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SANDIA NATIONAL LABORATORIES

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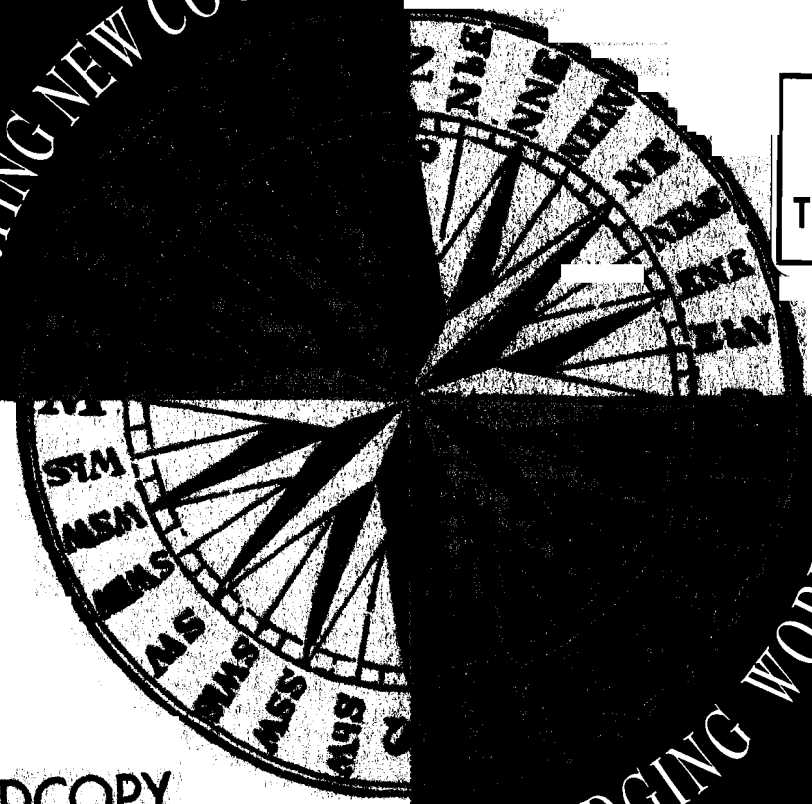
CHARTING NEW COURSES



BRIDGING WORLDS

RETAIN HARDCOPY

UNLIMITED

DEPARTMENT OF ENERGY

Sandia National Laboratories was born out of the nation's successful effort to harness nuclear power during World War II. Its mission was outlined by President Harry Truman decades ago, and it has remained the same through the years: exceptional service in the national interest. In 1949, Sandia became the nation's first advanced engineering research and development laboratory; at that time almost all of its work was defense related.

In the 1970s during the nation's energy crisis, Sandia began to apply its high-tech capabilities to energy. Renewable energy technologies were just being considered at this time both for satellites and for terrestrial uses, and the Laboratories tackled many complex problems associated with them, such as developing solar cells and solar arrays to produce electricity from sunlight, creating and testing specialized concentrating mirrors to produce intense heat and sophisticated lenses to focus sunlight, and developing egg-beater shaped vertical axis wind turbines and specialized drill bits to explore geothermal sources.

The practical needs of U.S. industry that could be addressed using state-of-the-art engineering became a Laboratories' priority during the 1980s, and Sandia increased its cooperative efforts to apply research and development to industry's concerns. This thrust has become the most important part of work being done at Sandia today, and the vitality of Sandia's science and engineering continues to be strengthened by research and development carried on across this multi-program facility, challenged by problems industry poses.

A philosophy of cooperation with industry sustains what has become a bridging of worlds—as Sandia links U.S. industry with the Laboratories' capabilities and with programs within the Department of Energy using mechanisms such as joint ventures, cooperative agreements, design assistance work, and formal cooperative research and development agreements. This philosophy of cooperation pervades and motivates the area of renewable energy at Sandia—the Laboratories' energy programs are designed to help U.S. industry develop technologies based on solar, wind, and geothermal resources that will become significant in the domestic and international arena.

Sandia focuses much of its outreach effort at electric utilities, demonstrating to these major suppliers of the world's electricity the merits of renewable energy technologies not only as supplemental energy supplies, but as customer options. Sandia also assists state and Federal agencies, international assistance organizations and other entities involved with providing services demanding power, advising and advocating use of renewables where they make sense.

Having charted the course toward new sources of energy and finding that they are reliable and clean, Sandia is now helping bridge understanding, acceptance, and sustainable use of these new environmentally benign technologies. Sandia's nearly two decades of staff experience with renewables coupled with its vast research and development base positions it ideally to find solutions to a variety of energy problems.

SANDIA'S RENEWABLE ENERGY PROGRAM ENCOMPASSES THE FOLLOWING TECHNOLOGIES:

PHOTOVOLTAICS The goal of this project is to develop cost-effective, reliable energy system technologies for energy supplies worldwide produced by U.S. industry. It encompasses cell research and development, collector development, technology evaluation, systems engineering, domestic and international applications, and design assistance.

Please contact Dave Hasti, 505-844-8161, for more information about technical or user support.

SOLAR THERMAL This project endeavors to develop and increase acceptance of solar thermal electric and industrial technologies as cost-competitive candidates for power generation and to promote their commercialization. Its major activities are with dish/Stirling systems, the Solar Two power tower, design assistance to industry and users, technology development and research activities.

Please contact Paul Klimas, 505-844-8159, for more information about technical or user support.

WIND The wind project impacts domestic and international markets with commercially feasible systems for utility-scale and other applications of wind energy. The project conducts applied research in aerodynamics, structural dynamics, fatigue, materials and controls, and engineering systems, and develops cooperative work with industry.

Please contact Henry Dodd, 505-844-5253, for more information about technical or user support.

GEOTHERMAL This project is developing technology to increase proven geothermal reserves and is assisting industry in expanding geothermal power on-line. Development work is in stemhole drilling, drilling techniques, instrumentation for geothermal wells, acoustic telemetry, and drilling exploratory wells.

Please contact Jim Dunn, 505-844-4715, for more information about technical or user support.

**For information on user assistance and the Design Assistance Center, please call Gary Jones, 505-844-2433.*

Solutions to Energy Problems

The following examples illustrate laboratory successes and appropriate and sustainable use of renewable technologies in a variety of situations, all of which show how Sandia's broad research base and philosophy of design assistance work together to bring creative solutions to energy problems.

Problem

Manufacturers of solar cells wanted to integrate low-cost multicrystalline silicon into photovoltaic cells.

Solution

Sandia organized a research cooperative to investigate multicrystalline silicon solar cells. Industry, Sandia, and the National Renewable Energy Laboratory are coordinating efforts to address the issue of improving the performance of multicrystalline silicon solar cells using high-temperature processes to remove impurities.

PROBLEM

A battery in the 100-amphour and larger size range capable of discharge in five hours was needed for applications with solar-powered generators and those requiring maintenance-free systems.

SOLUTION

Sandia worked with industry in a four-year co-funded program to develop a sealed starved electrolyte lead-acid battery for remote stand-alone energy storage applications. The outcome was a commercial product.

In related work, Sandia and another industrial partner developed a high-performance nickel-hydrogen battery for remote applications with a cost reduced by a factor of 30 over the baseline design.

PROBLEM

A major cost for wind farm operators is maintenance of the wind turbines. To be competitive with conventional sources of electricity, such as coal and oil, the cost for maintenance has to be reduced.

SOLUTION

In cooperation with private industry, Sandia developed an expert system to reduce the amount of time it takes to troubleshoot a faulty wind turbine. When a turbine is taken out of service, the expert system makes a diagnosis and gives a list of causes, in order of their priority, to field maintenance personnel.

PROBLEM

Wind turbines were failing at unexpectedly high rates when subjected to the fatigue loads of the turbulent winds. Fatigue analyses were greatly hampered by the lack of suitable fatigue characterizations for turbine materials.

SOLUTION

Sandia is working with U.S. industry to obtain samples of "as constructed" materials. The samples are being tested in a combined industry/university program to obtain a suitable data base for the fatigue analysis of turbines. In related work, Sandia developed a generalized computer code for the fatigue analysis of wind turbines and a model that simulates the turbulent input winds for the aerodynamic and structural analysis of wind turbines.

PROBLEM

Blades of wind turbines are susceptible to deterioration—and to a build up of foreign matter, such as dead bugs, both of which can adversely affect the performance of the turbine. Manufacturers and operators need to determine the cause(s) of reduced performance to be able to improve it.

SOLUTION

In cooperation with industry, Sandia developed a device that can measure precisely any change in a turbine blade's surface. By measuring dead bug build-up and blade deformities, Sandia can help in analyzing and improving the structure of wind turbine blades.

PROBLEM

The photovoltaic industry needs to be able to ensure that its components and systems meet certain standards for reliability and lifetime. Data for operating systems under varying conditions often is not readily available.

SOLUTION

Sandia developed evaluation procedures, such as module qualification tests, laboratory cell measurements, means to track the performance of fielded systems, and new charging algorithms and set-points for battery chargers to assist industry with evaluations.

PROBLEM

Utilities have to service customers even in remote locations where line extensions are not economical for the loads being served.

SOLUTION

Sandia is working with more than thirty utilities across the nation to develop and demonstrate photovoltaic systems that can supply electricity at a cost lower than line extension. Examples are water pumping for watering livestock and powering homes in remote areas.

PROBLEM

Many governments in less developed countries want to use renewable energy to improve the living conditions of their rural populations, but they often lack the information and infrastructure to carry out such projects.

SOLUTION

Sandia is working with international agencies in the United States and other countries to help implement projects that use renewable energy sources for power.

PROBLEM

In separate instances, commercial solar electric generating plants needed help 1) with reducing their operation and maintenance costs, 2) with learning the reasons for a rapid decrease in solar radiation in one geographic area, and 3) with averting problems caused to their systems by earthquakes.

SOLUTION

Sandia formed an on-going joint-venture partnership with one company to determine the root cause of operation and maintenance items and to improve them. 2) Sandia determined that the solar radiation had decreased 20 percent because of pollution in the air caused by a volcano and that the condition would improve within a few years. 3) Sandia used a finite-element analysis technique to analyze the structure of the systems damaged by earthquakes and recommended retrofits to mitigate against future damage.

PROBLEM

The owners of a solar industrial process heat system were having problems with maintenance and no longer knew how to monitor the system, which was less than 50 percent operational at the time.

SOLUTION

Sandia introduced the owners to new solar thermal technology developed under the Department of Energy program and showed them how to increase efficiency and improve its performance. It has been upgraded and is now 100 percent operational.

PROBLEM

Solar power towers seemed attractive to utilities for generating large amounts of electricity, but the pumps and valves associated with the newer molten-salt technology used to transfer heat in the system were relatively untested. Industry was unsure of how well the molten-salt system would work compared with a steam system, which was better known.

SOLUTION

Sandia used its National Solar Thermal Test Facility to test the molten-salt system and its components and helped develop a consortium of utilities, the Department of Energy, and Sandia to retrofit Solar One, a test power tower, into a utility-scale commercial power tower plant that uses molten salt.

PROBLEM

Various companies across the United States had pieces of expertise needed to put together dish-Stirling systems, but it was difficult to put all the pieces together to create and test this kind of a system, which seemed promising for intermediate power loads.

SOLUTION

Sandia arranged strategic teaming of all the organizations to bring together needed expertise. Sandia brought its own expertise in flux mapping to the team, which now works as part of a joint venture to commercialize dish-Stirling systems.

PROBLEM

It is much easier to complete and maintain geothermal wells if forming fractures can be located and casings can be inspected. However, borehole instruments used for this purpose in oil and gas wells will not work at the temperatures encountered in geothermal wells.

SOLUTION

A high-temperature borehole acoustic televiewer was developed in cooperation with industry. The televiewer has been tested extensively in high-temperature wells up to 300°C. In addition, a new feature was added to provide real-time color display of the borehole showing features of interest. The technology has been transferred to private industry to use in commercial systems.

PROBLEM

Early detection of high-pressure 'kicks' or loss of fluid circulation remain important problems during drilling operations.

SOLUTION

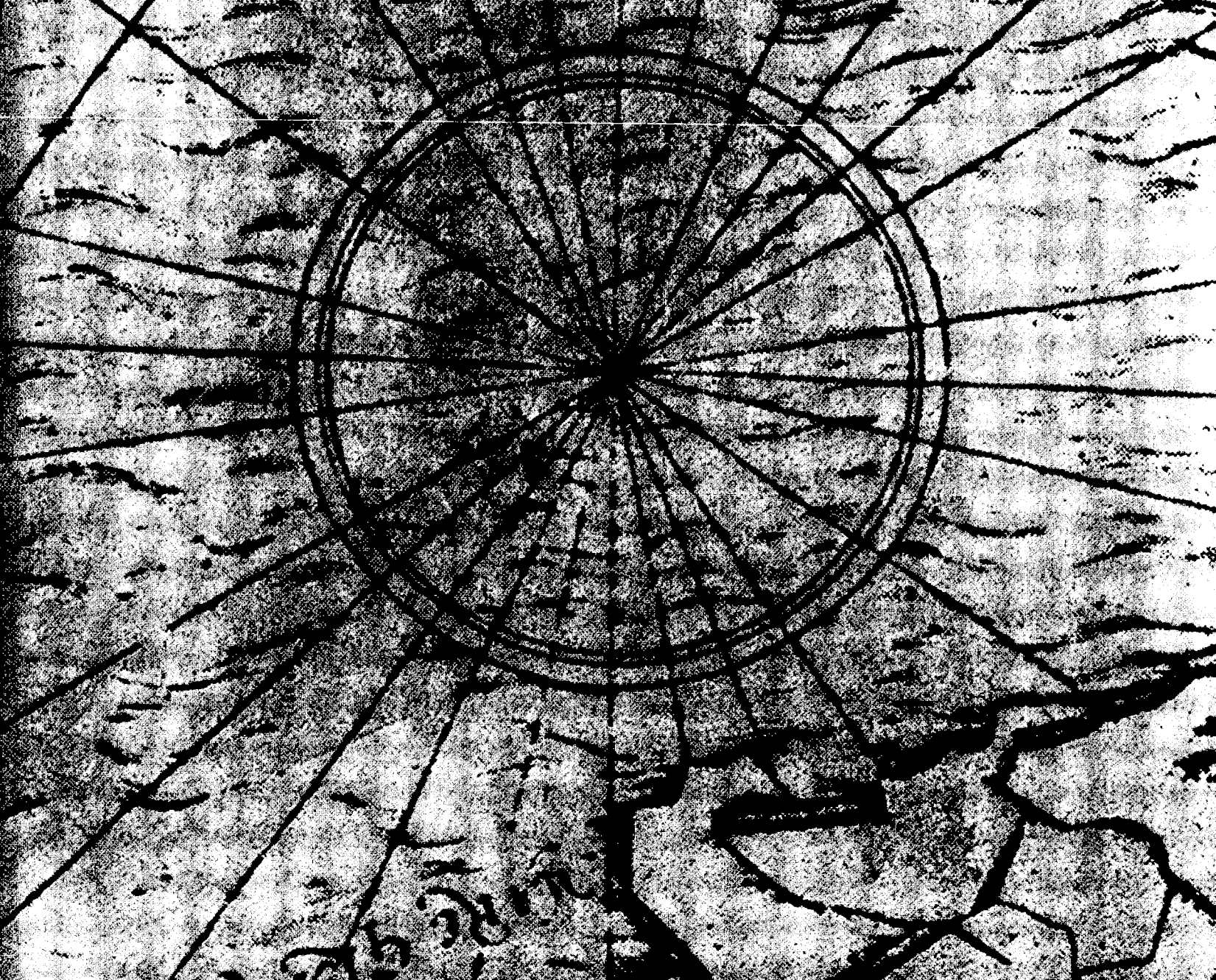
A new 'rolling float' meter was developed to accurately measure fluid flow rate in the mud return line. When compared with known mud inflow rates, the precision of the return flow measurement allows early warning of differences, thereby indicating kicks or lost circulation. The new rolling float meters have been proven both in the laboratory and in field drilling operations. Currently, seven prototype instruments are being evaluated by six drilling service companies.

PROBLEM

The bit performance and design criteria for polycrystalline diamond compact cutters for drilling rock were poorly understood, and they had been used since the 1970s.

SOLUTION

The cutter performance, wear mechanisms, and bit design criteria were established in an extensive program at Sandia that resulted in more than thirty technical reports and several years of bit testing. The technical information was combined in a computer code, PDCWEAR, developed to assist industry in the design and operation of its polycrystalline diamond compact bits. This code is used by several of the major bit companies to predict the performance and wear of their bits.



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