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SOLAR TOTAL ENERGY-LARGE SCALE EXPERIMENT

SHENANDOAH, GEORGIA

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ABSTRACT

The first industrial application of the Solar Total Energy concept has been initiated as a cooperative venture of the United States Department of Energy (DOE) and Georgia Power Company.

A part of the National Solar Total Energy Program (STEP), this large-scale experiment is the outgrowth of research started in 1972 by Sandia Laboratories. This effort seeks to evaluate a solar energy system which will provide electrical power and process heat, along with heating, cooling and domestic hot water supplies.

This "total energy" idea is not new, having been used commercially for years. Simply defined, it is a system which uses "waste heat" from electrical power generation to serve other useful functions. Combined with a solar energy system it offers these attractive features:

- Provides energy from a renewable resource
- Adaptable to applications in a wide range of types and sizes
- Makes maximum use of energy collected
- Has a closed loop system which does not pollute
- Compatible with existing utility systems

After research projects confirmed the feasibility of the solar total energy concept, an actual working system was designed and installed at Sandia Laboratories. Successful from the beginning, the Solar Total Energy Test Facility operation has provided the technology and operating experience which make the Shenandoah, Georgia large-scale experiment feasible.

The project objectives are to:

: Develop within industry, the engineering and development experience on large scale solar total energy systems as preparation for subsequent commercial size demonstrations.

: Acquire additional data to reduce the uncertainties of cost and performance predictions.

: Insure dissemination of technical data to provide a basis for expanded growth of solar total energy.

Progress to date covers activities through a final definitive design phase. Major accomplishments include the legal recording of a solar easement and development of a parabolic dish solar collector.

Now being completed is the Phase IV Definitive Design of a six-phase Project for conducting a Solar Total Energy Large Scale Experiment in late 1981. General Electric Company is designing the Solar Total Energy System (STES) with capacity to supply 60% of the total electric and thermal requirements of the 42,000 square foot Bleyle of America knitwear plant to be served at the Shenandoah Site. The system will provide 400 kilowatts electrical and 3.5 megawatts thermal energy.

The STES has a classical, cascaded total energy system configuration. It utilizes parabolic dish collectors, trickle oil thermal energy storage and a steam turbine-generator. The electrical load peak shaving system is being designed for interconnected operation with the Georgia Power system.

An account will be given of the technical considerations and interactions among the parties during the development of the Solar Easement Agreement applicable to the Solar Total Energy-Large Scale Experiment. Although the agreement is specifically tailored to the Shenandoah Project Site, the review of the key technical results and practical resolutions of the different interests of the several parties involved in the Shenandoah Project will be of benefit to anyone involved in present and future solar projects where the sun rights must be established and protected.

This paper also discusses the design and development of a 7-meter diameter parabolic dish solar collector. Each of the four main subsystems of the collector; (1) reflector, (2) mount and drives (3) receiver and (4) the controls is discussed briefly with the major emphasis on the receiver design.

To minimize development risks and production costs, a dish design based on use of stamped aluminum petals (sectors) was chosen. This design is similar to the design of a communication antenna already commercially produced. The reflective surface of the petals has a total reflectance of .86 and a specularity (dispersion) of 8 mrd. This performance is obtained by mechanical polishing and chemical brightening of the petal surface, followed by application of a clear RTV silicone protective coating. Selection of the material and weather proofing coating are discussed. Results from performance tests on an engineering development dish collector will be presented. Test results will be compared with pretest predictions.

At the completion of the preliminary design in September 1978, the engineering specifications for major equipment was as given in the following table 1. Final design now being completed, is only nominally different due to programmatic and technical considerations.

Table 1

Collector Field

Type	Paraboloidal Dish
Size	7M Diameter
Area	79,500 Ft^2
Fluid	Dow Corning Syltherm 800
Outlet Temperature Collector	750 F
Min. Inlet Temperature Collector	500 F
Maximum Fluid Flow Rate	387 GPM
Minimum Collectible Insolation	50 Btu/Hr-Ft^2

High-Temperature Thermal Storage

Type	Trickle Oil
Volume	17,600 Ft^3
Size	13 Ft Dia, 12 Ft Ht (1 Tank) 20.6 Ft Dia, 16 Ft Ht (3 Tanks)
Storage Medium	Taconite
Void Fraction	45%
Temperature Change	250 F
Capacity	100 MMBTU
Max. Charge/ Discharge Rate	16/8.2 MMBTU/Hr
Insulation Thickness	12 In.
Oil Inventory	11,225 Gal

Turbine Generator Set

Cycle	Rankine Turbine
Working Fluid	Steam
Admission	Multi Valve
Stages	Multiple
Pressure Ratio	140
Inlet Condition	720 F/700 Psig
Extraction Steam Condition	105 Psig
Condensing Condition	5 Psig
Generator	Brushless Air Cooled
Maximum Rating	400 kW

Low-Temperature Thermal Storage

Type	Stratified Water
Volume	120,000 Gal
Size	18 Ft Dia, 63 Ft Long
Storage Medium	Water
Temperature Range	210 F - 190 F
Capacity	20 MMBTU
Insulation Thick- ness	4 In

Specifications for Major Items of Equipment