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**SOLAR TOTAL ENERGY—LARGE SCALE EXPERIMENT
SHENANDOAH, GEORGIA SITE**

Annual Report for Period June 1978—June 1979

MASTER

By
E. J. Ney

July 1979
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SOLAR TOTAL ENERGY — LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA SITE

**Annual Report for the Period
June, 1978 through June, 1979**

**Coordinated by
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Site Project Integrator**

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270 Peachtree Street
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Published July, 1979

**PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY
DIVISION OF SOLAR ENERGY
UNDER COOPERATIVE AGREEMENT NO. EG-77-A-04-3994**

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ACRONYMS

ALO	Albuquerque Operations Office
CDDR	Coordinated Design Data Required
DCST	Division of Central Solar Technology
DOE	Department of Energy
DOT	Department of Transportation
DRC	Development Review Committee
EG&G	Edgerton, Germhausen & Greer
EPD	Environmental Protection Division
FPC	Federal Power Commission
FURI	Fiberglass/Urethane Roof Insulation
GIT	Georgia Institute of Technology
GE	General Electric Company
GPC	Georgia Power Company
GTR	Government Technical Representative
ICWG	Interface Control Working Group
IEEE	Institute of Electrical and Electronics Engineers
IES	Independent Energy Source
LSE	Large Scale Experiment
NWS	National Weather Service
OMB	Office of Management and Budgets
POB	Point of Beginning
RTU	Roof-top Unit
SDI	Shenandoah Development, Inc.
SERI	Solar Energy Research Institute
STE-LSE	Solar Total Energy—Large Scale Experiment
STEP	Solar Total Energy Program
STES	Solar Total Energy System
TPM	Technical Project Manager
TTO	Technology Transfer Office

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OBJECTIVES

PROGRAM OBJECTIVES

The U.S. Department of Energy (DOE) objectives for the National Solar Total Energy—Large Scale Experiment at Shenandoah, Georgia are to:

- Develop within industry the engineering and development experience on large scale solar total energy systems as preparation for subsequent commercial size demonstrations.
- Assess the interaction of solar energy technology with the application environment.
- Narrow the prediction uncertainty of the cost and performance of the Solar Total Energy System (STES).
- Expand solar engineering capability and experience with large-scale hardware systems.
- Disseminate information relative to Solar Total Energy (STE).

SITE OBJECTIVES

The primary objective of the Solar Total Energy Site/Application effort at Shenandoah, Georgia is to provide a commercial facility to utilize solar-derived electrical and thermal energy, and to provide a suitable area for erecting a solar energy system to supply energy to the facility. This effort includes data acquisition and analysis, as well as design interface.

The objectives of Georgia Power Company are to:

- Evaluate the significance of an emerging alternate energy technology in an industrial application.
- Promote the utilization of energy conservation and load management.
- Consider the applicability of co-generation facilities.
- Analyze the economic potential of solar total energy in an industrial application.

The achievement of these objectives will help Georgia Power Company to provide reliable, economical, and environmentally acceptable energy to its consumers, and help lead the Nation to a partial solution of the energy dilemma.

Georgia Power Company is vitally interested in the successful and rapid commercialization of solar energy and has committed the necessary company resources, for the scheduled ten-year period, to assist DOE in advancing solar total energy technology.

PROGRESS ABSTRACT

Progress during the second year of Cooperative Agreement No. EG-77-A-04-3994 has met or exceeded expectations. Efforts in all major task areas are proceeding on schedule, and project milestones have been achieved within specified cost and manpower constraints.

SITE/APPLICATION PREPARATION

Dramatic progress occurred in preparation of the STES site for the collector field, beginning with groundbreaking on July 31, 1978. Clearing of the site began early in November, as well as installation of a sediment fence, construction of an imperfect trench, and stockpiling of top soil. After a series of weather delays during December, grading work resumed and was completed by February. Grassing of the leveled site was completed during April.

The Bleyle Knitwear Plant expanded operations to include a line of blouses in addition to the skirts and slacks it had been manufacturing. Signatures were secured for all required Solar Easements during November. Satisfactory operation of the economizer/air conditioning system has been achieved.

METEOROLOGY STATION

The Government-supplied meteorology station was expanded from eight to 16 channels during the year with installation of an improved EG&G Data Logger and other associated equipment. Weather and insolation data continued to be collected and transcribed on a routine basis with only minor difficulties encountered.

INSTRUMENTATION

Georgia Power Company instrumentation, installed in the facilities at the site, continued to monitor and record energy usage in the knitwear plant. Measurement of steam flow and pressure continued to be a problem area. Humidity sensors also exhibit anomalous operation. The first computer data tapes were submitted to General Electric, the DOE-selected Solar Total Energy System designer, by the end of August.

DESIGN PHASE INTERFACE

The Georgia Power Company Site Team continued to participate in reviews of the Solar Total Energy Preliminary Designs, and is exchanging data with General Electric. A system of documentation and configuration was successfully implemented for control of physical and functional requirements affecting design or operation, and the Site Team continued to review and issue appropriate Interface Drawings.

INFORMATION DISSEMINATION

Using the facilities at the site as a temporary Information Center, the Georgia Power Team continued its program of tours, presentations, and displays. Reaction has been extremely favorable.

1.0 INTRODUCTION

This second Annual Progress Report, prepared by Georgia Power Company and its Site Team, is provided in conformance with the Cooperative Agreement between the U. S. Department of Energy (DOE) and Georgia Power Company (GPC) for the conduct and evaluation of a Solar Total Energy—Large Scale Experiment.

This Annual Report is structured to present a background summary and a complete description of the progress and current status of activities relative to the Cooperative Agreement for the Solar Total Energy—Large Scale Experiment at Shenandoah, Georgia. As requested in DOE specifications, the report is prefaced with a statement of objectives and an abstract of progress to date. This is followed by a short introduction containing a project overview, a summary of the participants and their respective roles, a brief description of the Solar Total Energy System (STES) design concept, and a chronological summary of progress to date.

General background data are provided in this Report only to the extent necessary to make meaningful the current data on site/application development progress. Detailed background information is included in the First Annual Report published in June, 1978. This material includes data on environmental impact, weather, topography, area socio-economics, site suitability, and technical specifications. Also included is the text of the recently-signed Solar Easement Agreement. Copies of the First Annual Report (ALO/3394-77/3) are available from the National Technical Information Service as specified on the back of the Title Page of this document.

Section 2.0 of this Report contains a general description of the site in terms of appearance and location. Also included are descriptions of the STE-LSE application (Bleyle of America, Inc. Knitwear Plant), the DOE-owned Meteorology Station operating at the site, and the instrumentation provided by the Georgia Power Company to measure energy usage within the knitwear plant.

Section 3.0 contains the detailed report of progress at the Shenandoah Site, introduced by the STE-LSE schedule and the Cooperative Agreement work tasks. Progress is described in terms of the following major task areas: Site/Application; Instrumentation/Data Acquisition; Meteorology Station; Site-to-STES Interface; Information Dissemination.

Section 4.0 contains a brief summary of anticipated progress during the third year of the subject Cooperative Agreement.

Appendix A contains a set of Interface Control Drawings as well as a list of Building and Equipment Data Required to perform Bleyle plant load analysis.

1.1 PROJECT OVERVIEW

The Site/Application of the Solar Total Energy—Large Scale Experiment (STE-LSE) at Shenandoah, Georgia is based upon Cooperative Agreement No. EG-77-A-04-3994 between the U. S. Department of Energy and the Georgia Power Company. Under terms of the Cooperative Agreement, DOE will design, construct and operate a Solar Total Energy System (STES) to provide solar-derived electrical

and thermal energy to the Georgia Power Company's designated application—a knitwear factory operated by Bleyle of America, Inc. The Solar Total Energy System is being designed by the General Electric Company, Space Division, under Contract EG-77-C-04-3985.

As the first industrial application of Solar Total Energy, this experiment will help evaluate the effectiveness and efficiency of using solar energy to provide electrical power and process heat, in addition to the more conventional heating, cooling, and domestic hot water supplies. Solar energy is collected and used to generate electricity, while the exhausted heat from power generation is used for other purposes, making maximum use of energy collected.

Under terms of the Cooperative Agreement, work tasks are divided into three categories: Cost-Shared Services; DOE Funded Services; and Georgia Power Company Special Services.

Those tasks designated as Cost-Shared Services include the following:

- Provide load and energy displacement data and analysis.
- Provide subsurface exploration support.
- Procure permits and licenses.
- Provide analysis and reporting of solar technology data.
- Assess interaction of the proposed STE-LSE in an actual operating environment including data collection and analysis in performance, operation and economic areas.
- Communicate with DOE and Sandia on progress and changes, and provide monthly cost and status reports.
- Provide utilities support activities.
- Support cost and schedule activities.
- Support cost, schedule and performance control and reporting.
- Provide liaison with DOE design, construction, and operational activity contractors.
- Provide site/application operation and planning data documentation and Site/STES interface configuration control support.
- Provide STES checkout, operation, training and maintenance support and disposition analysis.

Those tasks designated as DOE-Funded Services include the following:

- Provide interface definition and control (design phases).
- Install, operate and maintain the STE-LSE meteorology station.
- Carry out information dissemination activities.
- Grade the site.

Those tasks designated as Georgia Power Company Special Services include the following:

- Provide a temporary transformer pad to the Bleyle Plant.
- Provide energy usage recording instrumentation in the Bleyle Plant.
- Provide an underground transmission line to the Bleyle Plant.
- Provide a transformer stepdown station and breakers for the plant.
- Provide auxiliary turbine interface equipment.
- Provide energy conservation services.

Georgia Power Company and its associate companies have provided a site for the STES and DOE meteorology station, a knitwear manufacturing application, an independent energy source (IES) for electric and heating/cooling energy, and appropriate instrumentation for measuring and recording energy usage within the plant. Georgia Power Company has committed itself and its Site Team to supporting and cooperating with DOE and DOE contractors throughout the remaining phases of the STE-LSE.

The site for the STE-LSE is approximately 30 miles south-southwest of Atlanta in the developing community of Shenandoah, surrounding the intersection of highways I-85 and Ga-34. The 15.5-acre tract contains a 5.25-acre area for the manufacturing facility and a 5.72-acre area for the STES and the meteorology station.

Following is the schedule by which the Georgia Power Company Team will assist in completing the Solar Total Energy Project at Shenandoah and fulfill its Cooperative Agreement with the Department of Energy. Present analysis of the total program elements indicates initial STES operation in October of 1981.

SOLAR TOTAL ENERGY LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA

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1.2 PROJECT PARTICIPANTS

The organizations participating in the Solar Total Energy—Large Scale Experiment at Shenandoah, Georgia and their relationships are shown in Figure 1-1 and are described in the following paragraphs.

LOCKWOOD GREENE

**GEORGIA INSTITUTE OF TECHNOLOGY
HEERY & HEERY, ARCHITECTS AND ENGINEERS
SHENANDOAH DEVELOPMENT, INC.
OWENS-CORNING FIBERGLAS CORP.
WESTINGHOUSE ELECTRIC CORPORATION**

Figure 1-1. Overall Organizational Relationship Among Participants in Solar Total Energy Project at Shenandoah, Georgia

1.2.1 UNITED STATES DEPARTMENT OF ENERGY

The United States Department of Energy (DOE) Division of Central Solar Technology (DCST), through its National Solar Electric Applications Program, has responsibility for executing the Solar Total Energy Program (STEP) of which the STE-LSE-SS is a key element. The overall objectives of STEP are "to demonstrate the technical, economic, and institutional feasibility of the solar total energy concept and to promote within an appropriate industrial sector a technology which offers the prospect of being economically competitive with other energy sources." The DOE Albuquerque Operation Office has been designated as the field office responsible for implementation of this project.

1.2.2 SANDIA LABORATORIES

Sandia Laboratories, Albuquerque (a national laboratory) serves DOE, DCST and DOE/ALO as a technical resource and in a technical management role. In its role as Technical Manager for DOE's STEP, Sandia Laboratories is assisting DOE in the implementation of the STEP.

1.2.3 GEORGIA POWER COMPANY

As a growing and progressive utility, Georgia Power Company is committed to the advancement of effective utilization of solar energy in general, as well as to the successful completion of the STE-LSE in particular. Georgia Power Company is committed to seeking alternative energy sources and using available energy wisely in order to provide customers with the electricity they require. Part of this commitment involves furthering research and development in the field of solar energy.

1.2.4 SHENANDOAH DEVELOPMENT, INC.

Shenandoah Development, Inc. (SDI) also is vitally interested in advancing the effective utilization of solar energy, as demonstrated by its participation in this and other related projects. SDI made available the property for the STE-LSE and constructed the energy-efficient knitwear plant being leased and operated by Bleyle of America, and has been awarded various contracts from DOE for the planning and use of solar energy.

1.2.5 GEORGIA INSTITUTE OF TECHNOLOGY

The Georgia Institute of Technology (GIT) also is highly involved in solar energy research and development. Acting under subcontract to Georgia Power Company, GIT is operating a DOE meteorology station located on the specific site of the Shenandoah solar collector field. GIT is using the equipment to measure, record, and analyze solar radiation and other meteorological parameters.

1.2.6 HEERY & HEERY, INC.

Heery & Heery Architects and Engineers, Inc., is providing A/E services to Georgia Power Company, especially in preparing and maintaining Interface Definition and Control Documents related to the STE Project, incorporation of energy-conserving features into the Bleyle plant design, review of site plans and specifications, and engineering of interconnection piping.

1.2.7 OWENS-CORNING FIBERGLAS, INC.

Owens-Corning Fiberglas Corporation provided insulation systems expertise and roof and wall insulation used in the Bleyle Knitwear Plant. These contributions were important to the overall energy efficiency of the building, which will be an important factor during operation of the STE-LSE.

1.2.8 WESTINGHOUSE ELECTRIC CORPORATION

Westinghouse Electric Corporation is providing STE-LSE site coordination and integration.

1.2.9 BLEYLE OF AMERICA, INC.

Bleyle of America, Inc., a subsidiary of Bleyle Knitwear Corporation of Stuttgart, Germany, is a producer of high quality apparel. Until the addition of the facility in Shenandoah, the company had eleven plants, all in Europe. The 25,000 sq. ft. Shenandoah facility was designed to incorporate a series of energy-saving concepts to provide additional benefits to DOE during operation of the STE-LSE.

1.2.10 GENERAL ELECTRIC COMPANY

As designated design contractor for the STE-LSE at Shenandoah, under Contract No. EG-77-C-04-3985, General Electric has been closely involved with site development activities carried out under the subject Cooperative Agreement. Scientific-Atlanta, Inc. was a participant with General Electric during the Conceptual Design phase of the Project. Lockwood Greene, Architects and Engineers, continues to support General Electric.

1.3 PROJECT DESCRIPTION

The closed-loop solar energy system planned for Shenandoah begins with circulation of Syltherm 800, a heat transfer fluid of the Dow-Corning Corporation, through the receiver tubes of a parabolic dish solar collector field. As solar energy is focused on the receivers, the heat transfer fluid is heated to approximately 399°C (750°F) and is pumped to a heat exchanger for immediate use, or to a thermal storage system for later use.

Once in the heat exchanger, the fluid heats a working fluid that produces the steam required for operating the turbine. After performing this task, the heat transfer fluid returns to the collectors to repeat the cycle, while the steam turbine-generator system supplies the electrical demands for the knitwear plant and the STES. During STES operation, maximum thermal and electrical requirements of the application are expected to be at 1.08 MWth and 161 kWe, respectively.

During the power generation phase, some of the steam is extracted for use as process steam in the knitwear manufacturing process, while exhaust steam from the turbine is passed through a condenser to produce hot water for heating, domestic use, and absorption air conditioning. Figure 1-2 contains a simplified schematic illustration of the overall Solar Total Energy—Large Scale Experiment at Shenandoah.

Figure 1-2. Simplified Schematic Illustration of the Solar Total Energy-Large Scale Experiment at Shenandoah

The solar collector specified in the system design for Shenandoah is a seven-meter parabolic dish as shown in Figure 1-3. Some of its features are as follows:

Cavity Receiver (Double Coil)	
Energy Delivery* Rate/Dish	54,000 Btu/Hr
Energy Delivery* Rate/Field	$9.5 \times 10^6 \times \text{Btu/Hr}$
Collector Efficiency	65%

*Insolation = 200 Btu/Hr-Ft² (Direct Normal)

Figure 1-3. General Electric Parabolic Dish Solar Collector to be used at Shenandoah STE-LSE

The remainder of the baseline design concept is shown schematically in Figure 1-4. Figure 1-5 contains a description of the overall STES, Figure 1-6 contains specifications for major items of equipment, and Figure 1-7 shows a prototype solar collector of the type to be used at Shenandoah.

An Energy Summary, containing requirements and capacities for the Bleyle Knitwear Plant, as well as annual energy contributions expected from the Solar Total Energy System, appears in Figure 1-8.

The STE-LSE Site Plan shown in Figure 1-9 defines the overall site layout and collector field arrangement. There are 20 rows of collectors. Twelve rows contain 11 collectors each, four rows contain 10 collectors each, and four rows contain five collectors each. The collector rows are spaced 30.22 feet on center with a spacing of 29.38 feet between collectors in a given row.

The collector field will be a combination of green area and blacktop.

The East-West main supply header will be placed below grade in an open conduit. Covers will be placed on conduit between rows for vehicle access from the South to the North end of collector field. The North-South branch lines will run above ground at an elevation of 78 inches above grade. The piping layout is also shown in the Site Plan.

The mechanical building will be located in the southwest corner of the STE-LSE Site. The building will contain the control room, office and conference room, maintenance area, storage area, motor control center, absorption air conditioning unit, and turbine. Located north of the building will be the Syltherm 800 equipment, including three large thermal energy storage tanks, one small thermal energy storage tank, the Syltherm 800 fossil fuel fired heater, and the collector field circulating and boiler pumps. The hardware will be installed on a concrete pad with provisions for containing spills of Syltherm 800. The drain system will contain a separator for reclaiming the fluid. Also contained in this area will be the unfired boiler and its ancillary equipment. All the equipment will be insulated and sealed for outdoor application.

Equipment located on the south side of the building will include the low temperature thermal energy storage tank, the absorption air conditioner cooling tower, the condenser cooling tower, the condensate storage tank, and ancillary equipment. The low temperature thermal energy storage tank will contain an expansion tank and will be insulated for outdoor application.

The meteorology station, which will be removed during final preparation of the Site, will be reinstalled at another site location.

The mechanical building will be designed to allow for visitor access to the building to observe operations in the control room and to permit visual access to the mechanical equipment. Parking will be provided at the end of the access road for visitors and plant operating personnel.

1.4 CHRONOLOGICAL SUMMARY OF PROGRESS

Tables 1-1 and 1-2 contain brief chronological summaries of key events that occurred throughout the first two years of the Cooperative Agreement. A detailed progress report for the subject reporting period, subdivided by major work tasks, appears in Section 3.0 of this Report.

Figure 1-4. General Electric Baseline Design Concept for STE-LSE at Shenandoah, Georgia

SITE	5.72 Acres
COLLECTOR FIELD	192 Parabolic Dishes Cavity Receiver Dow Corning Syltherm TM 800 at 750° Heat Transfer Fluid Trickle Oil/Dual Media Storage (Iron Ore) Fossil Fired Heater
POWER CONVERSION SYSTEM	400 KW Turbine Generator (Mechanical Technology, Inc.) 100 KW GPC Base Load Process Steam
THERMAL UTILIZATION LOOP	354 Ton Absorption Air Conditioner Hot Water Heating Stratified Storage Tank
ANNUAL % BLEYLE LOADS PROVIDED	Electrical 33% (389 MWH) Process Steam 62% (3.8×10^9 Btu) Heating 98% (130 MBTU) Cooling 85% (5.2×10^9 BTU) Total 63.4%

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Figure 1-5. General Electric System Description

THERMAL UTILIZATION LOOP

COOLING SYSTEM

ABSORPTION A/C	OPERATION 174 TONS RATED 354 TONS
INLET TEMP	210°F
OUTLET TEMP	190°F
COP AT 210°F	0.7

LOW TEMP. STORAGE

TYPE	WATER
VOLUME	120,000 GAL
SIZE	30 FT. DIA., 23 FT HEIGHT
TEMPERATURE RANGE	210°F – 190°F
CAPACITY	20 M BTU

CONDENSER COOLING TOWER

CAPACITY	7.2 M BTU/HR
-----------------	---------------------

HOT WATER HEATING

HEAT EXCHANGER	0.56 M BTU/HR
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615454-1A

Figure 1-6. Specifications for Major Items of Equipment (May 1978)

COLLECTOR FIELD

COLLECTOR

TYPE COLLECTOR	192 PARABOLIC DISHES
SIZE	7 METER DIAMETER
AREA	79,500 FT ²
FLUID	DOW CORNING SYLTHERM 800
TEMPERATURE RANGE	500°F TO 750°F

HIGH TEMPERATURE STORAGE

TYPE	TRICKLE OIL/DUAL MEDIA
VOLUME	17,600 FT ³
SIZE	13 FT. DIA., 12 FT. HT (1 TANK) 20.5 FT. DIA., 16 FT. HT (3 TANKS)
STORAGE MEDIUM	IRON ORE
VOID FRACTION	36%
TEMPERATURE CHANGE	250°F
CAPACITY	131 M BTU
MAX CHARGE/DISCHARGE RATE	16 M BTU/HR
INSULATION THICKNESS	14 IN.
OIL INVENTORY	14,000 GAL.

ALTERNATE HEAT SOURCE

FOSSIL HEATER	11 M BTU/HR
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615454-2A

Figure 1-6. Specifications for Major Items of Equipment (May 1978) (Con't)

POWER CONVERSION SYSTEM

PCS OPERATING MODE

PEAK SHAVING (PRIME)	100 KW GPC BASE
STAND ALONE	400 KW STES CAPABILITY

TURBINE GENERATOR

CYCLE	RANKINE TURBINE
WORKING FLUID	STEAM
ADMISSION	VARIABLE
STAGES	FOUR
PRESSURE RATIO	140
INLET CONDITIONS	720°F/700 PSIG
CONTROLLED EXTRACTION	110 PSIG
CONDENSING CONDITION	6.1 PSIG
MAXIMUM RATING	400 KW

STEAM GENERATOR

POOL TYPE	10,500 LB/HR
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Figure 1-6. Specifications for Major Items of Equipment (May 1978) (Con't)

Figure 1-7. Prototype Parabolic Solar Collector

ENERGY SUMMARY

	LOAD REQUIREMENTS			ANNUAL STES CONTRIBUTION
	<u>BLEYLE⁽¹⁾</u>	<u>STES⁽⁶⁾</u>	<u>STES CAPACITY</u>	
ELECTRICAL	259 KW	137 KW ⁽⁵⁾	400 KW ⁽²⁾	389 MWH (33%)
COOLING	1,955,000 BTU/HR ⁽⁵⁾	120,000 BTU/HR	2,075,000 BTU/HR ⁽³⁾	3.8×10^9 BTU (62%)
HEATING	527,000 BTU/HR	32,000 BTU/HR ⁽⁶⁾	559,000 BTU/HR	130×10^6 BTU (98%)
PROCESS STEAM	1,424,000 BTU/HR	-----	1,424,000 BTU/HR	5.2×10^9 BTU (85%)
				TOTAL 63.4%

KNITWEAR PLANT REQUIREMENTS

259 KWe

1.39 MWth⁽⁴⁾

(1) L-1, 3/24/78 SIGN-OFF

(2) EXCESS CAPACITY FOR EXPERIMENTAL USE

(3) AT 210°F INLET DESIGN POINT

(4) ASSUMING COOLING W/7 COP CHILLER

(5) INCLUDES BLEYLE STORAGE AREA

(6) INCLUDES FIELD PLUS MECHANICAL BUILDING AND VISITORS' CENTER LOADS

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Figure 1-8. Energy Summary for the Bleyle Knitwear Plant

Figure 1-9. STE-LSE Site Plan

TABLE 1-1: STE-LSE-SS KEY EVENTS — 1977-1978

May 1977	Cooperative Agreement award announced
June	Formal meetings--Site Team; Sandia; and Conceptual Design Teams (GE, Stearns Roger, Acurex)
July	Energy-saving features incorporated into plant design
August	Concrete flooring for plant poured, insulated roof completed Government-furnished meteorology station installed, operation initiated First set of design interface drawings submitted to Sandia
September	Interconnection piping task added to Cooperative Agreement
October	First coordination meeting with GE Design Team Energy measurement program defined; measurement points selected Formal change procedures (Master Index Sheet) instituted for interface drawings
November	Interconnection Piping System inspected
December	Knitwear Plant completed, keys presented to Bleyle Plant side of interconnection piping system activated
January 1978	Bleyle plant begins operations
February	GPC single-line diagram incorporated into interface set Mobile Instrument and Visitor Center installed at site
March	Plans for adding eight instruments to Meteorology Station submitted to Sandia Electrical data collection lines installed
April	Site surveys completed, Solar Easement document drafted, Initial kilowatt hour data recorded CDDRs (Coordinated Design Data Required) incorporated, interface drawings reissued
May	Rough grading bid package submitted to G.E. and Lockwood Greene Instrumentation wiring completed, tested

TABLE 1-2: STE-LSE-SS KEY EVENTS — 1978-1979

June 1978	<p>Coordination Meeting to discuss planned expansion of Bleyle Plant Coordination Meeting with Site Team to plan for GE design review at Valley Forge</p> <p>Review Meeting with Shenandoah to discuss first draft of legal document to transfer 5.7-acre tract to GPC</p> <p>Site tour and presentation, Nevada Power Company and State of Nevada personnel</p> <p>Testimony presented to House Sub-Committee on Government Relations</p> <p>First Energy Data Report sent to GE reflecting kWh consumption in Bleyle Plant</p>
July	<p>Groundbreaking ceremony for collector field and open-house held at site</p> <p>ICWG and GE Design Review Meetings held at Valley Forge</p> <p>Tours and presentations conducted for several groups including Georgia Professional Engineering Society and Governor's honor students</p> <p>Status report on Site activities presented at Valley Forge</p>
August	<p>Contract validation and approval of site grading and TTO programs received from DOE</p> <p>Site tours included PRC Energy Analysis Company</p> <p>Monthly energy data sent to GE, Sandia and Heery & Heery; first computer data tape submitted to GE</p>
September	<p>Final review conducted for land transfer and solar easement documents</p> <p>Technical Interchange Meeting held with GE at Shenandoah</p> <p>Tours and presentations included Honeywell and various civic groups</p> <p>Paper on Energy Conservation in Bleyle Plant submitted to Southeastern Electric Exchange, Energy Efficiency Competition</p>
October	<p>DOE approval received for grading work</p> <p>Site Team meets with WSB-TV (Channel 2) to discuss Met Station; two-minute presentation broadcast on news programs on two consecutive days</p> <p>Presentations made to Georgia Public Service Commission, Xerox Corporation, and other business and Government representatives</p> <p>Bleyle Plant wins Southeastern Eastern Electric Exchange competition in Industrial Building Category</p> <p>Bids received for rough grading; selection submitted for DOE approval</p>
November	<p>New data logger installed by EG&G and GIT personnel; channel capacity expanded from 8 to 16</p> <p>Site clearing work begins: sediment fence installed, imperfect trench begun, topsoil stockpiled</p>
December	<p>Presentations made to Texas Utilities Service Company and other groups</p> <p>Construction of energy dissipator completed</p>

TABLE 1-2: STE-LSE-SS KEY EVENTS — 1978-1979 (Continued)

January, 1979	Presentations made to Texas Electric Services Company, Texas Utilities, and DOE representatives Land Transfer and Solar Easement documents officially recorded in Coweta County Court House
February	"Energy Challenge" show presented to IEEE, Power Generation Division of Atlanta Presentation made at meeting of Southern Company Services System Research Advisory Committee Earth moving activities completed at STES site
March	Participated in DOE sponsored Solar Energy Workshop Series of meetings conducted with GPC and H&H engineers to evaluate Bleyle Plant HVAC system and Energy Measurement and Reporting Programs
April	Presentations made to several Swedish engineers, Gulf States Utility Company, and representatives from Federal and State governments Grassing of steep slope areas completed at site
May	Site Team participates in 1979 International Solar Energy Society (ISES) convention; more than 600 attendees from 60 nations tour STES site Grassing of entire site completed
June	Presentations made to several groups including heating/air conditioning students at Atlanta Federal Penitentiary

2.0 BACKGROUND SUMMARY

This Section contains a brief summary of information relative to the Shenandoah Site and the Bleyle Knitwear Plant application. This material is not explored in depth in this Report and is provided only to orient the reader to the overall project.*

2.1 SHENANDOAH SITE

The site for the STES, the Bleyle Knitwear Manufacturing application, and the independent energy source (IES) is a multi-acre tract in the industrial park within the planned New Town of Shenandoah, 35 miles southwest of Atlanta. The knitwear facility, already in operation, will require approximately 161 kWe and up to 1.08 MWth for heating/cooling/process needs when the STES is operational in late 1981. Since the site is under the control of Shenandoah, necessary solar easements have been provided. The close proximity of several continuing solar projects (by Shenandoah Development Inc. and Georgia Institute of Technology) and GPC Plants Yates and Wansley enhances dissemination of STE-LSE technology.

2.1.1 LOCATION AND DESCRIPTION

Shenandoah is in Coweta County, 20 miles southwest of I-285, Atlanta's perimeter expressway, at the intersection of I-85 with State Route 34, as shown in Figure 2-1, near Newnan, Georgia. From I-285, other interstate highways lead to the Georgia and South Carolina seaports, and to the northern and western industrial/business areas. I-85 and I-65 lead southwest from Shenandoah to Mobile and New Orleans. The main line of the A & WP Railroad (a Seaboard Coastline affiliate) touches Shenandoah's primary industrial district, and the main line of the Central of Georgia (a Southern Railroad affiliate) touches the southern boundary of Shenandoah on its way to the port cities of Brunswick and Savannah.

I-85 is the main street of Shenandoah, which has approximately six miles of expressway frontage on both sides of the three mile stretch through the New Town. The intersection of I-85 and Georgia Route 34 is the main intersection of Coweta County. The town of Newnan (the county seat) touches the west boundary of Shenandoah, and the two communities are connected by Route 34, a four-lane, median-divided highway. Newnan-Coweta Airport is only five minutes south of Shenandoah.

Shenandoah officials worked with Coweta County to make it the first county in Georgia to offer tax incentives for solar systems and inventory. The county offers a property tax exemption for any solar system as well as a property tax exemption for equipment used in the manufacture of solar systems. The State of Georgia also exempts solar equipment from sales and use taxes, and Coweta County exempts from inventory taxes any goods destined for shipment out of state. Shenandoah designed and built the Bleyle Knitwear Plant, a manufacturing facility of 25,000 square feet, with plans for expansion to 42,000 square feet by 1981. Operations began in January, 1978.

The STES site in the Shenandoah Industrial Park is located northwest of the Interstate 85 and GA-34 intersection. The site consists of 5.72 acres adjacent to and east of the Bleyle facility. There is a direct exit from I-85 to Georgia State Route 34, which forms the southern boundary of the Industrial

*Additional comprehensive site and application details can be found in the STE-LSE First Annual Report (ALO/3394-77/3), available from the National Technical Information Service, as indicated on the back of the Title Page of this document.

Intersection of I-85 and GA-34 at Shenandoah

Bleyle Knitwear Factory and STE-LSE Site (Prior to Clearing and Grading)

Figure 2-1. Location of STE-LSE Site 35 Miles South of Atlanta

Atlanta receives as many total hours of sunshine per year as the east coast of Florida, including Cape Canaveral, site of Florida's new state solar center (Climatic Atlas of the United States, 1968). Atlanta is in the same bracket as Phoenix and Mesa, Arizona, in measurements by the Environmental Science Services Administration Weather Bureau of extraterrestrial solar radiation on a horizontal surface at true solar noon.

Shenandoah's climate is balanced between required heating and cooling. The total number of heating degree days for Atlanta is 3,095, and the total number of cooling degree days is 1,595 (using 65°F as a base). The heating season generally extends from October to April, with occasional heating required in May and September. The cooling season extends from May through September with occasional cooling required during March, April and October. This balanced situation allows research data gathered at Shenandoah to be generalized for much of the United States.

The area surrounding the STES site is fully under the control of Shenandoah Development, Inc., ensuring that future construction will not interfere with operation of the STE-LSE. All required solar easements were secured early in the second year of the Cooperative Agreement.

SHENANDOAH DEVELOPMENT GUIDELINES

Shenandoah is following initial environmental guidelines set forth in 1971-1972 during a major study by the nationally recognized firm of Nicholas Quennel and Associates. That study of soils, land cover, climate and topography was utilized by the master planning firm of Llewellyn Davies and Associates of Great Britain for the A-95 Review, water and sewage systems, solid waste disposal, roads, and similar urban designs. Those guidelines have also been incorporated into the Development Review Guidelines, which apply to all construction within the New Town.

The Developer of the New Town of Shenandoah has recorded a Declaration of Covenants, Restrictions and Easements, which is designed to:

- Preserve Shenandoah's natural environment.
- Achieve a high level of quality of the siting, planning and design of structures within the New Town.
- Ensure the conformity and harmony of the external design and general quality of each structure both with its natural environment and with its neighboring structures.

In order to fulfill these objectives, Shenandoah's Declaration created a Development Review Committee (DRC) and charged it with the responsibility of approving plans and specifications for all structures that are constructed, placed or altered in the New Town. The DRC has established Development Guidelines that provide environmental site and building criteria for projects within Shenandoah. Environmental quality control measures are required to minimize air, water, noise, and soil pollution; to control water run-off; and to aid in the preservation of native trees and plants.

Site planning, building design, and site details are reviewed for compatibility with existing topography, for harmony with design of adjacent projects, and for complementary appearance of exterior design details. Additional site planning criteria include lot coverage ratios, set-backs, parking ratios, and landscaping guidelines. The guidelines do not prohibit construction of a field of solar concentrators on the 5.72-acre STE-LSE site, providing there is appropriate concern for aesthetics.

Park, and then easy access to the STES site via Amlajack Boulevard. Figure 2-2 is a plot plan for the STES site, and Figure 2-3 is an artist's conception of the STES collector field, STES building, and the Bleyle knitwear manufacturing facility.

For the purpose of this program, the 5.72-acre site was selected on the assumption that up to 10,000 m³ of collector area at 50 percent packing fraction may be desirable even though this appears to be more than adequate for the subject application.

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Figure 2-2. Plot Plan of STES Site

Figure 2-3. Artist's Conception of Bleyle Knitwear Facility with Solar Collector Field

2.1.2 SUITABILITY OF THE SITE

The Shenandoah Industrial Park site is ideal in terms of the requirements of the STE-LSE for a variety of reasons. The climate in the Shenandoah area is relatively mild, and the direct-normal insolation varies from about 4 kw hr/m²xD in winter to about 6 in late spring and summer, with an annual average of 5.18.

The climate in the Shenandoah area has a nearly equal balance between months that require heating and those that require cooling. Therefore, Georgia is a better place than the sun states in which to test equipment that would be useful for the nation as a whole. The map in Figure 2-4 shows climate zones as plotted by Midwest Research Institute of Kansas City, Missouri. The Shenandoah site is located near the intersection of Zones 2, 3 and 5, providing a variety of weather conditions in close proximity. These three climatic zones include areas where cooling degree days vary from 1,000 to 4,000, and heating degree days range from 0 to 5,000.

Figure 2-4. Shenandoah is Located Near Intersection of Climate Zones 2, 3 and 5

2.2 BLEYLE KNITWEAR MANUFACTURING APPLICATION

The Bleyle Knitwear Manufacturing application for the STE-LSE, now in operation at the Shenandoah Site, is ideally suited for the project for a variety of reasons. The facility offers a high degree of rapid and widespread commercialization, it requires energy beyond the sunlight hours for two-shift operations, and it provides a usage for any desired degree of thermal storage incorporated into the STES. In addition to its use of electrical energy and low temperature steam for heating and cooling, the plant requires approximately 1000 lb/hr of process steam for its machinery.

2.2.1 DESCRIPTION

The Bleyle Knitwear Manufacturing Plant, shown in Figure 2-5, is a 25,000 square foot facility. The plant, which has expanded its production to include a line of blouses in addition to its skirts and slacks, will utilize solar energy for electricity for cutting and sewing, thermal energy for heating and cooling, and process steam for pressing operations. The plant employs 90 residents of Shenandoah and other near-by communities, with an ultimate goal of more than 300 local employees.

Figure 2-5. Bleyle Knitwear Plant

During construction of the building in late 1977, by Shenandoah Development, Inc., interconnecting piping was installed for eventual hookup of the solar energy system. This was done under Revision No. 1 to the subject Cooperative Agreement and will allow the solar energy source to be phased into operation with a minimum of disruption to manufacturing operations. Other considerations relative to efficient use of solar energy also were incorporated into the plant during its construction as discussed in the following section.

2.2.2 ENERGY CONSERVATION FEATURES*

The Solar Total Energy Project Team recognized the need for an energy conservative building since the collector field size and the installed and operating cost of the experiment is in direct proportion to the user energy requirements. This need for energy conservation and effective use of collected solar energy was stressed in both the site solicitation and the Cooperative Agreement negotiations.

During the early weeks of the project, Shenandoah Development, Inc. contracted a local architectural firm, to provide architectural services to satisfy the needs of Bleyle. During a series of meetings, several methods of reducing energy consumption were proposed by the site team, resulting in a list of energy-conservative features to be incorporated into the construction of the building. The overall effect on the first cost of incorporating these energy-conservative features into the 25,000 square foot building was a reduction of approximately \$65,000. Recognizing that this figure includes the true market effect of these features is a first cost reduction of \$9,000.

Following is a summary of the energy conservative features:

- Air conditioning economizer cycle
- Four foot earth berm
- Reduced building height
- Wall insulation "U" factor equal .05
- Roof insulation "U" factor equal .03
- Reduced window area
- Double glazed windows
- Fluorescent lighting
- Increased lighting and motor voltage
- East-west orientation
- Central hot water heating
- Reflective aluminum-painted roof
- Various process system refinements

*This material is excerpted from the following report: Hammock, R. Bruce. "A Case Study of Shenandoah Energy Conservation Features in Connection with STE-LSE." ALO/3994-78/1 (3/78).

Figure 2-6. Energy-Conserving Earth Berm Surrounding Bleyle Plant

It must be pointed out that certain of the savings figures are empirical, and as such, are based on experience in this field. The discussion of these features is treated on an individual basis. The amount of energy saving is based on the difference between the estimated energy consumption of the original feature and the energy conservative feature. The estimated energy consumptions are based on an expanded knitwear plant at 42,000 sq. ft. of floor area. Projections indicate a 46 percent savings in annual energy consumption due to incorporation of the energy conservative features. Applicable rate structures translate this into a savings of \$25,000, or a billing drop from \$66,000/year to \$41,000/year. Detailed formulas for estimating probable energy consumption, as well as other supporting data, are included in the report on Energy Conservation Features of the Bleyle plant. Figure 2-6 illustrates the earth berm surrounding the building.

2.2.3 OPERATIONAL LOAD CHARACTERISTICS

An overall description of the expected load characteristics of the Bleyle Knitwear Plant is presented in Section 1.3 of this report. The solar energy system design will be refined as new data become available through the Georgia Power Company Instrumentation now in place at the site and constantly recording energy usage within the plant.

2.3 GOVERNMENT-OWNED METEOROLOGY STATION

In the design of advanced-concept solar energy systems such as the Solar Total Energy System planned for Shenandoah, it is of prime concern that a comprehensive and accurate solar data base be available. This is important since many of the design decisions are based on estimates of system performance in specific modes of operation under representative "normal" as well as "extreme" conditions. In addition, concentrating solar collectors such as those proposed for the Shenandoah Total Energy System can effectively collect only the direct component of solar radiation, which to date has been measured at few research sites across the country.

The only available solar data in the Atlanta region are the daily totals of global insolation recorded by the National Weather Service at the Atlanta Airport, which cover a 22-year period. However, due to budgetary considerations, the collection of these data by the National Weather Service was terminated in 1973. No beam radiation or diffuse radiation measurements were made.

The Shenandoah Meteorological Station was constructed by Heery & Heery, with equipment and instrumentation designed and installed at the project site by Sandia. The station instruments and data acquisition system were designed and constructed by EG&G-Las Vegas under direction from Sandia Laboratories. The station, shown in Figure 2-7, began with a set of eight solar radiation and surface weather instruments, appropriate mounting or support structures, and a compact, portable, cassette tape data logger. However, during the second year of the Cooperative Agreement, the station was expanded to include the following equipment:

Instrument	Variable Measured
1. Pyranometer (horizontal)	Global radiation
2. Pyrhelimeter	Direct normal radiation
3. Pyrhelimeter	Direct normal radiation
4. Resistance thermometer	Dry bulb temperature
5. Humidity cell	Relative humidity
6. Cup anemometer	Wind speed
7. Wind vane	Wind direction
8. Pressure transducer	Barometric pressure

9. Spectral Pyrheliometer (RG630 Filter)	Filtered Direct Radiation
10. Spectral Pyranometer (RG630 Filter)	Filtered Global Radiation
11. Tilted Pyranometer (Latitude Angle)	Global Radiation, Latitude Plane
12. UV Pyranometer	Ultra-Violet Radiation
13. Diffuse Pyranometer	Diffuse Component Only
14. Net Pyrradiometer (CSIRO Funk Type)	Net Radiation
15. Cavity Temperature	Part of Pyrradiometer
16. Rain Gage	Rainfall

Each variable is measured at one minute intervals, 24 hours per day, and the results are stored on small digital magnetic tape cassettes.

The station was installed on a fenced concrete pad located at ground level at the center of the southwest quadrant of the proposed Total Energy System collector field. The instruments require 110 Vac power for operation and this service is provided at the site. The logger operates from the same power source but is capable of operation from internal batteries for up to 45 minutes. At a recording interval of one minute, the logger can record data from the 16 instruments for a little more than five days before a cassette is filled.

In order to perform numerical modeling of the Solar Total Energy-Large Scale Experiment at Shenandoah, accurate data on direct and global insolation as well as other meteorological parameters are required. At the initiation of this project, the only available data for Georgia consisted of daily total global insolation recorded by the National Weather Service at the Atlanta Airport Station some 25 miles to the northeast of Shenandoah, and a few years of solar radiation records from Griffin. Whereas approximately 23 years were available for Atlanta, only the daily totals were recorded, so no hourly data (required to properly evaluate transient system performance) were logged. The original circular charts, however, were available in Asheville, North Carolina.

Daily total solar radiation data from 1952 to 1974 were examined and the monthly mean and standard deviation of these daily totals were calculated. A composite year was then selected consisting of those months for which the mean and standard deviation most closely matched the 23 year averages, and for which complete data were available. Table 2-1 lists the selected model year months and the comparison of the mean and standard deviations of the daily totals to the long term averages. The circular charts were then read for each day of this composite year and 15 minute values were then read for each day of this composite year and 15 minute values of daily total radiation were recorded. The 15 minute values were transcribed onto magnetic tape, which was processed at the Aerospace Corporation to separate direct and diffuse components, and then returned to Georgia Tech. The solar radiation data were rehabilitated by Georgia Tech using a regression analysis of the performance of each instrument under clear sky conditions over its lifetime. These data were then recorded in SOLMET format along with corresponding other meteorological parameters to produce a complete SOLMET tape. The final solar year model tape has been made available for distribution in accordance with contract provisions, and will be updated utilizing direct solar radiation data from the STEP meteorological station when they become available.

With the installation of a new EG&G data logger in November, 1978, the quality of the weather data improved dramatically to the point where the Met Station is now gathering near 100 percent of required data. Daily and monthly data summaries have been provided to Sandia and Georgia Power Company since November.

Section 3.2 of this report contains a detailed chronological summary of Met Station operations throughout the subject reporting period.

Figure 2-7. Government-Owned Meteorology Station at Shenandoah Site

TABLE 2-1**MODEL YEAR MONTHS SELECTED AND THEIR COMPARISON TO LONG TERM AVERAGES**

Model Month	Year Selected	Mean*	Std. Ratio**	Std. Dev.*	Ratio**
Jan.	1953	793	1.03	420	1.04
Feb.	1971	1047	1.01	538	1.01
Mar.	1969	1427	1.02	597	0.94
Apr.	1965	1780	1.02	623	0.95
May	1957	1943	0.99	645	1.06
Jun.	1957	1932	1.03	564	1.07
Jul.	1970	1906	0.99	472	1.04
Aug.	1959	1740	0.99	332	0.81
Sep.	1963	1438	0.98	487	1.02
Oct.	1967	1272	1.02	472	1.09
Nov.	1967	951	1.02	451	1.16
Dec.	1970	708	0.97	372	1.03

*Means and Std. Dev. are in units of Btu/ft²/day (total horizontal)

**Ratio is with respect to 23 year average monthly values

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2.4 GEORGIA POWER COMPANY INSTRUMENTATION*

At the Solar Total Energy-Large Scale Experiment at Shenandoah, Georgia, the objective of DOE and General Electric is to optimize the design of the solar total energy system. The acquisition of quality data documenting energy consumption characteristics of the Bleyle Knitwear Manufacturing Plant application provides system designers with recorded observations from which the energy optimization objective can be met. Heavy emphasis is placed on analysis of acquired data to achieve this objective.

Analysis requires the extraction and proper formatting of meaningful data by designing and tailoring the manner in which physical data are actually collected, conditioned and recorded, placing equal emphasis on data handling, validation and presentation.

Measurement of consumption of electric energy and application environment conditions (such as temperature, relative humidity, pressure, and mass flow of liquids and gasses) is essential in determining energy utilization within the application.

An examination of analog and digital data acquisition reveals the broad array of equipment and measurement alternatives available to the building instrumentation engineer. Some measurement alternatives are dictated by the configuration and use of the building, while others are defined by the requirements and accuracy of the data to be collected. Factors that determine these requirements are exposure, occupancy, and construction.

A building may be divided into a number of zones. In new construction, such as the Bleyle Knitwear Plant, provision for energy and environmental measurements can be made by zone. Measuring energy in a building zoned for exposure requires consideration of prevailing wind direction, wind velocity, solar radiation, and outside-air temperature and humidity. In measuring energy in the industrial building, zoning for occupancy affects the heating and cooling requirements of the parts of the building.

In general, an industrial plant should be zoned for occupancy rather than exposure. In that zone used for offices, higher space heating temperatures are required for worker comfort than in the production area. In addition, lights, machinery, and process steam for the presses may reduce production zone space heating supplied from the heating boiler and may in fact require space cooling. Storage areas require minimum space heating and do not require mechanical cooling. Simultaneous use of space heating and cooling can have serious design impact on the solar total energy system being designed to serve this plant.

Building occupancy and use determine the equipment measurement points and environmental or production system applications to be instrumented. A listing of instrumentation equipment being used at the Bleyle Plant is contained in Appendix A, Interface Control Drawings. Figure 2-8 shows the Mobile Instrumentation and Visitors Center installed at the site, and Figure 2-9 shows the equipment installed in a console. Section 3.2 of this report contains a detailed chronological description of the Data Acquisition effort conducted during the subject reporting period.

*Excerpted from a report by Edward T. Houts and Steven K. Hubbart, "Energy Measurement and Data Management Program: Solar Total Energy-Large Scale Experiment, Shenandoah, Georgia," 1/2/78.

Figure 2-8. Mobile Data Acquisition Center

Figure 2-9. Data Acquisition Equipment In Mobile Center

3.0 DETAILED PROGRESS REPORT

This section contains detailed accounts of activities related to the STE-LSE Site and application during the period June 1978 through June 1979. These activities are presented in the following format:

- 3.1 General Site/Application
- 3.2 Meteorology Station
- 3.3 Instrumentation/Data Acquisition
- 3.4 Design Interface
- 3.5 Information Dissemination

As mentioned in the abstract introducing this report, general progress exceeded expectations during the second year of the Cooperative Agreement between the U.S. Department of Energy and the Georgia Power Company (and its Site Team). This Cooperative Agreement, No. EG-77-A-04-3994, provides the schedule below for selection of a site and application, as well as design, construction and operation, of a Solar Total Energy-Large Scale Experiment:

SOLAR TOTAL ENERGY LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA

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The following pages identify the work tasks in the subject Cooperative Agreement, and are presented here for reference and background information. Under terms of the Cooperative Agreement, DOE "agrees to design, construct and operate a Solar Total Energy System (STES) to provide solar derived electrical and thermal energy to the Participant's Development . . . and a meteorological station to obtain data for evaluating the performance of the STE-LSE. The STES shall include a high-temperature energy collection and storage loop, an electrical generation loop with fossil fueled back-up capability, a low-temperature loop with fossil fueled auxiliary and an energy conditioning loop."

Under terms of the same Agreement, Georgia Power Company has made available (through team member Shenandoah Development, Inc.) a site and industrial application for the STES, a specific site for the DOE-supplied meteorology station, and all instrumentation necessary to monitor and record

energy usage data within the knitwear manufacturing application. This includes all necessary personnel, materials, services, and facilities to run the application.

During the early months of the Cooperative Agreement, the planned work program for the six year activity was changed to include not only the entire work scope proposed by Georgia Power Company, but other tasks that logically should be performed by the Georgia Power Company Team.

COST SHARED SERVICES

- Provide load and energy displacement data and analysis.
- Provide subsurface exploration support.
- Procure permits and licenses.
- Provide analysis and reporting of solar technology consultive services.
- Assess interaction of proposed STE-LSE in actual operating environment including data collection and analysis in performance, operation and economic areas.
- Communicate with DOE on progress and changes including GTR and Sandia and provide monthly cost and status reports.
- Provide utilities support activities.
- Support cost, schedule and performance control and reporting.
- Provide liaison with conceptual, preliminary, and final design teams and construction and operational activity.
- Provide site, application and operation and planning data documentation and configuration control support.
- Provide STES checkout, operation, training and maintenance support and disposition analysis.

DOE FUNDED SERVICES

- Provide interface definition and control (design phases).
- Provide, operate and maintain STE-LSE meteorology station.

COOPERATIVE AGREEMENT SPECIAL SERVICES

- Provide temporary transformer pad to Bleyle Plant.
- Provide instrumentation to Bleyle Plant.
- Provide underground transmission line to Bleyle Plant.
- Provide transformer stepdown station and breakers.
- Provide auxillary turbine intertace equipment.
- Provide energy user conservation services.

During the latter part of the first contract year, two additional tasks were initiated:

- Information dissemination
- Rough grading of the site

The following sections contain a detailed description of progress made at the Shenandoah STE-LSE site from June, 1978 through June, 1979. Tasks accomplished during the first year of the Cooperative Agreement are cited where appropriate to provide a frame of reference for more current activities.

3.1 SITE/APPLICATION

BACKGROUND

In May, 1977, subsequent to the announcement of Georgia Power Company as the winning proposer in the DOE Solar Total Energy Site Selection Program, the major activity consisted of formulating an acceptable Cooperative Agreement between DOE and Georgia Power Company. Several iterations of contract language evolved relative to terms, conditions and funding schedules, until an acceptable agreement emerged. Simultaneously, contracts, approval forms, required audit procedures, funding and other subcontractor issues were being resolved for Georgia Tech, Heery & Heery, and Westinghouse—all members of the Site Team.

All aspects of the Cooperative Agreement between DOE and Georgia Power Company were resolved early in June of 1977, and the document was submitted for DOE approval. Shenandoah agreed to clauses concerning sun rights, site access, addition of energy conservation features to the Bleyle Plant, and financing for the plant. Meanwhile, Georgia Tech, Heery & Heery, and Westinghouse signed their respective sub-contracts. After the required approvals were obtained, the Cooperative Agreement was formally signed on June 16, 1977.

Change Notice Request No. 1 to the Cooperative Agreement was submitted in August, 1977 for the design and installation of interconnection piping to provide both solar heating and solar cooling. The interconnection system was installed during construction, with appropriate connection points in the plant mechanical room, so that knitwear operations would not be disturbed at the time of connection to the STES. The system was conceived to include the capability to heat and cool the plant, including the storage area, and to facilitate monitoring of heating energy.

Construction of the Bleyle Knitwear Plant proceeded on schedule with formal dedication of the plant taking place on August 4, 1977. An important consideration in selecting Shenandoah for the site of the STES Project was the developer's willingness to agree to a Solar Easement on property adjacent to the STES Site. This easement was intended to accomplish two objectives: it would provide adequate protection for the STE site from development on adjacent property that might interfere with the collection and use of solar energy, and it would preclude an undue encumbrance on the adjacent property that might interfere with the marketability and use of this property. The Solar Easement and related Property Transfer Agreement were signed and filed in January, 1979.

PROGRESS DURING SUBJECT REPORTING YEAR

SITE

The most dramatic and visible progress at the STE-LSE Site during the second year of the Cooperative Agreement was the clearing and grading effort for the solar collector field. A major groundbreaking ceremony was conducted at the site on July 31, 1978, followed by a general open-house at the Knitwear Plant. Among those in attendance were U.S. Congressman Mike McCormack and other

Government and Civic dignitaries. Mr. Ingo Weber-Bleye hosted the ceremonies and subsequent site tour. Figure 3-1 illustrates some of the groundbreaking activities.

In June, 1978, prior to the award of the site grading contract, preliminary application was made to the local Soil Conservation Service and the State Department of Natural Resources (DNR) for sediment and erosion control permits. DNR agreed to a proposed 1:1 slope at the site with the stipulation that it be planted with Lovegrass or Sericea Lespedeza, and asked that the sediment fence be extended. These requirements were incorporated into the bid package.

Following a contract award in early October, the contractor made a formal application for a State sediment and erosion control permit. The permit was issued with the stipulation that the discharge ditch from the energy dissipator, shown in Figure 3-2, be redesigned to include larger rip-rap. This condition was resolved by Lockwood-Greene, and depth of the ditch was increased by six inches, and its width increased by one foot. Actual clearing and grading work began at the STES collector site November 6, 1978, and continued throughout the winter.

By the end of November, the sediment fence was in place, a portion of the imperfect trench* had been begun, clearing and grubbing was nearly complete, the drop inlet had been begun, and topsoil was being stockpiled. During the latter week of the month, essentially no progress was accomplished due to the holidays and several consecutive days of rain. Bad weather added significantly to the Contractor's initial 60 day estimate.

Construction of the energy dissipator was completed during December. The imperfect trench also was completed with the exception of the final compaction. Manhole elevations (Figure 3-2) were changed to finished grades.

Earth moving activities were nearly complete by the end of January. The energy dissipator and discharge ditch and the imperfect trench were completed with the required degree of compaction achieved after some difficulty. Erosion control measures were shown to be effective in limiting the impact of construction on the local environment. Grassing was the only potential problem in January, due to the time of year. All steep slope areas had to be grassed to take advantage of whatever stabilization possible from mulch and root growth. However, the topsoil remained stockpiled and the flat area remained ungrassed until spring in order to avoid erosion and freeze-kill of grass. Grass seeding of steep perimeter slopes took place in February, 1979, to prevent erosion during spring rains. Grassing of the level surface took place in March and April. Figure 3-3 is a chronological photographic record of the clearing, grading, and grassing efforts. At the end of June, the site was completely covered by grass.

3.2 METEOROLOGICAL STATION

BACKGROUND

Installation of the Meteorological Station, described in detail** in Section 2.3, was completed in August 1977, under supervision of personnel from Sandia Laboratories and EG&G. Georgia Tech personnel were instructed on proper operating procedures, and the station began operation on September 1, 1977.

*The imperfect trench was required to distribute the load of the fill material in order to protect the sewer line under the property along the north boundary.

**Drawing MS-1, Appendix A, provides additional information relative to the Meteorological Station.

Dr. Eric H. Willis, Deputy Assistant Secretary for Energy Technology, DOE

Ingo Weber-Bleyde, President, Bleyde of America

Lee Farnham, Vice-President and General Manager, General Electric Space Division

Figure 3-1. Groundbreaking Ceremonies and Associated Activities

U. S. Congressman Mike McCormack

Experiment
city, heating, cooling and steam

Dieter Franz, General Manager, Shenandoah Development, Inc.; Walt Hensley, Project Manager, Georgia Power Company; Robert Scherer, President, Georgia Power Company

Figure 3-1. Groundbreaking Ceremonies and Associated Activities (Continued)

Figure 3-2. Energy Dissipator Discharge Ditch and Elevated Manhole

Wooded and Sloped Site for Collector Field

Clearing and Burning of Vegetation

Figure 3-3. Sequence of Events During Clearing and Grading of Site for STES Collector Field

Grading Work Beyond Meterology Station

Bleye Building in Right Background

Figure 3-3. Sequence of Events During Clearing and Grading of Site for STES Collector Field (Continued)

Perimeter of Graded Field

Elevated Manhole in Right Background

Figure 3-3. Sequence of Events During Clearing and Grading of Site for STES Collector Field (Continued)

View from Meterology Station Showing Water Tower

**Grassy, Level Site Shown from same Vantage Point as
Photo Showing Clearing of Vegetation**

**Figure 3-3. Sequence of Events During Clearing and Grading of Site for STES Collector Field
(Continued)**

Monitoring of the station operation, routine preventive maintenance, and cassette tape retrieval had been planned to be performed by Georgia Tech, as well as data transcription, verification, and distribution. However, due to unanticipated difficulties with cassette tape transcription early in the program, this responsibility was temporarily shifted to EG&G-Las Vegas. Since tapes required verification, analysis and copying software were developed. Data transcription, verification, and distribution duties reverted to Georgia Tech when transcription problems with the logger tapes were resolved.

PROGRESS DURING SUBJECT PERIOD

The highlight of the subject reporting year, in terms of the Meteorology Station, occurred in November of 1978 when the new EG&G Data Logger was installed at the site. In addition to increasing the number of available channels to 16 (to accommodate eight new pieces of equipment), the unit allowed the Met Station to gather near 100 percent of required data. These data have been gathered into daily and monthly summaries and submitted to Sandia and Georgia Power Company since November. Figure 3-4 shows the Meteorology Station as it appeared in June, 1978 and June, 1979.

Following is a summary of the station operation during the past year, including problems as well as prominent events.

During June, 1978, operation of the Meteorology Station continued on a routine basis, with cassettes being sent to EG&G for transcription. Planning continued for addition of the eight new instruments. During July, site visits continued on a Monday-Wednesday-Friday basis and plans were made to increase the visits to a daily basis, in order to keep the instruments clean, once grading efforts were underway. At mid-month, a status report on the operation of the station was presented at the Third Design Review for the STE-LSE at Valley Forge. Operations were routine during August.

By September, the proposal for conversion of the energy data acquisition system to accept 16 meteorology station weather and solar data channels was in final draft, with plans to transmit the proposal to Sandia Laboratories during the first week of October. Operation of the Met Station during October was routine, with no significant problems reported. Since this month is close to the equinox, when solar declination angles were varying rapidly from day to day, special efforts were made to insure that the tracking system was properly adjusted. This involved making special site visits on the first clear day following several cloudy days. A tape was received from EG&G containing data from 18 cassettes covering the months of November-December 1977 and January-February 1978 (some data were temporarily missing). No problems were encountered in processing the tape, and a summary was ready during the first week in November.

In conjunction with the Fort Hood design review at Sandia Labs on November 11, Georgia Tech discussed with Sandia the proposed Georgia Power data logger expansion to include the Met Station. Their schedule and work plan would not be affected, no matter which approach was adopted. The main requirement was to obtain reliable data in a timely manner. However, the schedule showed that modifications would not be completed until sometime in January or February. Due to the importance of obtaining midwinter solstice period solar data, it was desirable to install the new "improved" EG&G data logger promptly. In this way, the data could be processed and given to GE in time to be considered in current design studies.

As a side benefit, Georgia Tech requested that the EG&G logger be left in place along with the GPC system for educational purposes since students from Tech could then operate the system, which would serve as a second-level backup to the GPC system. It also would serve as a long-term operational check of the portable system (this has strong implications if such a system is to be used for the photovoltaic national program).

With 8 Instruments

With 16 Instruments

Figure 3-4. Meteorology Station in June, 1978 and in June, 1979

Georgia Tech was sent a copy of the GPC data system proposal in November, and comments were transmitted to Georgia Power. Georgia Tech's involvement was to assist in the procurement of the signal conditioners and to make the appropriate connections to the transducers and to the new logger. All trenching and cable-laying or pulling was the responsibility of Georgia Power. Georgia Tech also assisted in the check-out of the system. Operation of the Met Station during November proceeded with no significant problems. Major changes were made in the number of instruments, and the data logger was upgraded. These events proceeded without problems and are described in detail below:

- During the second week of November, a new and substantially improved model of the data logger was installed by EG&G and Georgia Tech personnel. No problems were encountered in the changeover and the new system was functioning on November 10. Key features of the new logger are:
 - Channel capacity is expanded from 8 to 16 channels.
 - All signals are sampled at two-second intervals and are digitally integrated over the specified measurement period.
 - The display is capable of indicating transducer outputs in engineering units using previously stored calibration values.
 - The tape cassette is buffered so that no data are lost during routine tape changes.
 - The logger is capable of operation for up to 24 hours without external power. After this point, only the processor and clock are maintained by internal batteries.
 - Tapes can be read directly on TI 733 ASR terminals.

The new system operated without problems. The tapes, which were changed at weekly intervals, were being processed at Georgia Tech. Minor problems with computer interface were encountered but were resolved.

- At the same time as the logger upgrade was made, Georgia Tech added seven solar instruments to the Station (an eighth instrument was to be employed for short-term studies). These additions extend the measurement capability to the UV and IR wavelengths. Also included were direct measurement of diffuse radiation, measurement of rainfall, and measurement of atmospheric scattering. These extended data were to be reported along with the basic eight Sandia/EG&G channels.
- At the Design Review Meeting on November 14-15, copies of tapes containing roughly 40 percent of the first year's data from the Station were turned over to Sandia and GF. The preliminary data were organized into monthly files of 15 minute (LST) averages.

The new data logger was functioning properly in December. A problem resulting from improperly changing a tape resulted in loss of about one week of data. The difficulty was due to operator error and was corrected by additional instruction. Based on extensive conversations with EG&G personnel, an operations manual was written by Georgia Tech.

Continuing analysis of data received by Georgia Tech from EG&G, covering about 40 percent of the past year, revealed lower-than-expected direct normal radiation values. Georgia Tech began carrying out further tests and comparisons to the global data. It appeared that the discrepancies might be due to tracker alignment problems (the tracker can be aimed at the sun at one hour and be off later in the

day). A site visit was made and the tracker was carefully disassembled; reassembled, and aligned using precision protractors and levels. Magnetic compasses were used to make a preliminary NS alignment and sunset adjustments were made. After several weeks of checking, the problem appeared to have been resolved.

Operation of the Met Station proceeded with no major problems during January. Progress during the month was as follows:

- Data from November and December were transcribed and processed. Copies of the 15 minutes and daily totals were sent to EG&G for review. The following points were noted:
 - The relative humidity exceeded 100 percent, indicating problems with the sensor, perhaps resulting from direct contamination of the sensor during rainy conditions.
 - The radiation instruments indicated negative daily totals on some days, due to accumulation of the zero error at night and during very heavily overcast days.
 - The spectral NIP (SP-DIR) showed significant error in December, which was traced to a broken wire inside the cable connector. It was repaired on January 23. The problem was caused by poor connector design and the frequent need to disconnect and reconnect the cables (for untwisting).
- Georgia Tech continued to watch the tracking accuracy of the equatorial drive and to adjust it as required. No problems were encountered.

Operation of the Met Station proceeded with no major problems during February. All equipment functioned properly. Specific progress was as follows:

- There were no power outages or loss of data for the month, so that a complete monthly record was available.
- Data from January were transcribed and processed. The problem with the spectral pyrheliumeter that showed high readings was corrected.
- No problems were encountered with tracking accuracy and second-order quality control checks indicated that the data were consistent.

Operations proceeded with no major problems during March. All equipment functioned properly. Specific progress was as follows:

- There were no power outages or loss of data for the month, so a complete monthly record was available.
- Data from February were transcribed and processed.
- No problems were encountered with tracking accuracy and second-order quality control checks indicated that the data were consistent.

Operations were routine during April. All equipment, with the exception of the humidity sensor, functioned properly. During May, however, some difficulty was experienced:

- The data logger was removed on May 7 in order to perform a recalibration of the input channels and to modify channel No. 16 to accept an AD590 temperature sensor as input from the pyrriometer. The modification was arranged in advance with Sandia personnel. The logger was reinstalled on May 28, and has operated without incident since then. The reason for the three week delay (only 3-5 days downtime were anticipated) was the failure of one of the logger power supplies. This was caused by age and somewhat high operating currents. A replacement was fitted and checked out in the lab. A spare module was then purchased, since it was anticipated that the same module might fail within a year, especially if the logger displays are accidentally left on.
- The three weeks of missing data were filled in with data taken at the Georgia Tech site, since solar radiation values were not substantially different. The logger recalibration revealed a maximum of about 1 percent error between channels.

Progress was satisfactory during June. The power supply failure appeared to have occurred simultaneously with the maintenance, but was within Site Team capabilities. No data were lost overall. Several operational notes are provided below:

- From 1200 hours on May 31 until 1030 hours on June 11, the met station operated with only six of the 16 channels being recorded. This was because of an accidental positioning of the "number of channels" switch, which was changed from 16 to 06. The source of this error is not clear since no Georgia Tech personnel visited the site on May 31. Tech feels that someone may have opened the logger during one of the ISES Congress visits and accidentally moved the switch. The surface meteorological channels were recorded but all solar instruments except one NIP were lost. No other problems were encountered.
- The wind speed and direction sensors were moved to a three-meter tower in the NW corner of the pad to provide more representative wind data.

Near-term plans call for correlation of site weather data with similar data being gathered at a station on the Georgia Tech Campus to provide comparisons between rural and urban insolation characteristics and weather conditions.

3.3 INSTRUMENTATION/DATA ACQUISITION

BACKGROUND

The program to measure energy utilization within the Bleyle Knitwear Plant was fully defined in October, 1977. The program included selection of temperature, humidity, flow, and steam pressure data collection points; selection of equipment; and finalization of key measurement function decisions. Thermal and mechanical system instrumentation equipment was procured from Honeywell for 56 data channels, including necessary engineering and shop drawings, wiring diagrams, and full instructions for installation and calibration. Doric Scientific Systems was selected as a supplier of datalogger thermodynamic sensors and recording equipment.

All data acquisition equipment (Figure 2-9) for the Bleyle Plant is housed in a mobile unit installed at the site. This unit, shown in Figure 3-5, also serves as a temporary Visitor's Center.

PROGRESS DURING SUBJECT REPORTING PERIOD

On June 7, a Technical Representative from Doric Scientific spent the day at Shenandoah performing equipment checkout, calibration, and operational training on the data recording system. Eight GPC

Figure 3-5. Mobile Data Acquisition and Visitor Center at Shenandoah STE-LSE Site

personnel associated with the Bleyle Plant instrumentation attended the training. During the equipment check, a troublesome input/output circuit problem was identified and corrected by replacement of the shielded cable from the microprocessor unit to the tape recorder. The data recording system functioned with perfect reliability after the repair.

During the Doric equipment checkout, a new CPROM was installed that allows temperature, humidity flow and pressure measurements to be resolved to the nearest 0.1 unit. Square root extractors and integrators were installed in late June, completing all components and wiring to make the system fully functional.

On June 12, the first management report was sent to G.E. and Sandia Laboratories reflecting kWh hourly consumption in the Bleyle Plant for the period of May 9-16. During the month, GPC and Southern Company programmers worked to reformat data displays to a weekly format compatible with Southern Company load research computer programs to allow extended flexibility to data analysis.

The highlight of the month of July was the formal presentation of the GPC energy measurement and data reporting program at the final Preliminary Design Review held at Valley Forge on July 18 and 19. Emphasis was placed on data handling, expected report output, report format improvements, and anticipated engineering equations for energy analysis.

The report output was reprogrammed to include electrical and thermal peak 15-minute interval occurrence and to record the time of day this peak occurred. At Heery and Heery's request, the output was programmed to give the average kWh integrated over 15-minute intervals for Bleyle Plant operating hours (Monday—Friday, 1600—2315 hours). Methods were also being examined and implemented to reduce computer costs of loading data to the permanent history file.

Data measuring devices functioned properly during July with exception of flow and pressure channels. The complex electronic interface between the Honeywell differential pressure transmitters and the Doric microprocessor added about 12 mandays of re-engineering, but the interface problem was solved and all flow and pressure channels became operational.

On August 10, the monthly recording of energy data from the Bleyle plant was sent to General Electric, Sandia Laboratories and Heery & Heery. Because of vacation schedules, this recording covered the period June 26 through July 16. The first computer data tape was mailed to General Electric on August 24.

At the request of Sandia Laboratories, the Georgia Power team investigated the alternative of recording 16 weather data channels on the GPC/Bleyle plant data measurement system. With the assistance of Georgia Tech and Doric's Atlanta representative, the equipment and installation schedule was completed and a formal proposal, including conversion cost estimates, was submitted to Sandia Laboratories.

Unavailability of flow and pressure data continued through September. Approximately 12 mandays were spent on the problem by the GPC instrumentation team, assisted by Honeywell and AGM Electronics. It appeared that problems concerning these instruments were rectified by August 30, but false readings through signal conditioners to the data logger were misleading. On September 27, it was determined that an "open" circuit existed within Honeywell differential pressure transmitters. Honeywell technicians and applications engineers began investigating their equipment.

In late September, all flow and pressure measurement devices and signal conditioners were made functional after malfunctions had affected the readings of six of the seven channels. Magnetic tapes were changed on October 3 and October 16 and were read at the SCS Data Center. A study of the

scaling of these devices was conducted during October to allow these instruments to contribute to Bleyle process steam and space heating calculations.

A proposed draft for new monthly report of the Bleyle Plant Measurement Program was designed as specified at the September 27 GE-GPC Technical Interchange Meeting in Atlanta, and on October 13, 1978, the proposal for the Meteorological Station data acquisition conversion was transmitted for evaluation. This conversion would place 16 channels of weather and solar data on the GPC data acquisition system.

As a result of the GE/GPC Technical Interface Meeting in Atlanta, the revised Bleyle Plant Measurement Report was approved as specified by GE, and Georgia Power Company computer programming of this report went into the final phase of development. Several sample reports were generated, analyzed, and checked for accuracy by Heery & Heery and Georgia Power. Further data required before issuing the first revised report were identified as HVAC air quantity values and conversion formulas for liquid and steam flows.

In order to supply the required data for the Energy Measurement Report, Georgia Power on November 27 issued a request for a purchase order for tests to be performed at the Bleyle Plant to determine accurate air and liquid flow characteristics. Contracting for this test work was initiated in accordance with receipt and evaluation of three competitive bids by qualified test and balance companies. Determination of liquid and steam flow values was under study in November, with the scaling relationship between data signal conditioning equipment and the data logger presenting the key problem.

On November 15, the power meter measuring electric consumption of office receptacles and vending machines was overloaded and internally burned. However, the GPC meter lab was able to salvage the pulse initiator and register and rebuild the meter to original specifications. This saved a minimum 90 days loss of data if the meter had been returned to the manufacturer for repair. Because this incident occurred due to new equipment installation in the Bleyle Plant, all plant electrical circuits and their metering were reviewed. Bids from electrical contractors were requested to modify some circuits to better distribute the loads and to prevent future overloads and damage to GPC metering equipment.

As a result of a GPC contract with HYDRO-Air, Inc. to measure air distribution CFM, velocity, temperature and relative humidity as per Heery & Heery specifications, these measurements were taken during the first week of February. Addition of electrical panels to the Bleyle plant for redistribution of selected electrical loads also was carried out during February.

In February, three problems remained in producing complete Energy Measurement reports:

- Requirement for air CFM values
- Better understanding of relative humidity readings and psychrometric effects of air conditions affecting enthalpy calculation programming
- Confirmed interpretation of flow and pressure measurements

The Doric 220 Datalogger system appeared to be functioning reliably in February. Although ice storms interrupted power in the Metro Atlanta area, no power outages were experienced on the circuit serving the Shenandoah Industrial Park. Data tapes were changed as scheduled and forwarded to Southern Company Services for file building. Review of November and December data showed some anomalies in three data channels. These, however, were easily corrected by Honeywell and GPC meter lab.

During late February and throughout March 1979, meetings were conducted between Georgia Power and Heery & Heery engineers to evaluate the operation and state of the Bleyle plant HVAC system, and the status of the energy measurement and reporting programs. Heery & Heery emphasized the proper operation and maintenance of the Bleyle HVAC system, and particular interest was directed toward equipment controls, outside air damper operation, and enthalpy controllers and their relationships with measured thermal data.

During March, with the assistance of GE and AGM Electronics, perplexing problems experienced with the Bleyle flow and pressure measurements were identified. It was discovered that in a power-up condition, Honeywell's Model 411 Diffused Silicon Differential Pressure Transmitters induced an over-current conditioning of greater than normal duration on their Square Root Extractor Signal Conditioners. The "buffer" resistor within the module was not designed to protect the internal electronics from power-up overloads for more than two seconds. The fact that Honeywell's transmitter exceeded the design specification resulted in electronic "deforming" of the signal linearization logic circuits in the AGM signal conditioners.

Georgia Power Meter Lab technicians tested each of the seven AGM modules and found three units with input resistors totally shorted and four units requiring recalibration. All units were returned to AGM on March 20 to be modified with 250 ohm input resistors to protect the signal conditioner. The Honeywell transmitters were the only differential pressure measurement devices that created this problem when power was applied.

Georgia Power Company continued meeting with Heery & Heery to establish procedures for calculation of thermal heat gain and loss for the monthly Plant Operating Analysis Report. A new system for handling the data base was programmed to include better computer efficiency in storage allocation and run time. The objective of the new data base handling system was to provide faster report generation on current data at a lower cost.

In April, all data collected during March was loaded into computer file and processed using the GE requested data management report format. Considerably more programming time was required to write and test the revised format than the original data report output.

Review of Bleyle plant equipment operation and its relationship to data measurement sensors was continued through April with recommendations to eliminate redundant temperature/humidity sensors. This made available additional data channels for measurement of outside air conditions at the inlets to the roof-top air conditioning units.

Also during April, computer input for the Bleyle plant was prepared for the "Version 6" model of the Edison Electric Institute AXCESS Energy Requirements Program. Joint engineering efforts of Heery & Heery and Georgia Power provided in-depth analysis of Bleyle plant operations to simulate a more representative model of the plant's energy needs and operations than any previously run computer model. One important consideration in this input was the change in Bleyle's production schedule to a single work shift between 8:00 a.m. and 4:30 p.m., Monday through Friday, which began April 16. The AXCESS program modeled requirements for these production hours as well as previous two-shift and modified single-shift operations.

On May 4, it was determined that the operation of the Doric 220 Datalogger was intermittent, since the digital display reflected zeroes. With the unit locked in this mode, no data were being recorded on magnetic tape. It was determined by a Doric service engineer that a faulty electrical contact in one of the unit's six printed circuit boards was the problem, and repairs were made. The data logger was recalibrated using electronic calibration equipment and ice bath for T/C channels.

On May 11, new AGM square root extractors were installed in the equipment racks, allowing thorough checkout and confirmation of operation of the Bleyle flow and pressure measurement channels.

Subsequent to receipt of new signal conditioners in May, Honeywell checked calibration and output current of the differential pressure transmitters to the sensors in the flow measurement system. It was determined that all but one transmitter were within calibration tolerance. This unit was recalibrated and the entire sensing and current loop was checked for proper operation. All flow channels performed properly, and data were collected from May 18 through May 31, confirming the proper operation of Channels 80 through 86.

Concurrent to the work performed on the flow/pressure hardware were the HVAC system analysis efforts of Heery & Heery. It was determined that four Honeywell relative humidity sensors installed in the system air stream were producing questionable output. Inspection of these sensors by Honeywell and GPC engineers determined that the sensing elements were dirty and clogged with lint. Replacement sensors were installed.

Early in the month, a manual "quick scan" of the latest printout (November) was made. Of the 86 channels, 11 were not printing and 11 temperature channels and four humidity channels were reporting questionable values. As a result of this scan, several of the channels were tested. The channels for the electric meters (1 thru 23) were observed, tested and found to be working properly except channel 10; its pulse accumulator was borrowed for one of the indoor fan channels.

The five channels (24 thru 28) for the indoor fans of the roof top units (RTUs) were reconnected to terminals on the printed circuit board in the RTUs so that these channels would be energized only when the indoor fan was operating, and deenergized when it was not. These channels were then tested, and pulse accumulators were switched until these channels gave satisfactory results.

The testing of temperature channels 29 thru 69 was begun by sending heating water through the water coil of RTU-3 in Production NW and letting the Dual Temperature Boiler (Heating Boiler) run. Temperatures for the RTU and the heating water were observed. Channels 31, 36, 41, 46, 57 and 58 were found to be working properly. When the humidity channels (70 to 77) were examined by Honeywell, four sensors were found to be too dirty to perform. These were replaced.

Channels for the two gas meters (78 and 79) were tested and found to have pulse accumulators that had to be repaired or replaced. The register for channel 79 on the process boiler was defective in that its gears were not meshing, thereby transmitting no signal even though gas was being used. Atlanta Gas Light Company repaired the register.

During early June, efforts continued to ensure that data channels from the Bleyle Plant to the Doric Datalogger were working properly. On June 5, verification was made on electrical channels recording data for domestic water heating, material cutting operations, and roof-top Air Conditioning Unit air handling fans. Thermocouple channels associated with the plant HVAC system were tested and determined to be working properly. Natural gas flow and fluid flow channels were also verified, but the AGM integrator for Channel 86, steam pressure, appeared erratic in the reset of its internal counter. Corrective action was taken.

On June 14th, a meeting was held at Shenandoah to review and designate work tasks remaining to the data hardware inspection and report generation functions. Fourteen tasks were defined and appropriate personnel and completion dates were assigned to complete these tasks by July 13.

At the Solar Total Energy Project Re-Scoping Review held at Sandia Laboratories in June, emphasis was placed on the importance of Bleyle plant operating data and empirical analyses to verify the STES design.

3.4 DESIGN INTERFACE

BACKGROUND

The Preliminary Design of the Solar Total Energy System (STES) was completed in July 1978, and Definitive Design efforts commenced in August 1978. Initial testing of the Engineering Prototype Collector (EPC) also was completed at Sandia during the summer of 1978. Based on this developmental test data, the heat receiver was modified and the EPC was retested in the fall of 1978. The modified EPC achieved performance objectives. Fabrication of four 7-1/2 meter (diameter) Quadrant Test Collectors commenced in the spring of 1979, and collector installation commenced during the summer of 1979 (testing is now in progress).

Starting in early April 1979, system and design studies were performed and planning exercises were completed, resulting in the following recommendations that were accepted by DOE:

- To reduce the number of solar collectors from 192 to 120
- To accelerate the Project Schedule to achieve an October 1, 1981 date for start of system operations at Shenandoah

These changes were made to meet DOE budget requirements.

Specific procedures were defined to address the GPC/DOE interface control drawings based on agreements by their designated agencies. Interface design considerations are co-functioning, interdependent, or interacting design parameters at the interfaces between participants; interface control drawings (ICD) depict physical and functional interface engineering requirements that affect the design or operation of co-functioning items. Interface drawings may be categorized as mechanical, electrical, thermal, architectural, interconnections, configuration and installation, operational sequence requirements, or system switching. The interface control drawings addressed in this Report are among GPC, GE, and Sandia, the primary participants in the establishment of the STE-LSE at Shenandoah. ICDs are initiated and released as "Comment Issues" for approval whenever two or more participants have established a design agreement.*

The first set of interface control drawings was prepared and transmitted to Sandia for review in August, 1977. The set contained nine drawings covering mechanical, thermal, electrical, instrumentation, and site interfaces. A modified load analysis, based upon as-built building materials and conditions, and adjusted to Bleyle's operating plans, was issued in September. The set underwent changes and additions following review by Sandia and GPC and a new set of drawings was issued in November, 1977. This next iteration included architectural, and Meteorology Station drawings as well as the earlier issued sections. Drawings were again reviewed at an October 20 coordination meeting. Formal change procedures were instituted in the form of a Master Index Sheet listing all drawings, latest revision number, and data. It was then decided that each drawing would be issued or re-issued as completed, rather than issuing them as sets.

PROGRESS DURING SUBJECT REPORTING PERIOD

The primary area of activity during the subject reporting period was related to electrical interface drawings, which were expanded significantly. Following is a detailed description of all interface activities from June, 1978 through June, 1979. A current set of drawings is included as Appendix A to this Report.

*"Operational Interface Control Drawing Procedure for STE-LSE, Shenandoah," George S. Kinoshita, March 1978, Sandia Laboratories, SAND78-0329.

The interface drawing set continued to expand during June with the Comment Issue of the following drawings:

- S-1 Existing Site Plan
- S-3 Boundary Survey
- S-5 Sun Rights
- E-2 Electrical Wiring Diagram
- E-2a Lighting Plan
- I-2 Electric Meter Locations and Description Cover Sheet

At the end of the month, GE approved incorporation of CDDRs to drawings E-1, M-1, and M-2, and Comment Issues E-2, E-2a, I-2, S-1, and S-3 were approved for re-issue and sign-off. GE commented that S-5 required additional solar easement information and requested that any further calculations be based upon actual data gathered from the instrumentation installation.

In addition to continued work on drawings, an ICWG meeting was held in Valley Forge on July 17, and a status report was given at the GE Design Review on July 19. Drawing E-3, Electrical Load Interconnection, newly issued and signed off, was the primary topic of discussion. Changes to the drawing were the result of relocation of station service with associated power transformers and relays. A cover sheet and drawings S-1, S-3, E-2, and E-22 all were signed off at the ICWG meeting. In addition, fourteen items were identified and designated as CDDRs. ICWG members were supplied with interface control materials.

Interface drawings I-1, E-2 and E-2a were re-issued August 16, incorporating CDDRs established at the July Design Review. An electrical load analysis update was made based upon the data issued on August 17.

Updated interface drawing sign-off sheets and CDDR status lists were distributed during September. Meetings between GE and GPC on September 27 identified changes necessary to existing electrical interface drawings, as well as a need for the issue of a drawing E-5, Elementary Diagram. Several other preliminary CDDRs were identified related to drawings M-4 and L-1. Upon concurrence of all interface committee members, these CDDRs were formally incorporated. There also was a need indicated for issue of new "T" thermal, series drawings. Many of these items were contingent upon operation of flow recording channels.

Information identified at the September GE-GPC meeting as possible CDDR material was formally incorporated into CDDR status list format and released during October. Again, electrical drawings E-3 and E-4 received the most attention. GE and GPC continued to resolve information necessary to these drawings. A new drawing, E-5 Elementary Diagram, also was being prepared.

Georgia Power Company efforts on the Electrical Supply Interface System were spent on making minor modifications to the control and relay circuitry and coordinating these changes with G.E. An elementary diagram of the Electrical Supply Interface System controls was prepared and incorporated into the interface drawing series.

Definitive design and specification writing continued at a slowed pace due to the change in the required operation date. Establishment of the STES operational date as mid 1981 allowed a slip in procurement schedules by six months.

Changes in the Electrical Supply Interface System, agreed to by GE, included the following:

- Revising elementary diagrams to show closing as well as tripping

- Revising other Electrical Supply Interface drawings to show transducers at certain points desired by GE
- Addition of relay parameters to allow a time for the T-G to pick up a 100 kW step increase in load without tripping

At an ICWG meeting on November 14 in Washington, Drawing S-5, "Sun Rights," was signed off, and E-5, "Elementary Diagram," was issued for comment. I-2, "Electric Meter Locations and Descriptions," also was issued for sign-off, although rewiring of meters required further confirmation prior to sign-off. Several of CDDRs were resolved and several new ones were designated.

Interface status was reviewed as a part of the GE Design Review, November 15, 1978.

Interface drawings undergoing changes and several new drawings were issued during December:

- 11-14-78 — Sign-Off Sheet (8-1/2" x 11")
- S-5 — Solar Easement—prints and reproducible
- MS-1 — Meteorology Station—prints and reproducible with new instruments
- L-1 — Load Requirements and Analysis (8-1/2" x 11") with new schedule
- E-3 — Electrical Load Interconnection—prints and reproducible with corrections
- E-4 — Electrical Load Interconnection Details—prints with new legend for comment
- E-4a — Electrical Load Interconnection Details and Power Quality—prints with new legend for comment
- I-2 — Electrical Motor Locations and Descriptions—prints for comment

All new drawings issued at the end of December were out for review and comment during January and February. In March, GE comments were received on electrical and met station drawings. The electrical drawings were referred to GPC prior to incorporating comments. Changes to the met station were begun.

Drawings E-3, E-4, E-4a, and E-5 were reissued as Comment Issues in April, incorporating GE and GPC comments. Discussion with GIT, GE and Sandia clarified that while the STES may record weather conditions from the met station for its own use, control will use a separate set of instruments. GIT comments on the revised MS-1 drawing were received and incorporated in May.

All recently revised drawings were issued in early June in preparation for the Design Review in Albuquerque, June 19 and 20.

3.5 INFORMATION DISSEMINATION

BACKGROUND

Information dissemination has continued as a primary activity at the Shenandoah site since the project began. Using the Mobile Visitors' Center as a base of operations, the Site Team has maintained

an ambitious schedule of tours, presentations, and other activities designed to provide maximum visibility for the project, and to disseminate information about the project to interested organizations, groups, and individuals.

PROGRESS DURING SUBJECT REPORTING PERIOD

On June 6, a presentation was made to Nevada Power Company and to State of Nevada personnel interested in Solar Energy application. On June 9, the STES program status was presented to Mr. Steven Sim and Mr. Arthur Litka, both Research Associates from the State of Florida Solar Energy Center; Mr. Walter Pate, AIA, CSI from Thompson, Hancock, Whitte & Associates, Inc., Architects and Planners; and Ms. Kitty Cox from Georgia Tech.

On June 14, a presentation was made to Amelia Hamilton, Senior Copywriter in the Training Services Section of Employees Relations Department, Georgia Power Company. The purpose of her trip was to gather information and slides to use in a recruitment program for the Personnel Section, Employees Relations Department. This program will be shown on college campuses around the country and will be used by civic, social, educational, and church groups.

Testimony on solar energy was presented to the House Sub-Committee on Government Relations on June 14, and on June 21, the material was presented at the Solar Energy Policy Forum.

The new STES model was exhibited in the lobby of the Georgia Power Building and in the STES Visitor Center.

The Shenandoah STES project was featured in the June 1978 issue of the Solar Engineering Magazine.

During July, the STES-LSE was presented to two groups composed of Governor's honor students from all over Georgia and to the Georgia Professional Engineering Society. Mr. Herb Grey, an Executive Vice President for Westinghouse, along with seven executives, toured the Shenandoah STES site on July 18.

The STES First Annual Report was approved by DOE in July, and a new STES Audio Slide show was presented during the groundbreaking ceremonies. News coverage of groundbreaking activities was extensive.

Presentations during the month of August included the Canton Rotary Club, teachers from the DeKalb County School System, and the Georgia Solar Energy Association. In addition, a meeting and tour of the STE-LSE site was held with PRC Energy Analysis Company. As a part of a contract with the DOE, this company was evaluating a technical assistance program and requested a briefing on the STE-LSE information dissemination program.

On September 12, presentations were made to representatives from the Honeywell Corporation, and a visit was made to the site by Mr. Walt Pijawka, Manager, Solar Electric Programs, General Electric Corporation, for a coordination visit with Georgia Power and Shenandoah.

A presentation made to the Kiwanis Club of Columbus, Georgia included the Solar Energy Program, along with the slide presentation "Energy Challenge."

Forty-five German industrialists, who were in Shenandoah to tour the Bleyle Plant, also were given the "Energy Challenge" slide show. Other presentations were made to economics classes at Shamrock High School in Atlanta, on Georgia Power's solar energy applications and other alternate energy sources. This was done in coordination with the Youth & Educational Services Department.

The "Energy Challenge" slide show and Georgia Power Company's role in the STE-LSE Shenandoah site were presented to the GPC Financial Services Organization.

On September 15, a paper entitled "Energy Conservation Features of the Bleyle Knitwear Apparel Plant - Shenandoah, Georgia" was submitted to the Southeastern Electric Exchange, 1978 Energy Efficiency Competition. The content and exhibits were a condensation of the case study written by R. Bruce Hammock, P.E. and published in March, 1978 (ALO/3994-78/1). The Bleyle plant was entered in the new industrial construction category. If selected as a category winner, these energy conserving features would be presented to executives and managers of southeastern electrical utilities at their annual meeting October 23, 1978.

On October 5, the Site Team met with WSB-TV, Channel 2, Atlanta, at Shenandoah to review the Meteorological Station operation. On October 9 and 10, a two-minute presentation was made during the noon and 6 p.m. news broadcasts. One presentation was on the Meteorological Station, and the other was on the plant and solar field. More than a million people were exposed to the pertinent features of the STES program.

Presentations were made during October to the following groups:

- Berry College (45 people)
- The Georgia League of Women (200 people)
- Carroll County EMC, Carrollton, Georgia

On October 10, the STES slide presentation and briefing was given to members of the Georgia Public Service Commission Staff interested in Georgia Power Company activities in advance energy systems and load management.

A STES presentation was made on October 23 to 35 members of the Industrial Research Institute attending their annual convention in Atlanta. A bus transported the group to the Shenandoah Recreation Center where Ray Moore, Sr. Vice President, Shenandoah Development, Inc., presented the film "Energy Challenge" and slides on solar involvement at Shenandoah. He also conducted a tour and demonstration of the model parabolic dish collector at the GPC/DOE Visitors Center at the STE-LSE site. Numerous questions related to the Solar Total Energy Project were answered.

A tour of the Bleyle plant and a presentation of Georgia Power's efforts toward Solar Energy and other alternate sources was given to a group of Japanese industrialists visiting Shenandoah on October 11. On October 10, 11, and 12, Site Team members attended the Georgia Agri-Business Exposition in Moultrie to make hourly presentations of the "Energy Challenge" show, and to discuss the STE-LSE project at Shenandoah. There were more than 170,000 people in attendance at the Exposition.

On October 18 a 45-minute briefing was given to Senator Nunn and his staff and Representative Nathan Knight on the Shenandoah and AOB projects. On October 26, Mr. Walt Hensley spoke to a group of Auburn University Cooperative students at their annual banquet at the request of Mr. Jack Mangham, Employee Relations Department. His topic was Georgia Power Company's Solar Energy Efforts. Presentations were made on the Atlanta Office Building, Answer Houses, and Shenandoah STES.

"Energy Challenge" and Georgia Power's Solar Show were provided to representatives of Xerox Corporation and Newcombe & Boyd, an engineering firm, on October 20 at Shenandoah, and the Solar Total Energy System presentation was made to the following groups:

- Dr. Jerry Newman & Staff, U.S. Department of Agriculture
- 70 people from DOD, DOE, DOI, HUD

The paper entitled "Energy Conservation Features of the Bleyle Knitwear Apparel Plant-Shenandoah, Georgia," submitted to the Southeastern Electric Exchange 1978 Energy Efficiency Competition, won the award in the new industrial building category. The Bleyle plant was selected as the outstanding energy efficient building from among 27 entries representing 27 Southeastern electric utilities.

A presentation of this paper also was made to the 1978 Southeastern Electric Exchange Annual Meeting on October 23 at Bal Harbor, Florida. Attending this meeting were 200 managers, executives and suppliers of electric utilities located in the Southeastern United States.

A meeting was held in November with ENCO Contractors, Inc., to discuss possible utility roles in an industrial co-generation application here in Georgia, and a possible on-site generating plant.

The "Energy Challenge" slide show was presented at a luncheon of the GE Industrial Council on November 14, and presentations were made to students of Morris Brown College and Clark College, Atlanta, in Shenandoah, on November 16. Energy challenge show and remarks presented to 102 Kiwanis Club members on November 10 in Americus, GA. Work continued on the solar collector model for the Boy Scout Jamboree, to be held in December. This is being done in coordination with the Youth & Educational Services Department. The Project Team met with Joe Trower, Viscount Communications, to review the documentation movies that were being taken at the site to show the changes during clearing and grading.

On December 4 and 5, Mr. Lewis Austin, Chairman of the Board, Texas Utilities, visited the Georgia Power Company and associated solar activities at Georgia Tech and Shenandoah. He was accompanied by Ms. Jackie Lassiter, Consultant to the Department of Energy. The tour was well received by Mr. Austin, and his interest in solar research projects was increased as a result of detailed presentations on the complexity and difficulties of the total energy system and the Shenandoah Recreational Center.

In January, presentations were made to Bill Marquardt, President, Texas Electric Services Company; Bob Martin, Vice President, Texas Utilities; Tina Hobson, Director of Consumer Affairs for DOE, Washington; and again to Ms. Jackie Lassiter, Consultant for the Department of Energy. These involved the Solar Total Energy-Large Scale Experiment as well as tours of Georgia Tech, Heery & Heery Architects, and Shenandoah Industrial Park.

From information and printed brochures supplied by Site Team members to Wayne Markham, a reporter for the Miami Herald, an article was published on January 14 highlighting the energy conservative designs of the winning entries to the Southeastern Electric Exchange Energy Design Competition. Certain minor inaccuracies appeared in the article as related to the Bleyle plant, but these indicated a lack of understanding regarding the scope of the Solar Total Energy Project. This article was available to nearly one million readers of the Sunday Miami Herald. The February, 1979 issue of Apparel Industry Magazine carried an article on the Bleyle/STES system.

In February, the "Energy Challenge" show and STES technical data were presented to the IEEE, Power Generation Division of Atlanta. Approximately 100 people were in attendance at the Georgia Power Company Auditorium. Significant questions relative to the project were asked after the presentation.

On February 28, Site Team members attended a meeting of the Southern Company Services System Research Advisory Committee to review EPRI and System Solar Energy programs. At this time, presentations of the "Energy Challenge" show and the "Energy Economics" show were made.

The Site Team in March participated in the DOE-sponsored Solar Energy Workshop relative to financing and institutional aspects of solar energy applications. Other presentations were made to nationally known people such as Dr. S. Karaka and Dr. G. Lof of Denver.

Mr. Ingo Weber-Bleyle and his parents toured the Total Energy Plant site in March and were given presentations of the AOB and the STES. Mr. Charles Davis, Boeing, was given a presentation and tour of the Solar Energy Site and Bleyle Plant. Honeywell personnel also were given a tour and presentation of the STES site.

Approximately 100 teachers and representatives of the National Science Teachers Association were given a tour and presentation of the STES during March. A telephone interview was conducted with Mr. Scott Derks, a freelance writer doing an article on Commercial/Industrial applications of solar energy.

From information and printed matter supplied to Bruce Spurlock, Southern Company Services, Atlanta, concerning the scope and collector design of the STE-LSE, Shenandoah was included in a solar collector presentation made April 26 to Marketing and Load Management personnel of Mississippi Power Company. A great deal of interest was stimulated in concentrator collectors.

During April, tours and presentations on solar energy projects at Georgia Power were given to the following organizations and representatives:

- Eleven Swedish construction engineers
- Representatives from Gulf States Utility Company
- Georgia Society of Professional Engineers, Forest Park, Georgia
- Kiwanis Clubs—Fayetteville and Dublin, Georgia
- Representatives from Senator Sam Nunn and Senator Herman Talmadge's Office, Washington, D.C.
- Representatives from Governor George Busbee's Office, Atlanta

The 1979 International Solar Energy Society (ISES) was held in Atlanta during the week of May 28. Several GE representatives were on-hand at the STE-LSE-Shenandoah booth, which was on display. Members of the STES Site Team also participated in the STE-LSE booth as well as the associated Georgia Power Company booth that described various other solar activities. The show was well attended and a high degree of interest was expressed in the display information available at the Georgia Power Company and the Department of Energy exhibits. The tours of the STES, which were associated with the ISES activities, were also well attended, accommodating approximately 600 people from 60 nations.

Presentations during June included 25 members of a Life Enrichment Group from Atlanta. Approximately 18 inmates attended a presentation on solar energy in Georgia, at the Federal Penitentiary in Atlanta. The inmates were members of a heating/air conditioning school. A solar presentation was made to the Alabama Solar Energy Association at the University of Alabama, Huntsville.

The Solar Total Energy-Large Scale Experiment status was presented at the American Institute of Aeronautics and Astronautics in Orlando, Florida.

APPLICATION

The Bleyle Knitwear Plant continued to operate effectively, with production meeting or exceeding that of Bleyle's European plants. Although operations were cut back to a single shift, the plant's product line was expanded to include blouses in addition to the slacks and skirts that had been produced initially. During the subject reporting period, discussions continued on plans to expand the Knitwear Plant to 42,000 sq. ft. by the time the STES is available.

BT

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4.0 ANTICIPATED THIRD YEAR PROGRESS

Progress during the period of June 1979 to June 1980 will be a strong function of the effect of a program rescoping plan that was presented in a meeting of all program participants on June 19, 1979. The Master Schedule anticipated to be utilized for the rescoped program is given in Figure 4-1. This plan will not cause major changes to the work scope of the site team, and only slight adjustments to their schedule will be required.

Site preparation activity for the year will be opened by execution of a significant test program to pour and cure concrete piers, and to test them to destruction. The data obtained during the test will be used by the designers to optimize the final design.

Heery & Heery will initiate and complete the control and piping interconnection design between the Bleyle Plant and the STEP, and procurement of the power interface equipment will be initiated.

Weather station operation and data recording will be continued and final plans will be made for operation of the station while the STEP is functioning.

The GPC program for Bleyle Energy measurement and analysis will continue. The Bleyle plant expansion plans are expected to be fully developed and initiated.

Information dissemination will continue, with the level of activity expected to increase as physical activity around the site builds up. Site construction is planned for spring of 1980, with complete photographic documentation.

Final plans and costing for the operational phase of the STEP will be established during the year 1979-1980.

**SOLAR TOTAL ENERGY
LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA**

615378-3A

Figure 4-1. Program Schedule

APPENDIX A

INTERFACE CONTROL DRAWINGS (Provided for Information Only)

STE-LSE-SHENANDOAH

INTERFACE DRAWING SIGN-OFF SHEET

June 21, 1979

DWG NO	TITLE	DATE OF ISSUE	NO OF ISSUE	APPROVALS		
				SLA	GE	GPC (H&H)
S-1	EXISTING SITE PLAN	7/17/78	1	gpk	RLM	BBB
S-2	STE-LSE SITE PLAN		CI			
S-3	STE-LSE BOUNDARY SURVEY	7/17/78	1	gpk	RLM	BBB
S-4	HORIZON LINE AND SUN POSITION	3/24/78	2	gpk	RLM	BBB
S-5	SOLAR EASEMENT	11/14/78	1	gpk	RLM	BBB
	COVER SHEET	7/17/78	1	gpk	RLM	BBB
A-1	BUILDING PLAN	3/24/78	2	gpk	RLM	BBB
A-2	BUILDING ELEVATIONS	3/24/78	2	gpk	RLM	BBB
A-3	TYPICAL WALL SECTION	3/24/78	2	gpk	RLM	BBB
A-4	POSSIBLE 42,000 SQ.FT. EXPANSION PLAN		CI			
MS-1	METEOROLOGY STATION	3/24/78	2	gpk	RLM	BBB
M-1	HEATING/COOLING SYSTEM PIPING LAYOUT	3/24/78	2	gpk	RLM	BBB
M-2	HEATING/COOLING SYSTEM DETAILS	3/24/78	2	gpk	RLM	BBB
M-3	PROCESS PIPING AND EQUIPMENT	3/24/78	1	gpk	RLM	BBB
M-3a	PROCESS PIPING AND EQUIPMENT DETAILS	3/24/78	1	gpk	RLM	BBB
M-4	INTERCONNECTION PIPING AND DESCRIPTION	5/1/78	1	gpk	RLM	BBB
M-5	PLUMBING	3/24/78	2	gpk	RLM	BBB
M-6	MECHANICAL ROOM	5/1/78	1	gpk	RLM	BBB
M-7	MECHANICAL ROOM ISOMETRIC	5/1/78	1	gpk	RLM	BBB
L-1	LOAD REQUIREMENTS AND ANALYSIS (8 1/2 x 11)	3/24/78	2	gpk	RLM	BBB
T-1	PROCESS BOILER REQUIREMENTS (8 1/2 x 11)	4/13/78	CI			
T-2	HEATING DESIGN LOADS (8 1/2 x 11)	4/13/78	CI			
T-3	COOLING DESIGN LOADS (8 1/2 x 11)	4/13/78	CI			
E-1	ELECTRICAL LOAD PROFILE	3/24/78	1	gpk	RLM	BBB
E-2	BLEYLE PLANT WIRING DIAGRAM	7/17/78	1	gpk	RLM	BBB
E-2a	BLEYLE PLANT LIGHTING PLAN	7/17/78	1	gpk	RLM	BBB
E-3	ELECTRICAL LOAD INTERCONNECTION	5/1/78	1	gpk	RLM	BBB
E-4	ELECTRICAL LOAD INTERCONNECTION DETAILS AND POWER QUALITY	5/1/78	1	gpk	RLM	BBB
E-5	STATION SERVICE THROUOVER SCHEME	4/4/78	CI			
E-5	ELEMENTARY DIAGRAM	4/25/79	1	gpk	RLM	BBB
I-1	DATA GATHERING SYSTEM	3/24/78	1	gpk	RLM	BBB
I-2	ELECTRIC METER LOCATIONS AND DESCRIPTIONS	11/14/78	1	gpk	RLM	BBB
I-3	MECHANICAL INSTRUMENTATION	3/24/78	1	gpk	RLM	BBB
I-4	MECHANICAL INSTRUMENTATION	3/24/78	1	gpk	RLM	BBB

INTERFACE CONTROL DRAWINGS

SOLAR TOTAL ENERGY—LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA

U.S. DEPARTMENT OF ENERGY AND GEORGIA POWER COMPANY
COOPERATIVE AGREEMENT NUMBER EG-77-A-04-3994

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1) TIMES ARE SOLAR TIMES.

2) SHADOWS ARE FOR SOLSTICES

3) SHADOW IS FROM TOP OF WATER TOWER EXCEPT WHEN RANGE IS LESS THAN 100' - THEN IT IS FROM EDGE.

4) SHADOW POINTS ARE ON A HORIZONTAL PLANE AT 942.0' ELEVATION.
5) NO ACCOUNT IS TAKEN OF CUTS/BANKS OR LOCAL TOPOGRAPHY.

6) DECEMBER 22 SUNSET 1854 JUNE 22 SUNSET 1908

1600

Top 245.20
Int. 200.00 (8" A)
Int. 200.00 (8" A)
Int. 200.00 (8" A)

14. In the case of a person who is not a citizen of the United States, the person shall be considered to be a resident of the United States if the person is a resident of the United States for purposes of the Internal Revenue Code.

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NOTE:

1. Transcribed information file obtained by Field File Survey and Approved Confidentiality Act of 1974, 1976. The Confidentiality Act is Progress in Statistical Series of 1976.
2. Study Learning Sheet are to be obtained by Adult Field Survey or Observable System. All National Institute and National Council Reports are to be used in the National Survey Reporting Construction.

LEGEND

- H Handrail
- S Cold Water
- S Drain Inlet
- V Fire Hydrant
- V Water Valve
- W Water Meter
- W Water Line D.I.P.
- S Sewer
- S Sewer Service Line
- L Light Pole
- P Power Pole
- T Temporary Sewer Service
- T Telephone Pole
- T Temporary Street Mark
- G Gas Line
- WSP Underground Power (WSP)
- F Fence
- E Underground Electrical (EUV)

1800

TITLE: **HYDROLOGIC** (0001)
 TOPOGRAPHICAL SURVEY
 SOLAR TOTAL ENERGY SITE
 SUGARMANAN GORPORA
 Lot 24, 77 8th District
 Cavite County Group

Love Engineers, Inc.
 424.1000, 4000000

Date: 1-1-80
 Drawn: J. P. M.
 Checked:

LEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

signature	date 1/13/78	revisions
checked	correct	
approved		

S-1

NOTE: TYPE OF HORIZON AND APPROXIMATE RANGE ARE SHOWN

SHENANDOAH STE-LSE HORIZON
(FROM CENTER OF METEOROLOGY STATION PAD)
ELEVATION 946.5' ±

SHENANDOAH STE-LSE SOLAR POSITION
(FROM CENTER OF METEOROLOGY STATION PAD)
ELEVATION 946.5' ±

HORIZON LINE AND SUN POSITION

NOTE: This drawing is for information only and is not to be used for the fabrication or verification of parts.

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
CONTROL DRAWINGS**
HORIZON LINE AND SUN POSITION

DATE	10/20/77	DESIGNED	1/10/76
DRAWN		CHECKED	4/7/78
		APPROVED	3/24/76

THIR
THIR

S-4

BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
SOLAR EASEMENT

DATE	11-14-71
BY	
CHECKED	
APPROVED	

S-5

This document contains neither recommendations nor conclusions of the United States Government. It is the property of the U.S. Government and is loaned to your agency; it and its contents are not to be distributed outside your agency.

WEST ELEVATION
SCALE: 1/16" = 1'-0"

NORTH ELEVATION
SCALE: 1/16" = 1'-0"

EAST ELEVATION
SCALE: 1/16" = 1'-0"

SOUTH ELEVATION
SCALE: 1/16" = 1'-0"

ARCHITECTURAL ELEVATIONS (25,000 SQ. FT.)

NC7: This drawing is for engineering interface
reference only. It should not be used
for fabrication or verification of parts.

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
ARCHITECTURAL ELEVATIONS

drawn	date	10/20/77	remains	4/7/78
checked	comm			3/24/78
approved

A-2

TYPICAL WALL SECTIONS

SCALE: 1/4" = 1'-0"

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
TYPICAL WALL SECTIONS

Drawn	1/10/78	revision 2/8/78
Checked	Comm	4/1/78
Approved		3/24/78

A-3

NOTES:

1. NUMBERS REFER TO INSTRUMENTS LISTED BELOW.
2. ALL INSTRUMENTS, EXCEPT 11 & 12, ON STANDS AT SAME APPROXIMATE ELEV.
3. ALL SAMPLES TAKEN AT A RATE OF 1 PER MINUTE.

METEOROLOGY STATION PLAN

RESEARCH INSTRUMENTS AT FIXED SITE AT SHENANDOAH

1. *PYRANOMETER (EPPLEY PSP)-UNSHADED;WG 295 DOME.
2. PYRANOMETER (EPPLEY PSP)-UNSHADED;RG 830 DOME.
3. PYRANOMETER (EPPLEY PSP)-SHADED;WG 295 DOME.
4. PYRANOMETER (EPPLEY PSP)-TILTED 34°;WG 295 DOME.
5. *PYRHELIOMETER (EPPLEY NIP).
6. *PYRHELIOMETER (EPPLEY NIP)
7. PYRHELIOMETER (EPPLEY NIP)-WG 295, OG 530, RG 630, RG 895 FILTERS.
8. PYRADIOMETER (CSIRO)- THERMOPILE OUTPUT.
9. TEMPERATURE IN PYRADIOMETER CAVITY.
10. *THERMOMETER-NEW EG & G PORTABLE SYSTEM.
11. *HUMIDITY - NEW EG & G PORTABLE SYSTEM.
12. *PRESSURE TRANSDUCER-NEW EG & G PORTABLE SYSTEM.
13. *ANEMOMETER - NEW EG & G PORTABLE SYSTEM.
14. *WIND VANE - NEW EG & G PORTABLE SYSTEM.
15. RAIN GAUGE (SA 552).
16. UV PYRANOMETER (EPPLEY)-IF BUDGET PERMITS.

* MEASUREMENTS TO BE ARCHIVED FOR SHENANDOAH LSE USE: NOT FOR CONTROL.

METEOROLOGY STATION

INSTRUMENT MAINTENANCE

PYRHELIOMETER AND DIFFUSE RADIATION EQUATORIAL MOUNTS- THE TWO-AXIS EQUATORIAL MOUNT ROTATES THROUGH 360° DAILY. THIS MOTION DRAGS THE INSTRUMENT CABLES THROUGH 360°. AT EACH SITE VISIT THE CABLES ARE TO BE REMOVED, GIVEN REVERSE TWISTS AND RECONNECTED. THE OPTICAL ALIGNMENT OF THE MOUNTS IS TO BE VERIFIED AND CORRECTED. THE LENSES OF THE PYRHELIOMETERS ARE TO BE CLEANED AS REQUIRED. WHEN REQUIRED, LENS CLEANING, INCLUDING PYRANOMETER LENS, WILL BE ACCOMPLISHED BY DUSTING WITH A SOFT ARTIST'S QUALITY HAIR BRUSH AND CLEANING WITH LINT FREE CLOTH AND LENS CLEANER AS REQUIRED. IMMEDIATELY PRIOR TO AND FOLLOWING LENS CLEANING AND OTHER MAINTENANCE, DATA SAMPLES ARE REQUIRED. THE TIME INTERVAL FOR DATA RECORDING SHALL BE SET AT 15 MINUTE INTERVALS. AT THIS RATE A CASSETTE WILL REQUIRE CHANGING APPROXIMATELY EVERY 7 DAYS. MORE FREQUENT CHANGING IS PERMITTED TO FACILITATE TIMING OF VISITS. TAPES ARE SUPPLIED IN A MU METAL BOX (MAGNETIC SHIELDED BOX). THE MU METAL BOX SHOULD BE USED FOR LOCAL TRANSPORTING AND STORING TAPES. CASSETTE TAPES REMOVED FROM THE RECORDER SHALL BE TRANSCRIBED BY GEORGIA TECH AND THE REDUCED DATA TRANSMITTED IN SOLMET FORMAT.

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*NOTE: This drawing is for identifying building requirements only and is not to be used for fabrication or verification of parts.

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
METEOROLOGY STATION

DATE	BY	CHKD	APP'D
10/20/77			
4/7/78			
3/24/78			
1/8/78			
4/25/78			
5/2/78			

MS
1

HEATING/COOLING SYSTEM PIPING LAYOUT

SCALE: 1/16" = 1'-0"

- ① - ⑤ ROOFTOP 20 TON DIRECT EXPANSION COOLING ONLY UNITS, CARRIER MODEL NUMBER 50DD024 WITH HOT/CHILLED WATER COILS. SEE M-2 FOR COIL SPECIFICATION.
- ⑥ HOT WATER BOILER - GAS-FIRED CAST IRON.
- ⑦ EXPANSION TANK - PRESSURIZED, DIAPHRAGM TYPE
- ⑧ - ⑨ 10 TON FAN-COIL UNITS, MAGIC AIR HW DC-10A

SECONDARY HEATING COIL IN UNIT ① ONLY. SECONDARY HEATING COIL TO BE USED WHEN PRODUCTION AREA REQUIRES COOLING WHILE OFFICE AREA REQUIRES HEATING. HALSTEAD MITCHELL SW, 2 ROW, 24" x 48", 8 FINS/INCH.

SEE DRAWING M-6 FOR LARGE SCALE MECHANICAL ROOM

SEE DRAWING M-3 FOR LOCATION OF PROCESS EQUIPMENT

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
HEATING/COOLING SYSTEM PIPING LAYOUT

DATE	10/20/77	DESIGNED	1/18/78
DRAWN		CHECKED	2/8/78
REVIEWED		APPROVED	4/7/78
			3/23/78
			5/23/78

M-

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OUTLINE SPECIFICATIONS

PIPE - SCHEDULE 40 BLACK STEEL
2" AND SMALLER - SCREWED
2 1/2" AND LARGER - WELDED

INSULATION - PREFORMED, SECTIONAL GLASS FIBER - OWENS CORNING OR EQUIVALENT - FACTORY APPLIED JACKETS. COMPOSITE FIRE AND SMOKE RATINGS NOT EXCEEDING FLAME SPREAD OF 25 AND SMOKE DEVELOPED OF 50. DUAL TEMPERATURE (HW & CW) LINES - 2" THICKNESS WITH VAPOR BARRIER JACKET. HOT WATER HEATING - 1" THICKNESS WITH ALL SERVICE JACKET.

VALVES - JENKINS, CRANE OR EQUIVALENT.
2" OR SMALLER - ALL BRONZE WITH SCREWED ENDS
2 1/2" AND LARGER - IRON BODY, BRONZE MOUNTED WITH FLANGED ENDS

HEATING/COOLING COILS - HALSTEAD & MITCHELL WC, 4 ROW, 33" x 60" 8 FINS/INCH.
SURFACE TYPE: 6210 1 1/2 x 1.3 C/D
FIN: .006 ALUMINUM AT 8 PER INCH
FIN SURFACE: CORRUGATED FIN EDGE: STRAIGHT
TUBING: 5/8 O.D. COPPER x .023 WALL
RETURN BENDS: 5/8 O.D. x .032 WALL
CASING: 16 GA. GALV. STEEL
ROWS DEEP 4 x ROWS HIGH 22
22 CIRCUITS AT 4 TUBES EACH

SECONDARY HEATING COIL - HALSTEAD & MITCHELL SW, 2 ROW, 24" x 48", 8 FINS/INCH.
EXPANSION TANK - PRESSURIZED, DIAPHRAGM TYPE, AMTROL OR EQUIVALENT: SIZE EXTROL AX-200, 24" DIA. BY 62 1/2" LONG HORIZONTAL.

CIRCULATING PUMPS - INLINE TYPE, IRON BODY, BRONZE FITTED, ARMSTRONG
P-1: 102 GPM vs. 18 FT. HEAD, MOTOR 1/2 HP - ARMSTRONG S57, 3" SIZE
P-2: 8 GPM vs. 11 FT. HEAD, MOTOR 1/6 HP - ARMSTRONG S35, 2" SIZE

BOILER - GAS-FIRED CAST IRON TYPE, WEIL-MCLEAN MODEL MGB-7, 1,020,000 BTU INPUT (919,000 MIN) ATMOSPHERIC BURNER WITH FM CONTROLS. PROVIDE TEMPERATURE CONTROLS, LOW-WATER CUT-OFF, DRAFT HOOD, 14" DIA. TYPE "B" VENT THROUGH ROOF TO BREIDERT GAS CAP.

NOTE
G.E. GAUGE CONNECTION INCLUDING GAUGE COCK
T.N. THERMAL WELL-SEPARABLE SOCKET EXTENDED TO CLEAR INSULATION

DETAIL - SECONDARY HEATING COIL
NO SCALE

DETAIL - NEW COIL IN ROOF TOP UNIT
NO SCALE

DETAIL - PIPE CONNECTIONS TO BOILER
NO SCALE

HEATING / COOLING SYSTEM DETAILS

DETAIL - HEATING/COOLING COIL
NO SCALE

LEGEND

NOTE: This drawing is for engineering reference requirements only and is not to be used for fabrication or verification of parts.

NOTICE

This document was prepared as an element of work under a contract with the U.S. Army, Contract No. DA-36-039-MD-0001, for the purpose of providing a design for the construction of a heating/cooling system. The design is based on the information provided by the user and is not to be used for fabrication or verification of parts. The accuracy, completeness or verification of any information, equipment, product or process disclosed, or represented that its use would not infringe primarily owned rights.

BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
HEATING/COOLING SYSTEM DETAILS

DATE	10/20/77	REVISED	1/10/78
BY		DATE	2/8/78
CHECKED		DATE	4/7/78
APPROVED		DATE	3/24/78
		DATE	5/25/78

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M-2

SEE DRAWING M-6
FOR LARGE SCALE
MECHANICAL ROOM

PROCESS PIPING and EQUIPMENT

SCALE: 1/16" = 1'-0"

- VACUUM
- CONDENSATE RETURN
- HIGH PRESSURE STEAM
- COMPRESSED AIR
- ELECTRIC BUS DUCT
- ELECTRIC TROLLEY DUCT
- ELECTRIC POWER SUPPLY

- ① AIR COMPRESSOR, KELLOGG-AMERICAN TWO STAGE
MODEL NUMBER B352A0, 7½ HP 120 GALLON TANK
- ② WATER TREATMENT, NEPTUNE CHEMICAL PROPORTIONING
PUMP WITH STEEL TANK, #50CST
- ③ AIR DRYER, KELLOGG-AMERICAN, #35
- ④ PROCESS STEAM BOILER, ECLIPSE LOOKOUT COMPANY,
HORIZONTAL SCOTCH MARINE TYPE SM, 40 HP, 1380#/HR.
- ⑤ VACUUM PUMP, SPENCER CATALOG NUMBER 55X20, 20 HP
- ⑥ CONDENSATE TANK, ECLIPSE WITH CONDENSATE PUMP UNDER
XB-150-2
- ⑦ FLASH ECONOMIZER, PENNSYLVANIA SEPARATOR COMPANY
AMR-3

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BLEVINS MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
PROCESS PIPING AND EQUIPMENT

DATE	10/26/71	DESIGNED BY	1/10/78
CHECKED BY		DRAWN BY	3/24/78
APPROVED BY			

M-3

SECTION THROUGH PRODUCTION AREA

NO SCALE

DETAIL - SUPPLY LOCATIONS

NO SCALE

DETAIL OF STEAM, CONDENSATE, AIR AND VACUUM CONNECTIONS

NO SCALE

BLOWDOWN WATER COOLING SYSTEM DETAILS

NO SCALE

PIPE INSULATION SIZES		
PIPE DIAMETER	INSULATION THICKNESS FOR STEAM PIPING	INSULATION THICKNESS FOR CONDENSATE PIPING
1" AND SMALLER	2"	1"
1 1/4" TO 2"	2 1/2"	1 1/2"
2 1/2" TO 4"	3 1/2"	2"

PROCESS PIPING AND EQUIPMENT DETAILS

NOTES: This drawing is for preliminary interface requirements only and is not to be used for fabrication or verification of parts.

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
 PROCESS PIPING AND EQUIPMENT DETAILS

DATE 7/24/78

BY 110.78

DRAWN

CHECKED

APPROVED

110.78
 110.78
 110.78

M-3a

**STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
INTERCONNECTION PIPING
AND DESCRIPTION**

drawn	date	10 20 77	payments	10 78
backed	10 20 77	10 20 77	2 8 78	
approved	10 20 77	10 20 77	4 7 78	
			5 1 78	
			5 25 78	

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PLUMBING

SCALE: 1/16" = 1'-0"

MECHANICAL ROOM

SCALE: 1/4" = 1'-0"

NOTES: This drawing is
 equipment only and is not
 for fabrication or verification of parts.

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BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
 STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS
 MECHANICAL ROOM

DATE	10/76	2/8/78
DESIGNED		
CHECKED		
APPROVED		

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M-6

LEGEND

MECHANICAL ROOM ISOMETRIC

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BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
 MECHANICAL ROOM ISOMETRIC

DATE	1/10/78	DESIGNED	2/8/78
CHECKED		DATE	4/7/78
APPROVED		DATE	5/11/78
		DATE	5/25/78

U.S. GOVERNMENT
 PRINTING OFFICE

M-7

LOAD REQUIREMENTS

AND

ANALYSIS

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-NOTE This drawing is for engineering interface requirements only and is not to be used for fabrication or verification of parts.

	3/24/78	Sign-off		L - 1
II	1/10/78	General Update	SA	
I	12/5/77	General Update	SA	
REVISION NO.	DATE	DESCRIPTION	APPROVED	
			DATE: 10/20/77	

BUILDING AND EQUIPMENT DATA REQUIRED TO PERFORM BLEYLE PLANT LOAD ANALYSIS

I. PROCESS MACHINERY (Xzs, 20.6.77, Sch/GE)			Number Machines	
<u>Machine</u>	<u>kW</u>	<u>Operating Factor</u>	<u>25,000</u>	<u>42,000</u>
Carriage Knife	1.0	0.4	1	1
Band Knife	1.0	1	1	1
Straight Knife	0.5	0.5	2	3
Round Knife	0.16	0.25	2	3
Sewing Machines	0.6	0.7	60	110
Fuser	5.0	1	1	3
Hand Irons	2.0	1	6	9
Presses	0.1	1	13	13

II. PROCESS EQUIPMENT (As proposed to Bleyle by Stephenson Assoc.)

<u>Machine</u>	<u>hp</u>	<u>Volt</u>
Boiler Fan	1	460 - 3 ph
Feedwater/condensate pump	1½	460 - 3 ph
Vacuum Pump	20	460 - 3 ph
Compressor	7½	460 - 3 ph
Dryer	1/3	115 - 1 ph

(Diversity of 0.75 assumed on total for 25,000 sq. ft. building only.)

III. PIPING AND INSULATION

<u>System</u>	<u>Pipe Size</u>	<u>Insulation Thickness</u>
Steam: header	3"	3¼"
branches	1½	2½"
Condensate: header	2"	1½"
branches	1"	1"
Vacuum: header	4"	None
branches	3"	None

IV. MISCELLANEOUS EQUIPMENT

Heating/cooling system pumps: 3/4 hp 220V - 3 ph
1/6 hp 115V - 1 ph

Domestic hot water heater: 40 gallon, electric, 2-4500 w elements, 18 gallon recovery per hour at 100°F rise, demand 1.086×10^4 Btu/hr.

V. OPERATING SCHEDULE: 5 days/week, 52 weeks/year

VI. HEATING AND AIR CONDITIONING REQUIREMENTS

Desired summer: 78°F, 50% RH min., 65% desired.
Desired winter: 65°F, 30% RH min., 65% desired.

VII. STEAM PRESSURE AND TEMPERATURE

At boiler: 337°F, 113.6 psia
Piping: 337°F, 113.6 psia
Press faces: 302°F, 70.0 psig (311°F, 79.5 psia at press
steam branches)

VIII. LIGHTING

<u>Area</u>	<u>Level</u>	<u>kw</u>	
Office	75ft	11.3	
Storage & equipment	25	3.6	(All interior light - fluorescent.)
Production	75	32.4	
Exterior	--	<u>1.5</u>	
		48.8	

IX. AIR HANDLING EQUIPMENT

2 fan coil units in storage room, each unit: 10 ton nominal, 220V - 3
ph 1 hp fan motor, 3.6 FLA

5 roof-top DX units, each unit: 20 ton nominal, 460-3-60, compressor:
37.0 FLA; 2 indoor fans: 6.6 FLA (1) 5 HP motor

Toilet Exhaust Fans: 4 at 1/25 HP 150W each, 115v - 1 ph

Mechanical Exhaust Fan: 1 HP, 1.8 FLA, 460 V - 3ph

X. BUILDING CONSTRUCTION

Roof: built-up roof on rigid insulation, metal roof deck, bar joists
5' o.c.

Walls: 12" C.M.U. to 4'-0", bermed, with 6" metal studs faced with
brick, above.

Insulation, roof: $U = 0.03$
walls above block: $U = 0.05$
block walls below berm: none
interior partition walls: none

Windows: 5 on west wall, 12 sq. ft. each, insulating glass, clear.

Exterior doors, front: 1/4" clear glazed double entry doors.
 overhead loading doors: standard 5 section roll-up metal.
 other exit doors: 18 gauge hollow metal.

XI. HEATING, VENTILATION, AND AIR CONDITIONING

	<u>25,000</u>	<u>42,000</u>
Gross heat loss:	323,464 Btu/hr	526,807 Btu/hr
Net loss:	(-)272,168*	(-)438,864*
Tons of air conditioning		
(With economizer)	93.2*	142.9*
(With storage - 20 tons)*	113.2*	162.9*

Gas fired hot water boiler for space heating, coils in roof-top DX units.

Ventilation and infiltration: 5,000 cfm 8400 cfm

XII. BUILDING FUNCTION DISTRIBUTION

<u>Function</u>	<u>Existing</u>	<u>Future Expansion</u>
Employee Service	3,648 sq. ft.	3,648 sq. ft.
Office	2,808	2,808
Storage	6,590	11,590
Production	10,621	22,621
Equipment	<u>1,364</u>	<u>1,364</u>
TOTAL	25,031 sq. ft.	42,031 sq. ft.

XIII. BUILDING OCCUPANTS AND THEIR DISTRIBUTION

<u>Type</u>	<u>25,000</u>		<u>42,000</u>	
	<u>First Shift</u>	<u>Second Shift</u>	<u>First Shift</u>	<u>Second Shift</u>
Production	86	64	150	150
Visitors/Office	<u>10</u>	<u>2</u>	<u>14</u>	<u>2</u>
TOTAL	96	66	164	152

*Estimate

25,000 SQ. FT. BLEYLE PLANT LOAD ANALYSIS

I. ELECTRICAL Surges other than by equipment included are not anticipated.

a. Process machinery, sewing machines: 60 x 0.6 kw x 0.7 DF = 25		
fuser 1 x 5.0 kw =	5	
hand irons: 6 x 2.0 kw =	12	
presses: 13 x 0.1 kw =	1.3	
cutting equipment:	0.6	
	<u>TOTAL</u>	<u>43.9 kw</u>
		PF = 0.95
b. Lighting:	48.8 kw	= 0.91
c. Air handling equipment, fan coil fans: 2 x 3.6 FLA =	2.7 kw	= 0.84
compressors: 5 x 37.0 FLA =	147.4 (1)	= 0.81
indoor fans: 5 x 2 x 6.6 FLA =	<u>26.3</u>	= 0.89
	<u>TOTAL</u>	<u>176.4</u>
d. Process equipment, boiler fan: 1.8 FLA =	1.4 kw (1)	= 0.90
boiler feed/return pump: 2.6 FLA =	2.0	= 0.85
vacuum pump: 27 FLA =	21.5	= 0.89
compressor: 11 FLA =	<u>8.8</u>	= 0.81
	<u>TOTAL</u>	<u>33.7 kw</u>
	x 0.75DF =	<u>25.3 kw</u>
e. Heating/cooling system pumps: 2.8 FLA =	1.1 kw	
4.4 FLA =	<u>0.5</u>	
	<u>TOTAL</u>	<u>1.6 kw</u>
		= 0.85
f. Domestic hot water heater: 2 - 4500 w elements:	4.5 kw	= 0.99
g. Miscellaneous fans	<u>2.0 kw</u>	= 0.88
 TOTAL ELECTRICAL LOAD + 310.9 kw*		

II. PROCESS STEAM

a. Steam flow, 40 hp boiler, 337°F	1380#/hr
b. QATU x 14.2 = 113.6 psia	
c. 113.6 psia saturated steam	1190 Btu/#
d. Condensate of 190°F	158 Btu/#
e. Demand, 1380#/hr (1190 - 158) =	1.42 x 10 ⁶ Btu/hr.
f. Lost fluid, 0.25 x 1380#/hr =	345 #/hr

(1) For existing building analysis only. Load will not exist during STES operation.

*Estimate

III. COOLING CALCULATIONS

25,000 sq. ft.

- a. Cooled space (equipment and storage rooms not included) 17,077 sq. ft.
- b. Roof/ceiling: $17,077 \text{ sq. ft.} \times 0.03 \times 52^{\circ}\text{F} = 26,640 \text{ Btu/hr}$
- c. Walls, ext. N: $46' \times 9' \times 0.05 \times 14^{\circ}\text{F} =$
 E: $72.5' \times 9' \times 0.05 \times 14^{\circ}\text{F} =$
 S: $203.5' \times 9' \times 0.05 \times 20^{\circ}\text{F} =$
 W: $123' \times 9' \times 0.05 \times 28^{\circ}\text{F} = 4,128$
 int. N: $157.5' \times 13' \times 0.31 \times 17^{\circ}\text{F} =$
 E: $50.5' \times 13' \times 0.31 \times 17^{\circ}\text{F} = 14,250$
- d. Glass, windows, W: $5 \times 12 \text{ sq. ft.} \times 0.9 \times 148 \text{ Btu/hr/sq. ft.} = 7,992$
 $5 \times 12 \text{ sq. ft.} \times 0.58 \times 17^{\circ}\text{F} = 592$
 entry, W: $88 \text{ sq. ft.} \times 0.95 \times 148 \text{ Btu/hr/sq. ft.} = 12,373$
 $88 \text{ sq. ft.} \times 1.13 \times 17^{\circ}\text{F} = 1,910$
- e.
- f. Lighting: $43.7 \times 3413 \text{ Btu/hr/kw} = 149,148$
- g. People: $(86 \times 275) + (10 \times 250) = 26,150$
- h. Process machinery: $43.9 \times 3413 \text{ Btu/hr/kw} = 149,830$
- i. Pipe gains, steam: $60' \times 46 \text{ Btu/ft} = 2,760$
 $4 \times 90' \times 37 = 13,320$
 $13 \times 10' \times 28 = 3,640$
 19,720
 condensate: $60' \times 18 \text{ Btu/ft.} = 1,080$
 $4 \times 90' \times 15 = 5,400$
 $13 \times 10' \times 12 = 1,560$
 8,040
 Total pipe gains = 27,760
- j. Presses, sensible:
 $3.09 \text{ Btu/hr/sq. ft.} \times 6 \text{ sq. ft.} \times 220^{\circ}\text{F} = 4,079$
 $2.79 \times 6 \times 220^{\circ}\text{F} = 3,683$
 $2.06 \times 6 \times 140^{\circ}\text{F} = 1,730$
 $2.61 \times 6 \times 140^{\circ}\text{F} = 2,192$
 11,684 $\times 13 = 151,829$
- k. Fan heat: $26.3 \times 3413 \text{ Btu/hr/kw} = 89,762$

*(Estimate)

	25,000 sq. ft.
l. Domestic hot water heater:	
$0.10 \times 1.09 \times 10 \text{ Btu/hr}$	1,090
TOTAL ROOM SENSIBLE HEAT =	663,517
m. People, latent: $(86 \times 475 + (10 \times 200)) =$	42,850
n. Process steam, latent (est.):	
$1380 \text{ \#/hr} \times 0.10 \times 1190 =$	164,220 Btu/hr
TOTAL ROOM HEAT =	870,587 Btu/hr
o. Ventilation and infiltration, sensible:	
$5000 (95^\circ\text{F} - 78) \times 1.08 =$	91,800
p. Ventilation and infiltration, latent,	
$5000 (118 \text{ grns./\#} - 72) \times 0.68 =$	156,400
GRAND TOTAL HEAT =	1,118,787 Btu/hr or 93.2 tons (113.2 with storage)*

IV. HEATING CALCULATIONS

a. Heated space (equipment room not included)	23,677 sq. ft.
b. Roof/ceiling: $23,677 \text{ sq. ft.} \times 0.03 \times 47^\circ\text{F} =$	33,385 Btu/hr
c. Walls: $653' \times 10' \times 0.05 \times 47^\circ\text{F} =$	15,345
d. Glass, windows: $5 \times 12 \text{ sq. ft.} \times 0.58 \times 47^\circ\text{F} =$	1,636
entry: $88 \text{ sq. ft.} \times 1.13 \times 47^\circ\text{F} =$	4,674
e. Loading dock doors: $2 \times 100 \text{ sq. ft.} \times 1.0 \times 47^\circ\text{F} =$	9,400
f. Perimeter: $653' \times 4' \times 2 \text{ Btu/hr/sq. ft.} =$	5,224
g. Ventilation and infiltration: $5000 \times 47^\circ\text{F} \times 1.08 =$	<u>253,800</u>
GROSS HEAT LOSS =	323,464 Btu/hr
h. Internal gains, lighting:	149,148
people:	26,150
machinery:	149,830
pipe gains:	27,760
presses:	151,092
fans:	89,762
water heater:	<u>1,090</u>
	595,632
TOTAL HEAT LOSS (GAIN) =	(-) 272,168

*Estimate

SOLAR TOTAL
ENERGY SYSTEM

KNITWEAR FACTORY

ELECTRIC LOAD
302.5 KW

PROCESS STEAM LOAD
1380 LBS/HR, 113.6 PSIA, 337°F

HEATING LOAD
323,464 BTU/HR

AIR CONDITIONING LOAD
1,118,787 BTU/HR

50% TO 60% FEEDWATER RECOVERED

25,000 sq. ft. KNITWEAR FACTOR
ANTICIPATED LOADS

42,000 SQ. FT. BLEYLE PLANT LOAD ANALYSIS

I. ELECTRICAL Surges other than by equipment included are not anticipated.

a. Process machinery, sewing machines:		
110 x 0.6 kw x 0.7DF =	46.2 kw	
fusers: 3 x 5.0 kw =	15	
hand irons: 9 x 2.0 kw =	18	
presses: 13 x 0.1 kw =	1.3	
cutting equipment: =	<u>0.6</u>	
	TOTAL	81.1 kw PF = 0.95
b. Lighting:		
12.8 kw + 32.4 kw (22,621/10,621) + 3.6 kw		
(11,590/6,590) =	88.1 kw	= 0.91
c. Air handling equipment, fan coil fans:		
2.7 kw (11,590/6,590) =	4.8	= 0.84
indoor fans: =		
26.3 kw (29,077/17,077) =	<u>44.8</u>	= 0.88
	TOTAL	49.6 kw
d. Process equipment, boiler feed/return pump: 2.6 FLA =	2.0 kw	= 0.85
vacuum pump: 27 FLA =	21.5	= 0.89
compressor: 11 FLA =	<u>8.8</u>	= 0.81
	TOTAL	32.3 kw
e. Heating/cooling system pumps:	1.6	= 0.85
f. Miscellaneous fans	2.0	= 0.88
g. Water heater	<u>4.5</u>	= 0.99
	TOTAL ELECTRICAL LOAD	259.2 kw

II. PROCESS STEAM

a. Steam flow, 40 hp boiler, 337°F	1380 #/hr
b. 8ATU x 14.2 = 113.6 psia	
c. 113.6 psia saturated steam	1190 Btu/#
d. Condensate at 190°F	158 Btu/#
e. Demand, 1380 #/hr (1190 - 158) =	1.42 x 10 ⁶ Btu/hr
f. Lost fluid, 0.25 x 1380 #/hr	345 #/hr

III. COOLING CALCULATIONS

42,000 sq. ft.

- a. Cooled space, (equipment and storage rooms not included) = 29,077 sq. ft.
- b. Roof/ceiling: $29,077 \text{ sq. ft.} \times 0.03 \times 52^{\circ}\text{F} = 45,360 \text{ Btu/hr}$
- c. Walls, ext. N: $46' \times 9' \times 0.05 \times 14^{\circ}\text{F} =$
 E: $77' \times 9' \times 0.05 \times 14^{\circ}\text{F} =$
 S: $268.5' \times 9' \times 0.05 \times 20^{\circ}\text{F} =$
 W: $156.5' \times 9' \times 0.05 \times 28^{\circ}\text{F} = 5,164$
 int. N: $222.5' \times 13' \times 0.31 \times 17^{\circ}\text{F} =$
 E: $77' \times 13' \times 0.31 \times 17^{\circ}\text{F} = 20,518$
- d. Glass, windows, W: $5 \times 12 \text{ sq. ft.} \times 0.9 \times 148 \text{ Btu/hr sq. ft.} = 7,992$
 $5 \times 12 \text{ sq. ft.} \times -.58 \times 17^{\circ}\text{F} = 592$
 entry: W: $88 \text{ sq. ft.} \times 0.95 \times 148 \text{ Btu/hr/sq. ft.} = 12,373$
 $88 \text{ sq. ft.} \times 1.13 \times 17^{\circ}\text{F} = 1,910$
- e.
- f. Lighting: $81.8 \text{ kw} \times 3413 \text{ Btu/hr/kw} = 279,183$
- g. People: $(150 \times 275) + (14 \times 250) = 44,750$
- h. Process machinery: $81.1 \text{ kw} \times 3413 \text{ Btu/hr/kw} = 276,794$
- i. Pipe gains: $27,760 \text{ Btu/hr} (22,621/1,621) = 59,124$
- j. Presses, sensible = 151,892
- k. Fan heat: $89,762 \text{ Btu/hr} (29,077/17,077) = 152,838$
- l. Domestic hot water system: $0.10 \text{ (est.)} \times 1.09 \times 10^4 \text{ Btu/hr} = 1,090$
- TOTAL ROOM SENSIBLE HEAT = 1,059,580 Btu/hr
- m. People, latent: $(150 \times 475) + (14 \times 200) = 74,050$
- n. Process steam, latent (est.): $1380 \text{ \#/hr} \times 0.10 \times 10^4 \text{ Btu/hr} = 164,220$
- TOTAL ROOM HEAT = 1,297,850
- o. Ventilation and infiltration, sensible: 154,224
 $8400 (95^{\circ}\text{F} - 78) \times 1.08$

- p. Ventilation and infiltration, latent:
 $8400 (118 \text{ grns./} \# - 72) \times 0.68 =$

262,752

GRAND TOTAL HEAT = 1,714,826 Btu/hr or
 142.9 TONS
 (162.9 with storage)*

42,000 sq. ft.

IV. HEATING CALCULATIONS

- a. Heated space (equipment room not included) 40,667 sq. ft.
 b. Roof/ceiling: $40,667 \text{ sq. ft.} \times 0.03 \times 47^{\circ}\text{F} =$ 57,340 Btu/hr
 c. Walls: $869' \times 10' \times 0.05 \times 47^{\circ}\text{F} =$ 20,421
 d. Glass, windows: $5 \times 12 \text{ sq. ft.} \times 0.58 \times 47^{\circ}\text{F} =$ 1,636
 entry: $88 \text{ sq. ft.} \times 1.13 \times 47^{\circ}\text{F} =$ 4,674
 e. Loading dock doors: $2 \times 100 \text{ sq. ft.} \times 1.00 \times 47^{\circ}\text{F} =$ 9,400
 f. Perimeter: $869' \times 4' \times 2 \text{ Btu/hr/sq. ft.} =$ 6,952
 g. Ventilation and infiltration: $8400 \times 47^{\circ}\text{F} \times 1.08 =$ 426,384

GROSS HEAT LOSS = 526,807 Btu/hr

- h. Internal gains, lighting: 279,183
 people: 44,750
 machinery: 276,794
 pipe gains: 59,124
 presses: 151,892
 fans: 152,838
 domestic hot water: 1,090
 965,671

TOTAL HEAT LOSS (GAIN) = -438,864

V. DOMESTIC HOT WATER

- a. Minimum storage: 35 gallons
 b. Minimum demand: 26 GPH
 c. Temperature, 110°F (hand washing only)
 d. Demand: $26 \text{ GPH} \times 8.35 \text{ \#/gal} (110^{\circ}\text{F} - 60^{\circ}\text{F}) \times 1.0 =$ 1.086×10^4
 Btu/hr

*Estimate

SOLAR TOTAL
ENERGY SYSTEM

KNITWEAR FACTORY

ELECTRIC LOAD
259.2 KW

PROCESS STEAM LOAD
1380 LBS/HR, 113.6 PSIA, 337°F

HEATING LOAD
526,807 BTU/HR

AIR CONDITIONING LOAD
1,714,826 BTU/HR*

50% TO 60% FEEDWATER RECOVERED

42,000 sq. ft. KNITWEAR FACTOR
ANTICIPATED LOADS

ELECTRICAL WIRING DIAGRAM

SCALE: 1/8" = 1'-0"

EXISTING BUILDING		FUTURE EXPANSION	
3 648 SQ FT	EMPLOYEE SERVICE	3 648 SQ FT	
2 808 SQ FT	OFFICE	2 808 SQ FT	
6 590 SQ FT	STORAGE	11 590 SQ FT	
10 621 SQ FT	PRODUCTION	22 621 SQ FT	
1 364 SQ FT	MECHANICAL ROOM	1 364 SQ FT	
TOTAL 25 031 SQ FT		TOTAL 42 031 SQ FT	

- SYMBOLS**
- FLUORESCENT STRIP LIGHT
 - FLUORESCENT TROFFER 2 X 4 UNIT
 - FLUORESCENT TROFFER 2 X 2 UNIT
 - INCANDESCENT UNIT CEILING OR WALL MOUNTED
 - JUNCTION BOX
 - DUPLEX RECEPTACLE
 - SINGLE POLE SWITCH
 - THREE OR FOUR WAY SWITCH
 - MOTOR OUTLET RATING AS SHOWN
 - CONTROL PANEL WITH DISCONNECT SWITCH
 - CONDUIT FEEDER TO BUSWAY
 - FEEDER BUSWAY (C-1 INDICATES PANEL C CIRCUIT 1), (60/3 INDICATES 60 AMPERE 3 POLE)
 - HOMERUN TO PANELBOARD (A-1, 2, 3 DENOTES PANELBOARD A, CIRCUITS 1, 2, 3) CROSS MARKS INDICATES THE NUMBER OF #12 CONDUCTORS IN RACEWAY, NO CROSS MARKS INDICATES 2#12.
 - BRANCH CIRCUIT WIRING, NUMBER INDICATES AWG SIZE OF CONDUCTORS, NO NUMBER INDICATES #12
 - TRANSITION FROM CONDUIT TO BUSWAY

NOTE: This drawing is for engineering services requirements only and is not to be used for fabrication or verification of parts.

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BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**SITES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
ELECTRICAL WIRING DIAGRAM

Project	
Date	7/17/18
Drawn	
Checked	
Approved	

E-2

LIGHTING PLAN

SCALE: 1/16" = 1'-0"

EXISTING BUILDING		FUTURE EXPANSION	
3,648 SQ FT	EMPLOYEE SERVICE	3,648 SQ FT	
2,808 SQ FT	OFFICE	2,808 SQ FT	
6,590 SQ FT	STORAGE	11,590 SQ FT	
10,621 SQ FT	PRODUCTION	22,621 SQ FT	
1,364 SQ FT	MECHANICAL ROOM	1,364 SQ FT	
TOTAL	25,031 SQ FT	TOTAL	42,031 SQ FT

- SYMBOLS**
- FLUORESCENT STRIP LIGHT
 - FLUORESCENT TROFFER 2 X 4 UNIT
 - FLUORESCENT TROFFER 2 X 2 UNIT
 - INCANDESCENT UNIT CEILING OR WALL MOUNTED
 - JUNCTION BOX
 - DUPLEX RECEPTACLE
 - SINGLE POLE SWITCH
 - THREE OR FOUR WAY SWITCH
 - MOTOR OUTLET RATING AS SHOWN
 - CONTROL PANEL WITH DISCONNECT SWITCH
 - CONDUIT FEEDER TO BUSWAY
 - FEEDER BUSWAY (C-1 INDICATES PANEL C CIRCUIT 1), (60/3 INDICATES 60 AMPERE 3 POLE)
 - HOMERUN TO PANELBOARD (A-1,2,3 DENOTES PANELBOARD A, CIRCUITS 1,2,3) CROSS MARKS INDICATES THE NUMBER OF #12 CONDUCTORS IN RACEWAY, NO CROSS MARKS INDICATES 2#12.
 - BRANCH CIRCUIT WIRING, NUMBER INDICATES AWG SIZE OF CONDUCTORS, NO NUMBER INDICATES #12
 - TRANSITION FROM CONDUIT TO BUSWAY

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STEVES MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
 LIGHTING PLAN

Project	
Date	7/17/78
Drawn	
Checked	
Approved	

E-2a

RELAY LIST

DEVICE NO.	QUAN.	MODEL NO. AND RANGE	FUNCTION
550/551	3	WHSE CAT #CO-9H1111N(1-12T)(6-144T)	H. S. SUCC BANK A
550/551-G	1	WHSE CAT #CO-9H1111N(1-12T)(6-144T)	H. S. 3U GND BANK A
259	1	GE MOD #12IAY5101A(16-64V)	H. S. OV RELAY
751-G	1	WHSE CAT #CO-9H1101N(1-12T)	L. S. BU GND BANK A
651	3	WHSE CAT #CO-9H1101N(1-12T)	PHASE O. C. - ACB "I"
651-G	1	WHSE CAT #CO-9H1101N(1-12T)	GND O. C. - ACB "I"
66B2	1	GE MOD #12HEA618236(6-NO. 4-NC)	AUX. LOCKOUT RELAY
625	1	GE MOD #12IJS51A3A(115V..20/60°)	SYN. CHECK RELAY - ACB "I"
27/59	1	GE MOD #12IAY691A(55-140V)	UNDER- & OVER-VOLTAGE
32	1	GE MOD #12GGP5381A(0.025-3A)(1.5-30 SEC)	ANTI-MOTDRING RELAY
46	1	GE MOD #12INC7783A(WITH ALARM UNIT)	NEG. SEQUENCE RELAY
51V	3	GE MOD #12IJC51A18A(2-BT)	VOLT PSTR PHASE O. C.
25	1	BASLER PRS370	ALTO. SYNCHRONIZE - ACB "J"
66B	1	GE MOD #12HEA618236(6-NO. 4-NC)	AUX. LOCKOUT RELAY
66C	1	GE MOD #12HEA618236(6-NO. 4-NC)	AUX. LOCKOUT RELAY
81	3	WHSE STY. #HU- #290B346A21(HL- 2 REST.)	UNIT DIFFERENTIAL
81	1	GE MOD #12SFE21A1A(4-80 CY)	UNDERFREQUENCY
151-G	1	WHSE CAT #CO-9L1101N(0.5-2.5T)	GEN GND - P. F. "J"
150	1	GE MOD # 21AY51A1A(55-140V)	GEN OVERVOLTAGE
94	1	GE MOD #12HG11152	REMOTE TRIP - ACB "J"

250/251-G 1
351-G 1
451 3
451-G 1
425 1

SINGLE LINE ELECTRICAL LOAD INTERCONNECTION

NOTES:

- ALL CURRENT TRANSFORMERS USED FOR RELAYING SHALL BE RATED "C" OR 1200 OR BETTER.
- STES GENERATOR AND TRANSFORMER SIZES MAY BE CHANGED SUBJECT TO GPC REQUIREMENTS. DETAILED ON DRAWING E-4.

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

SINGLE LINE ELECTRICAL LOAD INTERCONNECTION

10/20/77	10/25/78
2/8/78	4/7/78
5/1/78	1/5/79
4/25/79	

HERI & HERI

E-3

DESCRIPTIVE LIST OF ITEMS SHOWN ON THE ELECTRICAL SINGLE LINE FOR THE STES AT SHENANDOAH

- A. POWER CIRCUIT BREAKER, RATED 25kV, 1200A, 500 MVA, 3P, USED TO PROTECT THE TRANSFORMERS (BK), (F) AND THE 25kV DISTRIBUTION LINE (UD) FROM FAULTS, ETC. QUANTITY - 1
- B. BREAKER ISOLATING SWITCHES RATED 23kV (NOM.), 1200A, SPST, 61KA MOMENTARY, USED TO ISOLATE THE BREAKER (BK-A) FOR MAINTENANCE PURPOSES. QUANTITY - 6
- C. BREAKER BYPASS, SWITCH, RATED 23kV (NOM.), 1200A, 3 PST, 61KA MOMENTARY, USED TO BYPASS THE BREAKER (BK-A) PRIOR TO ISOLATION FOR MAINTENANCE SO THAT SERVICE IS NOT INTERRUPTED. QUANTITY - 1
- D. POWER FUSE, RATED 23kV NOM., 100A, WITH 1.5 AMPERE KEARNEY LINK USED TO PROTECT THE SUBSTATION STATION SERVICE TRANSFORMER AND THE 25kV UD LINE FROM FAULTS ON THE SUBSTATION STATION SERVICE TRANSFORMER. QUANTITY - 1
- E. SUBSTATION STATION SERVICE TRANSFORMER, 10 RATED 14,400-120/240 VOLTS, 15kVA, 150kV BIL. USED TO PROVIDE STATION SERVICE POWER FOR OPERATING THE SUBSTATION. QUANTITY - 1
- F. POWER TRANSFORMER (S) EITHER 1-3P, 750kVA, 25-277/480V, DELTA-WYE CONNECTED, SUBTRACTIVE POLARITY, INSULATED FOR 150kV BIL ON THE HIGH SIDE. USED TO TRANSFORM THE 25kV DISTRIBUTION VOLTAGE TO 277/480 VOLTS TO SERVE THE LOAD. QUANTITY - EITHER 1-3P OR 3-1P.
- H. POWER CIRCUIT BREAKER, 3P, 400V, USED TO PROVIDE STATION SERVICE TO THE SOLAR TURBINE GENERATOR AND SOLAR FURNACE INSTALLATION FOR EMERGENCIES (LOSS OF NORMAL STATION SERVICE). QUANTITY - 1
- I. POWER CIRCUIT BREAKER, 3P, 400V, USED TO CONNECT THE TRANSFORMER TO THE LOWSIDE IN THE SUBSTATION AND TO PROTECT THE LOWSIDE BUS AND THE SUBSTATION FROM FAULTS. QUANTITY - 1
- J. POWER CIRCUIT BREAKER, 3P, 400V, USED TO SYNCHRONIZE AND CONNECT AND DISCONNECT THE STES GENERATOR-TRANSFORMER TO THE GPC BUS AND PROTECT THE GENERATOR AND GCU TRANSFORMER AND GPC BUS FROM FAULTS. QUANTITY - 1
- K. POWER CIRCUIT BREAKER, 3P, 400V, USED TO SUPPLY STATION SERVICE TO THE STES GENERATOR AND SOLAR FURNACE INSTALLATION DURING NORMAL CONDITIONS AND PROTECT THE GENERATOR-TRANSFORMER FROM FAULTS. QUANTITY - 1
- L. POTENTIAL TRANSFORMERS RATED 480-120V, CONNECTED GROUND WYE-GROUNDED WYE, USED TO MONITOR AND CONTROL GENERATOR TERMINAL VOLTAGE, ETC. QUANTITY - 3
- M. POWER TRANSFORMER, 3P, 480-480V, 750kVA, CONNECTED DELTA-WYE GROUND. USED TO PROVIDE SHORT CIRCUIT PROTECTION FOR THE GENERATOR AND REDUCE HARMONICS. QUANTITY - 3-1P OR 1-3P
- N. TURBO-GENERATOR, WYE GROUND, 3P, 500kVA, 0.8 PF, 480 VOLTS, USED TO GENERATE ELECTRICAL POWER FROM THE STES SYSTEM. QUANTITY - 1
- O. GENERATOR NEUTRAL GROUNDING RESISTOR, 20 OHMS, ONE MINUTE, 277 VOLTS. QUANTITY - 1 EACH.
- P. POTENTIAL TRANSFORMERS RATED 288-120V, CONNECTED WYE GROUND-WYE GROUND, QUANTITY: DOE SIDE 6, GPC SIDE 3.
- Q. POTENTIAL TRANSFORMERS RATED 2400-120 VOLTS, USED ON THE HIGH SIDE OF THE GPC SUBSTATION. QUANTITY - 3
- R. CURRENT TRANSFORMERS, RATED 1200/5 AMPERE, RELAYING ACCURACY C200, 1200 OR BETTER, QUANTITY: DOE SIDE 12, GPC SIDE 3.
- S. CURRENT TRANSFORMER, RATED 800/5 AMPERE, RELAYING ACCURACY T200 OR BETTER, QUANTITY: DOE SIDE 1, GPC SIDE 1.
- T. CURRENT TRANSFORMER, RATED 1200/5 AMPERE, METERING ACCURACY CLASS 0.3 FOR BURDENS 80.1 THROUGH 82.0, QUANTITY: DOE SIDE 3, GPC SIDE 3.
- U. CURRENT TRANSFORMER, RATED 200/5 AMPERE, METERING ACCURACY CLASS 0.3 FOR BURDENS 80.1 THROUGH 82.0, QUANTITY: DOE SIDE 3, GPC SIDE 3.
- V. CURRENT TRANSFORMER, RATED 600/5 AMPERE, METERING ACCURACY CLASS 0.3 FOR BURDENS 80.1 THROUGH 82.0, FOR REVENUE METERING BY GPC. QUANTITY - 3 (SEE I)
- W. CURRENT TRANSFORMER, RATED 5/5 AMPERE, RELAY ACCURACY CLASS T-100, TYPE JK-3, QUANTITY - 1.
- X. POTENTIAL TRANSFORMER RATED 380/120V, CONNECTED WYE GROUND, WYE GROUND, FOR REVENUE METERING BY GPC. QUANTITY - 2.
- Y. WATT TRANSDUCER, PRODUCES A 0-1.0 MILLIAMPERE D.C. OUTPUT SIGNAL FOR A 0-21500 WATT A.C. INPUT, QUANTITY, DOE SIDE 2, GPC SIDE 2.

(CONTINUED)

DEVICE	FUNCTION
OCB "A"	INCOMING 25kV SUPPLY CIRCUIT BREAKER: PROTECTS TRANSFORMER "A". OPENED (TRIPPED) BY DEVICES SHOWN BELOW AND 86B2. EQUIPPED WITH A DEMAND AMMETER TO INDICATE MAXIMUM CURRENT INPUT FROM 25kV CABLE INTO TRANSFORMER "A". NO RECLOSING IS PROVIDED.
550-551	PHASE OVERCURRENT RELAYS PROTECT TRANSFORMER "A" BY OPERATING AFTER GIVING 651 A CHANCE TO DO SO FIRST.
550-551-6	GROUND BACK-UP OVERCURRENT RELAY: SET TO ALLOW 651-6 TO OPERATE FIRST.
BANK "A"	G.P. CO. MAIN POWER TRANSFORMER, MAIN PROTECTION BY DEVICES ASSOCIATED WITH OCB "A" AND ACB "I" BACK-UP PROTECTION FURNISHED BY DEVICES BELOW:
259	ZERO-SEQUENCE OVER-VOLTAGE RELAY, OPERATES 86B2 FOR GROUND FAULT ON 25kV FED FROM STES ON LOW SIDE OF TRANSFORMER "A"
751-6	GROUND BACK-UP OVERCURRENT RELAY, OPERATES 86B2 IF 651-6 FAILS TO ACT OR ACB "I" DOESN'T OPEN.
86B2	AUXILIARY LOCKOUT RELAY, TRIPS AND BLOCKS CLOSING ON OCB "A" AND ACB "I". TRIPS ACB "H".
ACB "H"	EMERGENCY STANDBY STATION SERVICE SUPPLY CIRCUIT BREAKER, OPERATES NORMALLY-OPEN: IS PROVIDED WITH AUTOMATIC CLOSING DEVICE DESIGNED TO CLOSE "H" IF NORMAL SUPPLY ACB "M" OPENS AND BANK "A" 480 VOLT BUS IS ENERGIZED. TRIPPED BY BUILT-IN DEVICES FOR OVERLOAD OR FAULT ON OUT-GOING 480 VOLT CABLE AND BY 86B2.
CX-0, CX-R	AUXILIARY RELAY USED FOR ONE-SHOT RECLOSER. HAS FAST-OPERATE OPERATING COIL (CX-0) WHICH LATCHES RELAY IN THE ENERGIZED POSITION; RESET COIL (CX-R) RETURNS RELAY TO NORMAL CONDITION IF ACB "M" REMAINS CLOSED FOR AT LEAST 5 SECONDS.
WYM	WATT/WHOUR METER FOR MEASURING ENERGY CONSUMED BY STES AUXILIARIES WHEN OPERATED ON EMERGENCY STANDBY STATION SERVICE (ESSS).
WT-"H"	WATT TRANSDUCER FOR MEASURING KW DEMAND ON ESSS: PRODUCES 0-1.0 MILLIAMPS D.C. SIGNAL OUTPUT FOR 0-1500 WATT A.C. INPUT.
BANK "A" METERING	MEASURES ELECTRICAL QUANTITIES ASSOCIATED WITH BANK "A" USING DEVICES LISTED BELOW:
DEM AM	DEMAND AMMETER INDICATES MAXIMUM A.C. CURRENT FLOWING THROUGH 480 VOLT SIDE OF TRANSFORMER "A".
WT-"I"	WATT TRANSDUCER FOR MEASURING KW DEMAND ON BANK "A": PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-2 1500 WATT A.C. INPUT.
VART-"I"	VAR TRANSDUCER FOR MEASURING REACTIVE COMPONENT OF BANK "A" LOAD; PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-2 1500 VARS A.C. INPUT TO TRANSDUCER.
VT-"I"	VOLTAGE TRANSDUCER MEASURES BANK "A" 480 VOLT BUS VOLTAGE; PRODUCES A 0-1.0 MILLIAMPERE D.C. OUTPUT SIGNAL FOR A 0-150 VOLT A.C. INPUT.
WYM(1N)	WATT/WHOUR METER MEASURING ENERGY FLOW FROM STES INTO G.P. CO. 25kV SYSTEM.
WYM(OUT)	WATT/WHOUR METER MEASURING ENERGY FLOW FROM G.P. CO. 25kV SYSTEM INTO BLEYLE LOAD.
ACB "I"	G.P. CO. 480 VOLT LOW SIDE BREAKER: PROTECTS BANK "A" BY TRIPPING FOR FAULT ON BLEYLE AND DOE 480 VOLT BUSES BY 86B1, 86B2, AND DEVICES LISTED BELOW. ALL CLOSING IS MANUAL AND SUPERVISED BY A SYNCHRO-CHECK RELAY: PHASE OVER-CURRENT RELAY DETECTS OVERLOAD AND FAULTS NOT CLEARED BY BLEYLE EQUIPMENT.
651	GROUND OVER-CURRENT RELAY DETECTS FAULTS NOT CLEARED BY BLEYLE GROUND PROTECTIVE DEVICES.
651-6	SYNCHRO-CHECK RELAY PERMITS CLOSING OF ACB "I" IF PHASE ANGLE BETWEEN THE VOLTAGES ON EITHER SIDE OF ACB "I" IS WITHIN SET LIMITS.
625	

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(CONTINUED)

DEVICE	FUNCTION
ACB "I" CONTO.	SYNCHROSCOPE GIVES OPERATOR VISUAL INDICATION THAT PHASE ANGLE BETWEEN VOLTAGES ON EITHER SIDE OF ACB "I" IS ACCEPTABLE FOR CLOSING ACB "I"; IS TURNED OFF OR ON BY SYN SW. 2.
VB	INDICATING VOLT/METER READS VOLTAGES ON BANK "A" 480V BUS OR BANK "B" 480 VOLT BUS WHEN ENERGIZED FROM VU SW A OR VU SW B RESPECTIVELY.
ACB "K"	NORMAL STARTUP AND RUNNING STATION SERVICE (NSRSS) SUPPLY BREAKER, OPERATES NORMALLY-CLOSED. TRIPPED BY BUILT-IN DEVICES FOR OVERLOAD OR FAULT ON OUT-GOING 480 VOLT BUS AND BY 86B1: MANUAL CLOSURE.
WYM	WATT/WHOUR METER USED TO MEASURE ENERGY CONSUMED BY STES AUXILIARIES WHEN OPERATED ON NSRSS.
WT-"K"	WATT TRANSDUCER MEASURES KW DEMAND ON NSRSS: PRODUCES A 0-1.0 MILLIAMPERE D.C. OUTPUT SIGNAL FOR 0-1500 WATTS A.C. INPUT.
VART-"K"	VAR TRANSDUCER MEASURES REACTIVE COMPONENT OF NSRSS LOAD, PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-2 1500 VARS A.C. INPUT.
VT-"K"	VOLT TRANSDUCER MEASURES DOE-BLEYLE 480 VOLT BUS VOLTAGE; PRODUCES A 0-1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-150 VOLT A.C. INPUT.
DOE-BLEYLE BUS:	BLEYLE 480V BUS IS CONNECTED TO STES 480V BUS BY UNDERGROUND CABLES WITH DISCONNECT BEANS IN THE G.P. CO. 480V SWITCHGEAR. RELAYS AND METERS CONNECTED TO THESE BUS POTENTIAL TRANSFORMERS ARE:
61	UNDERFREQUENCY RELAY TRIPS ACB "I" IMMEDIATELY (8-20 CYCLES DELAY) AND ENERGIZES A TIEB, IF STES IS UNABLE TO RETURN TO NORMAL FREQUENCY AND CARRY THE BLEYLE LOAD IN STAND-ALONE MODE. THEN TIEB OPERATES 86B1 TO TRIP STES OFF.
27/59	UNDER-AND OVER-VOLTAGE RELAY, OVER-VOLTAGE PORTION OPERATES 86B1 AT ANY TIME A VOLTAGE EXCURSION PERSISTS (SUCH AS FOLLOWING A LOAD REJECTION); THE UNDER-VOLTAGE UNIT OPERATES 86B1 IF ACB "I" IS CLOSED AND UNIT VOLTAGE DROPS BELOW LIMITS.
REC VB	ROUND-CHART 8-DAY RECORDING VOLT/METER RECORDS 480 VOLT BUS VOLTAGE FOR RECORD.
VB	INDICATING VOLT/METER FOR VISUAL INDICATION OF DOE-BLEYLE 480 VOLT BUS VOLTAGE, OPERATED BY VU SWITCH.
ACB "J"	STES GENERATOR BREAKER PROTECTS GENERATOR BY TRIPPING FOR UNCLEANED FAULT ON DOE-BLEYLE BUS BY DEVICES LISTED BELOW AND BY 86B1 AND 86B2. MANUAL CLOSING IS SUPERVISED BY SYNCHRO-CHECK RELAY: AUTOMATIC CLOSING IS DONE UNDER CONTROL OF A SYNCHRONIZING RELAY AND THE STES CONTROL COMPUTER.
451	PHASE-OVERCURRENT RELAYS DETECTS OVERLOADS AND FAULTS NOT CLEARED BY BLEYLE OR G.P. CO. EQUIPMENT.
451-6	GROUND-OVERCURRENT RELAY DETECTS FAULTS NOT CLEARED BY BLEYLE OR G.P. CO. EQUIPMENT.
425	SYNCHRO-CHECK RELAY PERMITS CLOSING OF ACB "J" IF PHASE ANGLE BETWEEN VOLTAGES ON EITHER SIDE OF ACB "J" IS WITHIN SET LIMITS.
SYN	SYNCHROSCOPE GIVES OPERATOR VISUAL INDICATION THAT PHASE ANGLE OF VOLTAGE ACROSS ACB "J" IS ACCEPTABLE FOR CLOSING ACB "J"; TURNED ON OR OFF BY SYN SW. 1.
25	SYNCHRONIZING RELAY CAUSES CLOSING OF ACB "J" IF PHASE ANGLE BETWEEN VOLTAGES AND SLIP FREQUENCY ARE WITHIN SET LIMITS.

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
ELECTRICAL LOAD INTERCONNECTION
DETAILS

DATE	1-10-71	DESIGNED BY	WJG
CHECKED BY		APPROVED BY	
DATE		DESIGNED BY	
CHECKED BY		APPROVED BY	

DATE	1-10-71	DESIGNED BY	WJG
CHECKED BY		APPROVED BY	
DATE		DESIGNED BY	
CHECKED BY		APPROVED BY	

E-4

DEVICE	FUNCTION
ACB "J" (CONTINUED)	
WT-"J"	WATT TRANSDUCER MEASURES STES GENERATOR GROSS KW OUTPUT; PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-2 1500 WATTS A.C. INPUT.
VART-"J"	VAR TRANSDUCER MEASURES REACTIVE COMPONENT OF STES GENERATOR OUTPUT (GROSS); PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR 0-2 1500 VARS A.C. INPUT.
VT-"J"	VOLTAGE TRANSDUCER MEASURES BANK "B" 480 VOLT BUS VOLTAGE; PRODUCES A 0-1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR 0-150 VOLTS A.C. INPUT.
TOTALIZED METERING	
WHM (OUT)	THE GROSS OUTPUT OF STES GENERATOR IS MEASURED BY 3-1200/5A C.T. ON BANK "B" 480V BUS; FROM THIS, THE MNRSS LOAD IS SUBTRACTED VIA 3-8/1 A. AUX C.T. TO GIVE NET GENERATION WHICH IS MEASURED BY A WHM AND COMBINED WITH GPC MEASUREMENTS TO FURNISH BLEYLE LOAD DATA; WATTHOUR METER MEASURES NET STES GENERATOR ENERGY OUTPUT.
GR W DEN	CIRCULAR 8-DAY CHART INSTRUMENT MEASURES TOTAL OF BLEYLE KW LOAD DEMAND.
GR VAR DEN	CIRCULAR 8-DAY CHART INSTRUMENT MEASURES REACTIVE COMPONENT OF BLEYLE LOAD.
P	VOLTAGE-SENSING RELAY IS NORMALLY-ENERGIZED AND CONNECTS GRAPHIC METERS TO P.T.'S ON BANK "A" 480V BUS. IF BANK "A" BUS IS DE-ENERGIZED, P TRANSFERS THE GRAPHIC METERS TO P.T.'S ON BANK "B" 480 VOLT BUS. A SEPARATE CONTACT OF P IS USED IN THE AUTO-CLOSING SCHEME ON ACB "M".
BANK "B"	
351-G	STES POWER AND ISOLATING TRANSFORMER, PROTECTED BY DEVICES ASSOCIATED WITH STES GENERATOR, ACB "J", AND THOSE LISTED BELOW.
87	TRANSFORMER L.S. BACKUP GROUND OVERCURRENT RELAY, BACKS UP 451-G AND ACB "J", OPERATES 86G, COMBINATION GENERATOR AND TRANSFORMER DIFFERENTIAL, OPERATES 86G FOR ANY DETECTIBLE FAULT BETWEEN THE GENERATOR NEUTRAL AND THROUGH ACB "J".
88B1	AUXILIARY LOCKOUT RELAY, TRIPS AND BLOCKS CLOSING ON ACB'S "J", "I", AND "K". IS OPERATED BY DEVICES LISTED BELOW.
151-G	GENERATOR GROUND OVERCURRENT RELAY, LONG TIME, BACKS UP FOR FAILURE OF ACB "J".
81, 27/59	THESE DEVICES LISTED UNDER "DOE-BLEYLE BUS"
86G	GENERATOR AUXILIARY LOCKOUT RELAY, TRIPS AND BLOCKS CLOSING ON ACB "J", SHUTS STES GENERATOR DOWN BY TRIPPING FIELD AND THROTTLE. THIS RELAY IS OPERATED BY DEVICES 87 AND 351-G LISTED ABOVE (BANK "B") AND THOSE LISTED BELOW.
51-V	VOLTAGE RESTRAINED PHASE OVERCURRENT RELAY PROTECTS FOR PHASE-TO-PHASE AND 3-PHASE FAULTS
32	REVERSE-POWER (ANTI-MOTORING) RELAY PREVENTS DRIVING GENERATOR AS A MOTOR FOR NO INPUT FROM TURBINE OR LOSS OF TURBINE CONTROL.
46	NEGATIVE-SEQUENCE RELAY, PROTECTS FOR UNBALANCED LOAD OPERATION.
159	GENERATOR OVER-VOLTAGE RELAY.
250/251-G	GENERATOR GROUND OVER-CURRENT RELAY.
GENERATOR	
	CONVENTIONAL INSTRUMENTATION IS USED, CONSISTING OF INDICATING AMMETERS, WATTMETER, VAR METER, VOLT-METER, AND FREQUENCY METER. A WATTHOUR METER IS PROVIDED FOR MEASURING GROSS GENERATOR ENERGY OUTPUT.

ADDITIONAL METERING REQUIRED

(CONTINUED FROM SHEET E4)

- 1A. VAR TRANSDUCER PRODUCES A 0-2 1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-2 1500 VAR A.C. INPUT. QUANTITY: DOE SIDE 2, GPC SIDE 1.
- 1B. VOLT TRANSDUCER PRODUCES A 0-1.0 MILLIAMPERE D.C. SIGNAL OUTPUT FOR A 0-150 VOLT A.C. INPUT. QUANTITY: DOE SIDE 2, GPC SIDE 1.

GEORGIA POWER REQUIREMENTS ON STES ELECTRICAL INTERFACE AT THE BLEYLE PLANT

- NO DEGRADATION OF SERVICE NOR ANY INCONVENIENCE WILL BE CAUSED TO BLEYLE DUE TO THE PRESENCE OF THE STES.
- a. THE STES ELECTRICAL INTERFACE WILL BE DESIGNED SO THAT THE GPC SUBSTATION WILL BE IN OPERATION AT ALL TIMES TO SERVE BLEYLE'S ELECTRICAL LOAD (OTHER THAN FOR CONTINGENCIES) WHENEVER THE STES IS PLACED INTO OPERATION. IT WILL BE PARALLELED TO THE GPC 277/480 VOLT BUS. THIS WILL INSURE THAT BLEYLE WILL NOT HAVE ANY INTERRUPTIONS DUE TO THE STES BEING PLACED INTO OR REMOVED FROM OPERATION. THIS METHOD OF OPERATION WILL ALSO ENHANCE THE REGULATION OF VOLTAGE AND FREQUENCY OF THE ELECTRICAL SERVICE TO BLEYLE ABOVE THAT GIVEN BY OPERATION OF THE STES ALONE.
- b. THE STES ELECTRICAL INTERFACE WILL BE DESIGNED WITH APPROPRIATE BREAKERS, RELAYS, ETC., SO THAT FAULTS OR OTHER DISTURBANCES IN THE STES WILL NOT INTERRUPT ELECTRICAL SERVICE TO BLEYLE.
- c. SHOULD THE STES BE OPERATED ALONE, DUE TO CONTINGENCIES, TO SERVE THE BLEYLE LOAD, THE STES WILL MEET THE FOLLOWING POWER QUALITY REQUIREMENTS:
VOLTAGE REGULATION AT GPC 480 VOLT BUS - 480 VOLTS $\pm 5\%$ UNDER TRANSIENT LOAD CHANGES OF $\pm 10\%$ OF GENERATOR NAMEPLATE RATING.	
THE VOLTAGE REGULATION WILL BE ALLOWED TO BE $\pm 7\frac{1}{2}\%$ WITH FREQUENCY REGULATION OF $\pm .5\%$.	
FREQUENCY REGULATION	- 60 Hz $\pm .5\%$
MAXIMUM VOLTAGE WAVEFORM DISTORTION	- 5%
REQUIRED POWER OUTPUT (MINIMUM NET PEAK TO BLEYLE AT GPC 480 VOLT BUS)	- 300 KW $\pm$ 0.8 PF
2. NO INTERRUPTION OF THE GPC SYSTEM WILL BE CAUSED BY THE PRESENCE OF THE STES.
- a. APPROPRIATE BREAKER, RELAYING, DESIGN, ETC., WILL BE USED TO PREVENT PROBLEMS WITH THE STES FROM INTERRUPTING THE GPC 25KV SYSTEM.
- b. NO UNDESIRABLE HARMONICS, ETC., WILL BE GENERATED OR CAUSED BY THE STES TO FLOW ON THE GPC BUS (480V). SEE POWER QUALITY REQUIREMENTS.
3. LOAD FOLLOWING INTERCONNECTED OPERATION WILL HOLD BASE LOAD CONSTANT $\pm 5\%$ AVERAGED OVER 15 MINUTES.
4. WHEN INTERCONNECTED, STES GENERATOR SUPPLIES REACTIVE POWER IN PROPORTION TO REAL POWER CONTRIBUTION TO LOAD BY MANUAL SETTING.

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

**STES INTERFACE DEFINITION AND
CONTROL DRAWINGS
ELECTRICAL LOAD INTERCONNECTION
DETAILS AND POWER QUALITY**

DATE	1-10-79	REVISION	35-78
BY		CHKD	
APP'D		APP'D

E-4a

NOTE: This drawing is for engineering information requirements only and is not to be used for fabrication or verification of parts.

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BLEYLEY MANUFACTURING PLANT, SHENANDOAH, GEORGIA

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THE JEFFERSONS

E-5

- NOTE:
1. ALARM, ANNUNCIATOR, & EVENT RECORDER CONTACTS ARE NOT SHOWN.
 2. ALL CONTROL VOLTAGE SUPPLIES ARE 125V DC NOMINAL AND ARE ARBITRARILY NUMBERED.
 3. DEVICE CX-0 AND CX-R ARE THE OPERATE AND RESET COILS OF A STRATHEN-CUNN TYPE 256 LATCHING RELAY. FAST OPERATE AND 5 SEC. DELAY BEFORE RESET. CONTACT P 4S A VOLTAGE-SENSING CONTACT TO PERMIT CLOSING ONLY IF THE GPC SOURCE BUS IS ENERGIZED.
 4. DEVICE BI-X IS A TIME DELAY RELAY, SUCH AS AN AGASTAT, TO DELAY COMPLETE SHUTDOWN UNTIL STEG UNIT HAS HAD A CHANCE TO PICKUP THE BLEYLEY LOAD IN AN ISOLATED (STAND-ALONE) MODE OF OPERATION.
 5. POTENTIAL CIRCUITS ON 425 COMPLETED VIA MANUAL SYNCHRONIZING SWITCH 1 OR 25A CONTACTS. POTENTIAL CIRCUITS ON 25 COMPLETED VIA 25A ONLY. PRS-370 UNIT HAS SPEED WATCHING OUTPUT SIGNAL AND 0.07 HERTZ SLIP CUTOFF AT ± 10 DEGREE ANGLE SETTING. DEVICE 25A IS MULTI-CONTACT CONTROL RELAY SIMILAR TO GE TYPE CR2040BDB

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INPUTS

ACM PULSE ACCUMULATOR TO ANALOG CONVERTOR TA 4050 SERIES

THE TA 4050 PULSE ACCUMULATOR CONVERTOR MODULE COUNTS AND STORES PULSE INPUT SIGNALS IN A REGISTER AND CONVERTS THE OUTPUT OF THE REGISTER TO AN ANALOG QUANTITY THROUGH A D/A CONVERTER. PERIODICITY IS OBTAINED BY A PROGRAMMED DIGITAL CLOCK WITHIN THE TA 4050 MODULE.

DORIC DIGITREND 220 DATA LOGGER

- FRONT PANEL PUSH BUTTON CONTROLS
- VISUAL DISPLAY
- TIME-OF-DAY AND DATE CLOCK
- UP TO 100 INPUT SENSORS
- CHOICE OF UP TO 8 MEASUREMENT FUNCTIONS AND POINT SKIP
- SINGLE POINT, SINGLE SCAN; PERIODIC SCAN, CONTINUOUS SCAN, FIRST/LAST POINT SELECTION, ALARM MODES
- MAXIMUM SCAN RATE - EXISTING CAPABILITY - 2 POINTS PER SECOND
- FUTURE OPTIONAL HIGH-SPEED PRINTER - 20 POINTS PER SECOND

KENNEDY MAGNETIC TAPE RECORDER

WRITE RATE: 0 TO 300 CHARACTERS PER SECOND
 DENSITY: 558 CPI $\pm$ 3%
 INTER-CHANNEL DISPLACEMENT ERROR: 558 $\pm$ 200 MICROINCHES
 TAPE FORMAT: 7-TRACK, IBM COMPATIBLE NRZI
 CODE: BCD (IBM 8-BIT)
 REEL SIZE: 8 1/2" (21.6CM) 1600/5
 1/2" STANDARD COMPUTER TAPE 1.5 MIL.
 TAPE LENGTH: 1200' (365.7 M) 1600/5
 REWIND TIME: LESS THAN 2 MINUTES
 TAPE TENSION: 2 OUNCES

NOTE: This drawing is for engineering location requirements only and is not to be used for fabrication or verification of parts.

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BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
DATA GATHERING SYSTEM

DATE	1/10/78	REVISION	1/2A/78
BY		CHKD	
APP'D		APP'D

1-1

WEST WALL

NORTH WALL

ELECTRIC METER LOCATIONS AND DESCRIPTIONS

CHANNEL	METERED EQUIPMENT	GPC METER NUMBER	VOLTAGE	PHASE	METER TYPE	CHANNEL	METERED EQUIPMENT	GPC METER NUMBER	VOLTAGE	PHASE	METER TYPE
1	MAIN BUILDING SERVICE (ON SERVICE TRANSFORMER)	B-5838	277/480	3-WYE	TR	15	AIR COMPRESSOR	E-19251	480	3-WYE	SC
2	INTERIOR LIGHTING (OFFICE)	E-19253	277	3-WYE	SC	16	BOILER FAN (PROCESS)	E-19134	480	3-WYE	SC
3	INTERIOR LIGHTING (PRODUCTION)	E-19252	277	3-WYE	SC	17	EXHAUST FAN (MECHANICAL ROOM)	E-19145	480	3-WYE	SC
4	INTERIOR LIGHTING (STORAGE/MECHANICAL ROOM)	E-19254	277	3-WYE	SC	18	WATER SOFTENER AND AIR DRYER	E-21874	120	1	SC
5	RECEPTACLES (OFFICE FOOD VENDING MACHINES)	D-23907	120	1	SC	19	COMPRESSOR/CONDENSER FANS (PRODUCTION NE)	D-46102	480	3-WYE	SC
6	RECEPTACLES PRODUCTION AND STORAGE	E-19226	120	1	SC	20	COMPRESSOR/CONDENSER FANS (OFFICE)	C-86982	480	3-WYE	SC
7	DOMESTIC WATER HEATER	L-06220	240	1	SC	21	COMPRESSOR/CONDENSER FANS (PRODUCTION SE)	E-19454	480	3-WYE	SC
8	FAN COIL UNITS (STORAGE)	E-20086	240	3-WYE	SC	22	COMPRESSOR/CONDENSER FANS (PRODUCTION SW)	E-19250	480	3-WYE	SC
9	TRANSFORMER SERVING SEWING MACHINES/PRESSES/ HAND IRONS FUSER CUTTING KNIVES/SHOP WELDER	D-46095	240	3-DELTA	SC	23	COMPRESSOR/CONDENSER FANS (PRODUCTION NW)	D-46092	480	3-WYE	SC
10	CUTTING KNIVES (TROLLEY DUCT)	E-20875	240	3-DELTA	SC	24	AIR HANDLING FAN (OFFICE)	TIME CLOCK			
11	VACUUM PUMP	E-19228	480	3-WYE	SC	25	AIR HANDLING FAN (PRODUCTION NW)	TIME CLOCK			
12	FEEDWATER PUMP - PROCESS BOILER	E-19255	480	3-WYE	SC	26	AIR HANDLING FAN (PRODUCTION NE)	TIME CLOCK			
13	HOT WATER PUMP - DUAL TEMPERATURE BOILER	E-20085	240	3-WYE	SC	27	AIR HANDLING FAN (PRODUCTION SE)	TIME CLOCK			
14	REHEAT PUMP - HOT WATER (OFFICE)	E-20874	120	1	SC	28	AIR HANDLING FAN (PRODUCTION SW)	TIME CLOCK			

NOTE: This drawing is for engineering service requirements only and is not to be used for fabrication or verification of parts.

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
 ELECTRIC METER LOCATIONS AND DESCRIPTION

drawn	checked	approved
date 1-5-79	comm	
revisions		

THIRY
 THIRY

MECHANICAL INSTRUMENTATION

SCALE: 1/16" = 1'-0"

NOTE: This drawing is for engineering interface requirements only and is not to be used for fabrication or verification of parts.

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CHANNEL NUMBER	MEASURED APPLICATION	MEASURED RANGE	MEDIUM	OUTPUT SIGNAL	LOCATION	CHANNEL NUMBER	MEASURED APPLICATION	MEASURED RANGE	MEDIUM	OUTPUT SIGNAL	LOCATION
29-33	SUPPLY AIR TEMPERATURE-A/C UNITS	50°-100° F	AIR	"T" THERMOCOUPLE	SUPPLY DUCT MAIN	68	ENTERING TEMPERATURE-SECONDARY HTG. COIL	40°-100° F	WATER	"T" THERMOCOUPLE	COIL INLET
34-38	RETURN AIR TEMPERATURE-A/C UNITS	50-100 F	AIR	"	RETURN DUCT MAIN	69	LEAVING TEMPERATURE-SECONDARY HTG. COIL	40-150 F	WATER	"	COIL OUTLET
39-43	ENTERING TEMPERATURE-WATER COIL(S)	40-150 F	WATER	"	COIL INLET	70-73	SPACE HUMIDITY (PROD-2, OFFICE, STORAGE)	0-100%	AIR	0-100 MILLIVOLTS	SEE DRAWING
44-48	LEAVING TEMPERATURE-WATER COIL(S)	40-150 F	WATER	"	COIL OUTLET	74-75	Dx COOLING COIL ENTERING HUMIDITY	0-100%	AIR	0-100 MILLIVOLTS	UPSTREAM COIL FACE
49-50	SUPPLY AIR TEMP-STORAGE FAN COIL UNITS	50-100 F	AIR	"	SUPPLY DISCHG	76-77	Dx COOLING COIL LEAVING HUMIDITY	0-100%	AIR	1-100 MILLIVOLTS	DOWNSTREAM COIL FACE
51-52	RETURN AIR TEMP-STORAGE FAN COIL UNITS	50-100 F	AIR	"	RETURN INLET						
53-54	ENT. COIL TEMP-STORAGE FAN COIL UNITS	50-100 F	WATER	"	COIL INLET						
55-56	LEAV. COIL TEMP-STORAGE FAN COIL UNITS	50-100 F	WATER	"	COIL OUTLET						
57	DUAL-TEMP BOILER SUPPLY TEMPERATURE	60-200 F	WATER	"	SEE DRAWING	78	FOSSIL FUEL FLOW TO HOT WATER BOILER	0-80 FT ³	NAT. GAS	40 MILLIVOLTS	SEE DRAWING
58	DUAL-TEMP BOILER RETURN TEMPERATURE	50-200 F	WATER	"	SEE DRAWING	79	FOSSIL FUEL FLOW TO PROCESS BOILER	0-80 FT ³	NAT. GAS	40 MILLIVOLTS	SEE DRAWING
59	DOMESTIC HOT WATER TEMPERATURE	80-150 F	WATER	"	HW SUPPLY PIPE	80	HEATING COOLING CIRCUIT FLOW	75-100 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
60	PROCESS STEAM TEMPERATURE	300-360 F	STEAM	"	SEE DRAWING	81	SECONDARY HEATING COIL FLOW	0-0 GPM	WATER	4-20 MILLIAMPS	HW SUPPLY PIPE
61	PROCESS BOILER CONDENSATE RETURN TEMP	60-240 F	WATER	"	SEE DRAWING	82	DOMESTIC HOT WATER FLOW	0-0 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
62	PROCESS BOILER MAKE UP TEMP	40-100 F	WATER	"	SEE DRAWING	83	PROCESS STEAM FLOW	0-2000 LBS/HR	STEAM	4-20 MILLIAMPS	SEE DRAWING
63	PROCESS BOILER BLOW DOWN TEMP	300-350 F	WATER	"	SEE DRAWING	84	PROCESS BOILER MAKE UP FLOW	0-0 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
64-67	SPACE TEMP (PROD-2, OFFICE & STORAGE)	40-100 F	AIR	"	SEE DRAWING	85	PROCESS BOILER BLOWDOWN FLOW	0-0 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
						86	PROCESS STEAM PRESSURE	75-200 PSI	STEAM	4-20 MILLIAMPS	SEE DRAWING

BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
**STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS**
 MECHANICAL INSTRUMENTATION

DATE	1/10/78	REVISION	2/8/78
DESIGN		CHECKED	3/24/78
DRAWN		APPROVED	5/75/78

11111
 11111

LEGEND

(NO) - INDICATES CHANNEL NUMBER

END DEVICE LOCATION

MECHANICAL INSTRUMENTATION

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BLEVLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
 STES INTERFACE DEFINITION AND
 CONTROL DRAWINGS
 MECHANICAL INSTRUMENTATION

DATE	1/10/78
DESIGNED BY	3/24/78
CHECKED BY	5/78/78
APPROVED BY	