SANDIA REPORT

SAND97-0527 • UC-1302
Unlimited Release
Printed March 1997

Dish/Stirling for Department of Defense Applications Final Report

R. B. Diver, D. F. Menicucci

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-94AL85000

DoD EPA DOE SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

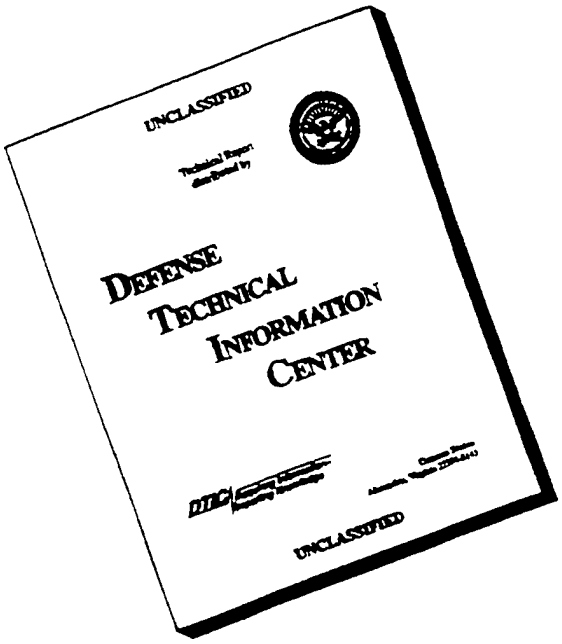
Available to DOE and DOE contractors from
Office of Scientific and Technical Information
PO Box 62
Oak Ridge, TN 37831

Prices available from (615) 576-8401, FTS 626-8401

Available to the public from
National Technical Information Service
US Department of Commerce
5285 Port Royal Rd
Springfield, VA 22161

NTIS price codes
Printed copy: A05
Microfiche copy: A01

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

REPORT DOCUMENTATION PAGE

OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1997	Final

4. TITLE AND SUBTITLE
Dish/Stirling for Department of Defense Applications Final Report

5. FUNDING NUMBERS

6. AUTHOR(S)
Richard B. Diver and David F. Menicucci

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Sandia National Laboratories
Solar Thermal Technology Department
P.O. Box 5800, MS 0703
Albuquerque, NM 87185

8. PERFORMING ORGANIZATION REPORT NUMBER
SAND 97-0527

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Strategic Environmental Research and Development Program
SERDP Support Office
8000 Westpark Drive, Suite 400
McLean, VA 22102 Attn: Mike Hathaway

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unlimited Release

12b. DISTRIBUTION CODE
UC-1302

13. ABSTRACT (M

This report describes a Strategic Environmental Research and Development Program (SERDP) project to field a dish/Stirling system at a southwestern U.S. military facility. This project entitled "Dish/Stirling for DoD Applications" was started in August 1993 and was completed in September 1996. The project's objective was to assist military facilities to field and evaluate emerging environmentally sound and potentially economical dish/Stirling technology. Dish/Stirling technology has the potential to produce electricity at competitive costs while at the same time providing a secure and environmentally benign source of power. In accordance with the SERDP charter, this project leveraged a U.S. Department of Energy (DOE) cost-shared project between Sandia National Laboratories and Cummins Power Generation, Inc. (CPG). CPG is a wholly owned subsidiary of Cummins Engine Company, a leading manufacturer of diesel engines. To accomplish this objective, the project called for the installation of a dish/Stirling system at a military facility to establish first-hand experience in the operation of a dish/Stirling system. To scope the potential DoD market for dish/Stirling technology and to identify the site for the demonstration, a survey of southwestern U.S. military facilities was also conducted. This report describes the project history, the Cummins dish/Stirling system, results from the military market survey, and the field test results.

14. SUBJECT TERMS
Dish/Stirling, solar energy, heat-pipe solar receiver, free-piston Stirling engine

15. NUMBER OF PAGES
81

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN

PLEASE CHECK THE APPROPRIATE BLOCK BELOW:

-AQ#M97-08-4879

☐ _____ copies are being forwarded. Indicate whether Statement A, B, C, D, E, F, or X applies.

☑ DISTRIBUTION STATEMENT A:
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

☐ DISTRIBUTION STATEMENT B:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT C:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND THEIR CONTRACTORS; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT D:
DISTRIBUTION AUTHORIZED TO DoD AND U.S. DoD CONTRACTORS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT E:
DISTRIBUTION AUTHORIZED TO DoD COMPONENTS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT F:
FURTHER DISSEMINATION ONLY AS DIRECTED BY (Indicate Controlling DoD Office and Date) or HIGHER DoD AUTHORITY.

☐ DISTRIBUTION STATEMENT X:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS OR ENTERPRISES ELIGIBLE TO OBTAIN EXPORT-CONTROLLED TECHNICAL DATA IN ACCORDANCE WITH DoD DIRECTIVE 5230.25, WITHHOLDING OF UNCLASSIFIED TECHNICAL DATA FROM PUBLIC DISCLOSURE, 6 Nov 1984 (Indicate date of determination). CONTROLLING DoD OFFICE IS (Indicate Controlling DoD Office).

☐ This document was previously forwarded to DTIC on _____ (date) and the AD number is _____.

☐ In accordance with provisions of DoD instructions, the document requested is not supplied because:

☐ It will be published at a later date. (Enter approximate date, if known).

☐ Other. (Give Reason)

DoD Directive 5230.24, "Distribution Statements on Technical Documents," 18 Mar 87, contains seven distribution statements, as described briefly above. Technical Documents must be assigned distribution statements.

Richard B Diver
Print or Type Name

Richard B Diver
Authorized Signature/Date

505 844-0195
Telephone Number

SAND97-0527
Unlimited Release
Printed March 1997

Distribution
Category UC-1302

Dish/Stirling for Department of Defense Applications Final Report

Richard B. Diver and David F. Menicucci
Energy and Environment Division
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0703

ABSTRACT

This report describes a Strategic Environmental Research and Development Program (SERDP) project to field a dish/Stirling system at a southwestern U.S. military facility. This project entitled "Dish/Stirling for DoD Applications" was started in August 1993 and was completed in September 1996. The project's objective was to assist military facilities to field and evaluate emerging environmentally sound and potentially economical dish/Stirling technology. Dish/Stirling technology has the potential to produce electricity at competitive costs while at the same time providing a secure and environmentally benign source of power. In accordance with the SERDP charter, this project leveraged a U.S. Department of Energy (DOE) cost-shared project between Sandia National Laboratories and Cummins Power Generation, Inc. (CPG). CPG is a wholly owned subsidiary of Cummins Engine Company, a leading manufacturer of diesel engines. To accomplish this objective, the project called for the installation of a dish/Stirling system at a military facility to establish first-hand experience in the operation of a dish/Stirling system. To scope the potential DoD market for dish/Stirling technology and to identify the site for the demonstration, a survey of southwestern U.S. military facilities was also conducted. This report describes the project history, the Cummins dish/Stirling system, results from the military market survey, and the field test results.

CONTENTS

FIGURES

TABLES

Project Background

The Strategic Environmental Research and Development Program (SERDP), enacted by Public Law 101-510 - November 5, 1990, is a cooperative program between the Department of Defense (DoD) and the Department of Energy (DOE) to identify and develop technology that will enhance the capability of the DoD and DOE to meet their environmental obligations. In response to this law, the DOE prepared a multi-disciplinary proposal for consideration by the SERDP council. One of the projects in the FY1992 DOE proposal was to support the demonstration of dish/Stirling technology at a DoD facility.

Dish/Stirling technology uses a sun-tracking system to concentrate solar energy onto a Stirling engine. This technology holds the record for conversion efficiency of sunlight to electricity of 29.4% and continues to show promise for producing low-cost electricity from the sun. Dish/Stirling technology development has been supported by DOE since the late 1970s and is described in detail in Stine and Diver (1994).

As part of the DOE Solar Thermal Program, in May 1991, DOE and Sandia National Laboratories (SNL) initiated the Dish/Stirling Joint Venture Program (DSJVP). The DSJVP was a 50/50 cost-shared joint venture contract with Cummins Power Generation, Inc. (CPG) with the objective to develop and commercialize a 5 to 10-kW_e dish/Stirling system for remote power markets. CPG is a wholly owned subsidiary of Cummins Engine Company, the world's largest manufacturer of diesel engines. CPG was formed to exploit the rapidly growing, environmentally benign power production market and to provide existing Cummins diesel-engine customers with a new product. The DSJVP goals and program plan are discussed in Bean and Diver (1992).

In FY92, DOE proposed the "Dish/Stirling for DoD Applications" project to the newly formed SERDP office. A copy of the DOE proposal is provided in Appendix A. The proposal was to field an additional DSJVP system at a southwestern U.S. military facility. A work for others proposal (Appendix B) was developed by Sandia National Laboratories for DOE during the summer of 1993, and authorized on August 13, 1993 (Appendix C).

Because of delays with the advanced components used in the Cummins system, specifically the free-piston Stirling engine, the system installation was delayed and results did not meet expectations. The solar concentrator was installed at the Ft. Huachuca, AZ site during October 1995, and the engine was installed during January 1996. A photograph of the system operating at the Ft. Huachuca, AZ test site is shown in Figure 1.

The following provides details on the project and the test results. Additional documentation is referred to in the appendices that follow.

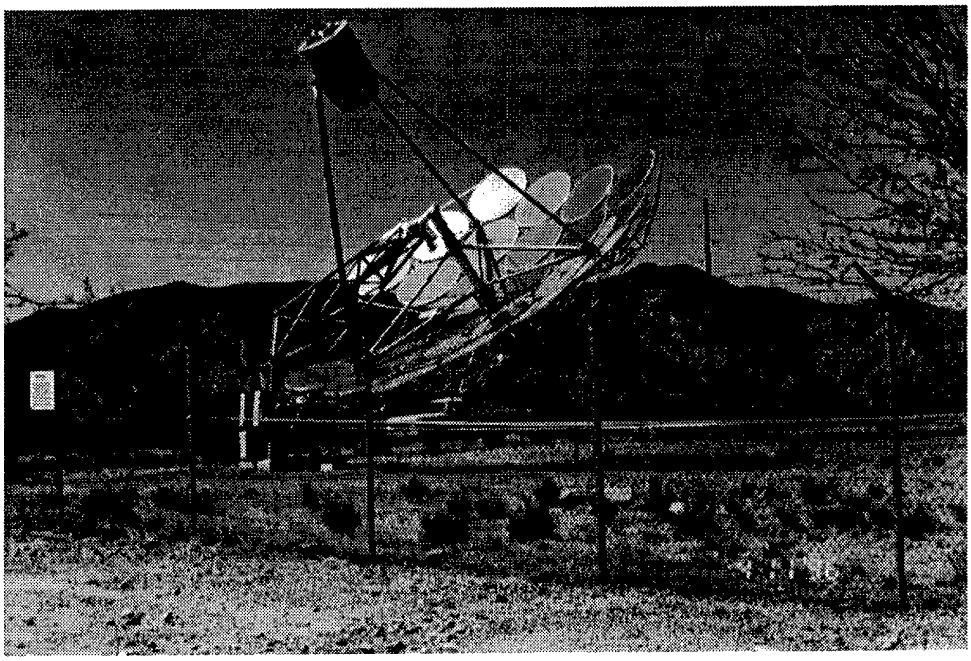


Figure 1. Photograph of the CPG dish/Stirling system operating on-sun at the Ft. Huachuca JITC test site.

Technology

The CPG dish/Stirling system makes use of advanced components that promise to be lower in cost and/or more reliable than components used in other dish/Stirling systems. A low-cost, faceted, stretched-membrane solar concentrator is used to focus the sun's rays onto a heat-pipe receiver. The heat-pipe receiver uses two-phase sodium to isothermally transfer heat to the heater tubes of a free-piston Stirling engine/linear alternator. The free-piston Stirling engine/linear alternator can be hermetically sealed and has only two moving parts, making it a potentially long-lived and reliable component.

In normal operation, the concentrator tracks the sun in two axes and focuses sunlight through the aperture of the heat-pipe receiver. The heat-pipe receiver serves as a thermal buffer to the engine's heater head and provides an isothermal temperature distribution through condensation of sodium on the heater-head tubes. The free-piston Stirling engine converts the thermal energy into mechanical energy, and the linear alternator converts the mechanical energy into single-phase AC power. Power conditioning hardware regulates and conditions the electrical energy. Waste heat from the engine is transferred to the atmosphere by the cooling system. Automatic start-up, operation, and system protection features are provided by the system controller. System components and technical issues are described in detail in Bean and Diver (1993, 1995).

The Cummins Power Generation, Inc. CPG-460 solar concentrator uses a geodesic, space-frame mirror support structure; a diurnal (polar axis) drive, pivoted near the center of gravity

of the tracking structure; and stretched-membrane, aluminized, polymer-film mirror facets. The concentrator has a diameter of approximately 33 feet and consists of 24 stretched-membrane mirror facets, each 5 feet in diameter. Each facet consists of an edge-supported, aluminized polyethylene terephthalate (PET) film on both the front and rear. Focus of the mirrors is maintained by a small vacuum in the cavity between the two films. The correct mirror curvature is provided by a tube mounted to the rear membrane that modulates flow by closing against the front membrane. Emergency defocus of the system is accomplished by venting the mirror cavity to atmosphere.

To provide thermal energy to the heater tubes of the Stirling engine in a uniform, efficient manner, a heat pipe receiver serves as a buffer between the solar concentrator and the Stirling engine. The heat pipe receiver transfers heat by evaporating sodium from the backside of a 16.3-inch diameter hemispherical solar absorber surface and condensing it on the heater head tubes of the Stirling engine. The liquid sodium is returned to the absorber by both gravity (refluxing) and preferentially-located liquid return ducts and is distributed over the absorber by capillary forces in the sintered nickel-powder wick. To operate properly, only sodium can be present inside the hermetically sealed vacuum vessel. At normal operating conditions, 675°C, the sodium vapor pressure inside the receiver is approximately 0.1 atmospheres. At lower temperatures, a hard vacuum exists inside the cavity. A schematic showing the heat-pipe receiver and free-piston Stirling engine is shown in Figure 2.

The free-piston Stirling engine was designed by Clever Fellows Innovation Consortium (CFIC) of Troy, NY and uses two opposed displacer/power piston/ linear alternators, Figure 2. In the CFIC free-piston Stirling engine, high pressure helium working fluid is alternatively heated in the heater head (by condensing liquid sodium provided by the heat pipe receiver) and cooled in the cooler. A foil regenerator, located between the heater and cooler, alternatively stores and liberates heat to the helium and is a key to high thermal efficiency. As the name free-piston Stirling engine implies, both the power piston and the displacer piston are free to move back and forth. Their relative motion is determined by their dynamics, which to a large extent are determined by springs. In this engine, the power piston springs are suspension straps and the displacer piston springs are coil springs. The power piston carries permanent magnets, which pass through coils in the alternator and produce electric power.

Project Scope

In accordance with the overall SERDP objectives, the Dish/Stirling for DoD Applications project was intended to assist military facilities to field and evaluate emerging environmentally sound and potentially economical dish/Stirling technology. The technology has the potential to produce electricity at competitive costs while at the same time providing a secure and environmentally benign source of power. To accomplish this objective, the project called for the establishment, at a military facility, first-hand experience in the operation of a dish/Stirling system. To scope the potential DoD market for dish/Stirling technology and to identify the site for the demonstration, a survey of southwestern U.S. military facilities was also conducted.

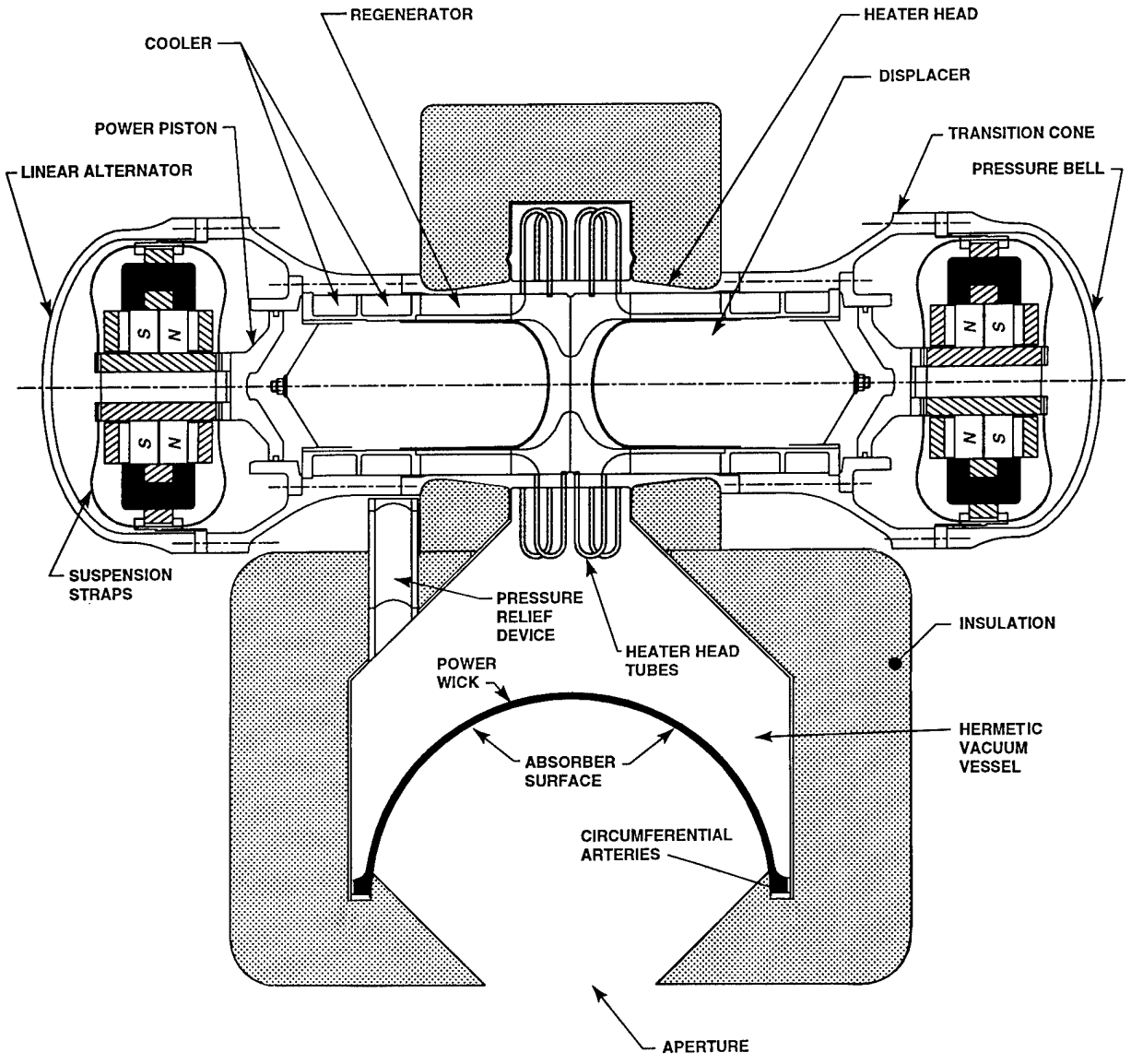


Figure 2. Schematic of the CFIC free-piston Stirling engine and heat-pipe receiver.

The work was divided into three tasks. The original project work plan can be found in Appendix B.

Task 1 - Facility Selection: Identify and select a DoD facility for installation of a dish/Stirling system. Assess the DoD market for dish/Stirling technology.

Task 2 - Hardware Installation: Prepare the site and install a CPG 7.5-kW_e dish/Stirling system.

Task 3 - Application Validation: Train DoD personnel in system operation and verify performance. Provide maintenance support over the first year of operation.

Project Summary

Task 1 Facility Selection.

Through this task, candidate sites were identified and evaluated. In selecting the DoD test site, facilities were limited to the southwestern United States with direct normal solar insolation levels of 6 $kWh/m^2/day$ (annual average). Other section criteria included military installations in remote areas where electricity is expensive (i.e., over $0.10/kWh) or where electricity is currently produced on-site by diesel or gas generators. Military facilities that appear to have a stable mission, a continuing need for electricity, and which have available land for a large-scale dish/Stirling facility were favorably rated. The military facility selection was also based on demonstrated support for other renewable energy projects and the level of facility cost sharing proposed for this project. Based on information from the solicitation, interviews, site visits, and other surveys, a market assessment of DoD installations was conducted. As a result of this process, Ft. Huachuca, AZ was selected as a candidate for the SERDP dish/Stirling demonstration. The Tri-Service Renewable Energy Committee subsequently endorsed the selection. Documentation of the selection process, including the military facilities considered, selection criteria, and overall rankings are provided in Appendix D.

In cooperation with Sandia, Ft. Huachuca, AZ provided foundations, a secure test site at the Joint Interoperability Test Command (JITC) facility, a control building, and data acquisition. Personnel for operating the system and recording system performance and operations and maintenance (O&M) data were also provided by Ft. Huachuca's JITC. A statement of work for the Ft. Huachuca facility was prepared by Sandia, and SERDP project funds were provided to support the installation and system testing. A copy of the Ft. Huachuca statement of work can be found in Appendix E. National Environmental Protection Act (NEPA) documentation was categorically excluded through the DOE Albuquerque Field Office.

Task 2 Hardware Installation.

Sandia purchased a CPG dish/Stirling system and contracted to have it installed at Ft. Huachuca on a fixed price basis (Contract AI-1360A). A separate time-and-material contract (Contract AI-1360B) was placed with CPG to provide operational maintenance and support, and spare parts. The concentrator foundation and interfaces with the facility's loads were prepared by the DoD facility in accordance with specifications provided by CPG.

CPG personnel managed the system installation with manual labor support provided by Ft. Huachuca's JITC personnel. The solar concentrator was installed at the Ft. Huachuca, AZ site during early October 1995, and the engine/receiver was installed during January 1996. Figure 3 is a photograph taken during of the concentrator installation. For both the concentrator and engine/receiver installations, CPG personnel remained on-site until the systems were operational and to train test site personnel.

Training included system operation and incident reporting procedures. A data acquisition system, similar to those used at other CPG test sites was specified by CPG and installed by JITC personnel.

To provide an independent assessment of system performance, the New Mexico State University South West Technology Development Institute (SWTDI) was contracted to independently record and report site solar insolation and weather data and system gross and net electrical output. The SWTDI monitoring equipment was installed during the summer of 1995 and was operational (except the wind speed indicator) by October 1995, when the concentrator was installed. The engine performance monitoring system began operating on January 18, 1996.

Task 3 - Application Validation.

There were a number of technical problems that arose with the dish/Stirling system at Ft. Huachuca, the most significant of which involved the Stirling engine. However, lessons were learned that will provide valuable information for dish/Stirling system developers as well as the DoD. Additionally, there were a number of successes from the project, especially from the perspective of the personnel at Ft. Huachuca. These are outlined below:

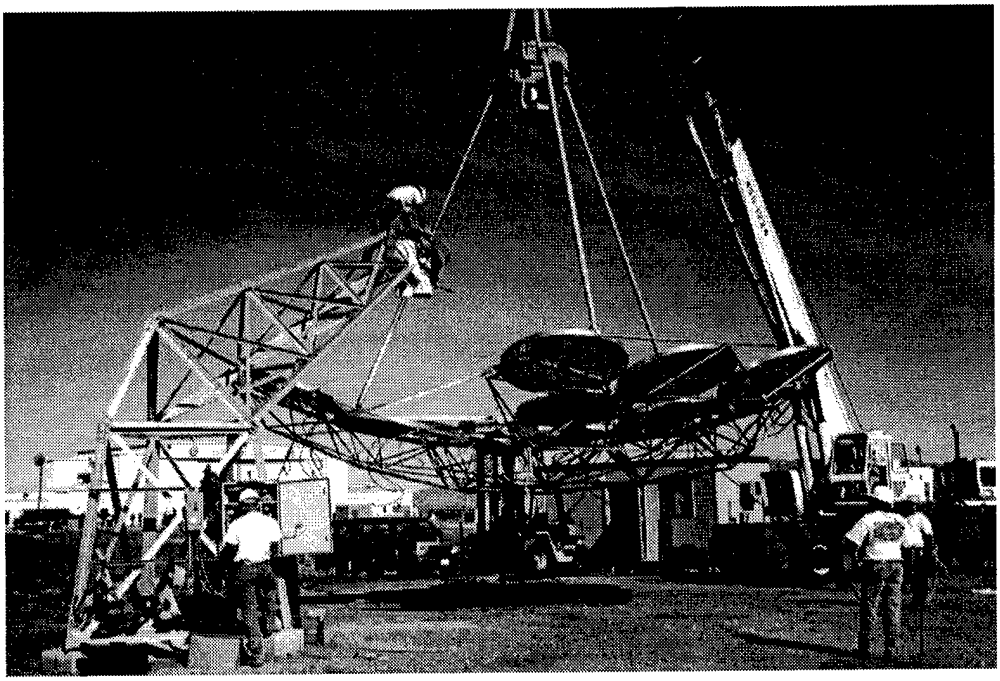


Figure 3. Photograph taken while the mirrors support structure, with mirrors attached, was being lifted to mate with the declination beam and drive assembly.

1) The engine is the most critical part of the system and must be highly reliable. In this case, because of side loads caused by the displacer's coil springs, Cummins operated the engine at reduced power. To reduce engine power, less than half of the mirrors were typically focused. Otherwise, the engine operated adequately until it was removed because of a problem with the heat pipe vacuum vessel.

2) The dish concentrator and its control system performed reasonably well. However, even this system encountered problems with a nearby lightning strike that rendered it immobile during a heavy rain storm. Ordinarily, the system would assume a protective stow position whenever wind speed exceeded limits (40 mph). In this case the lightning strike caused a power failure which prevented the concentrator from stowing. This in turn allowed water to enter some of the electronic control boxes, resulting in some control board failures. As a result, future designs should specify that the control boxes should be sealed to prevent water from entering in any orientation. Alternatively, an uninterruptible power supply (UPS) should be available to allow the system to stow under any condition.

   The system did successfully withstand a number of other nearby lightning strikes without incident. Also, the system withstood several moderate hail storm events (hailstones of about 3/8" in diameter) without any obvious damage.

3) The structural portion of the system was sound and operated through high winds, some of which involved wind gusts of over 12 m/s (27 mph). When wind speed exceeded 40 mph, the system was stowed. Additionally, the mirrored surfaces were apparently unaffected by airborne dust and sand that accompanied the high wind conditions. The system showed no obvious performance data reduction following the sand storms to indicate any reflectivity reduction.

4) The stretched membrane mirrors functioned adequately but need further development. The aluminized reflective film lost its aluminized coating as a result of ice build up. When the ice slid off one morning in December, 1995, as the dish tried to acquire the sun, it peeled off much of the aluminized reflective layer with it. Also, vacuum leaks in the focus/defocus system were difficult to diagnose and required a significant amount of attention.

5) The Ft. Huachuca site was well suited for testing the dish system. First, it has a high solar radiation resource. The large number of very clear days coupled with its southerly location provided a large number of hours of sunshine to operate the system. Second, the system was operated by the JITC. Personnel at this facility are accustomed to dealing with prototype systems and are skilled at problem solving. They were a valuable aid to Cummins in diagnosing and solving many of the problems that arose with the system. Third, Ft. Huachuca personnel strongly supported the dish/Stirling system project and provided both the resources and logistical support to operate the system in the most optimal manner possible. Although the SERDP program supplied resources to Ft. Huachuca to provide this support, the on-site commanders continually placed the problems with the dish system

as a high priority so that repairs could be facilitated as quickly as possible. Finally, the JITC is often visited by senior officers from all branches of the US military services. Thus, it provided an opportunity to brief these important decision makers on a new solar technology that may be applicable in their commands in the future. The Ft. Huachuca personnel conducted numerous tours of the dish system for visiting officers and provided each with a written description of the system and the project. The system was aesthetically attractive and was appreciated by personnel and visitors to the JITC.

Performance Data

The dish/Stirling system installation at Ft. Huachuca became operational in early January, 1996. The performance monitoring system began operating on January 18. During the remainder of January and until February 29 the system operated in an energy production mode.

During this period, the dish, its tracking subsystem, and the tracking controls operated with no problems; each day the dish acquired the sun in the morning, tracked the sun throughout the day, and stowed itself in the evening. Little operator intervention was needed during this period.

The weather during the period experienced a large number of days with low or medium levels of direct radiation. For example, 38% of the days had insolation levels of less than half of normal (normal is about 6.0 kWh/m^2). In most cases, the system was not operated or operated in a limited fashion during the low insolation times. The remainder of the days were clear or mostly clear.

Engine output was intentionally limited during this period because of problems with side loads caused by the engine's displacer springs.

A complete summary of the energy performance over this period is outlined in the table below. The "Total + AC Energy" is the total amount of electricity generated by the dish/Stirling system during the day. The "Total - AC Energy" is the total amount of energy the system consumed in order to operate. The "Runtime" is the total number of hours in which the system was operational. The "System Availability" is the percentage of time the system was operating when the direct solar radiation power level was above 500 W/m^2. The "Total Direct Normal" is the total amount of direct solar radiation for the day.

As can be seen, in the table, the dish system was off-line a large percentage of the time. The down time is due to a combination of poor insolation conditions and reduced engine output. However, even on days when the system was operating, the availability was rather low. For example, on the day of highest availability, February 7, the system availability was only 66%. Availability ranged downward to a low of 18% on February 16. It is noteworthy that the insolation energy level for the 16th is higher than on the 7th, which indicates that the system was experiencing mechanical problems that day.

	Total + AC Energy (kWh)	Total − AC Energy (kWh)	Runtime (Hour)	System Availability (%)	Total Direct Normal (NIP) (kWh/m^2)
19-Jan-96	3.36	−1.12	6.00	N/A	7.36
20-Jan-96	4.73	−1.32	8.00	N/A	7.71
21-Jan-96	2.02	−2.05	5.00	N/A	7.41
22-Jan-96	3.79	−1.02	6.00	N/A	6.49
23-Jan-96	7.11	−1.38	7.00	N/A	6.40
24-Jan-96	5.82	−1.84	7.00	N/A	6.22
25-Jan-96	5.48	−1.30	9.00	N/A	8.48
26-Jan-96	3.99	−1.29	7.00	N/A	7.46
27-Jan-96	4.82	−1.64	8.00	N/A	7.78
28-Jan-96	1.48	−2.05	3.00	N/A	6.20
29-Jan-96	3.90	−1.46	12.00	N/A	6.26
30-Jan-96	0.94	−4.19	8.00	N/A	4.96
31-Jan-96	2.52	−2.10	4.00	N/A	5.33
1-Feb-96	0.00	−1.38	0.00	0.00	0.79
2-Feb-96	0.00	−3.08	0.00	0.00	2.85
3-Feb-96	0.00	−0.96	3.00	0.00	0.55
4-Feb-96	2.20	−1.97	12.00	44.44	5.46
5-Feb-96	1.31	−3.10	3.00	33.33	5.82
6-Feb-96	0.00	−5.03	0.00	0.00	2.44
7-Feb-96	1.57	−2.02	9.00	66.67	8.03
8-Feb-96	4.53	−2.10	6.00	55.56	7.84
9-Feb-96	1.23	−5.16	3.00	25.00	4.79
10-Feb-96	3.13	−3.04	8.00	33.33	3.50
11-Feb-96	0.00	−3.92	0.00	0.00	2.69
12-Feb-96	0.00	−0.40	0.00	0.00	0.09
13-Feb-96	0.00	−3.97	0.00	0.00	2.78
14-Feb-96	1.01	−3.29	3.00	25.00	5.18
15-Feb-96	1.49	−3.27	5.00	40.00	6.03
16-Feb-96	0.96	−3.42	3.00	18.18	6.37
17-Feb-96	1.14	−3.47	5.00	33.33	6.95
18-Feb-96	0.66	−4.11	3.00	22.22	6.14
19-Feb-96	0.00	−2.33	1.00	0.00	0.88
20-Feb-96	0.00	−8.00	0.00	0.00	4.41
21-Feb-96	0.00	−0.70	0.00	0.00	0.44
22-Feb-96	0.00	−5.40	0.00	0.00	4.08
23-Feb-96	0.00	−2.04	0.00	0.00	0.55
24-Feb-96	0.00	−1.15	0.00	0.00	0.47
25-Feb-96	0.00	0.00	0.00	0.00	0.01
26-Feb-96	0.00	−0.61	0.00	0.00	0.48
27-Feb-96	0.19	−0.94	7.00	0.00	0.00
28-Feb-96	0.66	−2.37	15.00	28.57	1.63
29-Feb-96	0.73	−3.42	11.00	22.22	2.61

N/A - not available

Table 1. Performance Summary

On the days of maximum energy performance, January 23, the system produced 7.11kWh with operational losses of 1.38 kWh for a net of about 5.73 kWh. However, the maximum solar-to-electric conversion efficiency during the day was only 4.5%, about 20% of the expected value from a well-operating dish/Stirling system. Again, this is primarily a result of taking over 50% of the mirrors off line to limit engine output.

It is important to note that a sustained minimum insolation power level of 500 W/m^2 was needed for the dish to operate. This is primarily a result of limited engine power and the need to defocus facets. Other dish/Stirling systems typically operate at a minimum insolation of 200-300 W/m^2.

This is why days with low or moderate insolation levels (i.e., daily totals of less that 4.0 kWh/m^2) are usually when system operation was minimal. Conversely, days with high insolation levels are usually those in which the dish could operate most of the time, if in an operational state.

Because of problems with the heat pipe vacuum vessel, the engine operated on a limited basis during the period from March 1 through August 31. During September 1996, a leak into the heat pipe vacuum vessel was detected (an increased thermal gradient between the receiver absorber and engine heater tubes was measured) and the engine was removed.

On June 28, 1996, Cummins Engine Company (CEC) announced the closure of its solar research division to better align its resources with its core business, the manufacture of diesel engines. As a result of this decision, no engine development activity occurred during the last few months of this project and a new displacer designed to solve the side load problems and permit higher output was not retrofitted.

Conclusions

The dish/Stirling demonstration project at Ft. Huachuca provided valuable information to both its manufacturer and the DoD. Some of the most important conclusions are outlined below:

1) The manufacturer, CPG, experienced first-hand some of the operational difficulties of a system in a harsh desert environment. As a result, several design changes were made, especially related to the system reliability.

2) The weakest component in the system was the engine. This problem must be addressed before this system can be used within the DoD on a widespread basis. Although the engine accounted for very few of the failures, concerns about its durability and poor integration with the heat pipe (heat pipe vacuum vessel deformation and eventual leak) accounted for virtually all of the system downtime. Its poor performance also led to poor availability during the power production phase (January 19-February 29).

3) Similarly, the control system experienced some problems. The most significant was related to lightning. Corrective actions were considered in the system design.

4) The dish structure was found to be sound and can provide the level of reliability required for future dish systems. The mirrors performed adequately, however, loss of the reflective surface and difficulties tracking down leaks in the vacuum system were notable problems.

5) The SERDP Dish/Stirling for DoD applications project was intended to leverage DOE's and industry's substantial investment in dish/Stirling technology and explore its potential applicability to DoD. In this regard it was successful. However, this project suggests that the Cummins technology is still developmental and is not presently applicable for military applications. With continued work, dish/Stirling systems may one day be applicable for producing electricity in remote areas within DoD installations where grid electricity is not available or is very expensive.

References

Bean, J.R., and R.B Diver. 1992. "The CPG 5-kW_e Dish-Stirling Development Program," *Proceedings of the 1992 Intersociety Energy Conversion Engineering Conference*, Paper No. 929181, San Diego, CA.

Bean, J. R., and R.B. Diver. 1993. "Performance of the CPG 7.5-kW_e Dish-Stirling System," *Proceedings of the 1993 Intersociety Energy Conversion Engineering Conference*, Paper No. 93054, Atlanta, GA.

Bean, J. R., and R.B. Diver. 1995. "Technical Status of the Dish/Stirling Joint Venture Program," *Proceedings of the 1995 Intersociety Energy Conversion Engineering Conference*, Paper No. 95-202, Orlando, FL.

Stine, W.B., and R.B. Diver. 1994. *A Compendium of Solar Dish/Stirling Technology*, SAND93-7026, Sandia National Laboratories, Albuquerque, NM.

Appendix A

DOE Proposal
Dish/Stirling for DoD Application

TITLE: DISH/STIRLING FOR DOD APPLICATIONS

OBJECTIVE: Implementation of this proposal will establish the technology of using solar thermal dish/Stirling engine generation systems in the southwest for intermediate power. These plants could either be installed by a utility or an independent power producer at DOD facilities to provide power for military installations.

APPROACH: A 5 kWe dish/Stirling engine generation system is being developed by Cummins Power Generation Co. (CPGC) for remote applications. This is a joint venture proposal to field test units at user sites. The intention is to operate them under actual conditions as power units to learn their operating, maintainence and reliability characteristics for remote sites. It is proposed that an additional unit be purchased for installation and operation at a military facility to gain first-hand operational experience. A military installation would be a strong candidate for one of these plants when they are produced in production quantities, especially if the land were available at a DOD facility.

BENEFITS: This effort would result in the military being able to have independent and secure power on their installations. The power generated from these units when mass produced should be competitively priced for peaking/intermediate remote applications. The installation would not require additional power lines to the facility to meet future needs. Since land utilization for dish/Stirling systems is an important factor, utilization of existing military bases for solar thermal powerplant parks could benefit DOD and the utilities.

PARTNERS AND RELATED ACTIVITIES: DOE and CPGC have entered into a joint venture project to produce three proof of concept test articles, three design verification units and then ten manufactured units, and to test them at user sites. To fabricate a new design verification or manufactured unit and to test it at a military site would cost about $900,000.

MILESTONES: A unit could be installed by late 93 or 1994.

FUNDING: ~~$900,~~800,000

POINT OF CONTACT: Gary D. Burch, (202) 586-0081

Appendix B

Sandia Work for Others Proposal
Dish/Stirling for DoD Applications

Sandia National Laboratories
Albuquerque, New Mexico 87185
Livermore, California 94551

June 25, 1993

Robert Y. Lowrey, Director
Attn: V.A. Aschenbrenner, Branch Chief
Reimbursable and Energy Technologies Division
U.S. Department of Energy/Albuquerque Field Office
Albuquerque, NM 87185-5400

Dear Mr. Lowrey:

Subject: Proposal #62930517: "Dish/Stirling for DoD Applications"

Enclosed is a proposed Statement of Work prepared by Richard Diver, Department 6216, Sandia National Laboratories in response to an unsolicited request from the Department of Energy (DOE). The request from DOE was prompted by the Strategic Environmental Research and Development Program (SERDP) enacted by Public Law 101-510 - November 5, 1990. Public Law 101-510 states that SERDP is a cooperative program between the Department of Defense (DoD) and the DOE to identify and develop technology that will enhance the capability of the DoD and DOE to meet their environmental obligations. The enclosed Statement of Work reflects the activities directed by the DOE and approved by the SERDP advisory committee. The program sponsors are Dr. Robert Oswald, Executive Director of SERDP, Headquarters, U.S. Army Corps of Engineers, 20 Massachusetts Avenue, NW, Washington, DC 20314-1000 and Gary Burch, Director of the Solar Thermal and Biomass Power Division at DOE Headquarters, U.S. Department of Energy, CE-132, 1000 Independence Avenue, SW, Washington, DC 20585.

The enclosed proposal package provides an analysis of how we determined that the work does not place DOE or Sandia in competition with the domestic private or public sectors, as well as other documentation required for DOE certification of the proposed work.

This proposal has been reviewed and approved by Sandia management for compliance with the following policy requirements:

> This work will commence only on receipt of adequate funding for the cost estimate of $900,000 from FY93 through FY95 that includes Sandia costs and DOE Departmental Overhead.
>
> The cost estimate is in accordance with the Laboratories' pricing policy, which incorporates the DOE policy of full cost recovery.

This work is consistent with and complementary to Sandia's mission and will not adversely impact the execution of DOE-assigned programs or create a potentially detrimental future burden on the commitment of DOE resources.

This work has been reviewed for environment, safety, and health (ES&H) concerns; all costs for ES&H compliance are included in the cost estimate.

It is our judgment that this work would not place Sandia in direct competition with the domestic, private or public sectors or result in wasteful or inappropriate use of government-developed assets.

Sincerely,

Dan E. Arvizu
Energy and Environment Sector
Applied Energy Program

Copy to:
K.A. Carlson, DOE/AL KAO

June 15, 1993

STATEMENT OF WORK
prepared by : Sandia National Laboratories
Proposal 62930517 - Dish/Stirling for DOD Applications

PROJECT BACKGROUND:

The Strategic Environmental Research and Development Program (SERDP), enacted by Public Law 101-510 - November 5, 1990, is a cooperative program between the Department of Defense (DoD) and the Department of Energy (DOE) to identify and develop technology that will enhances the capability of the DoD and DOE to meet their environmental obligations. In response to this law, the DOE prepared a multi-disciplinary proposal for consideration by the SERDP council. This Statement of Work reflects the portion of the proposal that Sandia prepared as directed by the DOE.

PROJECT SCOPE:

The Strategic Environmental Research and Development Program (SERDP) will assist military facilities to field and evaluate emerging environmentally sound and economical dish/Stirling technology. Through a DOE-sponsored joint venture contract between Sandia National Laboratories and Cummins Power Generation, Inc. (CPG), a 7.5-kW_e dish/Stirling systems for remote power applications is being developed. The technology has the potential to produce electricity at competitive costs while at the same time providing a secure and environmentally benign source of power. This program will establish, at a military facility, first-hand experience in the operation of a dish/Stirling system.

The proposed work is divided into three tasks with the following completion schedules.

Task 1 - Facility Selection: Identify and competitively select a DoD facility for installation of a dish/Stirling system. Assess the DoD market for dish/Stirling technology. Task 1 is to be completed by February, 1994.

Task 2 - Hardware Installation: Prepare the site and install a CPG 7.5-kW_e dish/Stirling system. Installation is to be completed by May, 1994.

Task 3 - Application Validation: Train DoD personnel in system operation and verify performance. Provide maintenance support over the first year of operation. Operational testing is to be completed by June, 1995.

This project and the work being proposed is unclassified.

Estimated Costs (in Thousands)

	FY93	FY94	FY95	Totals
SNL Cost Estimate	$485	$301	$85	$871
DOE Dept. Overhead	$16	$10	$3	$29
Total Cost Estimate	$501	$311	$88	$900
Continuity funds	$399	<$311>	<$88>	$ 0
Required funding	$900	$ 0	$ 0	$900

The Department of Energy requires Sandia National Laboratories' request from other federal agencies, funding for the first fiscal year plus the first three months of the following year, if the work transcends fiscal years.

TECHNICAL CONTENT:

Task 1 Facility Selection
Scheduled completion date - 3/1/94

Through this task, candidate sites will be identified, evaluated, and competitively selected for dish/Stirling applications. The selected site will provide foundations, test facilities, data acquisition, NEPA documentation support, and personnel for operating the system and recording system performance and O&M data. Facilities will be limited to the southwestern United States with direct normal solar insolation levels of 6 $kWh/m^2/day$ (annual average). Military installations in remote areas where electricity is expensive (i.e., over $0.10/kWh) or where electricity is currently produced on-site by diesel or gas generators are desirable. Military facilities that appear to have a stable mission, a continuing need for electricity, and which have available land for a large-scale dish/Stirling facility will be favorably rated. The military facility selection will also be based on demonstrated support for other renewable energy projects and the level of facility cost sharing proposed for this project. The cost share could be in the form of in-kind service such as assuming some of the maintenance responsibility. Based on information from the solicitation, interviews, site visits, and other surveys, a market assessment of DoD installations will be conducted. Funds for this task will also be used to provide overall program administration and reporting. Specific activities for Task 2 are listed below.

1.1 Administration
    1.1.1 Coordination of project tasks
    1.1.2 Reporting

1.2 Site Selection
    1.2.1 Request for proposal for site participation
    1.2.2 Proposal evaluation
    1.2.3 Place DoD test site contract
    1.2.4 NEPA documentation

1.3 DoD facilities market assessment

Task 2 Hardware Installation
Scheduled completion date - 5/1/94

Sandia will purchase a Cummins Power Generation, Inc. (CPG) 7.5-kW_e dish/Stirling system and contract to have it installed at the selected facility. The concentrator foundation and interfaces with the facility's loads will be prepared by the DoD facility in accordance with specifications provided by CPG. CPG personnel will manage the system installation with manual labor support provided by DoD personnel. CPG personnel will remain on-site for the initial week of field testing to ensure proper system operation and to train test site personnel. A data acquisition system, similar to those used at other test sites, will be specified by CPG and Sandia. The DoD facility will be responsible for providing the data acquisition hardware and expanding it to their specific requirements.

Specific activities for this task are listed below.

2.1 Contract for CPG 7.5-kW_e dish/Stirling system
    2.1.1 Dish/Stirling hardware
    2.1.2 System installation and support

2.2 Test facility installation
    2.2.1 Concentrator foundations
    2.2.2 Facility utilities
    2.2.3 DoD facility's load interface

2.3 Data acquisition system installation

Task 3 - Application Validation
Scheduled completion date - 6/1/95.

During the first week of operation, CPG will train DoD personnel in system operation and maintenance, data acquisition, and reliability tracking. Operation and Maintenance manuals will be provided. CPG and Sandia personnel will meet with on-site personnel on a periodic basis to ensure proper operation and recording of system performance. Routine maintenance such as concentrator mirror washing and cooling system coolant level checks will be provided by the host site. If required, CPG will oversee major repairs and will minimize any system down-time by providing spare parts and/or additional operator training. CPG and Sandia will provide operational support for the first year of system operation.

Specific activities for this task are listed below.

3.1 Operator training
- 3.1.1 Routine operation training
- 3.1.1 Routine maintenance training
- 3.1.2 Data acquisition system training
- 3.1.3 Reliability tracking training

3.2 System operation
- 3.2.1 Performance measurements
- 3.2.2 Reliability tracking

DELIVERABLES:

7.5 kW_e Dish/Stirling System, DoD Dish/Stirling Market Survey, System Performance and Reliability Final Report, Presentations at Annual SOLTECH Meetings

Sandia National Laboratories (SNL)
Work For Others
Proposal Summary Information

SF 9140-SUM(11/92)

Proposal Number: 62930517 **Date:** June 15, 1993

DOE B&R Number: 400403209 **BAC** JAB JAE

SNL Case Number: 5305.000 **OPI** 0303

1. Proposal Title: **Dish/Stirling for DoD Applications**

2a. General Description: [*General description - must be 80 characters or less*]

Install a 7.5 kW_e solar dish/Stirling engine electric generating system on a DoD site

2b. Technical Description: [*Summarize Statement of Work - use nontechnical terms and no acronyms*]

Survey military facilities for potential applications for dish/Stirling systems. Select a DoD facility for installation of a dish/Stirling system. Contract with Cummins Power Generation for the manufacture, installation and support of a solar 7.5 kW_e dish/Stirling engine/generator system on the DoD facility.

3a. Relation to SNL Mission: [*Explain how the proposed work is consistent with and complementary to Doe's mission and SNL's Work For Others mission.*]

The Strategic Environmental/Research and Development Program (SERDP) is an expansion of the existing programs at Sandia National Laboratories to accelerate the use of dish/Stirling systems within the military and to demonstrate application to DoD facilities. The Solar Thermal Technology Department at Sandia has been working on Dish/Stirling technology development and system integration since 1985. Sandia has also provided solar thermal design assistance to military facilities for several years. This program provides an opportunity to offer to military facilities a promising technology which Sandia believes will be of benefit to both the DoD and the emerging dish/Stirling industry.

3b. Impact on DOE Resources: [*Explain how the proposed work would not adversely impact DOE-assigned programs or create a potentially detrimental future burden on DOE resources.*]

The SERDP Dish/Stirling for DoD Applications program is a natural extension of the assigned DOE mission. The level of effort from Sandia personnel and in-house resources (0.4 to 0.6 FTE/FY) will remain level and will not impact the assigned DOE mission. Additional personnel and resource required to expand the current program are minimal and this activity fits well into existing work. Further, the lack of any modification or construction requirements to Sandia facilities permit this project to be undertaken without any present or future detrimental burden on DOE resources.

Proposal Number: 62930517

3c. Unique SNL Capability: [*Explain in detail how it has been determined that the proposed work will not place DOE or Sandia in competition with the domestic public or private sector(s). The explanation should include; (1) a description of the specific SNL capabilities to be used; (2) how they are unique and (3) an analysis of whether private industry is or will/may be involved in this work.*]

Sandia is uniquely qualified for the proposed work. Through the existing DOE sponsored Solar Thermal Electric Program, Sandia has acquired relevant expertise in dish/Stirling technology and system integration. Through the Solar Thermal Design Assistance Center (STDAC), Sandia has provided technical assistance to DoD facilities in a variety of solar thermal applications and has established an understanding of DoD facility requirements. The Dish/Stirling for DoD Applications program is, in fact, a logical expansion of our current assigned DOE mission.

To increase the probability of successfully introducing dish/Stirling technology to the DoD facility market, it is important to identify, evaluate, and select an appropriate application for dish/Stirling technology and to provide an unbiased evaluation of system performance after it has become operational. Sandia is a recognized expert in dish/Stirling technology and has been providing technology evaluation services through the STDAC since 1988. Sandia's expertise as an independent consultant on solar thermal technology has been utilized by DoD facilities managers on numerous occasions. For example, the STDAC recently completed a contracted study for Fort Huachuca, in Arizona, regarding the the use of solar thermal systems in four of the fort's building facilities. No other organization outside Sandia in either the private or public sector currently possesses all the experience and expertise required to perform these activities. Although, another organization could develop the expertise, these services will not be required on a substantial or continuing basis and are therefore not a viable market for the private sector.

Sandia's industry partner, Cummins Power Generation Inc.(CPG), in the $14M Dish/Stirling Joint Venture Program will be contracted to provide a 7.5 kW_e "design validation" dish/Stirling system and operational support of the system for a period of one year. The Dish/Stirling Joint Venture Program is being cost shared equally by CPG and DOE. Sandia will work jointly with CPG and with a competitively selected DoD facility to integrate the dish/Stirling system into a useful load. Information from the demonstration will be of use to larger installations and for integration specifications of future systems being developed by other U.S. companies.

Approximately one-half of the program funds were designated for hardware and systems by DOE and the SERDP advisory committee. The CPG 7.5-kW_e dish/Stirling system was specified for the project because of its potential to meet the cost and performance needs of DoD facilities, and because it is the only dish/Stirling system currently available that is produced in the United States.

Sandia National Laboratories (SNL)
Work For Others
Proposal Summary Information

Proposal Number: 62930517

4. Preliminary Security Classification: [check only one] **Unclassified** X **Classified** ____

For classified projects (excluding SAP and Intelligence), Complete the WFO Proposal Summary Classification Guidance Form, SF 1008-WFO(8/92), and send to Department 7180. Returned Certification Letter signed by Department 7180 must be attached to proposal package.

[A project is classified if the sponsor requires Sandia to control through possession from the sponsor and / or generation for the sponsor any classified items, data, or documents.]

If this is a "Special Access" project, contact Phil Montoya, 9912 at 5-9909 for instructions.

5a. Cost/Funding Profile By Fiscal Year:

	FY93	FY94	FY95	Totals
SNL Cost Estimate	$485K	$301K	$85K	$871K
DOE Dept. Overhead	$16K	$10K	$3K	$29K
Total SNL Cost Estimate	$501	$311	$88K	$900K
Continuity Funding	$399K	<$311K>	<$88K>	0
Required Funding	$900K	0	0	$900K

5b. Total SNL Cost Estimate for all years (required only when submitting amended proposals). N/A

5c. FTE Level of Effort By Fiscal Year:

FY93 = 0.6 FTE FY94 = 0.6 FTE FY95 = 0.4 FTE

At this FTE level of effort, will the proposed work adversely impact the execution of DOE-assigned programs at SNL? **No** X **Yes** ____

6. Sandia Program Manager: [*name, organization, phone of manager of program named in item 11a*]

Dan E. Arvizu, 6200, 845-8336

7. Sandia Project Manager: [*name, organization, phone of manager with technical responsibility*]

Richard B. Diver, 6216, 844-0195

8a. Sponsor Identification: [*name, complete mailing address and zip code*]

Headquarters
U.S. Army Corps of Engineers
20 Massachusetts Avenue NW
Washington, DC 20314-1000

8b. Sponsor Contact(s): [*name(s), title, mail stop, phone of sponsor administrative and technical contacts*]

Technical Contact: Dr. Robert Oswald 202-272-1834
Executive Director of SERDP Council

Admin Contact: Fenton Carey 202-586-7008
DOE SERDP Coordinator

9. Schedule and Milestones: **Specific description in Statement of Work** [X]

Expected beginning of work date (mm/yy) 8/93

Expected completion of work date (mm/yy) 6/95

10. Deliverable(s): **Specific description in Statement Of Work** [X]

General Description [*two or three word capsulation of deliverables in 40 characters or less*] [*e.g., computer software, prototype hardware, technical consultation or report, test services*]

Dish/Stirling system and documentation

Sandia National Laboratories (SNL)
Work for Others
Proposal Summary Information

Proposal Number: 62930517

11a. Sandia Program Area: *[EE or WFO Sector program managed by individual named in item 6]*

Applied Energy Program (EE Sector)

11b. DOE/Hqtr Contact: *[DOE/Headquarters individual & FTS phone with interest in project progress, if known]*

Gary Burch; 202-586-0081

12. Additional Information: *[check No or Yes - a Yes response requires additional supporting information]*

a1)	**Are other DOE facilities involved?**	**No** X **Yes** ___
a2)	**Is there private industry or university involvement? (Refer to 3c, pg. 2)**	**No** ___ **Yes** X
a3)	**Is there construction/modification of facilities?** **If Yes,** contact SNL Organizations 7850 and 8510 for requirements	**No** X **Yes** ___
a4)	**Are there planned capital equipment acquisitions?** **If Yes,** attach list of each acquisition and cost ≥ $5000	**No** X **Yes** ___
a5)	**Are human or animal research subjects involved?** **If Yes,** reference current assurance documents in the attachment	**No** X **Yes** ___
a6)	**Are there related DOE/Sponsor Memorandum(s) of Understanding?** (Refer to attached MIPR and Acceptance)	**No** ___ **Yes** X
a7)	**Are foreign nationals/organizations involved?** (Refer to attached explanation and IA-473)	**No** ___ **Yes** X
a8)	**Is work/travel outside the 50 United States involved?** **If Work Yes,** contact Sandia Dept 7180 for export control awareness **If Travel Yes,** include an OCONUS travel form as the attachment	**No** X **Yes** ___
a9)	**Does this work involve procurement of automated data processing?** (computer equipment, software, telecommunications, etc.) **If Yes,** attach list of each ADP procurement and cost ≥ $5000	**No** X **Yes** ___
a10)	**Are services provided for sharing excess data processing capacity?** (sale, lease or rent of central processing computer time)	**No** X **Yes** ___
a11)	**Are subcontractors to be used?**	**No** ___ **Yes** X

If Yes: Estimated total subcontracting costs **$** 490K

Estimated subcontract % SNL total costs **%** 54

Brief description and justification of subcontracting.

Refer to 3c, pg. 2

a12)	**Will the work be sold back to DOE?**	**No** X **Yes** ___
a13)	**Is attached ES&H Checklist signed by a Sandia ES&H coordinator?**	**No** ___ **Yes** X
b1)	**Will there be radio frequency spectrum applications?**	**No** X **Yes** ___
b2)	**Is this a project that is jointly funded by DOE?**	**No** X **Yes** ___

Sandia National Laboratories (SNL)
Work for Others
Proposal Summary Information

Proposal Number 62930517

13. Additional Data: *[Required for NFE Proposals Only]*
(Check No or Yes)

a Non-Domestic Sponsor Issues (A yes response requires a memo of concurrence from DOE Headquarters.)

1) **Is the project for a non-Domestic sponsor?** **No ___ Yes ___**

2) **Will foreign nationals be involved in providing technical services or materials to the Non-Federal entity?** **No ___ Yes ___**

3) **Will the technical services or materials that will be provided to the domestic sponsor ultimately be provided to a foreign national or non-domestic facility?** **No ___ Yes ___**

b Patent and Data Rights Issues (A yes response requires additional supporting information.)

1) **Is the work to be performed under the proposed Agreement covered by another DOE facility contract or arrangement?** **No ___ Yes ___**

2) **Is there sufficient interest to the DOE programmatic mission to justify DOE supporting this work with direct program funding?** **No ___ Yes ___**

3) **Is it anticipated that patentable products or processes will be developed?** **No ___ Yes ___**

4) **Will proprietary data be provided by the Non-Federal Entity?** **No ___ Yes ___**

5) **Does the Non-Federal Entity want part or all of the generated data kept proprietary?** **No ___ Yes ___**

If "part," attach an explanation of the extent to which it is to be treated as proprietary. If certain generated data are to be treated as proprietary and SNL because of an increased benefit to DOE, supports a waiver of DOE Depreciation and Departmental Overhead, attach an explanation of how the DOE will obtain such increased benefit that will be sufficient to justify such a waiver if the data generated may be marked and removed by the Non-Federal Entity.

Reviewed By:	CFO WFO Support:	JM L 184 6/29/93	Date
If EE Pgm Mgr	EE Sector Manager:	6/23/93	Date
	WFO Sector Office:		Date
Approved By:	WFO Sector Manager:	7/2/93	Date

FOREIGN NATIONALS INVOLVEMENT

Dish/Stirling for DoD Applications
Proposal Number 62930517

The manager of the private sector portion of the Dish/Stirling Joint Venture Program , Dr. Isoroku Kubo of Cummins Power Generation, Inc. (CPG) is a Japanese foreign national. Under the scope of work for this project, a CPG 7.5-kW dish/Stirling system will be purchased. System operational support will also be provided by CPG. Dr. Kubo will therefore be involved in interactions between Sandia and the DoD facility.

Sandia is currently working with Dr. Kubo through a DOE approved Request for Foreign National Unclassified Visit or Assignment (Form IA-473 attached). Since the work involves only unclassified information, the only major restriction is the requirement of an escort.

Sandia National Laboratories
ES&H CHECKLIST

SF 9140-ESH(2/93)

Proposal Number: 62930517 **Date:** June 15, 1993

It is the intent of this checklist to assist the project manager, in a mindful consideration of ES&H issues that may be inherent in the work identified by this proposal; and to assist you in instituting a successful approach to satisfying the commitment of Sandia National Laboratories to achieve ES&H excellence.

*If the answer to any check question is "Yes" you **must** (1) contact the SNL organization corresponding to the question number, (2) name the SNL resource consulted, and (3) document as an attachment to this checklist the results of the contact including an identification of all ES&H requirements.*

	Yes	No	
Section 1: Environmental Considerations			
1		X	Will this project initiate new construction, modification of existing facilities, or decommission of existing facilities?

[1] Risk Management & NEPA 7731 or Environmental Protection Department 8642 to determine any National Environmental Policy Act (NEPA) requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

[1] Facilities Construction And Environmental Engineering Department 7013 or Plant Engineering Department 8612 to determine construction project requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

2		X	Will this change the existing environmental status by generating new or altered airborne emissions?

[2] Environmental Restoration Department 7723 or Environmental Protection Department 8642 to determine any Clean Air Act and/or State or Local requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

3		X	Will this project modify existing building/laboratory/site liquid effluent?
4		X	Will this project generate radioactive, hazardous or mixed (radioactive/hazardous) wastes?

[3/4] Radioactive and Mixed Waste Department 7722 or Environmental Protection Department 8642 to determine any Clean Water Act, Resource Conservation and Recovery Act (RCRA), Atomic Energy Act (AEA), State and Local requirements, and/or DOE Order requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

Section 2: Safety Considerations			
5		X	Will this project involve high energy sources (e.g. lasers, propellants and/or explosives) not currently covered by Standard Operating Procedures?

Orgn: _____ **Contact:** _____ **Phone:** _____

6		X	Will this project involve aviation operations (e.g. manned or unmanned aircraft including fixed wing, helicopters, drones, etc.)?

[5/6] Safety Engineering Department(s) 7732/7733 or Safety Programs Department 8643 for assistance in reviewing the adequacy of procedures and documentation.

Orgn: _____ **Contact:** _____ **Phone:** _____

7		X	Will this project involve radioactive substances or ionizing radiation not currently covered by a Standard Operating Procedure?

[7] Health Physics Department(s) 7713/7714 or Safety Programs Department 8643 to determine DOE Order requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

Section 3: Health Considerations			
8		X	Will this project involve toxic substances or non-ionizing radiation (lasers, electromagnetic) not currently covered by a Standard Operating Procedure, or involve the creation of new chemical(s) or "significant new use" of an existing chemical?
9		X	Will this project involve the use of carcinogenic substances?

[8/9] Industrial Hygiene/Toxicology Department(s) 7711/7712 or Health Protection Department 8641 to determine OSHA and/or DOE Order requirements.

Orgn: _____ **Contact:** _____ **Phone:** _____

10		X	Will this project involve research to collect data on any human subject?

[10] Medical Director, 7030, to determine whether the Sandia Human Studies Board (HSB) Review will be required.

Orgn: _____ **Contact:** _____ **Phone:** _____

Information concerning this checklist is provided to the best of my knowledge.

John Milt Stomp, 6200, 844-6576 John M Stomp J. 6/16/93

Sandia ES&H Coordinator [name, organization, phone, signature, date]

SA 9140-A(11/92)

COST ESTIMATE WORKSHEET

Date June 29, 1993
Project Manager Craig Tyner
Project Title Dish/Stirling for DoD Applications
Funding Source HQUSACE

Proposal Number 62930517
Organization 6216
Case Number 5305.000

(See INSTRUCTIONS On Back Of This Form)

Current Proposal / Amendment
(Completed for all New Proposals or Amendments)

	TYPE OF COST	COST FORMULA	COST ESTIMATES ($K) FY93	FY94	FY95
1.	Labor	Base FTEs	0.6	0.6	0.4
2.	Total Labor Costs	FTEs x Orgn Rate	93	93	62
3 a.	Travel		9	11	10
b.	Purchases				
c.	Other Charges		330	160	
d.	Total Direct Charges		339	171	10
4 a.	Computing	See Service Center Listing			
b.	Design	in appendix for contact in			
c.	Process Fabrication	each area to obtain cost			
d.	Test	estimate for each Service			
e.	Tech Communications	Center.	2	5	4
f.	Other				
g.	Total Service Center	*(formerly Direct Support)*	2	5	4
5.	Total Direct Costs	(2) + (3) + (4)	434	269	76
6.	Composite Sector Rate	11.8 % x (5)	51	32	9
7.	Sandia Cost Estimate	(5) + (6)	485	301	85
8.	DOE Dept Overhead	(7) x Rate 3.2 %	16	10	3
9.	Total Cost Estimate	(7) + (8)	501	311	88
10.	Continuity Funds (Applicable if costs transcend FY's) (Example on reverse side)	* % TIMES Next FY Costs (9) LESS Prior FY's Continuity Funds (10)	399	<311>	<88>
11.	Required Funding	(9) + (10)	900	0	0

3mL184
6/29/93

THIS COST ESTIMATE WORKSHEET CONTAINS SANDIA PROPRIETARY INFORMATION NOT TO BE DISTRIBUTED BY SANDIA OR DOE TO ORGANIZATIONS OUTSIDE DOE

* Continuity funding is greater than 25% because sponsor will provide all of the money this FY, however, project will take three years.

SF 9822-CAF (1-93)

Case/Project Authorization Form

(Must be typed & unclassified)

Mail to: Sharon Chino, 183

Case/Project Number 5305.000

Funding Agency (Reimbursable Only) U. S. Army Corps of Engineers

Title Dish/Stirling for DoD Applications

Case/Project Description: *(Must be brief - limit description to one case/project per page)*

Survey military facilities for potential applications for dish/Stirling systems. Select a DoD facility for installation of a dish/Stirling system. Contract with Cummins Power Generation for the manufacture, installation and support of a solar 7.5 kW_e dish/Stirling electric/generator system on the DoD facility.

FY 93 Objectives:

1. Release a request for proposal for DoD facility selection.
2. Release a request for proposal for a CPG 7.5 kW dish/Stirling system.
3. Initiate DoD market survey for dish/Stirling technology.

	Type Name	Signature	Org.	Date
Case/Project Mgr.:	Richard B. Diver	Richard B. Diver	6216	6/17/93
Program Mgr.:	Dan E. Arvizu		6200	13 June 93

(Refer to back for additional requirements - optional)

Fill in any known case/project attributes listed below. The Chart of Accounts Coordinator will forward the form to the appropriate Organization 180 Financial Analyst to review or complete any information not provided.

Account No. 343

Super Program/Workclass RGK

Status 9

Management Code JAE

Budget and Reporting (B&R) No. 40040 3209

DOE Supplemental Code ——

OPI Code 8323

Fund Type 3T

Appendix C

DOE Authorizaton
Dish/Stirling for DoD Applications

DOE F 1325.8

United States Government | Department of Energy

memorandum

Albuquerque Field Office

DATE: AUG 13 1993

REPLY TO ATTN OF: RETD/RDPB/SA3-228

SUBJECT: Strategic Environmental Research and Development Program (SERDP) Reimbursable Funds-Solar Thermal Dish/Stirling System

TO: S. G. Varnado, Org. 9900, SNL-NM

Based on the memoranda Annan/Twining dated March 30, 1993 and June 17, 1993, this memorandum provides the authorization for you to proceed with the work based on the following funding documents:

Funding Documents:	MIPR Number E8793L191, Initial and MIPR Number E8793L353, Initial
Dollar Amount:	$800,000 (SNL-$775,194, DOE-$24,806) for MIPR E8793L191; $100,000 (SNL-$96,899, DOE-$3,101) for MIPR E8793L353; for a total of $900,000 (SNL-$872,093, DOE-$27,907)
Project Title:	Dish/Stirling for DOD Applications; SNL Proposal Number 62930517, Case Number 5305.000

A copy of the MIPRs with appropriate certifications and Annan correspondences are attached.

By copy of this memorandum, Financial Management Division is requested to submit the billings on these MIPRs to the following HQ office for their consolidation and transmittal to the sponsor.

U.S. Department of Energy
Office of Headquarters Accounting Operations (CR-52)
Attn: George Tengan
P.O. Box 500
Germantown, MD 20875-5000

The above referenced project shall be performed under operating Contract DE-AC04-76DP00789 with AT&T Technologies, Inc.; the U.S. Economy Act of 1932, as amended; and in accordance with other applicable laws and regulations. Should additional funding be required to complete the project, please notify me as to the amount and date additional funds are needed.

If you have any questions, please contact H. Tom Davidson of my staff at 845-5644.

for George R. Tennyson Jr.
Robert Y. Lowrey
Director, Reimbursable and Energy Technologies Division

Attachments

cc w/attachments:
R. B. Diver, Org. 6216, SNL-NM
D. E. Arvizu, Org. 6200, SNL-NM
B. K. Davis, Org. 184, SNL-NM
D. F. Fowler-Lynch, FMD, AL
J. S. Johnson, BRMD, AL

cc w/o attachments:
F. Carey, AC-1, HQ
W. Chernock, DP-4, HQ
R. H. Annan, CE-13, HQ
G. M. Tengan, CR-52, HQ

MILITARY INTERDEPARTMENTAL PURCHASE REQUEST

PAGE 1 OF 1 PAGES

2. FSC	3. CONTROL SYMBOL NO.	4. DATE PREPARED	5. MIPR NUMBER	6. AMEND NO
		1/4/93	E87935L191	Initial

7. TO:	8. FROM: (Agency, name, telephone number of originator)
U.S. DEPARTMENT OF ENERGY ATTN: DR. FENTON CAREY 1000 INDEPENDENCE AVE., S.W. WASHINGTON, DC 20585	HQUSACE (CERD-L) ATTN: ELOISA BROWN (202) 272-1834 20 MASS. AVE NW WASH, DC 20314

9. ITEMS ___ ARE ___ ARE NOT INCLUDED IN THE INTERSERVICE SUPPLY SUPPORT PROGRAM AND REQUIRED INTERSERVICE SCREENING ___ HAS ___ HAS NOT BEEN ACCOMPLISHED.

ITEM NO.	DESCRIPTION (Federal stock number, nomenclature, specification and/or drawing No., etc.)	QTY c	UNIT d	ESTIMATED UNIT PRICE e	ESTIMATED TOTAL PRICE f
1.	$4,053,000.00 for Phase I, and $5,053,000.00 for Phase II, FY92 SERDP funds transferred to the Department of Energy for the completion of Installation Restoration and Energy Projects.				$9,106,000.00
2.	Request two (2) signed acceptance copies (attached) be promptly returned to the finance and accounting office named below (block #13). Submit SF1080 billings to the same address. The complete order number must appear on all billings. Indicate partial or final billings. Any unused balance should be reported for withdrawal immediately to the finance and accounting office below. Funds are issued on a reimbursable basis.				
3.	Funds expire 30 September 1993				

10. SEE ATTACHED PAGES FOR DELIVERY SCHEDULES, PRESERVATION AND PACKAGING INSTRUCTIONS, SHIPPING INSTRUCTIONS AND INSTRUCTIONS FOR DISTRIBUTION OF CONTRACTS AND RELATED DOCUMENTS.

11. GRAND TOTAL $9,106,000.00

12. TRANSPORTATION ALLOTMENT (Used if FOB Contractor's plant)

13. MAIL INVOICES TO (Payment will be made by)
U.S. Army Corps of Engineers
HECSA, ATTN: CEHEC-RM-F, Casey Bldg.
Ft Belvoir, VA 22060 DISBURSING OFFICE SYMBOL

14. FUNDS FOR PROCUREMENT ARE PROPERLY CHARGEABLE TO THE ALLOTMENTS SET FORTH BELOW, THE AVAILABLE BALANCES OF WHICH ARE SUFFICIENT TO COVER THE ESTIMATED TOTAL PRICE.

ACTN	APPROPRIATION	LIMIT SUBHEAD	SUPPLEMENTAL ACCOUNTING CLASSIFICATION	ACCTG STA SYMBOL SUBHEAD	AMOUNT
	9721400.1101		08-8000 633716 PD 2585 PF2541633769100 FUNDS AVAILABLE: FOR: JOAN A. MCDONALD, F&A OFC	S44213	$9,106,000.00 1-11-93

15. AUTHORIZING OFFICER (Type name and title): DAWSON C. MAY, ASST DIR, LAB OPNS

16. SIGNATURE

17. DATE 1/4/93

ACCEPTANCE OF MIPR

1. TO (Requiring Activity Address) (Include ZIP Code)	2. MIPR NUMBER	3. AMENDMENT NO.
U.S. Army Corps of Engineers HECSA,ATTN: CEHEC-RM-F, Casey Bldg. Ft. Belvoir 22060	E8793L191	Initial
	4. DATE (MIPR Signature Date) 1/21/93	5. AMOUNT (As Listed on the MIPR) $9,106,000.00

6. The MIPR identified above is accepted and the items requested will be provided as follows: (Check as Applicable)

a. [XX] ALL ITEMS WILL BE PROVIDED THROUGH REIMBURSEMENT (Category I)

b. [ ] ALL ITEMS WILL BE PROCURED BY THE DIRECT CITATION OF FUNDS (Category II)

c. [ ] ITEMS WILL BE PROVIDED BY BOTH CATEGORY I AND CATEGORY II AS INDICATED BELOW

d. [ ] THIS ACCEPTANCE, FOR CATEGORY I ITEMS, IS QUALIFIED BECAUSE OF ANTICIPATED CONTINGENCIES AS TO FINAL PRICE. CHANGES IN THIS ACCEPTANCE FIGURE WILL BE FURNISHED PERIODICALLY UPON DETERMINATION OF DEFINITIZED PRICES, BUT PRIOR TO SUBMISSION OF BILLINGS.

7. [ ] MIPR ITEM NUMBER(S) IDENTIFIED IN BLOCK 13, "REMARKS" IS NOT ACCEPTED (IS REJECTED) FOR THE REASONS INDICATED.

8. TO BE PROVIDED THROUGH REIMBURSEMENT CATEGORY I			9. TO BE PROCURED BY DIRECT CITATION OF FUNDS CATEGORY II		
a. ITEM NO.	b. QUANTITY	c. ESTIMATED PRICE	a. ITEM NO.	b. QUANTITY	c. ESTIMATED PRICE
		$9,106,000.00			
d. TOTAL ESTIMATED PRICE		$9,106,000.00	d. TOTAL ESTIMATED PRICE		

CERTIFICATION OF AVAILABILITY OF FUNDS
(8)
40-04-03-26-9 $775,194.00
E8793L191
F056
Date: 8/12/93 John D. Johnson

10. ANTICIPATED DATE OF OBLIGATION FOR CATEGORY II ITEMS

11. GRAND TOTAL ESTIMATED PRICE OF ALL ITEMS
$9,106,000.00

12. FUNDS DATA (Check if Applicable)

a. [ ] ADDITIONAL FUNDS IN THE AMOUNT OF $_____ ARE REQUIRED (See justification in Block 13)

b. [ ] FUNDS IN THE AMOUNT OF $_____ ARE NOT REQUIRED AND MAY BE WITHDRAWN

13. REMARKS

*F. CAREY authorized receiving official. W. CHERNOCK authorized accepting official.

*16. WP Chernock
WARREN P. CHERNOCK, Deputy Science & Technology Advisor for Defense Programs

14. ACCEPTING ACTIVITY (Complete Address)	15. TYPED NAME AND TITLE OF AUTHORIZED OFFICIAL	
U.S. Department of Energy ATIN: Dr. Fenton Carey 1000 Independence Ave. S.W. Washington, D.C. 20585	Fenton Carey, Director, Office of Space 16. SIGNATURE: Carey	17. DATE: 1/22/93

DD FORM 448-2 PREVIOUS EDITION WILL BE USED UNTIL EXHAUSTED. WILL GOVERN ALL AGREEMENTS

DOE F 1325.8
(8-89)
EFG (07-90)

93-1914

United States Government **Department of Energy**

memorandum

CERTIFYING OFFICIAL:
Fred Glatstein
Signature:
Date: 7/27/93

DATE: MAR 30 1993

REPLY TO ATTN OF: CE-13

04 3222 93.2037

SUBJECT: ***FY 93 Guidance to Sandia National Laboratories (SNL) in support of the Solar Thermal Dish/Stirling System for Department of Defense Applications [Part of the DOE-DoD Reimbursable Work Order Agreement for Strategic Environmental Research and Development Program (SERDP) Phase II]***

TO:

Mr. Bruce G. Twining, Manager
Albuquerque Field Office
P. O. Box 5400
Albuquerque, NM 87185-5400

This memorandum transmits $800,000 under the attached reimbursable work agreement to SNL to manage and support the purchase, installation, and operation of a 7.5 kW_e solar parabolic dish/Stirling system on a military facility. This task is one of the projects for the Phase II SERDP reimbursable work order agreement between DOE and DoD. The remaining balance of funds in the agreement will be obligated by other DOE organizations. The Budget and Reporting number is EB 4004-03209.

Attached are: the memorandum by Dr. Fenton Carey--DOE SERDP Coordinator--authorizing initiation of work; the Military Interdepartmental Request (MIPR) by the U.S. Army Corps of Engineers; the DOE acceptance of the MIPR; the Field Work Proposal; and the Statement of Work. The memorandum instructs Field Finance Officers to transmit their monthly bill (with reference to MIPR #E8793L191) to the following address where a consolidated DOE bill will be sent to the U.S. Army Corps of Engineers.

U.S. Department of Energy
Office of Headquarters Accounting Operations (CR-52)
ATTN: Mr. George Tengan
P.O. Box 500
Germantown, MD 20875-5000

Significant program issues regarding this program authorization should be directed to Gary Burch, Director of the Solar Thermal and Biomass Power Division at DOE Headquarters, (202) 586-0081. The SNL field representative is Craig Tyner, (505) 844-3340. Financial issues should be directed to George Tengan, Director of the Accounting Division at DOE Headquarters, (202) 586-5878.

Robert H. Annan, Director
Office of Solar Energy Conversion
Conservation and Renewable Energy

Attachments

cc: George Tengan, Director of Accounting (CR-52)
Office of Headquarters Accounting Operations

WORK AUTHORIZATION

U.S. DEPARTMENT OF ENERGY
Management and Operating (M&O) Contract Work Authorization

1. INITIATOR: Gary Burch 2/25/93 CE-132 (202) 586-0081
NAME & SIGNATURE ORGANIZATION CODE TELEPHONE NO.

2. PROJECT TITLE: Strategic Environmental R&D Program (SERDP)--Phase II:
Solar Thermal Dish/Stirling System for DoD Applications

3. RESPONSIBLE ASSISTANT SECRETARY: Conservation and Renewable Energy

4. RESPONSIBLE OPERATIONS OFFICE: Albuquerque Field Office

5. M&O CONTRACTOR NAME: AT&T Technologies, Incorporated

6. WORK AUTHORIZATION NO.: EB/40043/AL/08 7. REVISION NO.: 00

8. FUNDS HEREBY AUTHORIZED:

B&R No.	$000
EB/4004/03209	$800

9. PERFORMANCE PERIOD COVERED BY FUNDS
FROM: 02/01/93 TO: 9/30/95
10. WORK START DATE: 02/01/93
11. EXPECTED COMPLETION DATE: TBD
12. FUTURE FUNDING PLANNED ($000): None

13. WORK AUTHORIZED: (Brief description, schedule, results or products, and reporting requirements, and any shifting of funds permitted within the work authorization):

Through a reimbursable work order agreement with Department of Defense (DoD), DOE is tasked to buy, install, and operate a 7.5 kW_e Solar Parabolic Dish/Stirling system at a military facility. Sandia National Laboratories will select a military facility and then, in FY 94, purchase the dish/Stirling system from Cummins Power Generation, Incorporated (CPG). CPG will install and train DoD personnel to operate and maintain the system. Sandia and CPG will provide operational and maintenance support.

This effort is one of the Phase II Strategic Environmental R&D Program projects that will result in the military being able to generate clean, independent, and secure power from DoD installations. The effort also gives all involved parties first-hand operational experience on the solar dish/Stirling system.

Detailed task descriptions, schedules, and reporting requirements are per the Field Work Proposal (FWP) and the Statement of Work (SOW).

NAME & SIGNATURE DATE

14. WORK AUTHORIZATION OFFICIAL: Robert H. Annan 3-19-93

15. OPERATIONS OFFICE OFFICIAL: _____ _____

16. M&O CONTRACTOR OFFICIAL: _____ _____

Department of Energy

Washington, DC 20585

January 22, 1993

MEMORANDUM FOR ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
DIRECTOR OF ENERGY RESEARCH
ASSISTANT SECRETARY FOR ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

SUBJECT: STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM (SERDP) PHASE II PLANNING GUIDANCE

This memorandum authorizes your offices to initiate work on the Department of Energy (DOE) SERDP Phase II projects listed below at the plan level. The Department of Defense (DoD) fiscal year (FY) 1992 Supplemental Appropriations, Transfers, and Rescissions Bill (H.R. 5620) has approved $24.6 million for Phase II SERDP projects previously approved by the SERDP Council and Scientific Advisory Board.

	Funding Required Per Proposals $(000)	DOE Plan $(000)
■ Windfarm for Military Applications (CE-131)	$1,400	$1,300
■ Geothermal Heat Pumps (CE-131)	$ 500	$ 400
■ Solar Thermal Dish/Sterling for DoD Applications (CE-131)	$ 900	$ 800
■ Environmentally Safe Disposal of Explosive Wastes (DP-40)	$1,800	$1,400
■ Innovative Treatment of Contaminated Groundwater at McClellan Air Force Base	$1,200	$1,153
Total	$5,800	$5,053

Secretarial Officers are reminded that project managers must control and limit the reimbursable expenses to the allocation shown above. Please have your project managers provide me updated research proposals based on the revised funding by January 29, 1993.

Furthermore, the respective support Field Finance Officers should be instructed to transmit their monthly bill (with reference to MIPR number E8793L191) to the following address where a consolidated DOE bill will be sent to the U.S. Corps of Engineers.

U.S. Department of Energy
Office of Headquarters Accounting Office (CR-52)
ATTN: Mr. George Tengan
P.O. Box 500
Germantown, MD 20875-5000

If you have any questions, please have your staffs contact me at (202) 586-7008 or George Tengan at 301-903-5878.

Fenton Carey

Fenton Carey
DOE SERDP Coordinator

cc: Chief Financial Officer
DOE SERDP Working Group
DOE SERDP Technology Thrust Area
Working Group Members

MILITARY INTERDEPARTMENTAL PURCHASE REQUEST

1. PAGE 1 OF 1 PAGES

2. FSC	3. CONTROL SYMBOL NO.	4. DATE PREPARED	5. MIPR NUMBER	6. AMEND NO.
		5/12/93		INITIAL

7. TO:
DEPARTMENT OF ENERGY
ATTN: DR. FENTON CAREY
1000 INDEPENDENCE AVE SW
WASHINGTON, DC 20585

8. FROM: *(Agency, name, telephone number of originator)*
HQ, U.S. ARMY CORPS OF ENGINEERS
ATTN: ELOISA E. BROWN (202) 272-1834
20 MASS AVE, NW,
WASHINGTON, DC 20314-1000

9. ITEMS ☐ ARE ☐ ARE NOT INCLUDED IN THE INTERSERVICE SUPPLY SUPPORT PROGRAM AND REQUIRED INTERSERVICE SCREENING ☐ HAS ☐ HAS NOT BEEN ACCOMPLISHED.

ITEM NO. a	DESCRIPTION *(Federal stock number, nomenclature, specification and/or drawing No., etc.)* b	QTY c	UNIT d	ESTIMATED UNIT PRICE e	ESTIMATED TOTAL PRICE f
1	$1,000,000.00 FY93 SERDP funds provided to the Department of Energy (DOE) for the remaining of their Phase II projects.				$1,000,000
2	Request two (2) signed (DD448-2), acceptance copies be promptly returned to the finance and accounting office named below(block #13). Submit SF1080 billings to the same address. The complete order number must appear on all billings. Indicate partial or final billings. Any unused balance should be reported for withdrawal immediately to the finance and accounting office below.				
3	Funds expire 30 Sep 94.				

10. SEE ATTACHED PAGES FOR DELIVERY SCHEDULES, PRESERVATION AND PACKAGING INSTRUCTIONS, SHIPPING INSTRUCTIONS AND INSTRUCTIONS FOR DISTRIBUTION OF CONTRACTS AND RELATED DOCUMENTS.

11 GRAND TOTAL $1,000,000

12. TRANSPORTATION ALLOTMENT *(Used if FOB Contractor's plant)*

13. MAIL INVOICES TO *(Payment will be made by)*
U.S. Army Coprs of Engineers (HECSA)
ATTN: CEHEC-RM-F (Casey Bldg)
Ft. Belvoir, VA 22060
PAY OFFICE DODAAD

14. FUNDS FOR PROCUREMENT ARE PROPERLY CHARGEABLE TO THE ALLOTMENTS SET FORTH BELOW, THE AVAILABLE BALANCES OF WHICH ARE SUFFICIENT TO COVER THE ESTIMATED TOTAL PRICE.

ACRN	APPROPRIATION	LIMIT/ SUBHEAD	SUPPLEMENTAL ACCOUNTING CLASSIFICATION	ACCTG STA DODAAD	AMOUNT
	9730400	1101	08-8000 633716 PD 2585 PF3541633769100 FUNDS AVAILABLE: [signature] 5/17/93 FOR: JOAN A. MCDONALD, F&A OFFICER	S44213	$1,000,000

15. AUTHORIZING OFFICER *(Type name and title)*
DAWSON C. MAY, ASST DIR, LAB OPNS

16. SIGNATURE [signature]

17. DATE 5/12/93

DD FORM 1 JUN 72 448 PREVIOUS EDITION IS OBSOLETE.

ACCEPTANCE OF MIPR

1. TO (Requiring Activity Address) (Include ZIP Code)	2. MIPR NUMBER	3. AMENDMENT NO
U.S. Army Corps of Engineers (HECSA) ATTN: CEHEC-RM-F, Casey Bldg. Ft. Belvoir 22060	E8793L353	Initial
	4. DATE (MIPR Signature Date): 5/12/93	5. AMOUNT (As Listed on the MIPR): $ 1,000,000

6. The MIPR identified above is accepted and the items requested will be provided as follows: (Check as Applicable)

a. [XX] ALL ITEMS WILL BE PROVIDED THROUGH REIMBURSEMENT (Category I)

b. [ ] ALL ITEMS WILL BE PROCURED BY THE DIRECT CITATION OF FUNDS (Category II)

c. [ ] ITEMS WILL BE PROVIDED BY BOTH CATEGORY I AND CATEGORY II AS INDICATED BELOW

d. [ ] THIS ACCEPTANCE, FOR CATEGORY I ITEMS, IS QUALIFIED BECAUSE OF ANTICIPATED CONTINGENCIES AS TO FINAL PRICE. CHANGES IN THIS ACCEPTANCE FIGURE WILL BE FURNISHED PERIODICALLY UPON DETERMINATION OF DEFINITIZED PRICES, BUT PRIOR TO SUBMISSION OF BILLINGS.

7. [ ] MIPR ITEM NUMBER(S) IDENTIFIED IN BLOCK 13, "REMARKS" IS NOT ACCEPTED (IS REJECTED) FOR THE REASONS INDICATED.

8. TO BE PROVIDED THROUGH REIMBURSEMENT CATEGORY I			9. TO BE PROCURED BY DIRECT CITATION OF FUNDS CATEGORY II		
ITEM NO. a	QUANTITY b	ESTIMATED PRICE c	ITEM NO. a	QUANTITY b	ESTIMATED PRICE c
		$ 1,000,000			
d. TOTAL ESTIMATED PRICE		$ 1,000,000	d. TOTAL ESTIMATED PRICE		

CERTIFICATION OF AVAILABILITY OF FUNDS

(8)
40-04-03-209 $96,899.00
E8793L353
#057
Date: 8/12/93 John S. Johnson

10. ANTICIPATED DATE OF OBLIGATION FOR CATEGORY II ITEMS

11. GRAND TOTAL ESTIMATED PRICE OF ALL ITEMS: $ 1,000,000

12. FUNDS DATA (Check if Applicable)

a. [ ] ADDITIONAL FUNDS IN THE AMOUNT OF $_____ ARE REQUIRED (See Justification in Block 13)

b. [ ] FUNDS IN THE AMOUNT OF $_____ ARE NOT REQUIRED AND MAY BE WITHDRAWN

13. REMARKS

* F. CAREY authorized receiving official
W. CHERNOCK authorized accepting official

*16. W. P. Chernock
Warren P. CHERNOCK, Deputy Sceince & Technology Advisor for Defense Programs

14. ACCEPTING ACTIVITY (Complete Address)	15. TYPED NAME AND TITLE OF AUTHORIZED OFFICIAL	
U.S. Department of Energy ATTN: Dr. Fenton Carey 1000 Independence Ave. SW, Wash., DC 20585	Fenton Carey, Director, Office of Space 16. SIGNATURE	17. DATE: 5/17/93

DD FORM 448-2 JUL 91 PREVIOUS EDITION WILL BE USED UNTIL EXHAUSTED. ☆U.S. GPO: 1985-461-033/27163

DOE F 1325.8
(6-89)
EFG (07-90)

93-1915

United States Government

Department of Energy

memorandum

CERTIFYING OFFICIAL:
Fred Glatstein
Signature:
Date: 6/17/93

DATE: JUN 17 1993 EE-132

REPLY TO ATTN OF:

SUBJECT: FY 93 Additional Funding to Sandia National Laboratories (SNL) in support of the Solar Thermal Dish/Stirling System [Part of the DOE-DoD Reimbursable Work Order Agreement for Strategic Environmental Research and Development Program (SERDP)]

SOLAR DISH/STIRLING SYSTEM

TO: Bruce G. Twining, Manager
Albuquerque Field Office
P. O. Box 5400
Albuquerque, NM 87185-5400

This memorandum transmits an additional $100,000 to the original $800,000 reimbursable work agreement to SNL to manage and support the purchase, installation, and operation of a 7.5 kW_e solar parabolic dish/Stirling system on a military facility. This task, now totaling $900,000, is one of the projects for the Phase II SERDP reimbursable work order agreement between DOE and DoD. The Budget and Reporting number is EB 4004-03209.

Attached are: the memorandum by Dr. Fenton Carey--DOE SERDP Coordinator--authorizing the revised FY 93 funding levels; the Military Interdepartmental Request (MIPR) by the U.S. Army Corps of Engineers; and the DOE acceptance of the MIPR. These three documents are addendums to the original documents sent in the March 30, 1993, FY 93 Guidance to SNL to support SERDP; the March 30, 1993, cover memorandum is also attached for your reference.

The Carey memorandum instructs Field Finance Officers to transmit their monthly SF1000 bill, with reference to MIPR #E8793L-353 for the additional work funded, to the following address where a consolidated DOE bill will be sent to the U.S. Army Corps of Engineers. Please note that the MIPR number and funding expiration date (September 30, 1994) for this additional $100,000 funding differ from the original MIPR #E8793L-191 and expiration date of September 30, 1993.

U.S. Department of Energy
Office of Headquarters Accounting Operations (CR-52)
ATTN: Mr. George Tengan
P.O. Box 500
Germantown, MD 20875-5000

Significant program issues regarding this authorization should be directed to Gary Burch, Director of the Solar Thermal and Biomass Power Division at DOE Headquarters, (202) 586-0081. The SNL field representative is Craig Tyner, (505) 844-3340. Financial issues should be directed to George Tengan, Director of the Accounting Division at DOE Headquarters, (301) 903-5878.

Robert H. Annan, Director
Office of Solar Energy Conversion
Energy Efficiency and Renewable Energy

Attachments

cc: George Tengan, Director of Accounting (CR-52)
Office of Headquarters Accounting Operations

WORK AUTHORIZATION

U.S. DEPARTMENT OF ENERGY
Management and Operating (M&O) Contract Work Authorization

1. INITIATOR: Gary Burch 6/8/93 | CE-132 | (202) 586-0081
   NAME & SIGNATURE | ORGANIZATION CODE | TELEPHONE NO.

2. PROJECT TITLE: Strategic Environmental R&D Program (SERDP)--Phase II:
   Solar Thermal Dish/Stirling System for DoD Applications

3. RESPONSIBLE ASSISTANT SECRETARY: Conservation and Renewable Energy

4. RESPONSIBLE OPERATIONS OFFICE: Albuquerque Field Office

5. M&O CONTRACTOR NAME: AT&T Technologies, Incorporated

6. WORK AUTHORIZATION NO.: EB/40043/AL/08

7. REVISION NO.: 01

8. FUNDS HEREBY AUTHORIZED:

B&R No.	$000
EB/4004/03209	$100

9. PERFORMANCE PERIOD COVERED BY FUNDS
   FROM: 02/01/93 TO: 9/30/94
10. WORK START DATE: 02/01/93
11. EXPECTED COMPLETION DATE: TBD
12. FUTURE FUNDING PLANNED ($000): None

13. WORK AUTHORIZED: (Brief description, schedule, results or products, and reporting requirements, and any shifting of funds permitted within the work authorization):

An additional $100,000 FY 93 funding is being added to the original $800,00 reimbursable work order agreement between Department of Defense (DoD) and DOE for DOE to buy, install, and operate a 7.5 kW_e Solar Parabolic Dish/Stirling system at a military facility. Sandia National Laboratories will select a military facility and then, in FY 94, purchase the dish/Stirling system from Cummins Power Generation, Incorporated (CPG). CPG will install and train DoD personnel to operate and maintain the system. Sandia and CPG will provide operational and maintenance support.

This effort is one of the Phase II Strategic Environmental R&D Program projects that will result in the military being able to generate clean, independent, and secure power from DoD installations. The effort also gives all involved parties first-hand operational experience on the solar dish/Stirling system.

Detailed task descriptions, schedules, and reporting requirements are per the Field Work Proposal and the Statement of Work provided in the original work authorization package sent on March 30, 1993.

	NAME & SIGNATURE	DATE
14. WORK AUTHORIZATION OFFICIAL:	Robert H. Annan	6/15/93
15. OPERATIONS OFFICE OFFICIAL:		
16. M&O CONTRACTOR OFFICIAL:		

Rec 5/26 HHM
EE-10 0622

Department of Energy
Washington, DC 20585

May 24, 1993

1993 MAY 26 P 3:00

MEMORANDUM FOR ASSISTANT SECRETARY FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY
ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
DIRECTOR, OFFICE OF ENERGY RESEARCH
ASSISTANT SECRETARY FOR ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

SUBJECT: STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM (SERDP) PHASE II REVISED PLANNING GUIDANCE

This memorandum updates my memorandum of February 24, 1993, authorizing your offices to perform additional work on SERDP Phase II projects. In January 1993, SERDP reduced the Department's $6.5 million funding for Phase II projects by $1.447 million to offset Congressional undistributed adjustments with the expectation that $1.232 million additional funding would be provided in 1993. On February 19, 1993, SERDP forwarded $432,000 of the funding to the Department and on May 12, 1993, provided an additional $1.0 million fiscal year 1993 funds. The following is the revised funding level for the Department's SERDP Phase II projects based on the additional $1,000,000.

	Previous DOE allocation $(000)	Current DOE allocation $(000)
• Windfarm for Military Applications (CE-131)	$1,385	$1,385
• Geothermal Heat Pumps (CE-131)	$ 400	$ 500
• Solar Thermal Dish/Sterling for DoD Applications (CE-131)	$ 800	$ 900
• Environmentally Safe Disposal of Explosive Wastes (DP-40)	$1,700	$1,800
• Innovative Treatment of Contaminated Groundwater at McClellan Air Force Base (EM-50)	$1,200	$1,200
• Rapid Screening Reversibie Sensor for Environmental Screening and Monitoring (EM-50)	0	$ 700
Total	$5,485	$6,485

Secretarial Officers are reminded that project managers must control and limit the reimbursable expenses to the allocation shown above. Please have your project managers update the research proposals based on the revised funding.

Furthermore, the respective support Field Finance Officers should be instructed to transmit their monthly SF1000 bill with reference to MIPR number E8793L353 for the additional work funded above to the following address where a consolidated DOE bill will be sent to the U.S. Army Corps of Engineers.

U.S. Department of Energy
Office of Headquarters Accounting Office (CR-52)
ATTN: Mr. George Tengan
P.O. Box 500
Germantown, MD 20875-5000

If you have any questions, please have your staffs contact me at (202) 586-7008 or George Tengan at (301) 903-5878.

Fenton Carey
DOE SERDP Coordinator

cc: Chief Financial Officer
DOE SERDP Working Group Members
DOE SERDP Technology Thrust Area
Working Group Members

Appendix D

Site Selection

Sandia National Laboratories

P.O. Box 5800
Albuquerque, New Mexico 87185-0703

Managed by Martin Marietta Corporation
for the U.S. Department of Energy

date: May 19, 1994

to: R. B. Diver, MS 0703, Dept. 6216

from: D. F. Menicucci, MS 0703, Dept. 6216

subject: Site Selection for SERDP Dish/Stirling System/Completion of Military Site Survey

As we agreed, I am responsible for identifying a military installation to receive a prototype dish/Stirling system funded through the SERDP program. I also agreed to survey southwest U.S. military installations to assess their applicability for dish/Stirling applications. This is a progress report on both efforts.

Attachment 1 is a summary of the results of the application of the dish/Stirling site selection criteria to twelve military installations in the Southwest U.S. The criteria, which we jointly reviewed and approved, are described in my memo to Warren Louis (6218) dated April 13. As you can see, Ft. Huachuca received the highest point total indicating that it is probably the best location for the dish/Stirling system. The next step is to present these results to the DOD Tri-Service Renewable Energy Committee (TREC) and ask for their concurrence in selecting Ft. Huachuca as the site for the system.

Since Sandia will be funding most of the installation of the system, we intend to place a sole-source contract with the selected institution. Last year I consulted with our purchasing department about our selection process. At that time, I was told that the process we planned was sufficient to justify a sole source contract. However, I was encouraged to again review our selection process with purchasing after we had applied our criteria and/or had received the TREC's final recommendation. I am planning to meet with Roy Crumley sometime in the next month. You are welcome to join me.

Attachments 2-13 are summary sheets for each of the twelve military installation in the Southwest U.S. that were candidates for receiving the dish/Stirling system under the SERDP program. These sites represent all of the major military installations within the high direct normal resource region of the U.S. (Bases/forts that are being considered or are scheduled for closure were not included). Please let me know if these data satisfy the requirement for the survey that is required as part of this SERDP effort.

DFM:6216

Copy to:
MS 0703 6216 C. E. Tyner
MS 0703 6216 D. F. Menicucci

DISH/STIRLING SITE SELECTION

Maximum Points and Criteria for Dish/Stirling (D/S) site location:

1. Max=22pts, Minimum of 6.0 kWh/mxm/day solar resource.
2. Max=22pts, Base willingness to share project cost.
3. Max=14pts, Amount of land area available for system.
4. Max=14pts, Bases electrical cost, (>$.10 per kWh).
5. Max=14pts, % of available insolation hrs allowed to operate.
6. Max=14pts, Level of command support.

Military Bases considered:

A. Kirtland Air Force Base, Albuquerque, NM
B. White Sands Missile Range, Alamogordo, NM
C. Fort Bliss, El Paso, TX
D. Fort Huachuca, Sierra Vista, AZ
E. Yuma Proving Grounds, Yuma, AZ
F. Marine Corps Air Station, Yuma, AZ
G. Luke Air Force Range, Gila Bend, AZ
H. Marine Corps Air Ground Combat Center, Twentynine Palms, CA
I. Chocolate Mountain Gunnery Range, Salton Sea, CA
J. Fort Irwin Military Reservation, Ridgecrest, CA
K. China Lake Naval Weapons Center, Ridgecrest, CA
L. Nellis Air Force Base, Las Vegas, NV

Point Accumulation for each Base:

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.
1.	20.2	20.2	20.2	17.3	20.2	20.2	13.7	15.4	20.2	14.8	14.8	22.0
2.	0.0	0.0	11.0	22.0	11.0	11.0	0.0	5.5	11.0	22.0	0.0	0.0
3.	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	7.0	14.0	14.0	14.0
4.	6.5	4.1	3.6	6.5	4.8	2.9	2.9	14.0	1.0	4.8	0.0	2.4
5.	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	0.0	14.0
6.	11.0	14.0	11.0	14.0	7.0	11.0	11.0	4.0	11.0	14.0	4.0	4.0
Total	65.7	66.3	73.8	87.8	71.0	73.1	55.6	66.9	64.2	83.6	39.8	56.4

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: A.

BRANCH OF SERVICE: AIR FORCE

BASE NAME: KIRTLAND AIR FORCE BASE

BASE LOCATION: ALBUQUERQUE, N.M

POINT OF CONTACT: STEVE KLEM, ENERGY MGT OFFICE

TELEPHONE #: 505/846-2453

FAX #: 7903

ADDRESS:

POINTS:

1. 20.2, ALBUQUERQUE, NM, 7.32 kWH/M²/DAY
2. 0, NONE FROM BASE
3. 14, PLENTY
4. 6.5, 7/¢/KWH, PNM
5. 14, 100%
6. 11, FAIR

TOTAL: 65.7

REMARKS: INSTALLING A 200 KW FUEL CELL, MIKE BINDER @ CERL.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: B

BRANCH OF SERVICE: ARMY

BASE NAME: WHITE SANDS MISSILE RANGE

BASE LOCATION: ALAMOGORDO, NM

POINT OF CONTACT: CRAIG BROWN / JULIEN DELGADO

TELEPHONE #: 505/678-8759 / 5415

FAX #: 2792

ADDRESS: STEWS-EH-PE WSMR, NM 88002-5076

POINTS:

1. 20.2, EL PASO, TX, 7.32 KWH/M²/DAY
2. 0, NO!
3. 14, PLENTY
4. 4.1, 7.7 ¢/KWH
5. 14, 100%
6. 14, GOOD

TOTAL: 66.3

REMARKS: 1. TRACY DOWDY, SOLAR COORD 505/678-2815
2. NUCLEAR EFFECTS, DR MEASON

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: C

BRANCH OF SERVICE: ARMY

BASE NAME: FORT BLISS

BASE LOCATION: EL PASO, TX

POINT OF CONTACT: MR. MATHIS, ENERGY COORD.

TELEPHONE #: 915/568-2300

FAX #:

ADDRESS:

POINTS:

1. 20.2, EL PASO, TX, 7.32 KWH/M²/DAY
2. 11, SOME $
3. 14, PLENTY
4. 3.6, 7.5¢/KWH
5. 14, 100%
6. 11, FAIR

TOTAL: 73.8.

REMARKS: 1. GEOTHERMAL SOURCE, SNTD1, 4TEP & SERDP.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: D

BRANCH OF SERVICE: ARMY

BASE NAME: FORT HUACHUCA

BASE LOCATION: SIERRA VISTA, AZ

POINT OF CONTACT: BILL STIEN, ENERGY COORD.

TELEPHONE #: 602/533-1861

FAX #:

ADDRESS:

POINTS:

1. 17.3, TUCSON, AZ, 7.12 KWH/M²/DAY
2. 22. YES
3. 14. PLENTY
4. 6.5. 8.7¢/KWH
5. 14. 100%
6. 14. HIGH

TOTAL: 87.8.

REMARKS: BASE IS VERY ACTIVE IN ALTERNATIVE ENERGY PROJECTS AND HAS A VERY HIGH VISIBILITY TO WORLD WIDE ORGANIZATIONS THAT USE THEIR FACILITIES!

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: E

BRANCH OF SERVICE: ARMY

BASE NAME: YUMA PROVING GROUNDS

BASE LOCATION: YUMA, AZ

POINT OF CONTACT: JACK NIXON, ENERGY COORD.

TELEPHONE #: 602/328-2198

FAX #:

ADDRESS:

POINTS:

1. 20.2, YUMA, AZ, 7.31 KWH/M²/DAY
2. 11, YES, IF NOT EXCESSIVE
3. 14, PLENTY
4. 4.8, 8¢/KWH
5. 14, 100%
6. 7, FAIR, DEPENDING

TOTAL: 71,

REMARKS: HAVE EXISTING PROJECT FOR ECIP.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: F

BRANCH OF SERVICE: MARINES

BASE NAME: MARINE CORPS AIR STATION YUMA

BASE LOCATION: YUMA, AZ

POINT OF CONTACT: RON DHRFEY, ENGY MGR, CHUCK FOSTER, BASE EE,

TELEPHONE #: 602/341-2734 / 3521

FAX #: 2551

ADDRESS: FACILITIES, CODE 3JD3, BOX 99140, 85369-9140

POINTS:

1. 20.2 YUMA, AZ, 7.31 KWH/M²/DAY
2. 11, SOME
3. 14, PLENTY
4. 2.9, 7.2¢/KWH
5. 14, 100%
6. 11, FAIR

TOTAL: 73.1

REMARKS: RANGE OFFICER, CAPT LITTLE, 602/341-3651

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: G

BRANCH OF SERVICE: AIR FORCE

BASE NAME: LUKE AIR FORCE RANGE

BASE LOCATION: GILA BEND, AZ

POINT OF CONTACT: JESSE COLE/RON LOPER, CAPT MCWETHY, BASE C.E.

TELEPHONE #: 602/856-5205/5224

FAX #:

ADDRESS:

POINTS:

1. 13.7, PHOENIX, AZ, 6.90 KWH/M²/DAY
2. 0, NO
3. 14, PLENTY
4. 2.9, 7.2¢/KWH, APS
5. 14, 100%
6. 11, GOOD

TOTAL: 55.6,

REMARKS: LUKE AIR FORCE BASE, GLENDALE, AZ, 602/856-7411, GILA BEND, AZ AUXILIARY AIR FIELD, 7074, UTIL; 7422, CE-5224 683-6200

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: H.

BRANCH OF SERVICE: MARINES

BASE NAME: MARINE CORPS AIR GROUND COMBAT CENTER (MCAGCC)

BASE LOCATION: TWENTY NINE, PALMS, CA

POINT OF CONTACT: LUKE LUDREN, ENERGY MGR

TELEPHONE #: 619/830-5128

FAX #: 7128

ADDRESS: CIV, FAC & MAINT MCAGCC 92278-5000

POINTS:

1. 15.4. DAGGET T, CA, 7.08 KWH/M²/DAY
2. 5.5. LOW
3. 14. PLENTY
4. 14. 11.8¢/KWH, SCE
5. 14. 100%
6. 4. MED TO LOW.

TOTAL: 66.9.

REMARKS: PV HYBRID SYSTEM, 100KVA, BEING INSTALLED AT RANGE 500, ECIP.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: I

BRANCH OF SERVICE: MARINES

BASE NAME: CHOCOLATE MOUNTAIN GUNNERY RANGE

BASE LOCATION: EL CENTRO, CA

POINT OF CONTACT: TOM ROLF, RANGE OPERATIONS

TELEPHONE #: 619/339-2665, 2627

FAX #:

ADDRESS:

POINTS:

1. 20.2. YUMA, AZ, 7.31 KWH/M²/DAY
2. 11. SOME
3. 7. LIMITED LAND WHERE POWER NEEDED.
4. 1. 6.2¢/KW.H, IMPERIAL IRRIGATION DIST. 619/339-9416 MR. PATE.
5. 14. 100%
6. 11. FAIR

TOTAL: 64.2.

REMARKS: COMM, DATA, ELEC., DEPT, MCAS
ATTN: DENNIS HANSEN
BOX 99105
YUMA, AZ 85369-9105
602/341-2973 BASE ELECTRONICS

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: J

BRANCH OF SERVICE: ARMY

BASE NAME: FORT IRWIN MILITARY RESERVATION

BASE LOCATION: RIDGECREST, CA

POINT OF CONTACT: RENÉ QUINONES, DPW

TELEPHONE #: 619/386-3743

FAX #:

ADDRESS:

POINTS:

1. 14.8, CHINA LAKE, CA, 6.96 KWH/M²/DAY
2. 22. YES
3. 14. PLENTY
4. 4.8. 8¢/KWH
5. 14. 100%
6. 14. GOOD

TOTAL: 83.6.

REMARKS: GAVE HIM ROCH DUCEYS TEL.#.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: K

BRANCH OF SERVICE: NAVY

BASE NAME: CHINA LAKE NAVAL WEAPONS STATION

BASE LOCATION: RIDGECREST, CA

POINT OF CONTACT: CNWCK COMBS

TELEPHONE #: 619/939-0048

FAX #:

ADDRESS:

POINTS:

1. 14.8, CHINA LAKE, CA, 6.96 KWH/M²/DAY
2. 0, NO!
3. 14, PLENTY
4. 0, 6¢/KWH
5. 7, 50%
6. 4, LOW

TOTAL: 39.8,

REMARKS: CURRENTLY HAVE SEVERAL ALTERNATIVE ENERGY DEMO'S.

DISH/STIRLING SITE SELECTION DATA SHEET

LETTER DISIGNATION: L

BRANCH OF SERVICE: AIR FORCE

BASE NAME: NELLIS AIR FORCE BASE (AIR COMBAT COMMAND)

BASE LOCATION: LAS VEGAS, NV

POINT OF CONTACT: GENE ROGERS, STAFF CIV. ENGR.

TELEPHONE #: 702/652-6862, 1110

FAX #:

ADDRESS:

POINTS:

1. 22, LAS VEGAS, NV, 7.43 KWH/M²/DAY
2. 0, NO!
3. 14, PLENTY
4. 2.4, 7¢/KWH
5. 14, 100%
6. 4, LOW.

TOTAL: 56.4

REMARKS:

Sandia National Laboratories

P.O. Box 5800
Albuquerque, New Mexico 87185-0703

Managed by Martin Marietta Corporation
for the U.S. Department of Energy

date: June 10, 1994

to: W. Louis, MS 753, Dept. 6218

from: D. F. Menicucci, MS 0703, Dept. 6216

subject: Additional Information Regarding Potential for Dish/Stirling in Military Facilities

Thank you for your memo dated May 18, 1994 that reported the results of the application of our dish/Stirling site selection criteria. We concur with the conclusion that among the twelve military installations you surveyed, Ft. Huachuca is most applicable to receive a dish/Stirling system. As we discussed yesterday, please advise me on the procedure for presenting this information to the Tri-Service Renewable Energy Committee.

Also, as we have discussed, we are interested in the market potential for dish/Stirling systems within the sites that you recently surveyed. Specifically, we would like to have the following information: 1) a general description of each facility, 2) a description of the type of operations at each facility, and 3) an estimate of the number of dish/Stirling systems that might be installed in each facility in the near and distant future. We believe that dish/Stirling systems are most applicable in remote locations where grid electricity does not exist or in areas where the cost of electricity during daylight hours is very high. In potential applications where grid electricity would be displaced, it would be useful to estimate the current and anticipated costs of the displaced electricity.

If possible, I would like to have the market survey information by early July.

DFM:6216

Copy to:
MS 0703 6216 C. E. Tyner
MS 0703 6216 R. B. Diver
MS 0703 6216 D. F. Menicucci

DATE: July 21, 1994

TO: D.F. Menicucci, MS 0703, Dept. 6216

FROM: W.D. Louis, MS 0753, Dept. 6218

SUBJ: Dish/Stirling candidate site elaboration.

As you requested in your letter dated June 10, 1994 I will elaborate on the twelve candidate sites for the dish stirling project. You had requested: 1) a general description of each facility, 2) a description of the type of operations at each facility, and 3) an estimate of the number of dish/Stirling systems that might be installed in each facility in the near and distant future.

A. Kirtland Air Force Base, Albuquerque, NM, total population 15,350, land area 44,025 acres, major function 542 Air Crew Training Wing, AFOTEC and Sandia National Labs. Very few systems as grid is well established.

B. White Sands Missile Range, U.S. Army, Alamogordo, NM, total population 6,954, land area 1,746,720 acres, All Services R&D weapons test center. Few systems because of lack of support from end users due to cost, size and reliability.

C. Fort Bliss U.S. Army Base, El Paso, TX, total population 20,678, land area 125,300 acres, major function Air Defense Center and Schools. Few system as grid is well established.

D. Fort Huachuca U.S. Army Base, Sierra Vista, AZ, total population 12,312, land area 121,449, major function International Joint Interoperability Test Center, Communications Command and Intelligence School. Several systems due to high level of local support, and high visibility for national and international organizations.

E. Yuma Proving Grounds, U.S. Army, Yuma, AZ, total population 2,090, land area 259,736 acres, major function R&D test center, few systems due to low power requirements and lack of base support. Low visibility.

F. Marine Corps Air Station, Yuma, AZ, total population 5,612, land area 2,930 acres, major function tactical aviation and training base, few system due to small size and established grid.

G. Luke Air Force Gunnery Range, Gila Bend, AZ, total population 328, land area 750,000 acres, major function auxiliary airfield and gunnery range, few systems due to limited local support.

H. Marine Corps Air Ground Combat Center, Twentynine Palms, CA, total population 13,071, land area 595,589, major function air/ground combat arms training and communication and electronics school, few systems due to local support and base mission.

I. Chocolate Mountain Gunnery Range, El Centro, CA, Marine Corps operated and Navy owned gunnery range, total population 717, land area 63,137 acres, major function tactical gunnery range, few systems due to very low electrical costs and availability of land at electrical load locations.

J. Fort Irwin Military Reservation, U.S. Army, Barstow, CA, total population 6,254, land area 636,308 acres, major function training site and aviation test range, several systems, low visibility.

K. China Lake Naval Air Weapons Station, Ridgecrest, CA, total population 9,455, land area 1,127,266 acre, major function naval air warfare and missile systems, few due to lack of local support.

L. Nellis Air Force Base, Las Vegas, NV, total population 8,333, land area 141,059 acres, major function attack aircraft training, few due to lack of local support.

Appendix E

Ft. Huachuca, AZ
Statement of Work

Statement of Work for PR AO-3827
SERDP Dish-Stirling for DoD Applications
Ft. Huachuca - Test Site for Cummins Dish/Stirling System

01-26-95.

As part of the Strategic Environmental Research and Development Program (SERDP) a 6-kW_e Cummins dish-Stirling system will be installed and operated on a DoD facility. The Joint Interoperability Test Command (JITC) at Ft. Huachuca, AZ has been selected for the this installation. The following are specific tasks for the contractor, JITC, that are required to support the Cummins dish/Stirling installation and operation.

Task 1. Site Preparation.

1.1 General site preparation. The site shall be located within the JITC fenced compound and shall encompass an area with minimum dimension of 80 ft by 120 ft (with the longest dimension along the north and south boundaries). Because the concentrator's standby position for tracking the sun is to the east of the sun, the position of the dish should be biased towards the west side of the site. The site shall be fenced to control unauthorized access, and should be level and stable enough for the safe usage of manlifts and ladders. The site should be reasonably free of solar obstructions. Site grading, drainage, surface conditioning and compacting, and road access for cranes, trucks, drilling rigs, concrete trucks, manlifts, etc. are the responsibility of JITC.

1.2 Control room. A 200 ft^2 building shall be provided to housing data acquisition equipment and operating personnel. To minimize the length of cabling, it should be as close as possible to the dish-Stirling system. The building shall be heated and air conditioned and have four telephone lines (data modem, voice, JITC LAN, and a spare), and electric power available (120 V, estimated 20 amp service) for the data acquisition hardware, lighting, etc. A 3x3 ft. (or larger) window for viewing the system from inside the building shall be provided.

1.3 Foundations. JITC shall be responsible for the site geotechnic survey, and surveying (for site grading, foundation location, and north-south alignment ±3 degrees). JITC shall be responsible for pouring the foundations.

1.4 Instrumentation wiring. One 1 1/4 inch conduit for control and data acquisition wires between the junction box at the base of the concentrator and the outside wall of the control room are to be provided by Ft. Huachuca. The conduit can be shared with the weather monitoring station.

1.5 Power wiring. One 1 1/4-inch conduit for power wiring between junction boxes at the base of the concentrator and the utility connection shall be provided by JITC. Wiring should be sized for 50 Amps three phase (3 wires plus ground) at 240

Volts. The system to be provided by Cummins is single phase 240 volts. Therefore only 2 wires plus ground will be needed.

1.6 Electrical interface. Electrical output from the Cummins dish/Stirling system is nominal 240-Volt single-phase, 60-Hertz, AC power. Power factor will be in the range 0.95 to 1.0 and total harmonic distortion will be less than 5%. JITC shall provide connections, power meters, a 10 kVA transformer (240 V to grid), and a visual disconnect.

1.7 Computer. A personal computer shall be provided by JITC for data acquisition. The computer should be an IBM or IBM compatible type with a 486 processor and a serial card. Software shall include DOS plus Windows. At least 50 Mb free disk space shall be provided.

1.8 Mirror washing. Provisions for washing mirrors with de ionized water shall be provided by JITC.

Task 1.9 Monitoring Station: The contractor shall supply two 1-1/4" conduits (one for instrumentation wiring and one for AC power) that runs from the JITC building equipment room to the monitoring station's DAS enclosure on the dish pad. These conduits can be run along the fence line. The DAS enclosure box shall be installed by a Sandia contractor, and all wiring will be pulled by the Sandia contractor. Since the engine pad will not be in place before installing the monitoring station, Sandia contractor personnel shall secure the DAS enclosure by anchoring uni-strut to the ground in the area of the pad site or within the control room, if it is in place.

JITC shall supply a 1-1/4" conduit for instrument wiring and a 1/2" conduit for dc power that runs from the DAS enclosure to the weather station. The conduit that runs from the DAS enclosure to the weather station shall be placed as far south on the site as reasonably possible. The location of the weather station shall be south of the dish to prevent shading of the weather station.

All wiring required for supporting the monitoring station will be supplied and installed by the Sandia contractor. The contractor shall supply a dedicated phone line and power in the JITC equipment building.

1.10 Grid Power to Dish. A 30amp, single phase electrical grid service shall be supplied to the dish and located near the dish pad from the control room.

Task 2. System Installation

2.1 Hydraulic crane. A 15 to 18 ton hydraulic crane (or equivalent) shall be supplied by JITC for assembly. The maximum weight to be lifted at one time will be 2500 lb. The maximum reach of the crane shall be 60 feet at approximately 15-25

feet from the structure. The crane shall be provided for an estimated 3 hours to unload the trucks on day 1 of the installation and then for 6 hours on day 2, 3 or 4 of the installation.

2.2 Lifting straps. Three (3) each 10 to 15 foot straight nylon straps, or 1/2 inch diameter steel choker cable (rated capacity of 6000 to 8000 lb.) shall be provided for dish installation.

2.3 Manlift. A 40 foot manlift with an aerial platform shall be provided for installation, which may extend for a 2 week period. In addition, a manlift shall be periodically required for maintenance during the one-year operational phase of the system.

2.4 Forklift. A 5 ton forklift shall be provided to unload the truck and for installation of the power conversion unit (engine/receiver/cooling system assembly).

2.5 Electronic test equipment. A digital voltmeter, (AC-DC, 480 Volt) shall be provided for installation and maintenance.

2.6. Pneumatic tools. An air compressor and pneumatic wrenches for hardware size 1/2-13 hex bolt and nut shall be provided for the installation processes.

2.7 Hand tools. American standard box or open end wrenches shall be provided for installation. Adjustable wrenches can be substituted for one of the fixed wrench sizes.

The following tools shall be provided:

Quantity	Tool Description
2	1-7/8 inch wrench to fit a 1-1/4 - 7 hex head bolt and nut
2	1-5/16 inch wrench to fit a 7/8 - 9 hex bolt and nut
2	1-1/8 inch wrench to fit a 3/4 - 10 hex head bolt and nut
2	15/16 inch wrench to fit a 5/8 - 11 hex head bolt and nut
4	3/4 inch wrench to fit a 1/2 - 13 hex head bolt and nut
4	7/16 inch wrench to fit 1/4 - 20 hex head bolt and nut
1	6 inch adjustable wrench
1	10 inch adjustable wrench
1	12 inch adjustable wrench
1	8 foot free standing ladder
1	10 foot free standing ladder
1 set	Electrical service tools including cutters, strippers, crimpers, etc.
2 set	Metalx fire extinguisher

2.8 Personnel. JITC shall provide one qualified electrician and two-to-four mechanical technicians for the assembly. Additional laborers (1-2 persons) may be required in the first three or four days of assembly. Cummins has been contracted to supervise the assembly, installation, and checkout processes.

Task 3. System operation and maintenance.

3.1 Operational objectives. The operational goal is to operate from sunrise to sunset at least 5 days per week. Operation from sunrise to sunset 6 or 7 days per week is desirable.

3.2 Senior operator. A senior operator provided by JITC shall oversee operation and serve as a single point of contact to Cummins and Sandia. The senior operator shall have a good technical background, preferably in electronics or related engineering. The senior operator shall train operators and shall be responsible for overall operation. This operator shall receive one week of training at the Cummins Abilene, TX facility.

3.3 Operational personnel. Because the Cummins dish-Stirling system is a prototype, JITC shall provide a qualified operators during operation to insure that operation, data acquisition, system safety, and personnel safety are properly addressed. Operators shall be responsible for routine operation of the system, and responding to and recording of system faults. Operators need not be on site at all times, but shall be capable of responding to alarms within 15 minutes. Failures shall be documented in accordance with Cummins Standard Engine Reliability Tracking System (SERTS). Cummins has been contracted to provide on-line telephone, and field support for the system. Operators shall have a working knowledge of the system.

3.4 Routine maintenance. Operators shall provide the following tasks on a routine basis. Sandia may specify a more frequent interval on specific occasions such as during diagnostic check out of a specific problem.

Task	Frequency
Mirror washing	monthly or as needed
Receiver inspection	monthly
Coolant check	monthly
Measure mirror reflectivity	weekly

3.5 Operations during periods of abnormal performance. During periods of operational problems with the dish, normal operation may be suspended but operators shall be required to be available to provide assistance to Sandia and Cummins personnel and their contractors.

Task 4. Project management and reporting.

4.1 System supervision. Operators shall provide startup and shutdown supervision on a daily basis. Before starting, the system shall be inspected for obvious damage. After shutdown, data shall be downloaded and archived. Operational problems shall be responded to and documented.

4.2. Monthly reports. A monthly report detailing operational hours, gross power production, system availability, and operational problems (SERTS reports) shall be provided. Sandia will specify to JITC regarding the data collection methods and the report format. Two copies each shall be sent to Sandia and to Cummins in Abilene, Texas.

4.3. Conference report. A conference presentation and report detailing overall operational experience and the applicability of the Cummins dish/Stirling system to Ft. Huachuca in particular, and military facilities in general are to be provided at a SOLTECH (or equivalent) conference.

4.4 Final report. A final report detailing overall operational experience and the applicability of the Cummins dish/Stirling system to Ft. Huachuca in particular, and military facilities in general are to be provided, within 30 days of contract completion. The report shall conform to Sandia's requirements for a SAND report.

Period of Performance: The period of performance begins as soon as the dish system has been certified as being operational by Cummins and Sandia. The period of performance ends one year from that date.

Distribution:

U.S. Department of Energy (2)
Forrestal Building
Code EE-132
1000 Independence Avenue, S.W.
Washington, DC 20585
Attn: G. Burch
T. Rueckert

U.S. Department of Energy (2)
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87115
Attn: G. Tennyson
R. Lowrey

U.S. Department of Energy
Forrestal Building
Code EE-131
1000 Independence Avenue, S.W.
Washington, DC 20585
Attn: J. Rannels

U.S. Department of Energy
DOE - Renewable Resources
Office of Technology Policy (PO-40)
Forrestal Building
1000 Independence Avenue, S.W.
Washington, DC 20585
Attn: R. Burrow

U.S. Department of Energy
Division of Advanced Energy Projects
Code ER-33
Office of Basic Energy Sciences
U.S. Department of Energy
19901 Germantown, Road
Germantown, MD 20874-1219
Attn: W. Polansky

ARMY - Renewable Resources
U.S. Army Construction Engineering
Research Laboratory
2902 Newmark Drive
Interstate Research Park
Champaign, IL 61821-1076
Attn: G. Schanche

AIR FORCE - Renewable Resources
Chief of the Air Base Technology Branch
WL/FIVCF
139 Barnes Drive, Suite 2
Tyndall AFB, FL 32403-5323
Attn: R. Salavani

California Polytechnic State University
Department of Mechanical Engineering
3801 West Temple Ave.
Pomona, CA 91768-4062
Attn: W. Stine

Clever Fellows Innovation Consor., Inc.
302 Tenth Street
Troy, NY 12180
Attn: J. Corey

COAST GUARD - Renewable Resources
External Agency Coordinator
Commandant (G-SIR)
U.S. Coast Guard
2100 Second Street, SW
Washington, D.C. 20593-0001
Attn: B. Hartberger

Cummins Engine Company (2)
Mail Code 60125
P.O. Box 3005
Columbus, IN 47202-3005
Attn: I. Kubo

Dr. Patricia A. Sanders
Director, Test, Systems Engineering, and Evaluation
DT&E, Room 3D1067
3110 Defense Pentagon
Washington, DC 20301-3110

Defense Technical Information Center
8725 John J. Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
Attn: DTIC-OCP (Joyce Chiras)

DNA - Renewable Resources
Program Manager Defense Nuclear Agency
Radiation Sciences Directorate
6801 Telegraph Road
Alexandria, VA 22310-3398
Attn: Dr. M. Owais

Electric Power Research Institute
P.O. Box 10412
3412 Hillview Ave.
Palo Alto, CA 94303

EPA - Renewable Resources
Air and Energy Research Laboratory
U.S. Environmental Protection Agency
85 Alexander Drive, Highway 54
Mail Drop 60
Research Triangle Park, NC 27711
Attn: F. Princiotta, Director

Ft. Huachuca
U.S. Army Garrison
Director of Engineering and Housing
ATZS-EHE
Ft. Huachuca, AZ 85613
Attn: B. Stein

Ft. Huachuca
Joint Interoperability Test Center (5)
Fort Huachuca, AZ 85613
Attn: W. DePew

National Renewable Energy Lab. (4)
1617 Cole Blvd.
Golden, CO 80401-3393
Attn: T. Williams
T. Wendelin
U. Lewandowski
M. Bohn

NAVY - Renewable Resources
Deputy, PublicWorks Office
Code 823A00D (C8301)
Naval Air Weapons Station
China Lake, CA 93555-6001
Attn: G. Smith

SERDP (2)
SERDP Support Office
8000 Westpark Drive, Suite 400
McLean, VA 22102
Attn: Mike Hathaway

ODUSD(ES) - Renewable Resources
Director, Energy and Engineering
OASD (ES) O400 Army Navy Drive
Room 206
Arlington, VA 22204-2884
Attn: M. Carr

Tech Reps, Inc. (2)
5000 Marble N.E. Suite 222
Albuquerque, NM 87110
Attn: D. Andersen

SW Technology Development Inst. (2)
New Mexico State University
P.O. Box 30001/Dept. 3SOL
Las Cruces, NM 88003
Attn: S. Durand

Thermacore Inc. (2)
780 Eden Rd.
Lancaster, PA 17601
Attn: P. Dussinger

University of Chicago
5640 South Ellis Ave.
Chicago, IL 60637
Attn: J. O'Gallagher

W.G. Associates
6607 Stonebrook Cir.
Dallas, TX 75240
Attn: V. Goldberg

Internal Distribution:

MS	Org.	
0702	6200	D Arvizu
0703	6216	C. Andraka
0703	6216	R. Diver (5)
0703	6216	D. Menicucci (5)
0703	6216	C. Tyner
0704	6201	P. Klimas
0704	6215	J. Strachan
0735	6200	A. VanArsdall
0752	6219	M. Tatro
0753	6218	C. Cameron
1127	6215	J. Chavez
0899	4414	Technical Library (5)
0619	12690	Review and Approval Desk for DOE/OSTI (2)
9018	8940-2	Central Technical Files

Org.	Bldg.	Name	Rec'd by	Org.	Bldg.	Name	Rec'd by

MS- 0703 R. Diver (6216) (5)

Sandia National Laboratories