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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 largescale 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.

•	Collector Field		High-Temperature Thermal Storage	torage
	Туре	Paraboloidal Dish	Type	Trickle Oil
	Size	7M Diameter	Volume	17,600 Fr <sup>3</sup>
•	Area	79,500 Ft <sup>2</sup>	Size	13 Ft Dia, 12 Ft Ht (1 Tank) 20.6 Ft Dia, 16 Ft Ht (3 Tanks)
	Fluid	Dow Corning Syltherm 800	Storage Medium	Taconite
	Outlet Temperature Collector	750 F	Void Fraction	45%
	Min. Inlet Temperature	500 F	Temperature Change	250 F
•	Collector		Capacity	100 MMBTU
ž.	Maximum Fluid Flow Rate	387 GPM	Max. Charge/	16/8.2 MMBTU/Hr
	Minimum Collectible Insolation	50 Btu/Hr-Ft <sup>2</sup>	Discharge Rate	
	•		Insulation Thickness	12 ln.
			Oil Inventory	11,225 Gal
'	Turbine Generator Set		Low-Temperature Thermal Storage	orage
	Çycle	Rankina Turbine	Туре	Stratified Water
•	Working Fluid	Steam	Volume	120,000 Gal
-	Admission	Multi Valve	Size	18 Ft Dia, 63 Ft Long
	Stages	Multiple .	Storage Medium	Water
	Pressure Ratio	140	Temperature Range	210 F - 190 F
	Inlet Condition	720 F/700 Psig	Capacity	20 MIMBTU
	Extraction Steam Condition	105 Psig	Insulation Thick- ness	4 in
	Condensing Condition	5 Psig		
•	Generator	Brushless Air Cooled		
	Maximum Rating	400 kW		
		•	•	

Specifications for Major Items of Equipment