roll, and the current conduct and status of the project were considered. The meeting agenda is contained in Appendix B.

Definitions

For the purposes of the meeting, the following definitions were accepted by the panel.

> Turbine Roll - Generation from receiver steam of net electric power to the grid, in excess of parasitic plant load ($\sim$ 1.8 MWe).
>
> Start-up and Experimental Test Phase - The period following turbine roll during which subsystem activation and checkout are completed; operational experience is provided in all the operational modes; plant performance is measured; and stable, controlled operation is established.
>
> Power Production Phase - Normal utility electric power production.

Plant Status Before Turbine Roll

"Status of Solar Facilities Construction"
R. N. Schweinberg, DOE/San Francisco Operations Office

Summary

All major plant equipment installation was completed in September 1981, and final construction punch list items/field changes will be complete by the end of March 1982. Start-up of the heliostat, receiver, electric power, and master control subsystems has progressed to the final stage in which heliostats are being focused on the receiver to produce steam in a controlled and safe manner. Completion of the line item construction project will occur when the turbine roll milestone is achieved. Turbine roll is targeted for the end of March 1982 but may extend into April if poor weather continues to affect start-up.

All financial resources required to complete construction of the Solar Facilities have been provided to the DOE/San Francisco Operations Office. The required manpower, equipment, and procedures are also available at the site.

Heliostats - Installation of all 1818 heliostats and associated controls was completed in September 1981. Final acceptance testing of the heliostat system was satisfactorily completed in December 1981. DOE has accepted the system from Martin Marietta Corporation (MMC) and turned it over to Southern California Edison operations. Closeout of the MMC contract, including assurance that all deliverables are complete, has been underway since mid-February 1982.

Receiver - Installation, preoperational checkout, and cold flow testing are complete. Receiver steam tests leading to turbine roll started in early February and will be complete in late March or early April depending on good weather.

Master Control - All control equipment has been installed in the remote field stations as well as in the central control room. Subsystem level control has been checked out and will be used to achieve turbine roll.

Thermal Storage - After construction of the thermal storage tank was completed, oil leakage from a bottom steel plate was discovered at the outside edge of the tank foundation. The leak was located by tunneling under the tank. Repairs are complete and the start-up activities, which had been on hold, are underway. Preoperational checkout is nearly complete and cold flow testing will begin this month. Thermal storage start-up is not on the critical path to turbine roll.

Beam Characterization - All equipment has been installed and system checkout is on-going. Heliostat preliminary alignment, done by MMC without the use of this system, is adequate to achieve turbine roll.

Solar Facilities Design Integrator - Detailed start-up procedures are being used at the site. Most site-construction-funded activities will be complete when turbine roll is achieved. Final contract deliverables, including as-built drawings, will be supplied by the end of May 1982. Configuration control of drawings and documents is being maintained at the site.

Construction Manager - With the completion of electrical and piping insulation punch list items/field changes at the end of March, all Townsend and Bottum subcontracts will be in closeout.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- Should turbine roll take place before 100% acceptance?
- Regarding as-built drawings, documentation, and supplier manuals, what will be delivered and when?
- Transitions from construction to start-up to operation are not clear. How will they take place?
- It is important to document the lessons learned during the construction phase.
- Why isn't DOE buyoff tied to performance? What were DOE's criteria?
- There is concern about heliostat failures. How will the heliostats be fixed, and who has responsibility for their repair?
- What is planned if auxiliary power is lost?

"Status of Turbine-Generator Facilities"
N. DeHaven, Southern California Edison

Summary

The start-up activities of the electric power generation system (EPGS) are portrayed on the EPGS start-up schedule. These activities have been grouped into various categories:

1. The steam system controls and instrumentation checkouts, which are complete and on schedule.

2. The checkouts of the turbine control systems, which are within a day of being on schedule. The only exception are those controls associated with the thermal storage system that are not involved with turbine roll.

3. The checkouts of the generator control systems, which are within a day of being on schedule. Items (1) and (2) will be complete by March 15.

4. Turbine roll activities, which are dependent upon the completion of Receiver 1030A tests.

Southern California Edison has three concerns relative to the readiness of the plant:

1. The lack of plant operational display capability will inhibit multimode operations after turbine roll.

2. The fast scan sequence recorder or first-out recording capability of the Data Acquisition System (DAS) should be on-line at the time of turbine operation.

3. The lack of spares to be provided by Department of Energy/Solar Facilities Design Integration contractors may compromise plant readiness if the right part is broken at the wrong time.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- With no master control, how difficult will it be to run the plant?
- Shouldn't plant status displays be incorporated before plant operation?
- How will the computers be maintained?
- Who is responsible for spare parts? What spares are needed, and where will the funding for them be derived?
- An oil detection system is needed.
- Regarding freeze protection, what is the lower limit of the present system?

"Start-up Status"
R. Gervais, McDonnell Douglas

Summary

This presentation reviews system and subsystem requirements to afford perspective of the start-up testing verification; focus is given to the receiver and plant control subsystems.

The overall start-up schedule is presented with emphasis on the receiver cold flow test (1010) and the receiver steam generation test (1030). The approach to start-up testing is also provided, acknowledging parallel construction completion and start-up testing activities. Specifically, the evolution of 102 separate systems from the construction piping and instrumentation diagrams (P&IDs) into the test procedures is discussed, followed by definition of the preoperational (intrasystem) and integrated (intersystem) tests. The status of the remaining thermal storage and beam characterization system preoperational tests, tests 205/250 and 150 respectively, is given with projected completion dates in mid-April. Both these activities are lower in priority to the ongoing receiver steam generation test (1030).

A more detailed treatise of the receiver cold flow test (1010) discusses the test activities and incurred problems (i.e., why 42 hours of testing required six weeks). An in-depth treatment of the receiver steam operation tests (1030A) also describes the test activities, principal flow paths, status, and incurred problems. The test 1030A description includes a brief explanation on receiver control, i.e., open, closed, and blended metal/steam temperature control. Results of recent closed loop controls testing are presented. For example, control system performance as a result of 20 and 40% flux changes (simulated clouds) on individual receiver panels proved excellent: the panel metal and steam outlet temperatures did not vary more than $\pm$ 7°F as a result of these disturbances. Similarly, a temperature ramp from 860°F to 620°F with six receiver boiler panels in simultaneous closed loop control exhibits excellent stability.

A description of the receiver steam operation tests to be conducted after turbine roll (test 1030B), which concentrates on the 1500 psig operating range as opposed to the 500-800 psig range of 1030A, is presented. Finally, the scope of the 1100 test series (Modes 1-8) that will be conducted subsequent to test 1030B is described.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- The present start-up schedule makes turbine roll inconsistent with conventional utility turbine roll. What is the meaning of operational readiness?

- What is the delivery schedule for documentation (especially software documentation)?
- Control terms should be defined more clearly. Terms used include subsystem manual, OCS manual, automatic manual, coordinated, and cascade.
- There is concern about the loss of the Uninterruptable Power Source, instrument air, and station power. Will tests be run to determine what will happen if a loss of any of these occurs?
- What kind of computer programming and maintenance capabilities does SCE have?
- What contract requirements exist for lessons learned documents?
- There is concern about knowledgeable personnel leaving the project.

"Collector Subsystem Status"
M. Frohardt, Martin Marietta

Summary

Martin Marietta Denver Aerospace installed and performed acceptance tests on the collector subsystem. This subsystem consisted of the Heliostat Array Controller in the control room and a field of 1818 heliostats. The collector subsystem has met all requirements, is functioning properly, and is ready for turbine roll. Since the collector subsystem was turned over to DOE on December 15, 1981, several hardware problems have occurred:

1. The TI-820 CPU console is in need of repair.
2. The magtape unit on ERIN is in need of repair.
3. The HAC/HCF redundant line operation should be tested. This is recommended because of a problem seen after the field wiring was modified for lightning protection.

During the full-field operational tests, 99%+ heliostats responded to the commands. This was much better than the 90% requirement.

Acceptance Testing - Testing was performed on component assemblies, individual heliostats, and the complete collector subsystem. The major tests are:

1. Heliostat On-Site Component Testing

2. Heliostat Site Acceptance Test

3. Collector Subsystem Acceptance Test

Field Status - From December 15, 1981, to March 2, 1982, a total of 65 heliostat malfunctions occurred. This represents 0.8 failures/day, which is less than the 1 failure/day predicted from our reliability analysis. Evaluation of these malfunctions showed that erroneous activation of the elevation axis limit switch was the largest contributor, with 20 malfunctions. The maintenance record should be monitored to verify that the adjustment to increase the clearance corrects the operation.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- The limit switch fix using bonded wheel weights is not adequate.
- Additional SCE training on maintenance is needed.
- SCE maintenance of heliostats should not be deferred until FY83 as is presently planned.
- A letter from Bodine on no-cost motor replacement should be obtained by DOE.
- What are the contract requirement for lessons learned documents?

Plant Status After Turbine Roll

"Evaluation Plans"
E. Cull, Sandia National Laboratories Livermore

Summary

The objectives of the evaluations that will be performed at Sandia National Laboratories (SNL) support the programmatic goals of the 10 MWe Central Receiver Pilot Plant.

Programmatic Goal - "... establish the technical feasibility of the plant and collect data for repowering..."

Evaluation Objectives -

1. Determine the steady-state efficiencies of the components and the complete plant, as a function of power level.

2. Determine the suitability of the control system to the transient solar operating conditions.

3. Determine the instantaneous and integrated energy production capability of the plant.

4. Compare the actual component and plant system performance with design predictions, and assess the suitability of the design and analysis techniques for other applications.

Programmatic Goal - "...obtain operating and maintenance data to determine system operational and economic characteristics..."

Evaluation Objectives -

1. Determine the availability and reliability of the plant and its components.

2. Determine the costs to operate and maintain the plant and its components.

3. Compare the actual operations and maintenance requirements and costs to those of conventional electric-utility-type plants.

The data necessary to support the performance evaluations will be obtained from the plant's Data Acquisition System (DAS). DAS data, after appropriate processing, will supply records of process variables and control element responses. The data necessary to support operational and economic evaluations will be obtained from SCE's operations and maintenance logs. When integrated with the power production records, the logs will supply the data necessary for reliability, availability, and cost evaluations.

Heliostats. Individually, specially instrumented heliostats will be evaluated to determine the structural response to wind loads. By means of the Beam Characterization System (BCS) and HELIOS, the tracking accuracy and beam quality will be evaluated to determine pedestal movement, control stability, and facet curvature changes with time and temperature. Soiling rates will be determined by monitoring rainfall and mirror reflectivity.

Heliostat Field. Field performance, efficiency, and power distribution on the receiver will be determined with HELIOS. HELIOS will use DAS data and the results of individual heliostat performance evaluations.

Receiver. The receiver's steady-state efficiency and losses (reflected, radiative, and convective) will be determined through a series of thermohydraulic models. The models use DAS process data

and the results of HELIOS heliostat field evaluations. The transient performance of the receiver and its control system will be evaluated with RELAP.

Thermal Storage. The performance of the storage tank and media will be evaluated with ENRFLOW. ENRFLOW accounts for the movement of the thermocline as well as the energy content of, and the energy losses from, the tank. It uses DAS and indirect data. The performance of charging and discharging heat exchanges (effectiveness, fouling factors, energy exchange rates) will be determined using HIRI models. The models use DAS process data. The transient performance of the thermal storage subsystem will be evaluated with RELAP.

Quasi-Steady State Plant Performance. The plant performance will be determined using SOLTES. SOLTES is capable of predicting system performance by means of actual or hypothetical set points. SOLTES will determine the thermodynamic process variables at subsystem interfaces and will trace energy flow from insolation to net electrical output.

Transient Plant Performance. The transient performance and behavior of the plants and its controls will be investigated with RELAP. RELAP will determine the thermodynamic conditions internal to each subsystem in response to control element disturbances. RELAP will use DAS data and the steady-state component models for initialization.

Operations and Maintenance. The SCE operations and maintenance activities and costs are being tracked. When integrated with plant power production records, the data will be used to identify the availability and the reliability of the plant and its major subsystems and components. The availability and costs to operate and maintain the plant will be compared with conventional and other solar electric plants.

Evaluation Reports. These will be issued by SNL and SCE according to the requirements set forth in the Data Dissemination Plan.

Evaluation Planning Status. The evaluation plan will be released in draft for comment in April 1982. The models and procedures for performance evaluations are nearly complete. The SCE operations and maintenance data are now being supplied to and evaluated by SNL on a limited basis.

Areas of Concern Identified By The Panel

The panel discussion of the presentation identified the following areas of concern:

- Spot checks with portable instrumentation should be performed on the electrical power generating system to verify General Electric heat balances.

° Several heliostats should be left in stow position during rains to serve as a reference for assessing the benefit of natural washing.

"Operations and Maintenance Planning"
C. Lopez, Southern California Edison

Summary

Administration - The station has installed a computer terminal in the warehouse/maintenance shop to take advantage of material and maintenance management programs contained within the main frame computers (located in SCE's General Office, Rosemead, California). The material management program, currently in service, allows automated ordering and receipt and maintains the local material inventory. The maintenance management program will allow automated scheduling of preventative maintenance services as well as breakdown repairs. This system will accumulate labor and material expenditures and will thus provide an equipment history file for the solar facility.

Operation - All operating positions have been filled, and the operators are operating all equipment systems. Presently, their primary activities include daily plant start-up and shutdown of all systems other than the turbine-generator set, implementing the plant's safety policy, monitoring equipment, and preparing operating instructions. Before their assignment to the control room, operators were trained primarily by McDonnell Douglas, Rocketdyne, Stearns-Roger, Martin Marietta, and SCE Design Engineers. This training was excellent, as evidenced by the operators' proven ability to run the plant on their initial assignment to the control room.

Maintenance - All but four maintenance positions have been filled. Two positions are in the process of being filled, and the remaining two positions will not be filled until the thermal storage system is activated. Presently, assigned maintenance personnel are maintaining operating systems and assisting in the start-up of the balance of plant systems. On their initial assignment to the station, maintenance personnel were trained by Design Engineers as well as by the microprocessor and computer supplier representatives. After their initial exposure to this plant equipment, additional training will be conducted to prepare technicians for detailed microprocessor repair. Contacts have been made to arrange for support maintenance of plant systems. Maintenance service agreements for plant analog and discrete logic control systems are in progress.

Safety - The site safety guidelines are defined within SCE's Accident Prevention Manual (APM) and a Pilot Plant Safety Plan. The APM

identifies general industry safety criteria appropriate to the power industry. The Safety Plan was jointly prepared by Sandia National Laboratories, Livermore, the McDonnell Douglas Corporation, and the Southern California Edison Company with the cooperation of other project participants to identify a safety policy unique to the Pilot Plant. Following preparation of the plan, safety training classes were conducted for all site personnel. Generally, the Safety Plan does not allow personnel within the collector field or receiver tower when heliostats are in transit. Personnel or work groups assigned to work in these areas are provided with either a transceiver or pager so that they have direct communication with the control room. Two warning devices (rotating amber lights to indicate "test in progress" and a warbling siren to indicate heliostats are going up or down their wire walks) have been installed.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- The lack of adequate spares for DOE-supplied equipment may cause delays, especially during start-up.
- Is the administrative escort system adequate to prevent unauthorized personnel from entering the heliostat field?
- The alarm that warns of heliostat field activation should be automatic rather than manual.

"Test Management"
D. Christian, DOE/San Francisco Operations Office

Summary

The management structure for the operational phase of the 10 MWe Pilot Plant is consistent with the general provisions of the Cooperative Agreement between DOE and the Associates. Responsibilities and authorities of the principals are summarized below:

DOE Headquarters, Division of Solar Thermal Technology (DOE/HQ) - As the sponsor for the Solar Central Receiver Program, DOE/HQ sets overall DOE policies with respect to operation and funding of the Pilot Plant.

DOE/San Francisco Operations Office (SAN) - SAN, on behalf of DOE/HQ, has overall control and is the DOE contracting organization for the

Cooperative Agreement. SAN prepares the overall Project Plan and the Operational Test Management Plan and, with Southern California Edison, approves the Test Operations Plan.

Southern California Edison (SCE) - SCE, acting for the Associates, is responsible for the safe operation and maintenance of the Pilot Plant. With SAN, SCE approves the Test Operations Plan.

Sandia National Laboratories, Livermore (SNLL) - SNLL, on behalf of SAN, is responsible for the technical management of the experimental test program. SNLL, using both in-house and subcontract resources, will ensure completion of the originally planned capabilities of the solar portion of the plant and will provide the technical capability for preparing and accomplishing the Test Operations Plan. SNLL will evaluate, interpret, and report test data in terms of overall Central Receiver Program needs.

Steering Committee - The Steering Committee consists of senior-level representatives from DOE/HQ, SAN, SCE, LADWP (Los Angeles Department of Water and Power), and SNLL (a nonvoting member). The Steering Committee periodically reviews the project's status and provides general guidance and advice. Working under the terms of the Cooperative Agreement, the Steering Committee acts as an appeals board for major policy or project issues.

Site Project Office - The Site Project Office is a joint SAN-SCE-SNLL office. It provides the day-to-day coordination and management necessary for planning, scheduling, and conducting plant operations and maintenance in accordance with the Test Operations Plan. The Site Project Office is responsible for keeping the project on schedule and within budget. The SCE operator has primary authority on matters of safety and day-to-day operations. DOE provides operational direction to SCE for accomplishment of the experimental test program through the Test Operations Plan.

The key operational control documents are described below:

1. Operational Test Management Plan (Prepared by SAN)

   Delineates the roles and responsibilities among the organizations that are needed to execute the operational testing of the plant.

2. Operational Test Requirements Document (Prepared by SNLL)

   Defines the program requirements and objectives for all tests to be performed.

3. Test Operations Plan (Prepared by SNLL)

   Contains the testing index, test objectives, and test specifications. Acts as the basis for the scheduling and sequencing of plant testing for a two-year period.

4. Test Procedures (Prepared by SNLL)

Contains detailed test specifications, operating instructions, and supplemental test information. Also addresses any special instructions if needed for specific tests.

Areas of Concern Identified by the Panel

The panel discussion of the presentation identified the following areas of concern:

- Who has the final authority in providing guidelines to the control room operators -- DOE or SCE?
- If plant management disagreements occur, how will they be resolved?

"Test Planning"
J. Bartel, Sandia National Laboratories Livermore

Summary

The purpose of this overview is to provide information on the start-up and testing of the Pilot Plant after turbine roll. Through calendar year 1982, start-up of all major systems (e.g., receiver, storage, collector, and turbine-generator set) will be individually tested to design points. Plant operational display capability will also be complete.

In 1983, major activities will focus upon implementing integrated system operation. Concurrently, collector modulation and automatic clear- and cloudy-day operation testing will begin.

Although the scope of this two-year experimental test phase has significantly changed, testing requirements which were set forth several years ago will be fully satisfied. (These testing requirements are outlined in SAND79-8037; a March 1982 rough draft was supplied to the panel.)

To support the test program, an automatic data acquisition system (DAS) is now operational. Nearly 2000 sensors, excluding spares, are available to report engineering information. Evaluation of such data is discussed in the summary by E. T. Cull.

Areas of Concern Identified By the Panel

The panel discussion of the presentation identified the following areas of concern:

- The Operational Control System should be incorporated into the 2-year experimental test phase as early as possible so that mode testing takes place with the control system in its final configuration.

- The test plan seems to include more time for mode testing than is really necessary. Is there "fat" in the schedule in terms of sequencing, test hours, and manpower assignments?

Concerns

Status Displays

Concern--The panel strongly supports the early development of plant displays. These displays will become increasingly important as plant capabilities and modes are checked out.

DOE Action--The need for status displays has been reviewed with SCE and the Solar Facilities Design Integrator (SFDI). In October 1981, the decision was made by DOE to develop status displays as soon as practical. A contract has been negotiated for their development, and a schedule that integrates the status displays into the overall test schedule will be forthcoming.

Operational Control System

Concern--Several panel members strongly recommend that the operational control system (OCS), which will provide automatic control capabilities for the four plant subsystems (collector, receiver, storage, and electrical power generation), be developed and tested as quickly as possible. The OCS will increase plant operability and may reduce the required number of SCE operators. Concern was expressed that much of the early mode testing will be completed before OCS software is written. However, it was also recognized that this will also aid software development.

DOE Action--The panel recommendation supports DOE's decision to incorporate OCS capability in FY83. In order to minimize the cost of developing the OCS, current plans are to prepare the OCS specifications after some operational experience is gained with subsystem manual operation. However, DOE will reexamine the schedule to determine whether any acceleration can be achieved without increasing cost. A meeting will be convened with concerned panel members, Sandia National Laboratories, McDonnell Douglas, and SCE to discuss possible technical approaches.

Plant Design Documents and Equipment Manuals

Concern--The panel recommends that a detailed listing and schedule be prepared for the design and maintenance documents to be delivered by the contractors. Of particular concern is documentation of the software developed by McDonnell Douglas (MDAC). MDAC should be required to deliver the software description documentation (Unit Development Folders) to DOE for all software developed under construction funding; MDAC currently plans to deliver these folders when they leave the site. The panel also recommends that the Solar Ten Megawatt Project Office (STMPO) insure the delivery of all vendor equipment manuals.

DOE Action--DOE agrees that the plant in its as-built configuration must be thoroughly documented and all equipment manuals must be provided. Much of the documentation has been delivered to DOE. A detailed listing has been provided by MDAC, the principal DOE contractor. Additional detail will be provided for software documentation.

Spare Parts

Concern--The panel was concerned that the current supply of spare parts seemed inadequate, especially at a time when "infant mortality" problems can occur. The responsibilities of SCE and DOE need to be more clearly defined.

DOE Action--The understanding between DOE and SCE regarding the delivery of spare parts does need clarification. DOE and SCE, with assistance from contractors, have prepared a list of spare parts.

Loss of Experienced People

Concern--The panel expressed concern with the potential loss of key technical people from the Pilot Plant. These concerns were related to the expected loss of contractor and STMPO personnel. The panel recommends that knowledgeable people be retained wherever appropriate.

DOE Action--DOE shares the panel's concern in this area and has taken steps to ensure the retention of key people. Although some people will inevitably be lost as a result of transfers and resignations, and other people will be lost because it is not economically practical (or even desirable) to retain the entire design and construction team, continuity will be maintained. MDAC, their subcontractors, and Martin Marietta were awarded contracts for support during start-up and experimental testing. Sandia National Laboratories, involved since the early conceptual designs, will also maintain personnel continuity. SCE began training their operators almost a year ago and will be using the same people during start-up and operation.

Documentation of Lessons Learned

Concern--The lessons learned from design, construction, and operation should be thoroughly documented and the results widely disseminated. Although STMPO is preparing a report on lessons learned during design and construction, the panel believes additional effort is needed and that each major construction contractor should be required to deliver a lessons learned report.

DOE Action--The lessons learned from the design and construction of the plant are being documented under the direction of the project manager; a report was issued in June 1982.

SCE Staffing for Software Modification

Concern--Because of the plant's complex control system, the panel recommends that SCE have some in-house capability to modify software. SCE should not be dependent on MDAC and other contractors for this service. Other utilities have found it desirable to have an in-house software capability.

DOE Action--SCE has made a conscious decision not to try to build an in-house capability for modifying control software. They plan to rely primarily on contractor support in this area, as they do for their conventional plants. However, SCE will review this decision based on the recommendations made by other utilities.

Safety

Concern--The panel expressed concern with some of the present personnel safety procedures at the site. The panel endorses the public address system that is being incorporated so that adequate warning can be given to clear the tower and heliostat field. It was also suggested that the existing siren be automated, thereby eliminating the need for its manual activation. Efforts to keep unauthorized and unescorted visitors out of the area should be strengthened.

DOE and SCE Action--Present safety policies at the 10 MWe Pilot Plant are consistent with SCE's normal practices as applied to a new technology. The current administrative escort procedures will be reviewed to determine whether improvements are necessary. It should be remembered that safety procedures must be consistent with operation of the facility as a power plant. The panel's recommendation to automate the warning system has been under consideration and will probably be implemented.

Oil Detection Monitor

Concern--The large quantities of oil in the thermal energy storage system increase the possibility of oil leaking into the water/steam system. Early detection of oil could prevent an extensive cleanup operation

if a leak occurred. The panel therefore recommends that SCE consider installing a system to continuously monitor the presence of small quantities of oil in the water/steam system. Apparently oil detection equipment is commercially available; an evaluation should be made of the cost, reliability, and ease of operation of such a system.

SCE Action--SCE agrees that a monitor to detect small quantities of oil in the water/steam system is desirable. However, a cost/benefit study must be conducted before a monitor is installed. The equipment has only recently become available, and the cost of its installation and operation must be balanced against the risk of having to perform a cleanup operation. SCE is conducting a study and expects to reach a conclusion by June 1982.

Motor Generator Backup for Station Power

Concern--The panel recommends that an additional backup to the 33 KV and 4 KV lines, which provide station power to the plant, be considered. Although the likelihood of both lines going out simultaneously is probably low, some concern was expressed about losing coolant flow in the receiver while the heliostats were delivering energy to the receiver.

DOE and SCE Action--Presently, the primary source of power for the plant is a 33 KV line connected to the SCE grid. Backup power is provided by a 4 KV line to the nearby Cool Water plant. A battery/inverter system provides the computers with an Uninterruptible Power System (UPS), but this will not provide sufficient power to stow the heliostats or operate cooling pumps if both main power lines fail. It is the judgment of DOE and SCE that the risk of simultaneous interruption of the 33 KV and 4 KV lines is sufficiently small that no auxiliary backup generator is necessary. However, an engineering test will be considered that demonstrates that loss of the 33KV and 4KV lines has no major consequences on plant equipment or operation.

Heliostat Limit Switches

Concern--The panel concluded that the heliostat limit switch fix proposed by Martin Marietta with bonded wheel weights should not be used. An alternate fix should be developed.

DOE Action--To date, the failure of heliostat limit switches is not a widespread problem. Since the heliostat field has been operating for only two to three months, the problem cannot yet be quantified. However, failure rate data will be collected during the next few months and a decision to modify all or part of the limit switches will then be made. DOE agrees that the fix using bonded weights is not adequate, but at least two alternates have been proposed. If a decision is made to modify the limit switches, the changes will be thoroughly tested before they are implemented.

Conclusions

Readiness for Turbine Roll

With the successful completion of the initial phase of the receiver steam generation test (Test 1030A), the Pilot Plant will be ready for turbine roll and initiation of the start-up and experimental test phase.

Interpretation of Turbine Roll

Achievement of turbine roll should not be interpreted to mean that the plant will be ready for routine power production. Considerable start-up testing and incorporation of additional control capabilities will remain to be done.

APPENDIX A. MEETING PARTICIPANTS

Preoperational Readiness Review Meeting
March 9-10, 1982

Chairman: W. W. Auer, Chief, Systems Test and Evaluation Branch

Panel Members

Technical Group

Chairman: A. C. Skinrood, Supervisor, Systems Evaluation Division, Sandia National Laboratories

G. M. Kaplan, Senior Systems Analyst, Meridian Corporation

W. C. Martin, Consulting Mechanical Engineer, Burns & McDonnell

J. R. Medearis, Assistant Mechanical Engineer, Los Angeles Department of Water and Power

C. R. Ortiz, CESA-1 Project Manager, Centro de Estudios de la Energia, Almeria, Spain

J. V. Otts, Central Receiver Test Facility Manager, Sandia National Laboratories

M. A. Soderstrand, Associate Professor & Vice Chairman
Dept. of Electrical and Computer Engineering
University of California, Davis

W. H. von KleinSmid, Supervisor, Research Engineering
Southern California Edison

K. D. Zammit, Mechanical Design Engineer, Los Angeles Department of Water and Power

Readiness Group

Chairman: R. W. Hughey, Director, Solar Energy Division, DOE/San Francisco Operations Office

J. E. Bigger, Project Manager, Solar Thermal Projects, Electric Power Research Institute

K. T. Cherian, 10 MWe Pilot Plant Program Manager, DOE/Headquarters

S. D. Elliott, 10 MWe Pilot Plant Program Manager (on site), Solar Energy Division, DOE/San Francisco Operations Office

J. N. Reeves, 10 MWe Pilot Plant Program Director, Southern California Edison

A. A. Smith, Manager of Engineering, Generation Plant Design, Southwestern Public Service

APPENDIX A. MEETING PARTICIPANTS (Cont'd)

Observers

H. D. Egge, Burns & McDonnell
J. K. Hartman, DOE/San Francisco Operations Office
P. Skvarna, Southern California Edison
P. N. Smith, Sandia National Laboratories
K. E. Wolfs, Burns & McDonnell

APPENDIX B. MEETING AGENDA

Preoperational Readiness Review Meeting

March 9, 1982

8:30 - 10:00	Closed session. Panel members convene, discuss objectives of review, and criteria for assessing readiness.
10:00 - 11:15	Status of Solar Facilities Construction, R. N. Schweinberg, Department of Energy, San Francisco Operations Office; J. Abrams, Townsend and Bottum
11:15 - 11:25	Panel Discussion
11:25 - 12:25	Status of Turbine-Generator Facilities, N. DeHaven, Southern California Edison
12:25 - 12:35	Panel Discussion
12:35 - 1:30	Lunch
1:30 - 4:00	Tour of Plant
4:00 - 5:00	Start-Up Status, R. Gervais, McDonnell Douglas
5:00 - 5:10	Panel Discussion
5:10 - 6:10	Collector Subsystem Status, M. Frohardt, Martin Marietta
6:10 - 6:20	Panel Discussion
6:20 - 7:20	Closed Session Panel Discussion

March 10, 1982

8:30 -10:00	Question and answer session with those making presentations on March 9 (attendance by request of panel).
10:00 -11:00	Evaluation Plans, E. Cull, Sandia National Laboratories, Livermore
11:00 -11:10	Panel Discussion
11:10 -11:40	Operations and Maintenance Planning, C. Lopez, Southern California Edison
11:40 -11:50	Panel Discussion

11:50 - 1:00	Lunch
1:00 - 1:15	Test Management, D. Christian, Department of Energy, San Francisco Operations Office
1:15 - 2:00	Test Planning, J. Bartel, Sandia National Laboratories, Livermore
2:00 - 2:10	Panel Discussion
2:10 - 4:30	Closed Session Panel Discussion
4:30 - 5:30	Question and answer session with those making presentations on March 10 (attendance by request of panel).
5:30 - 7:30	Closed Session Summary Panel Discussion

APPENDIX C. PREPARATORY MATERIALS

The documents listed below were sent to the panel members in preparation for the Preoperational Readiness Review Meeting.

Papers and Reports

1. "Project Plan (Rev. 2) For the 10 MWe Solar Thermal Central Receiver Pilot Plant." February 12, 1982.

2. "Receiver Steam Generation Testing (Test Series 1030A): Summary Test Description."

3. "Receiver Steam Generation Test (1030) Safety Policies." December 23, 1981.

4. Recommendations for the Conceptual Design of the Barstow, California, Solar Central Receiver Pilot Plant - Executive Summary. Sandia National Laboratories, SAND77-8035, October 1977.

5. Solar Facilities Design Integration: Pilot Plant Start-up and Acceptance Test Plan (RADL Item 2-46). McDonnell Douglas Astronautics Company, contract DE-AC03-79SF10499, SAN/0499-78 and MDC G9330, December 1980.

6. Solar Facilities Design Integration: Pilot Plant System Description (RADL Item 2-1). McDonnell Douglas Astronautics Company, contract DE-AC03-79SF10499, SAN/0499-57 and MDC G8544, December 1980.

7. Solar Facilities Design Integration: Solar One Plant Control Seminar. McDonnell Douglas Astronautics Company, contract DE-AC03-79SF10499, SAN/0499-79 and MDC G9362, February 25-26, 1981.

Piping and Instrumentation Diagrams (P&IDs)

8. Solar Facilities Design Integration: Integrated (Operational) Piping and Instrumentation Diagrams (RADL Item 2-38). McDonnell Douglas Astronautics Company, contract DE-AC03-79SF10499, SAN/0499-81 and MDC G9704, June 1981.

The following P&IDs are included in Reference 8:

9. "10 MWe Solar Pilot Plant Operational Piping and Instrument Diagram Composite--Receiver Subsystem." P&ID (P3-1200), June 5, 1981.

10. "10 MWe Solar Pilot Plant Operational Piping and Instrumentation Diagram Composite--Thermal Storage Subsystem." P&ID (P3-1300), June 5, 1981.

11. "10 MWe Solar Pilot Plant Composite Operational Piping and Instrument Diagram--Electrical Power Generation System." P&ID (P3-1900), June 5, 1981.

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