Instrumentation and Telemetry at Sandia National Laboratories

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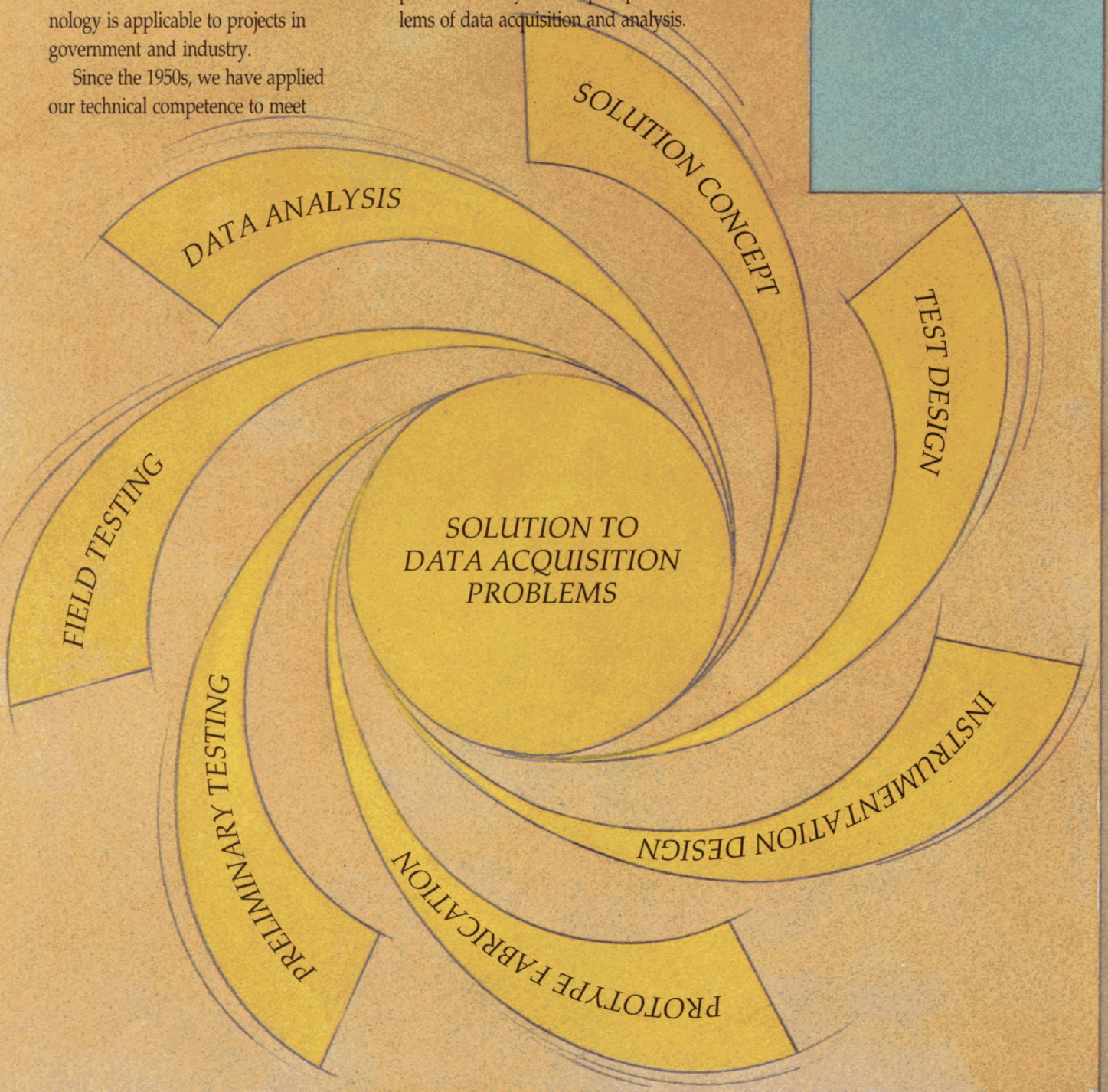
Front Cover: Sandia National Laboratories has fielded instrumentation and telemetry systems for data acquisition throughout the world as shown by the red dots on the map. The Albuquerque, New Mexico, facilities overlook the Sandia Mountains, so-named for the pinkish melon color (sandia is Spanish for watermelon) they acquire at dusk.

Instrumentation and Telemetry at Sandia National Laboratories

Sandia National Laboratories is a Department of Energy multiprogram engineering and scientific facility with unique design, development, and test capabilities arising from our work in nuclear weapons, energy resources, defense systems, nuclear safeguards, and specialized scientific endeavors. To support these programs, we have developed instrumentation and telemetry expertise not available elsewhere. This technology is applicable to projects in government and industry.

Since the 1950s, we have applied our technical competence to meet difficult challenges with innovative solutions to data acquisition and telemetry problems.

Sandia — with experience in fields as diverse as parachute design and plasma physics, geology and rocket guidance, human factors and high-speed aerodynamics, non-destructive testing and satellite communications — can use the power of synergism among our many disciplines to solve your complex problems of data acquisition and analysis.



Sandia National Laboratories Solves Difficult Data Acquisition Problems For Extreme Environments

With Expertise in...

- Advanced Telemetry Techniques
- High Data Rate Telemetry Design
- Specialized Electronics Packaging

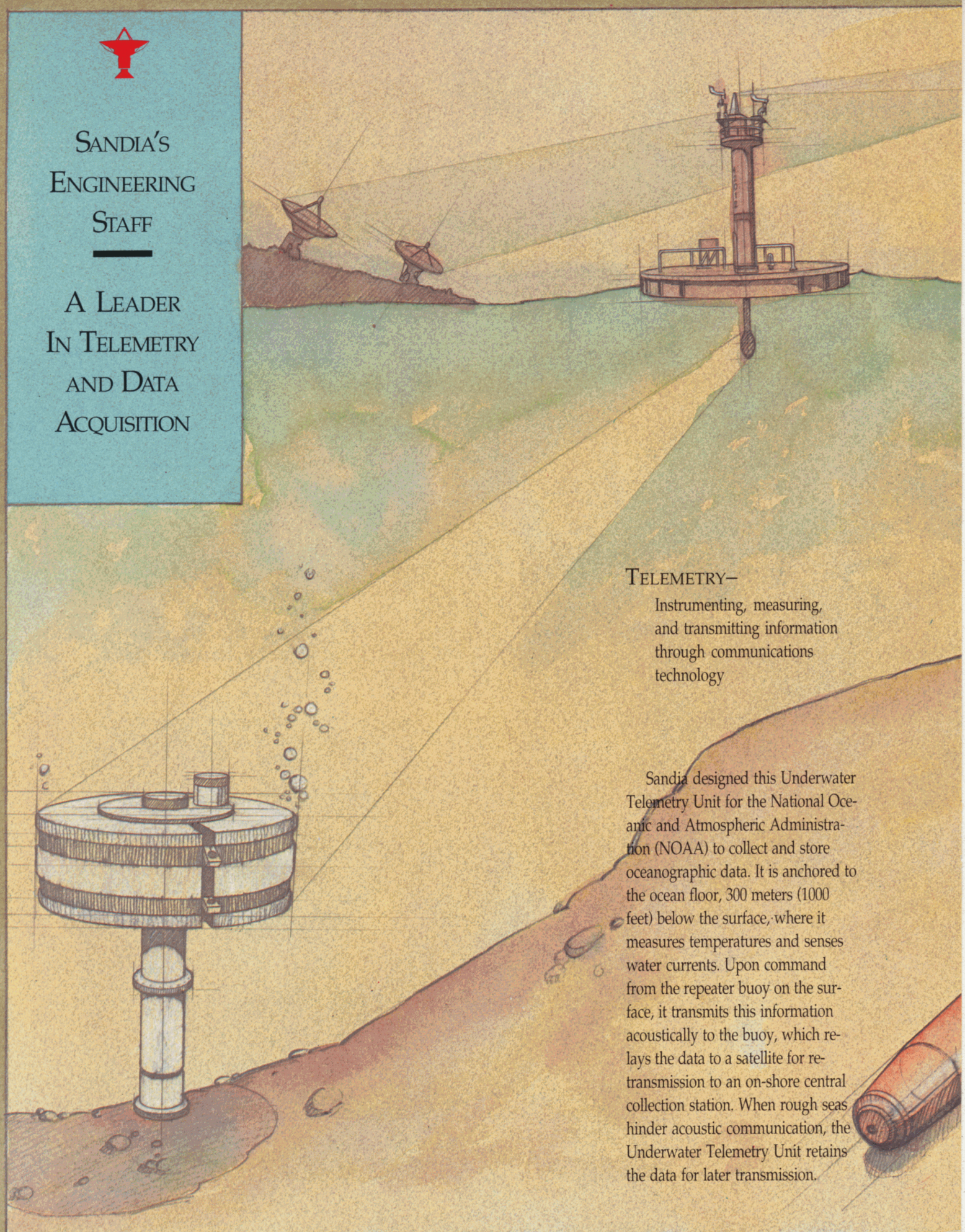
- MIL-STD-1553 Communications
- Instrumentation Development
- Real-Time Data Analysis

- Project Management
- Specialized Testers
- Data Encryption

For this crash test of a truck carrying a spent nuclear fuel cask, Sandia coordinated telemetry instrumentation and photometric documentation to provide comprehensive analysis of the test results.

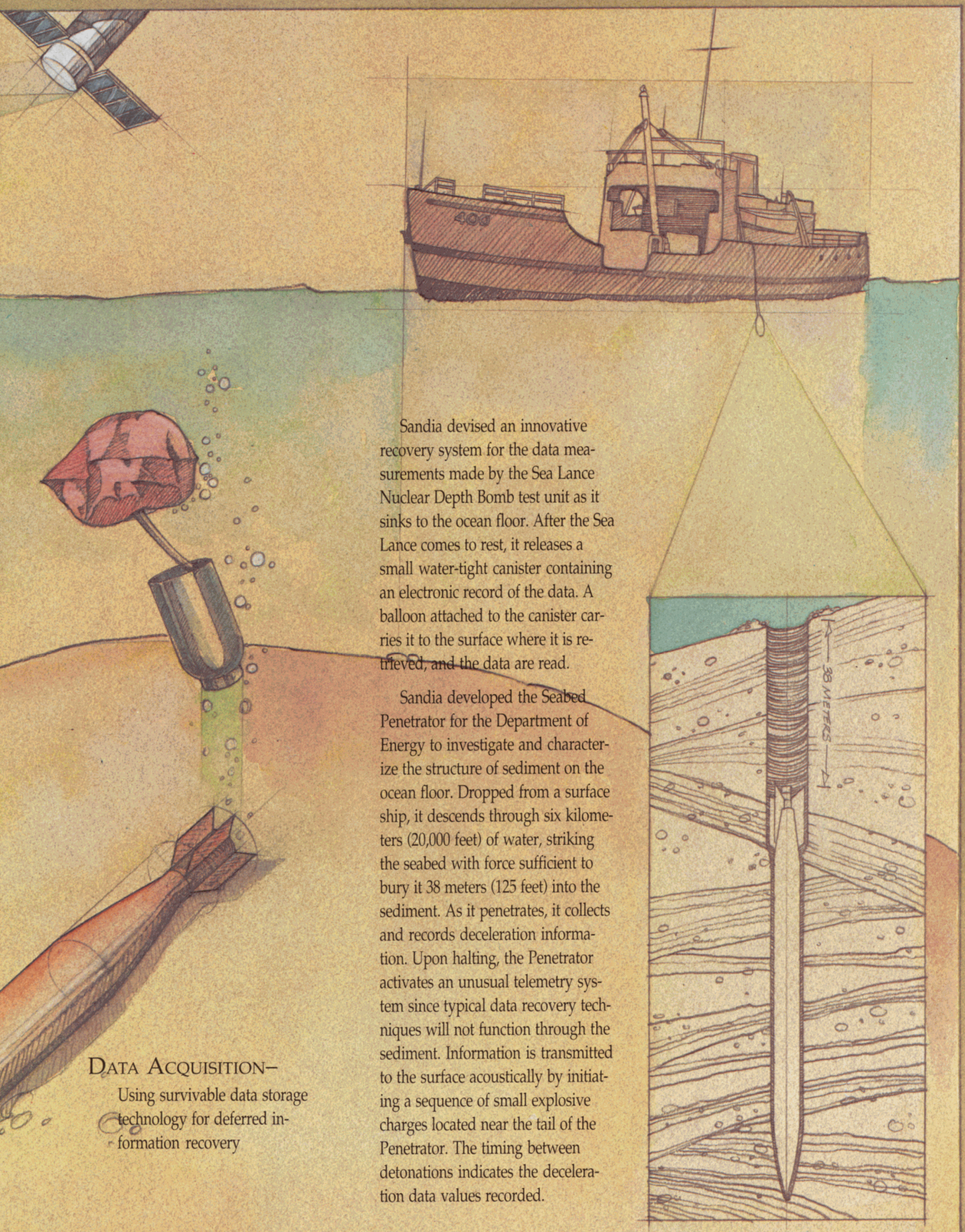
Sandia's Engineering Staff

A Leader In Telemetry and Data Acquisition



Telemetry—
Instrumenting, measuring, and transmitting information through communications technology

Sandia designed this Underwater Telemetry Unit for the National Oceanic and Atmospheric Administration (NOAA) to collect and store oceanographic data. It is anchored to the ocean floor, 300 meters (1000 feet) below the surface, where it measures temperatures and senses water currents. Upon command from the repeater buoy on the surface, it transmits this information acoustically to the buoy, which relays the data to a satellite for retransmission to an on-shore central collection station. When rough seas hinder acoustic communication, the Underwater Telemetry Unit retains the data for later transmission.



Data Acquisition—

Using survivable data storage technology for deferred information recovery

Sandia devised an innovative recovery system for the data measurements made by the Sea Lance Nuclear Depth Bomb test unit as it sinks to the ocean floor. After the Sea Lance comes to rest, it releases a small water-tight canister containing an electronic record of the data. A balloon attached to the canister carries it to the surface where it is retrieved, and the data are read.

Sandia developed the Seabed Penetrator for the Department of Energy to investigate and characterize the structure of sediment on the ocean floor. Dropped from a surface ship, it descends through six kilometers (20,000 feet) of water, striking the seabed with force sufficient to bury it 38 meters (125 feet) into the sediment. As it penetrates, it collects and records deceleration information. Upon halting, the Penetrator activates an unusual telemetry system since typical data recovery techniques will not function through the sediment. Information is transmitted to the surface acoustically by initiating a sequence of small explosive charges located near the tail of the Penetrator. The timing between detonations indicates the deceleration data values recorded.

Sandia Designs and Builds Instrumentation to Survive Re-entry and Float in the Air

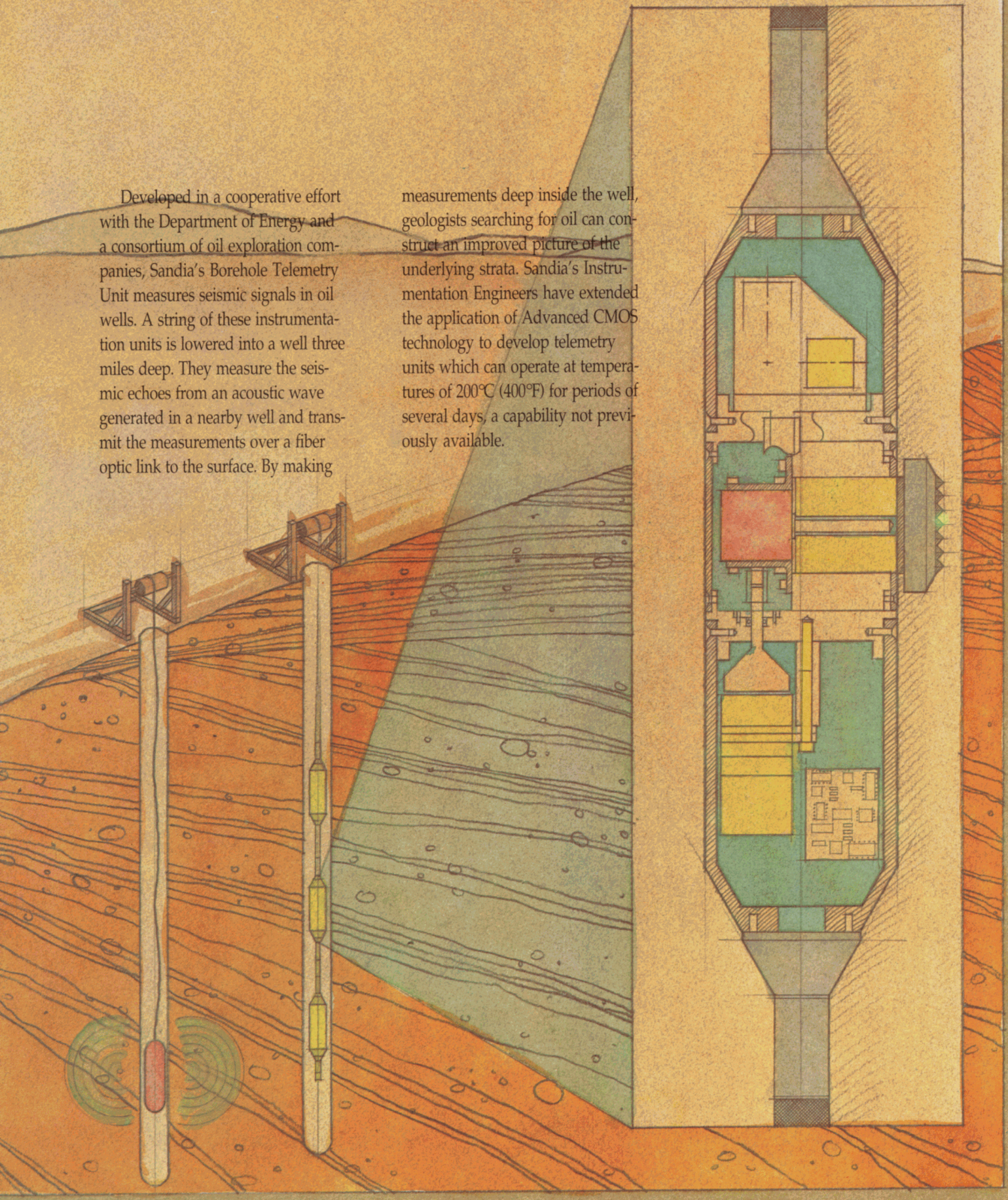
A long-range missile boosts this test unit equipped with a telemetry system. The system will survive severe stress during launch and atmospheric re-entry on its flight thousands of miles to the target. It transmits 25,000 data values every second, representing 200 different measurements. During the telemetry blackout phase while re-entering the atmosphere, special data processing techniques ensure that the measurements made are not lost. Even as the test unit is being crushed at impact, it will continue to transmit data.

A National Aeronautics and Space Administration (NASA) balloon 60 stories high lofts a gamma ray detection telescope 40 kilometers (130,000 feet) above the earth for stellar research seeking black holes. Sandia developed the telescope and specialized communications equipment, which must operate in temperature extremes from -65°C (-85° F) to 60°C (140°F), to control the telescope from the ground and transmit its measurements back to earth at the rate of 250,000 bits per second.

Sandia Designs and Builds Instrumentation to Penetrate the Earth and Function in Unusual, Severe Environments

Sandia's Earth Penetrator Projectile is fired from a special gun into hard rock at close range, experiencing forces exceeding 20,000 times that of gravity. Inside the Projectile, an extremely rugged electronics package called a Data Acquisition Unit measures and stores the shock data. After the Projectile is dug out, engineers use a portable computer to read and analyze the stored shock profile information.

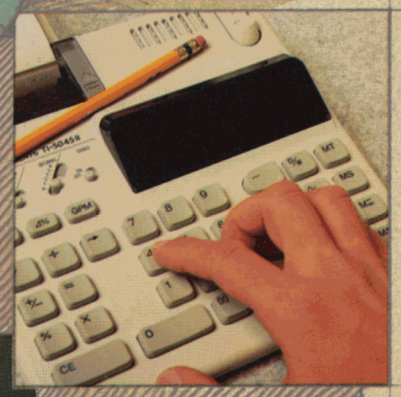
Developed in a cooperative effort with the Department of Energy and a consortium of oil exploration companies, Sandia's Borehole Telemetry Unit measures seismic signals in oil wells. A string of these instrumentation units is lowered into a well three miles deep. They measure the seismic echoes from an acoustic wave generated in a nearby well and transmit the measurements over a fiber optic link to the surface. By making measurements deep inside the well, geologists searching for oil can construct an improved picture of the underlying strata. Sandia's Instrumentation Engineers have extended the application of Advanced CMOS technology to develop telemetry units which can operate at temperatures of 200°C (400°F) for periods of several days, a capability not previously available.



Sandia Provides Comprehensive Project Management

Our Instrumentation Engineering Staff Can Provide Complete Project Services...

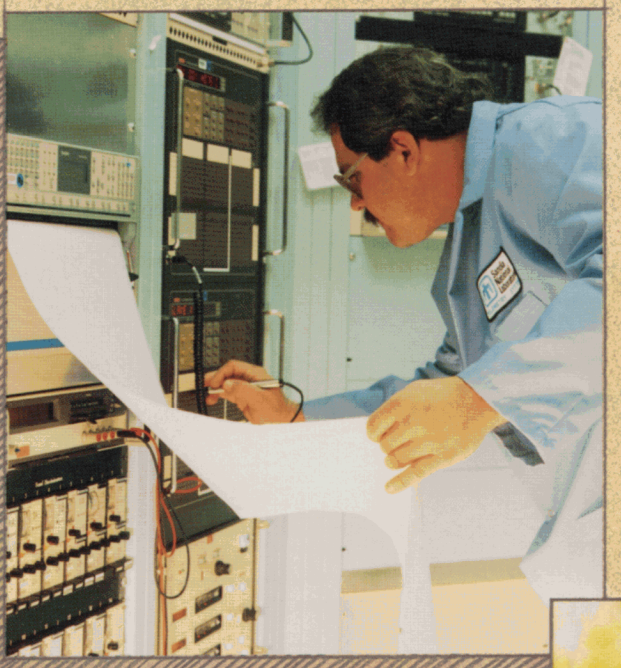
Defining Data Acquisition Requirements



Projecting Cost and Schedule Commitments

Designing and Developing Instrumentation

Fabricating Instrumentation

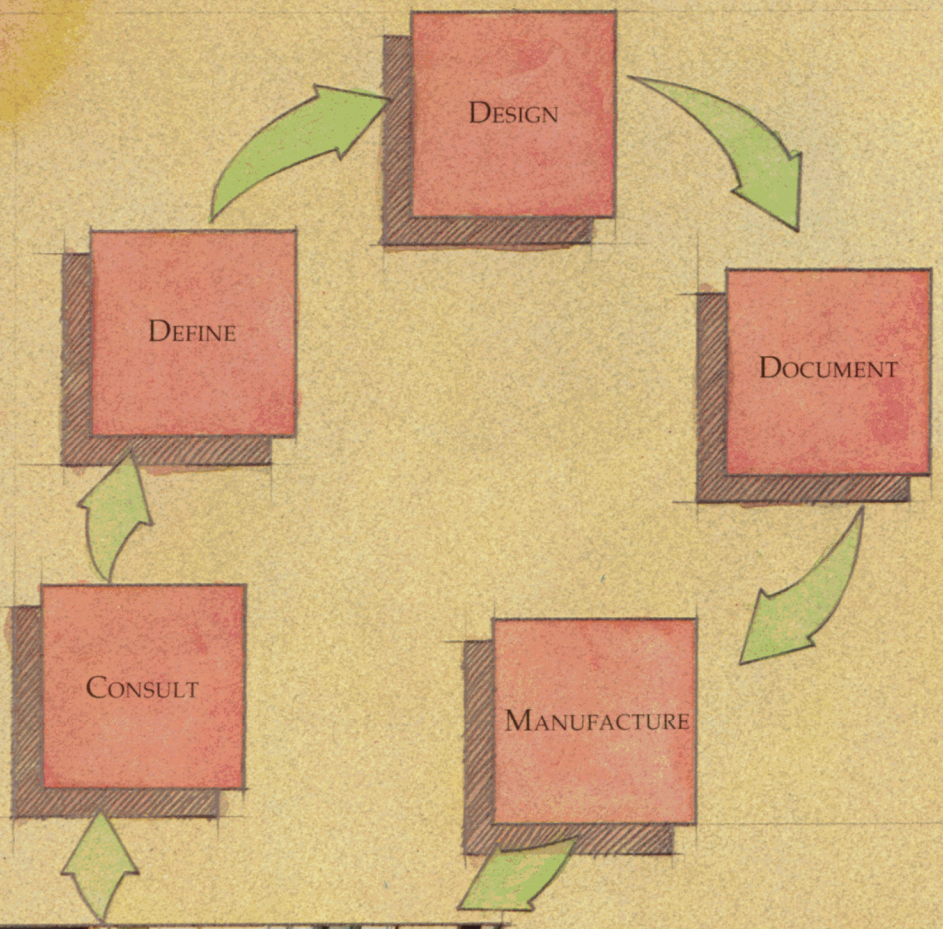


Delivering Processed Data to the Customer

Coordinating and Conducting Field Tests

Performing Laboratory Environmental Tests

Sandia Provides Comprehensive Commercial Component Qualification



Component Qualification Testing

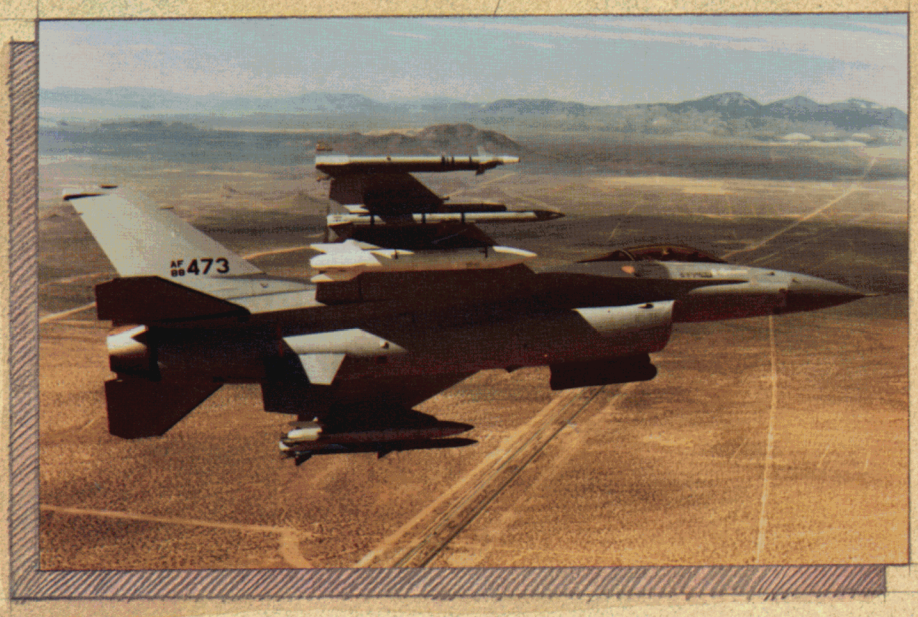
To reduce the cost of special electronic components for applications requiring very high reliability, Sandia's Instrumentation Engineers interact with the manufacturers of telemetry components to advance the technology and improve the quality of the components they supply. Specialized testers, such as this one developed by Sandia for telemetry transmitters, enable us to monitor the quality of the product, ensuring consistently high standards.

Transmitters
Encoders
Encryptors
Rate Gyroscopes
Transponders
Receivers
VCOs (Oscillators)

Products

Sandia Provides Specialized Tester Development

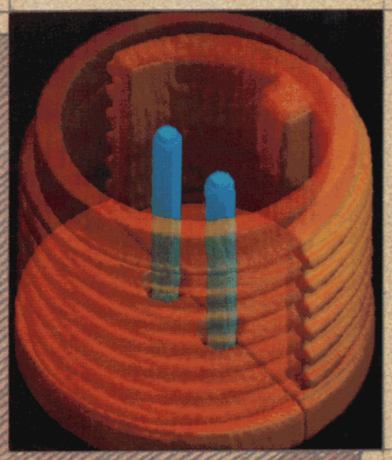
This portable tester emulates the MIL-STD-1553B protocol used by the B-2 military aircraft for communications with nuclear weapons. Since the tester can create the B-2 signal patterns, engineers who are developing specialized coding equipment for nuclear weapons can perform realistic tests without access to an actual aircraft.

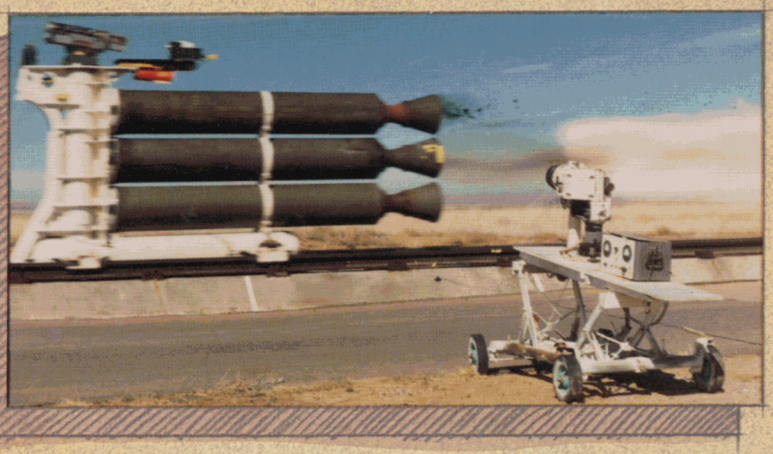


Sandia's Instrumentation Engineers, working with our experts in electromagnetic field theory, jointly designed the Electromagnetic Measurement System, which measures the radio frequency emanations from military aircraft in flight. The instrumentation is contained in a Measurement Test Pod in the shape of a nuclear weapon. Through our understanding of the compatibility between aircraft and weapons, we designed the Test Pod so that it exactly matches all physical and electrical characteristics of a weapon. This enables the aircraft, without being modified, to carry and control the Test Pod through its weapon control system.

Sandia Provides Unique Testing Facilities

Sandia's extensive Non-Destructive Testing capabilities include imaging with X-rays, gamma rays, neutrons, ultrasonic signals, and laser holometry. This photograph shows a Computer Tomography rendering (similar to a medical CAT scan) of an electrical connector.





This camera synchronizes the film motion with the movement of the image across the field of view to produce an extremely high-resolution photograph of a high-speed projectile. Sandia's extensive photographic capabilities range from schlieren photography to extoatmospheric videography, time-lapse motion pictures, and ultra-high-speed photography at a rate of 26,000,000 frames per second.

Above: Sandia's computer-controlled laser tracker systems provide high-accuracy tracking and range information for fast-moving targets. Coordinated cameras record simultaneous high-speed photographic coverage.

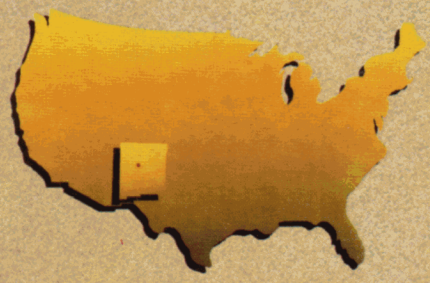
Below, Top: This centrifuge has the largest dynamic load capacity of any such machine in the United States. Its 8.9-meter (29-foot) arm can spin a 7200-kilogram (16,000 pound) load to simulate 100 times the force of gravity. Sandia has a wide range of other machines for testing up to 30,000 revolutions per minute.

Below, Center: The 5.8-meter (19-foot) Shock Tube provides controlled testing of blast effects. Coordinated electronic measurements and ultra-high-speed camera coverage are available.

Right: This controlled fire simulates a severe accident situation. Sandia has capabilities for thermal measurements, testing, and analysis. The Thermal Facilities include sites for climatic testing and high-temperature, high heat flux radiant-heat testing of large items.

Sandia National Laboratories

Sandia National Laboratories is operated for the U.S. Department of Energy (DOE) by a subsidiary of AT&T. We conduct comprehensive research, development, and testing activities in a wide range of fields. We employ more than 8,000 engineers, scientists, and support personnel at laboratories in Albuquerque, New Mexico, and Livermore, California, along with several remote sites for testing, including Tonopah, Nevada, and Kauai, Hawaii.



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