Sun♦Lab SnapShot

National Solar Thermal Test Facility Activities

Test capabilities into the new century

In support of the Department of Energy's Concentrating Solar Power (CSP) Program, Sandia National Laboratories and the National Renewable Energy Laboratory have combined their CSP programs into a single business unit called Sun♦Lab. One of Sun♦Lab's major facilities is the National Solar Thermal Test Facility (NSTTF) in Albuquerque, New Mexico. The list below describes current NSTTF activities as well upcoming and prospective activities.

Current Activities

DOE Programs

Thermocline Test - Thermal storage systems are an important part of solar thermal power plants. Thermal storage allows power to be dispatched, and tests of various systems are being conducted in an effort to improve the marketability of the technology. Two-tank molten-salt storage tanks have been evaluated in the past. In a thermocline molten-salt system, energy is stored in a single tank containing a filler material. Inexpensive filler material replaces more costly nitrate salt. Design and construction of a single-tank thermal storage system began in December 1999 with construction completed in September 2000. Checkout and testing began in mid September 2000 and should be completed by January 2001.

Hot Rocks Test - This test was designed to evaluate thermal cycling resilience of several different solid mediums exposed to liquid salt and to address the mechanical integrity of filler materials subjected to thermal shock that could be experienced in a thermocline storage tank. Thermal cycling tests were conducted where samples were held in a vessel and molten salt was passed through the samples from two tanks. The tests showed that quartzite and silica sand best held up to the cycling, are the most economical, and are more readily available than other materials tested. Design and construction of the test apparatus began in October 1999. Construction was completed December 1999 and testing began in February 2000. Accelerated testing for filler materials is now under way. More than 1,000 cycles on these materials have been conducted, which equates to three years of operation. The purpose of the current test is to record results of material for an equivalent of 30 years, and Sun♦Lab will continue testing until such results are obtained (approximately 11,000 cycles, or approximately one year of testing).

Remote Dish (Advanced Development Dish) - This project combines the best of the technologies of the dish/engine systems: a WG Associates dish,

The Remote Power System in operation at the NSTTF.

Concentrating Solar Power Program

Paneltec glass mirrors, and a Solo Stirling engine. This activity was initiated as a research and development (R&D) project; however, commercial interest has developed. We plan to install the first units at Indian reservations to obtain "real world" data and experiences. We are currently working on vibration reduction that is inherent in the engine due to the single power piston. Reducing vibration leads to longer lasting insulation packages and possibly lower noise levels. We routinely run the system to gather reliability and availability data. This ongoing R&D project began in October 1998.

Hybrid Receiver - The hybrid receiver project is aimed at developing a heat-pipe receiver that can be used in solar-only mode, natural gas-fired mode, or any combination of the two. A standard dome is used as the absorber for the solar flux, while an enclosed cylindrical pin-fin heat exchanger is used for the gas-fired portion. This technology will allow engines to be run continuously, in contrast to when only direct insolation is available. Full-scale design started in July 1998, and testing should start in mid 2001.

Full-Scale Wick Receivers - Heat-pipe receivers are under development at the NSTTF. This project consists of both bench-scale and full-scale designs and tests. Full-scale tests are performed on the test bed concentrators. In a sodium heat-pipe receiver, an evacuated vessel is made from two nested domes. A wick is bonded to the back of the solar receiver dome. The wick draws sodium across the absorber where it is evaporated by the solar input. Power is extracted through either gas-gap calorimeters or a heat engine. Sun♦Lab plans to interface these receivers to commercial Stirling engines in the future. This is an ongoing R&D project under continuous development since 1994.

Durability Sub-Scale Wick Receivers - This sub-scale test allows evaluation of various wicks in a vessel that simulates a section of a full-scale receiver. Simulated solar input is provided by quartz lamps, while a fan blowing cool air on the condenser section performs power extraction. Because these vessels are easier and cheaper to fabricate and can be operated 24 hours per day, much screening can be done before building a full-scale receiver. Design items tested include different wick designs, sintering techniques, and cleaning methods. This is an ongoing R&D project under continuous development since 1994.

Capsule Sub-Scale Wick Receivers - This sub-scale test allows Sun♦Lab to evaluate various wicks in a very simple heat-pipe vessel constructed from two concentric cylinders. Power input is provided by a quartz lamp, while power extraction is accomplished by passive convective and radiant cooling. Because power input is low, wick limits are not pressed in this test. However, much valuable material compatibility information has been gathered in these tests. We are currently running nine capsules with various wicks and cleaning methods. Several capsules have exceeded 20,000 hours. Some are still running, while others have been sectioned for analysis. This ongoing R&D project has been under continuous development since 1996.

AZTRAK Rotating Platform and High Temperature Fluid Loop Upgrades - The AZTRAK (AZimuthal TRAcKing) Rotating Platform system was originally designed and installed at Sandia during the early 1980s to enable more accurate and rapid thermal performance testing of parabolic concentrators. When a parabolic concentrator (or any other solar collecting device) is equipped with an elevation tracker and mounted on the rotating platform, the solar position of the collector can be continuously maintained at any desired orientation. The High-Temperature Fluid Loop was designed in conjunction with the AZTRAK system to supply heated fluid to the collector inlet, at steady-state fluid temperatures up to 375°C, to evaluate the thermal performance of a parabolic concentrator at system operating temperatures. Due to the limitations of the circa 1980s control technologies employed on both the AZTRAK and the high-temperature loop systems, an upgrade of the computer systems and controls is planned for FY01.

SEGS LS-2 trough undergoing test on Sandia's rotating platform.

Work For Others

VSHOT - The VSHOT is a laser-ray trace tool that measures the optical quality of solar concentrators. We are presently performing a feasibility study for the Ford Motor Co. Glass Division (Visteon) using the VSHOT to measure the shape of automobile glass coming off the assembly line. Testing for Ford should be complete in February2001; however, the VSHOT will be available for further testing for Ford or others.

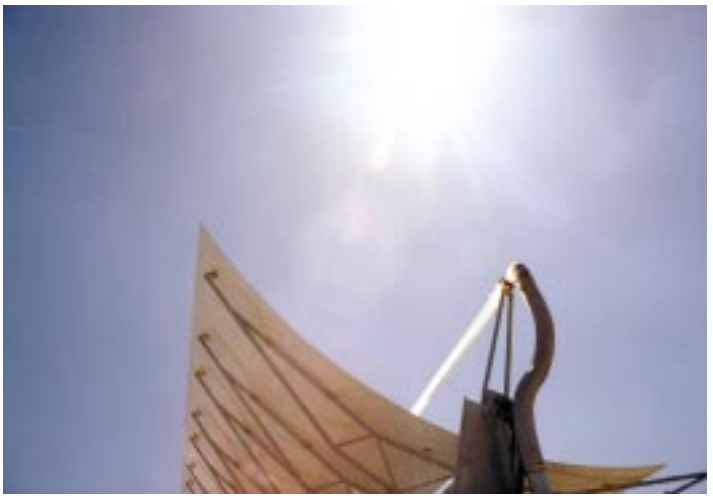
Applied Physics Laboratories - During recent flight tests, NATO Sea Sparrow missile radomes failed, and it is believed that thermal shock caused the failure. In

order to evaluate this failure mode, 10 of the radomes will be painted black and installed behind the NSTTF high-speed shutter located at a test bay in the solar tower. Up to 183 heliostats will be used to expose the radomes. Two exposures per day can be made, weather permitting.

To accommodate this urgent high-profile international program, staff at the NSTTF responded quickly. The Johns Hopkins University Applied Physics Laboratory contacted the NSTTF in early November, a work-for-others contract was put in place, equipment was delivered on December 4, the radome mount was lifted via the tower elevating module on the same day, and testing began December 8.

Cooperative Research and Development Agreement (CRADA)

Prototype Coating Process Development to Improve Durability of Trough Receiver Cermet Absorber Tubes - Using Sandia's proprietary sol-gel coating technologies, the in-air durability of cermet absorber tubes can be significantly improved. One of the most common heat collector element failures results from the rapid degradation of the cermet solar absorber coating when exposed to air at solar field operating temperatures. The owner and operator of Solar Electric Generating Stations (SEGS) 8 and 9, in Harper Lake, California, is interested in retrofitting the solar field with several hundred low-cost refurbished cermet receivers on an annual basis.



The LS-2 parabolic concentrator at Kramer Junction Operating Company under the noon day sun.

To simplify and reduce the capital cost of manufacturing refurbished cermet tubing, a customized coating die has been designed and fabricated at Sandia to allow the deposition and the controlled drying of a sol-gel protective layer onto the cermet tubing in one process step. The prototype coating process will be demonstrated at the NSTTF on several full-length cermet tubes with final protective coating evaluation in the SEGS 9 Florida Power & Light, Harper Lake (FPL-Harper Lake) solar field. FPL-Harper Lake will place protective glass envelopes around the sol-gel coated cermet tubes and will install the low-cost receiver into the solar field. The estimated cost of the sol-gel coated cermet tubing is less than $100. If the in-solar-field evaluation of the sol-gel coating is successful, this innovative coating process will be installed at Energy Laboratories, Inc., in Jacksonville, Florida, our CRADA partner in the development of solar absorber coatings.

User Facility Agreements

Astrophysics Experiments at the Solar Tower - Astrophysicists from a consortium of universities use the solar tower and heliostat field to conduct astrophysical experiments. These experiments use the heliostats at night to reflect showers of Cherenkov radiation to banks of photomultiplier tube cameras located at two of the test bays in the solar tower. They have had successful data collection during the past three years. The consortium has been awarded a three-year grant by the National Science Foundation to continue this work. The current campaign will extend through September 2001, but the experimenters plan to use the facility for viewing, about 15 nights per month, from September through May for the next three years.

Planned Activities

DOE Programs

Packed Downcomer - Existing power tower technology uses throttling valves to control and reduce the energy of the molten salt traveling down the downcomer from the receiver. These valves are of concern for several reasons, and this experiment will look at other alternatives for these valves. Ideas are being explored, such as packing the downcomer with material to absorb the energy and installing orifices throughout the downcomer. Design and construction should begin in January 2001 with testing starting by June 2001.

Salt Valve and Instrumentation Flow Loop - This experiment will evaluate several options for valves and pressure transducers. Existing power tower technology uses stainless steel valves with extended bonnets and special packing material where the packing techniques make the valve expensive. In addition, these valves have a long lead-time from ordering to receiving. The existing pressure transducer technology on the market has an upper operating temperature range of 400°F (the pressure transducers will not work on high temperature [565°F] molten-salt systems). Currently, several new valves and pressure transducer designs are being evaluated. Once evaluations are complete, valves and pressure transducers will be installed in a test loop and tested. Design should begin in December 2001, construction in March 2001, and tests in July 2001.

Level Detector - The existing level detectors are not reliable in high pressure, high temperature environments. Different designs and cost estimates will be evaluated. Initial discussions have begun. Once evaluations are complete, a test loop will be designed, constructed, and tested. Testing should be complete in September 2001.

Corrosion Test - Existing power tower technology uses 304 and 316 stainless steel that is susceptible to stress corrosion cracking. This test will evaluate other stainless steel. Initial discussion has begun and testing should begin in January 2001.

The NSTTF is an important resource for users and manufacturers of concentrating solar power systems. Manufacturers can use the facility to test new designs, ideas, and products.

Oven Covers - The existing oven covers for the receiver manifold allow an excessive amount of heat loss through the cover and receiver tube interface. This project will evaluate different materials and designs to enhance the oven performance and the interface material durability and performance. Initial discussions have started and design should begin in January 2001, construction in March 2001, and testing in June 2001.

Prospective Activities

Atmospheric Measurements Using the Heliostat Field - The capabilities of the NSTTF facilities meet the needs of the Air Force Research Laboratories (AFRL) at Kirtland Air Force Base. The AFRL will let the NSTTF know when it makes a determination; plans for the tests will be made at that time.

Air-Cooled Receiver Test for Atlantis Energie (Bern, Switzerland) - Atlantis Energie tested an air-cooled receiver at the NSTTF about 10 years ago and now plans to return with a larger receiver. The receiver uses quartz tubes with absorbers mounted inside. The air flows through the tubes and absorbers and is heated by the sunlight from the heliostats. The previous manufacturer of these tubes is no longer able to supply the tubes, so Atlantis is working with Quartz International in Albuquerque. Testing will be done at the NSTTF no sooner than the fall of 2001.

For on-line information about **Sun♦Lab,** please visit **http://www.eren.doe.gov/sunlab.** Information about the U.S. Department of Energy's Concentrating Solar Power Program can be found at **http://www.eren.doe.gov/csp.** Information about the Department's Solar Buildings Program can be found at **http://www.eren.doe.gov./solarbuildings/program.html**

For more information on renewable energy or for copies of this fact sheet, contact the Energy Efficiency and Renewable Energy Clearinghouse (EREC): 1-800-DOE-EREC (363-3732)

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