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SOLAR TOTAL ENERGY—LARGE SCALE EXPERIMENT SHENANDOAH, GEORGIA SITE

Annual Report, June 1977—June 1978

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Georgia Power Company
Atlanta, Georgia

U.S. Department of Energy

Solar Energy

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SOLAR TOTAL ENERGY - LARGE SCALE EXPERIMENT
SHENANDOAH, GEORGIA SITE

Annual Report for the Period
June, 1977 through June, 1978

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Published June, 1978

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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E. Ney	Westinghouse Electric Corporation	Site Integration
J. Filowat	Westinghouse Electric Corporation	Editor

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FIGURES

FIGURES (continued)

FIGURES (continued)

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
EPD	Environmental Protection Division
FPC	Federal Power Commission
FURI	Fiberglas/Urethane Roof Insulation
GIT	Georgia Institute of Technology
GE	General Electric
GPC	Georgia Power Company
GTR	Government Technical Representative
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
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

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 the Solar Total Energy (STE).

Site Objectives

The primary objective of the STE Site/Application effort at Shenandoah, Georgia is to provide a commercial facility to utilize solar-derived electrical and thermal energy, as well as a suitable area for erecting a solar energy system to provide the required energy to the facility. This 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 allow Georgia Power Company to better provide reliable economic and environmentally acceptable energy to the consumers of the State of Georgia 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 required ten years, to assist and cooperate with DOE in advancing solar total energy technology.

PROGRESS ABSTRACT

Progress during the first 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 most project milestones have been achieved within specified cost and manpower constraints.

Site/Application Preparation

Dramatic progress occurred in preparation of the manufacturing application for the Solar Total Energy System (STES). The energy-efficient building was completed during 1977, and Bleyle of America, Inc. took possession in January, 1978. The knitwear plant is running on two shifts, with fifty personnel and others being added on a regular basis. Heating and cooling piping for the STES supplied energy was installed during construction under Revision No. 1 to the Cooperative Agreement. Rough grading negotiations have been completed, and work at the collector field site is scheduled to begin early in the second year of the Cooperative Agreement. More effort than anticipated was required to consumate the solar easement (sun rights) agreement, but negotiations are being completed, and formal approval is imminent.

Meteorology Station

The Government-supplied meteorology station has been collecting data continuously since September. Although data have been collected more than 95% of the time, these data have not yet been reduced to a form applicable for system modeling and that portion of the program is behind schedule.

Instrumentation

Georgia Power Company has procured and installed in a mobile unit at the site. Instrumentation to monitor energy usage in the knitwear plant has been installed. The recording equipment is operating and calibration and resolution of initial system anomalies are in progress. Initial kilowatt-hour data were recorded on April 7, 1978.

Design Phase Interface

The Georgia Power Company Site Team participated in the review of the Solar Total Energy Conceptual Designs by Acurex, Stearns-Roger and General Electric. The Site Team has attended twelve formal and informal design review and coordination meetings, and is exchanging data with General Electric Company, the DOE selected Solar Total Energy System designer. A system of documentation and configuration has been successfully implemented for control of physical and functional requirements affecting design or operation.

Information Dissemination

Using the mobile unit at the site as a temporary Information Center, the Georgia Power Team has arranged 50 tours, presentations, and displays on a continuing basis. Reaction has been favorable.

1.0 INTRODUCTION

This first 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 (STE-LSE).

This Annual Report is structured to present a complete description of the progress, background 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.

Section 2.0 contains a description of the site in terms of location, suitability, accessibility, and other factors. Also included in Section 2.0 are detailed 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 overview of milestones to be accomplished during the coming months, followed by these Appendices:

- Appendix A: Solar Easement Agreement
- Appendix B: Interface Drawing Set
- Appendix C: Additional Site Background Data

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, the 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 the power generation is used for other purposes, making maximum use of energy collected.

The site and application now under development by the Georgia Power Company Team for the STE-LSE was selected by the Department of Energy from a field of 16 responses to its Request for Proposal, as shown in Figure 1.1-1.

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. The following pages contain detailed listings of these 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 proposed STE-LSE in 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.

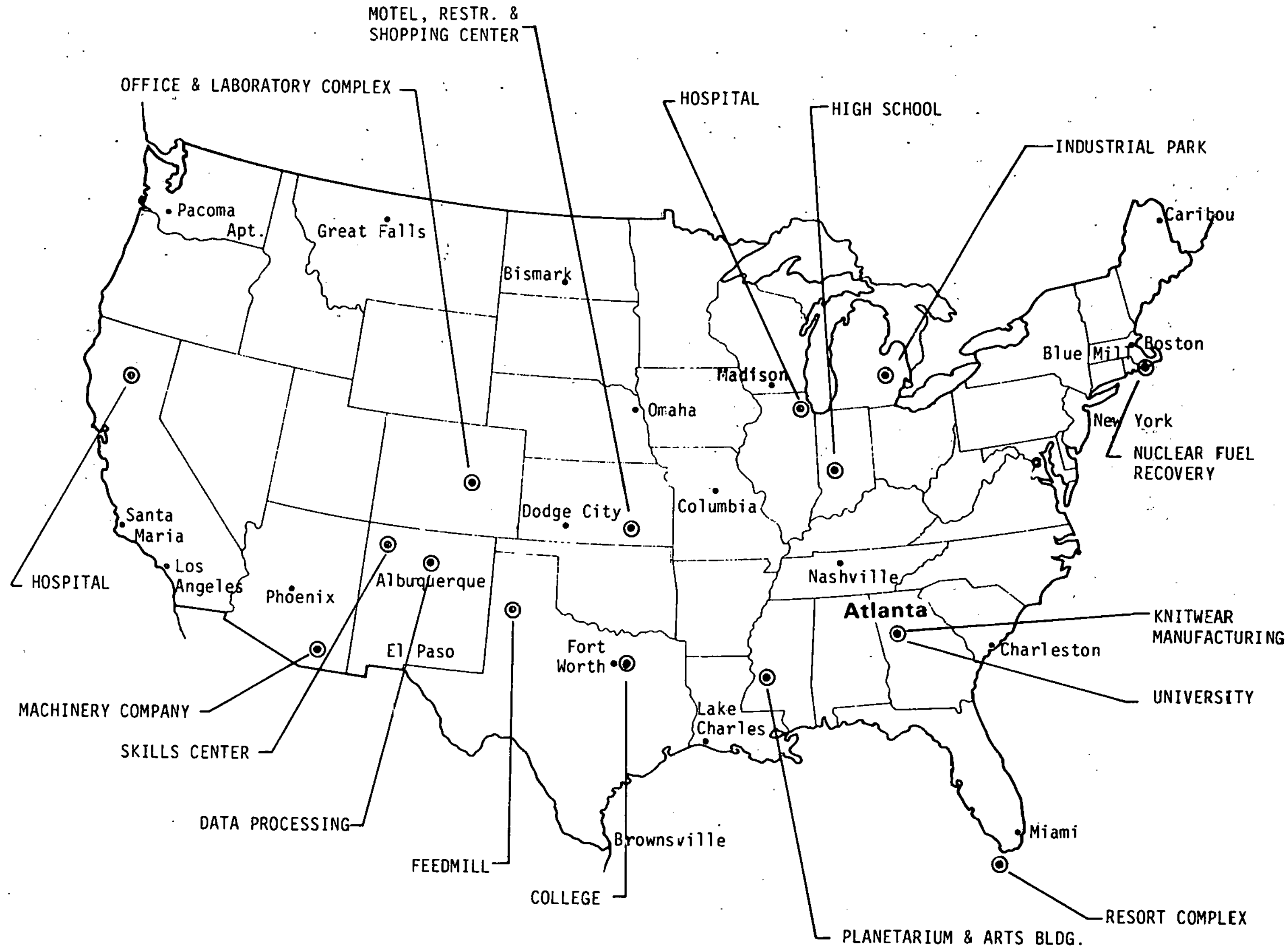


Figure 1.1-1. Responses to DOE Request for STE-LSE Site/Application Proposals

- 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.

To this end, 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. Further, 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.

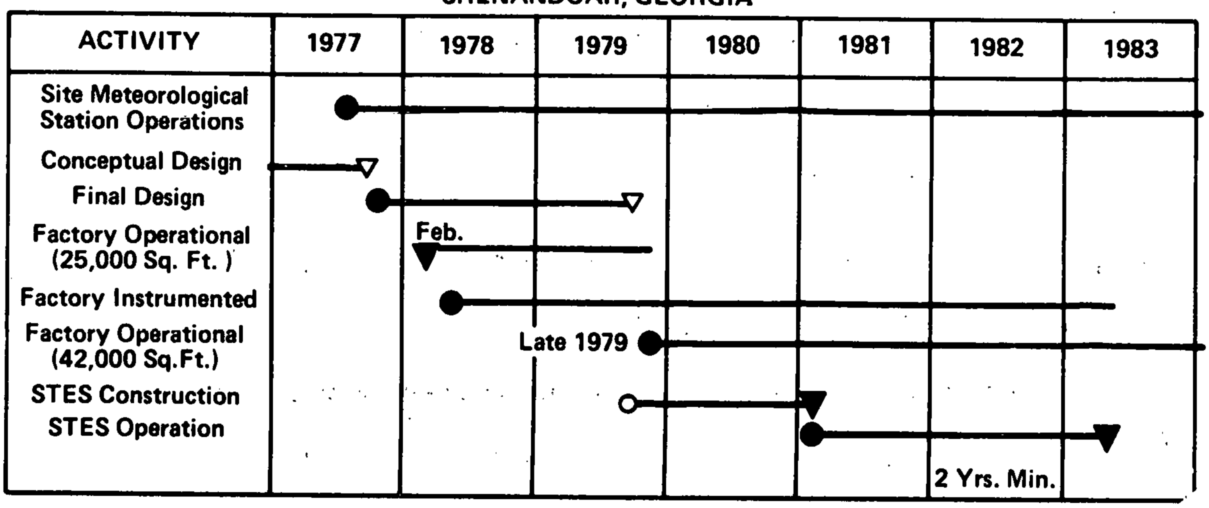
The site for the STE-LSE is approximately 25 miles south-southwest of the Atlanta, Georgia, airport in the developing, integrated community of Shenandoah, surrounding the intersection of highways I-85 and Ga-34. A 15.5 acre tract, containing a 5.25 acre area for the manufacturing facility and a 5.72 acre area for the STES and the meteorology station, is being developed.

---

*Tasks under negotiation and subject to Cooperative Agreement modification Number A002 are in process of approval at the time of this writing.

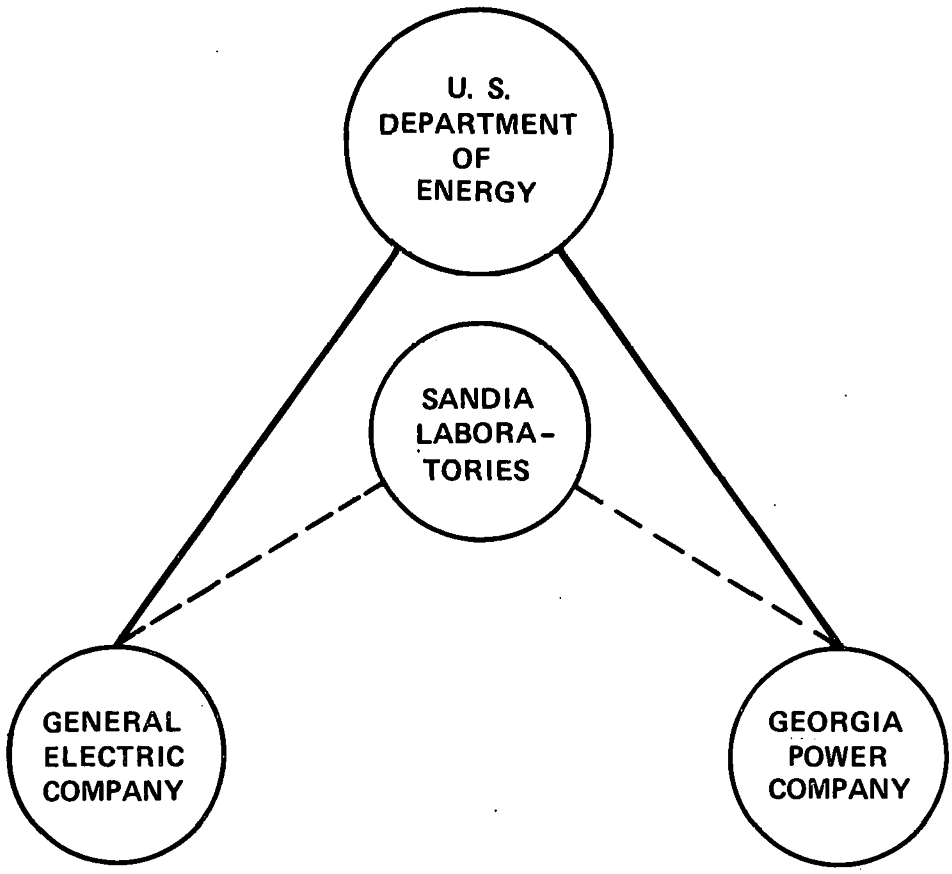
Following is the schedule by which the Georgia Power Company Team will assist in completing the Solar Total Energy Project at Shenandoah and fulfill its Cooperative Agreement with the Department of Energy. Present analysis of the total program elements indicates the possibility of initial STES operation in 1980, several months ahead of schedule.

SOLAR TOTAL ENERGY — LARGE SCALE EXPERIMENT
SHENANDOAH, GEORGIA



1.2 PROJECT PARTICIPANTS

The organizations participating in the Solar Total Energy - Large Scale Experiment at Shenandoah, Georgia and their relationship is shown in Figure 1.2-1 and are described in the following paragraphs.



DESIGN TEAM
LOCKWOOD GREENE
SCIENTIFIC ATLANTA

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

Figure 1.2-1. 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 Cental 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, including the design, construction, and operation of a series of Large Scale Experiments (LSE).

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 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. Many projects described elsewhere in this report describe the aggressiveness of their interest in energy conservation and solar applications.

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 a Cost Sharing contract from DOE for the planning of a 202-acre energy-conserving community of multiple land uses.

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 now located on the specific site of the solar collector field. GIT is using the equipment to measure and record direct and diffuse solar radiation, temperature, wind direction, wind velocity, humidity and barometric pressure.

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 factory Interface Definition and Control Documents related to the STE Project, incorporation of energy-conserving features into the 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 in 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

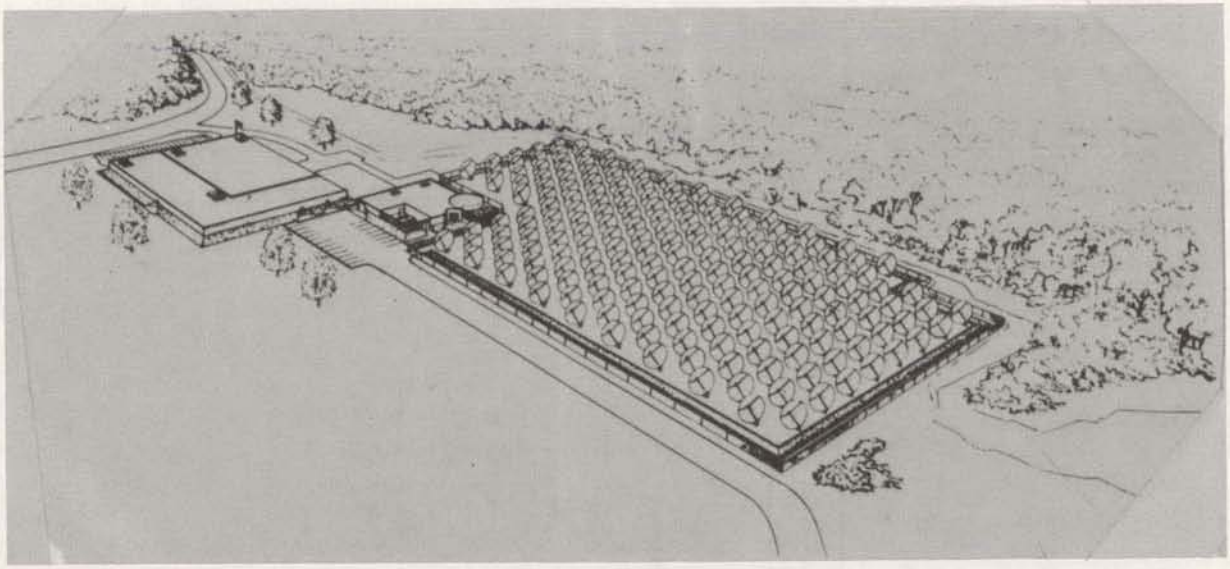
Westinghouse Electric Corporation is providing Georgia Power Company Team and STE-LSE site coordination and integration.

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, grossing $100 million annually, with sales of $10 million in the United States. The Shenandoah facility, which now covers 25,000 square feet, will be expanded to 42,000 square feet by 1981 when the STE-LSE is expected to operational. It has been 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.



1.3 PROJECT DESCRIPTION

The closed-loop solar energy system planned for Shenandoah begins with circulation of a Syltherm 800, a heat transfer product 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 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 boils and 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 42,000 sq. ft. expanded application are estimated at 1.24 MWth and 259 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 1.3-1 contains a simplified schematic illustration of the overall Solar Total Energy - Large Scale Experiment at Shenandoah.

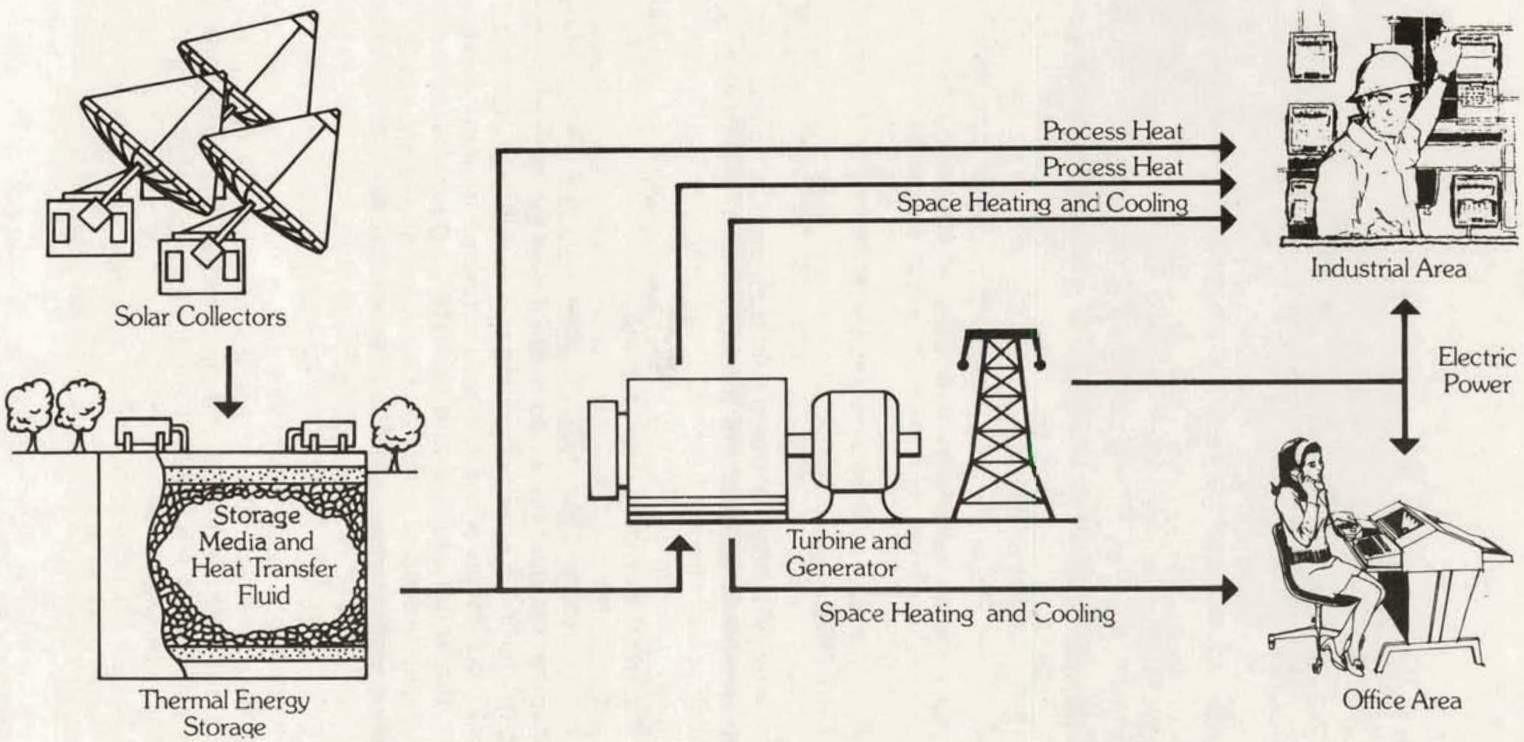


Figure 1.3-1. Simplified Schematic Illustration of the Solar Total Energy-Large Scale Experiment at Shenandoah

The solar collector specified in the Shenandoah system design for Shenandoah is a seven-meter parabolic dish as shown in Figure 1.3-2. Some of its features are as follows:

Cavity Receiver (Double Coil)

Energy Delivery* Rate/Dish	55,500 Btu/Hr
Energy Delivery* Rate/Field	9.8×10^6 Btu/Hr
Collector Efficiency	67%
Tracking Range	
• Polar Axis	±90°
• Declination	±23.4°

*Insolation = 200 Btu/Hr-Ft^2 (Direct Normal)

The remainder of the baseline design concept is shown schematically in Figure 1.3-3. Figure 1.3-4 contains a description of the overall STES, Figure 1.3-5 contains specifications for major items of equipment, and Figure 1.3-6 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 1.3-7.

The STE-LSE Site Plan shown in Figure 1.3-8 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 surfaced with blacktop. An oil-water separator will be installed to remove any Syltherm 800 in the event of a leak from the solar collectors or pipefield, after collection via the fuel drainage system. 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 the three large thermal energy storage tanks, the 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 ths area will be the unfired boiler and its ancillary equipment. All the equipment will be insulated and sealed for outdoor application.

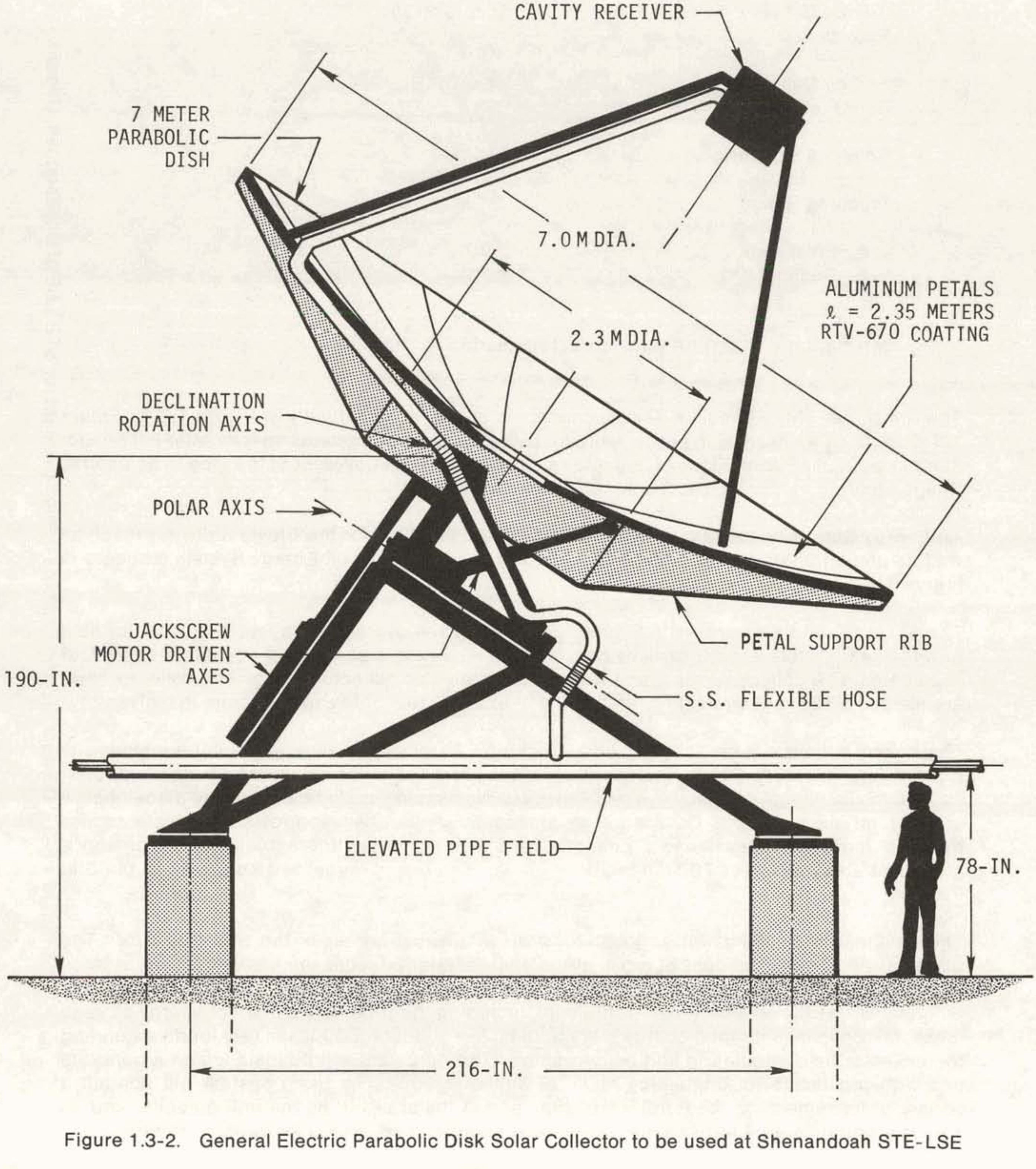


Figure 1.3-2. General Electric Parabolic Disk Solar Collector to be used at Shenandoah STE-LSE

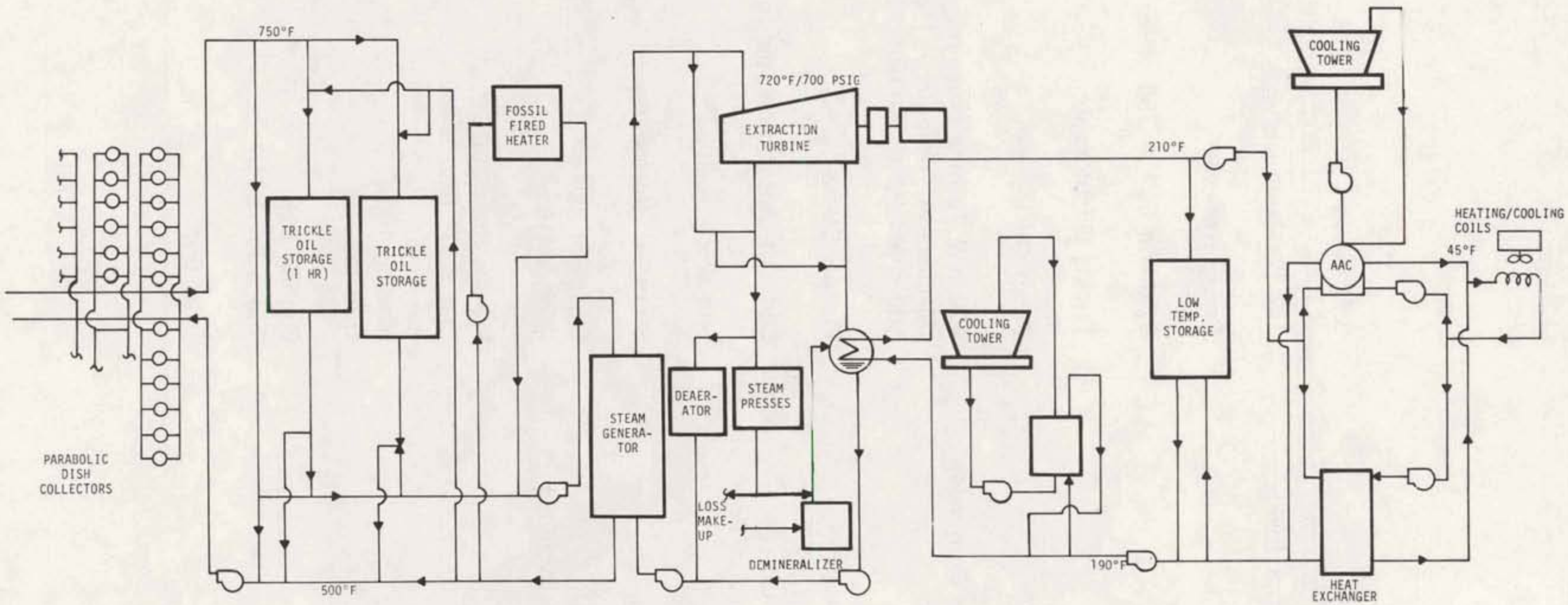


Figure 1.3-3. General Electric Baseline Design Concept for STE-LSE at Shenandoah, Georgia

Site	5.72 Acres
Collector Field	192 Parabolic Dishes
	Cavity Receiver
	Syltherm 800 at 750 Heat Transfer Fluid
	Trickle Oil Storage
	Fossil Oil Heater
Power Conversion System	400 KW Turbine Generator (Mechanical Technology, Inc.) 100 KW GPC Base Load
	Process Steam
Thermal Utilization Loop	354 Ton Absoprtion Air Conditioning
	Hot Water Heating
	Stratified Storage Tank
Annual % Bleyle Loads Provided	Electrical 33% (378 MWH)
	Process Steam 60% (3.8×10^9 Btu)
	Heating 100% (130 MBTU)
	Cooling 89% (5.3×10^9 BTU)
	Total 65%

Figure 1.3-4. General Electric System Description

Collector Field

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

High-Temperature Thermal Storage

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

Turbine Generator Set

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

Low-Temperature Thermal Storage

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

Figure 1.3-5. Specifications for Major Items of Equipment

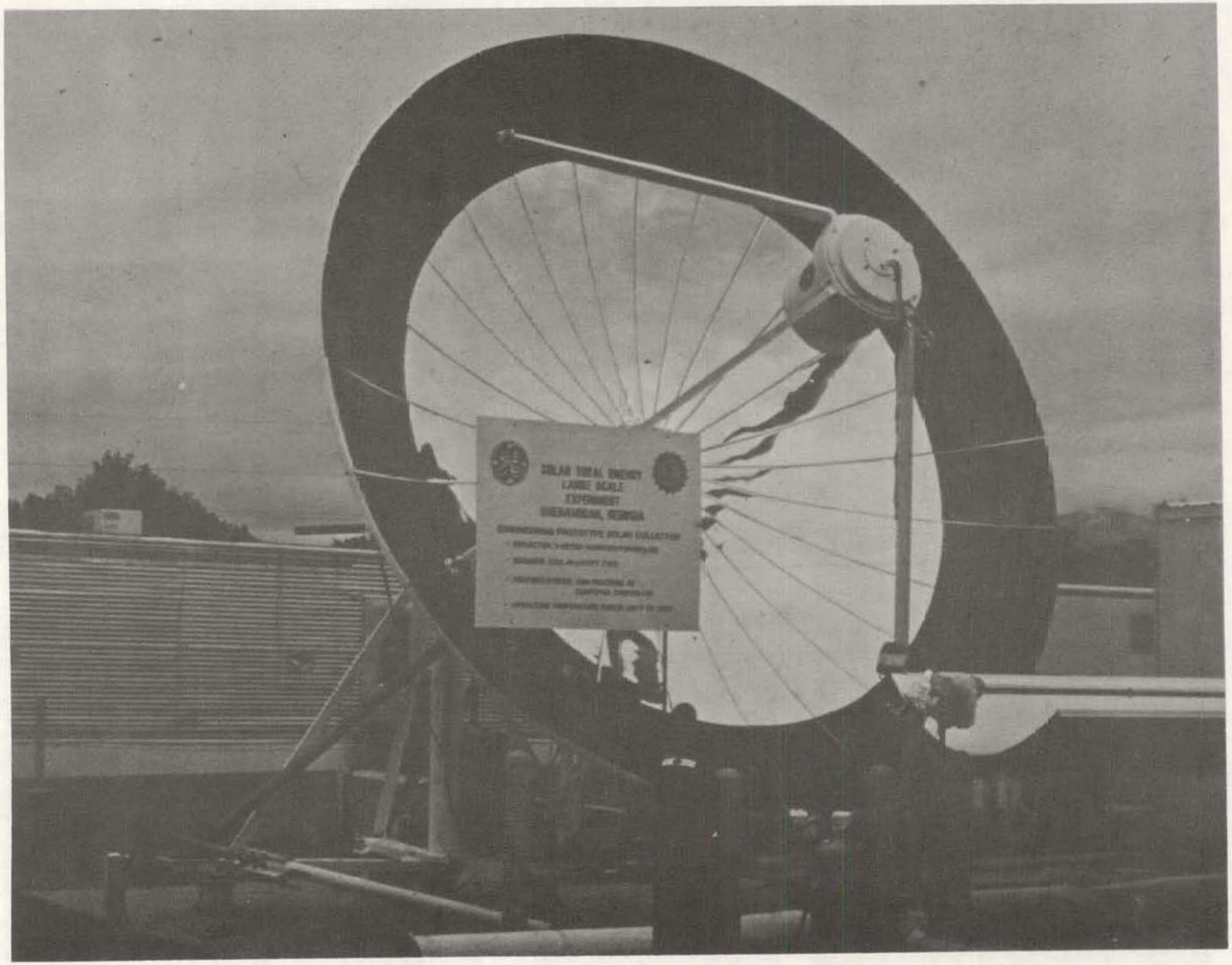


Figure 1.3-6. Prototype Parabolic Solar Collector

ENERGY SUMMARY

	LOAD REQUIREMENTS			
	BLEYLE[1]	STES	STES CAPACITY	ANNUAL STES CONTRIBUTION
Electrical	259 Kw	115 Kw	400 Kw[2]	378 MWH (33%)
Cooling	1,955,000 Btu/hr[5]	120,000 Btu/hr[6]	2,075,000 Btu/hr[3]	5.3 x 10^9 Btu (89%)
Heating	527,000 Btu/hr	32,000 Btu/hr[6]	559,000 Btu/hr	130 x 10^9 Btu (100%)
Process Steam	1,424,000 Btu/hr	-----	1,424,000 Btu/hr	3.8 x 10^9 Btu (60%)

KNITWEAR PLANT REQUIREMENTS

259 KWe

1.24 MWth[4]

(1) L-1, 3/24/78 Sign-off

(2) With 100 Kw Base Load by Utility

(3) At 210 F Inlet Design Point

(4) Maximum Load with Cooling with .7 COP Chiller and with Process Steam Load

(5) With Storage Area Cooled by STES

(6) STES Mechanical Building

Figure 1.3-7. Energy Summary for Bleyle Knitwear Plant

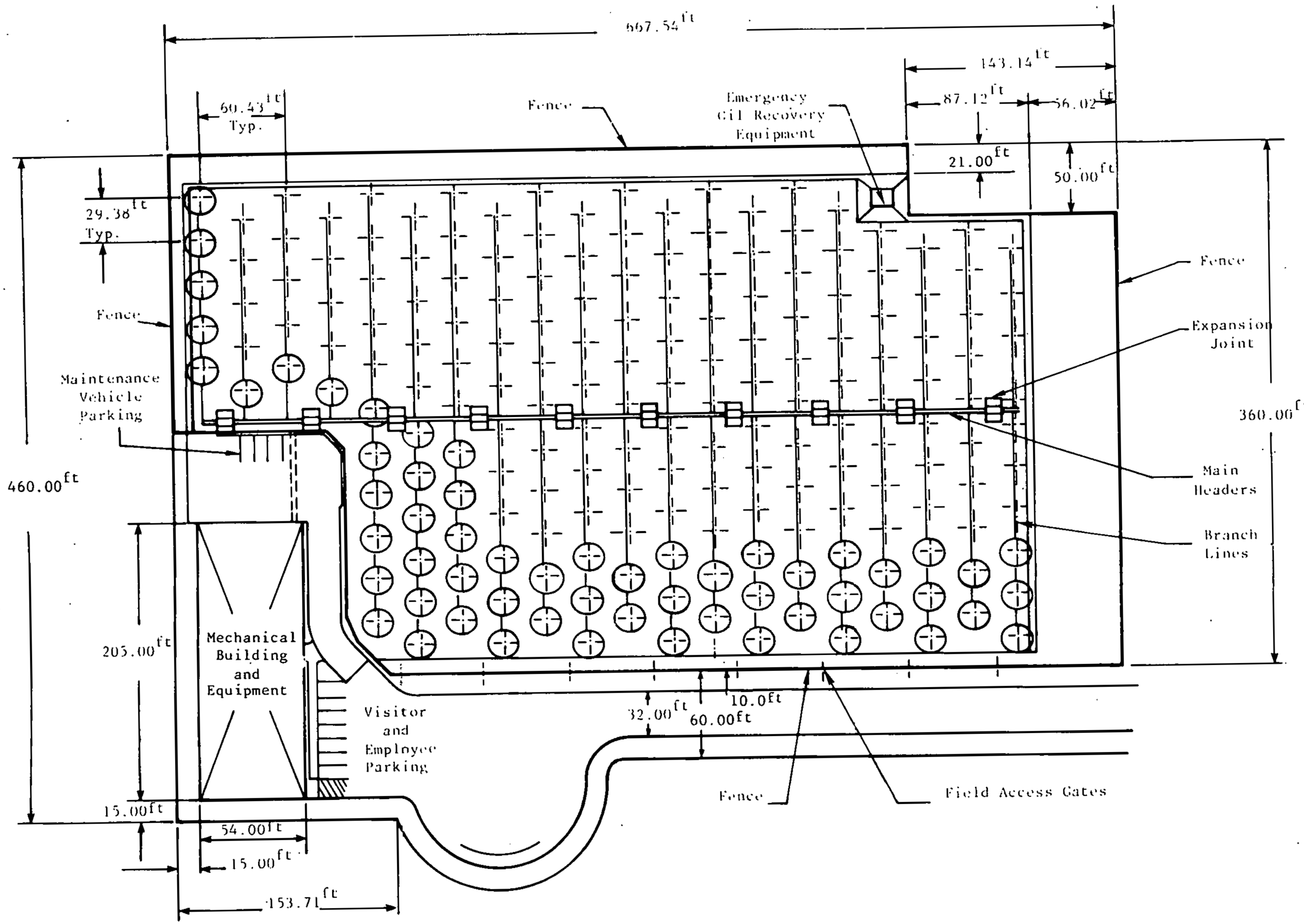


Figure 1.3-8. STE-LSE Site Plan

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 that will be removed during final preparation of the Site will be relocated and reinstalled on the roof of the mechanical building.

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

The following chart contains a brief chronological summary of key events that occurred during performance of Cooperative Agreement tasks throughout the subject reporting period. A detailed progress report, subdivided by major work tasks, appears in Section 3.0 of this Report.

May 1977	Cooperative Agreement award announced
June	Formal meetings--Site Team; Sandia; and Conceptual Design Teams (G.E., Stearns-Roger, Acurex)
July	Energy-saving features incorporated into plant design
August	GPC participates in design review as Utility Advisor
	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	GPC Team attends design reviews at Albuquerque
	Interconnection piping task added to Cooperative Agreement
October	First coordination meeting with G.E. Design Team
	Energy measurement program defined; measurement points selected
	Formal change procedures (Master Index Sheet) instituted for interface drawings
	Japanese Energy Conservation Committee visits site
November	Coordination meeting: Site Team, Design Team, Bleyle Staff
	Interconnection Piping System inspected
December	Knitwear Plant completed, keys presented to Bleyle
	Plant side of interconnection piping system activated
	STES model displayed at Textile Economics Seminar
January 1978	Bleyle plant begins operations
	Management meeting: Bleyle, DOE, Sandia, Shenandoah, G.E., GPC
	G.E. design review meeting
	GPC paper on Energy Measurement at Shenandoah STE-LSE and Heery & Heery paper on Energy Conservation features of Bleyle Plant presented at American Institute of Constructors symposium

February	GPC single-line diagram incorporated into interface set
	Mobile Instrument and Visitor Center installed at site
March	Major program participation meeting held at site
	Plans for adding eight instruments to Meteorology Station submitted to Sandia
	Electrical data collection lines installed
	Interface Control Working Group meeting held
	Site Team participates in Solar Outlook Conference in Washington
April	Site surveys completed
	Solar easement document drafted, revised
	Initial kilowatt hour data recorded
	CDDRs (Coordinated Design Data Required) incorporated, interface drawings reissued
	New STES model displayed at site
May	Rough grading bid package submitted to G.E. and Lockwood Green
	G.E. Phase III design review meeting held
	Instrumentation wiring completed, tested
	Interface Control Working Group Meeting held
	STES Model and slide show displayed in GPC lobby

2.0 BACKGROUND SUMMARY

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. Shenandoah is well started on a 25-year development program toward becoming a community of 45,000 people. It is situated on 7,400 acres surrounding the Newnan exit of Interstate 85, 25 miles southwest of Atlanta's Hartsfield International airport. Through this airport, the site is readily accessible to cities throughout the United States and Europe. An excellent network of highways and railroads fans out from Atlanta to provide easy access from all directions.

Both the site and the application are well suited to carrying out the STE-LSE. The site is nearly level, and future developments are under the control of Shenandoah. The knitwear facility, already in operation on a two-shift basis, will require approximately 259 kWe and up to 1.29 MWth for heating/cooling/process needs when the STES is operational in late 1980 or early 1981. Since the site is under the control of Shenandoah, solar easements can be ensured. The close proximity of several continuing solar projects (by Shenandoah, Georgia Institute of Technology and GPC Plants Yates and Wansley) will enhance the 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, near Newnan, Georgia, as shown in Figure 2.1-1. 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, shown in Figure 2.1-2, 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 provides a wide range of shopping, banking, industrial, medical, and recreational facilities for the residents of Shenandoah, and Newnan-Coweta Airport is only five minutes south of Shenandoah.

Development will occur slowly, neighborhood by neighborhood and village by village, to a projected population of 45,000 over a 20-year period. Each of seven villages is planned around an elementary school to preserve a sense of neighborliness, community pride and identity.

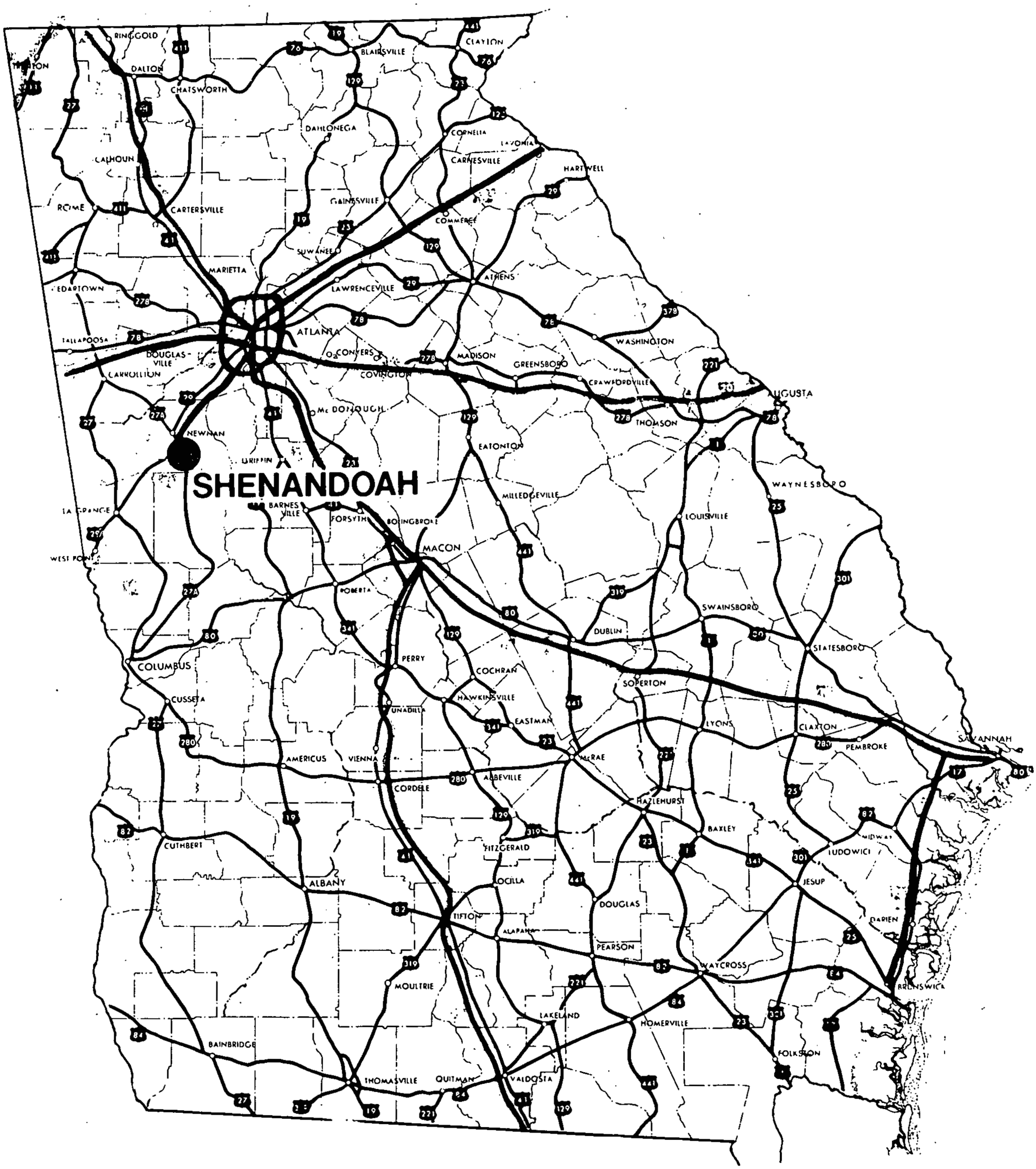


Figure 2.1-1. State of Georgia, Showing Location of New Town of Shenandoah

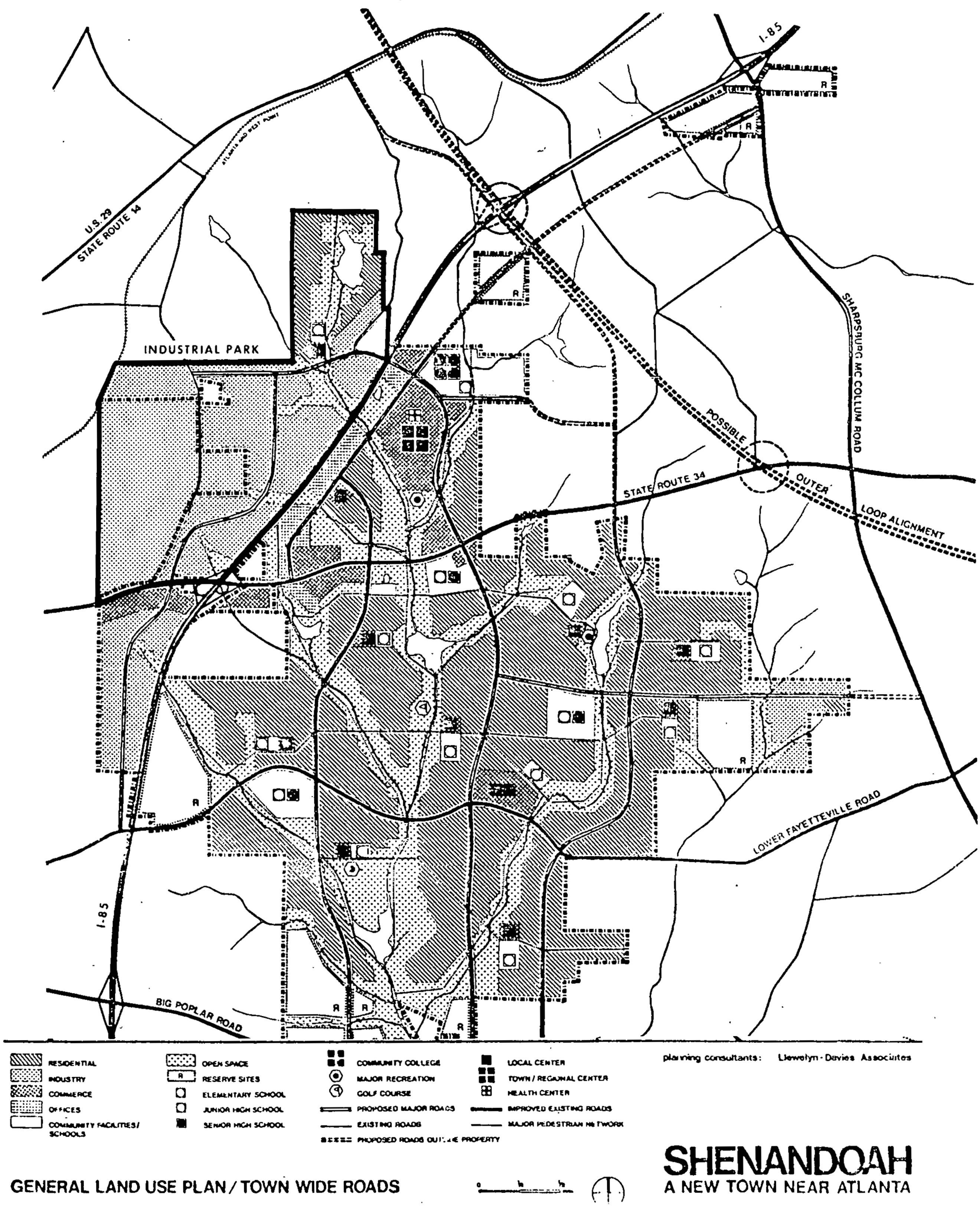


Figure 2.1-2. New Town of Shenandoah, Showing Industrial Park

Environment

More than 20 percent of Shenandoah's landscape will be preserved as permanent open land, so that the town will have a continuous area of green, natural beauty. Maximum effort will be made to preserve all natural waterways, trees, and native wildlife. The U. S. Soil Conservation Service presented Shenandoah with a Merit Award for Environmental Excellence in June of 1976.

Recreation

Since the overall plan of the New Town emphasizes recreation, facilities include a golf course, tennis courts, swimming pools, tot lots, athletic fields, basketball courts and a health club, as well as indoor facilities for ice skating and hockey.

Roads

The road system has been designed so that when Shenandoah reaches its ultimate population, the streets will not be overloaded. A continuous network of walkways and bike paths will permit children and adults to walk or ride bikes safely to school or to work.

Housing

Shenandoah will provide a wide range of housing to accommodate a broad spectrum of economic, aesthetic and age groups. These housing units will vary from single family homes to medium-rise apartment buildings.

Shopping

In addition to convenient shopping facilities in each village, the Town Center will feature a shopping mall containing department stores and diverse entertainment facilities.

Industry

Employment opportunities are under development in the Shenandoah Industrial Business Park. Entrance to the Industrial Park and the STE-LSE site, shown in Figure 2.1-3, is via Georgia Route 34, four-lane boulevard, and Amlajack Boulevard. Shenandoah's four-lane industrial boulevard begins less than a quarter of a mile from the I-85 exit ramp. The largest project in the Industrial Park is the 40-acre Southern Distribution Center occupied and operated by the S. S. Kresge Company on a 100-acre site. Opened in January of 1978, the facility will employ 600 persons, and supply more than 325 K-Marts from North Carolina to Texas.

The Georgia Chamber of Commerce, after a statewide competition, selected Shenandoah for the Georgia Foreign Trade Zone, which will attract international firms wishing to take advantage of customs tax incentives. The U. S. Foreign Trade Zone Board formally approved the site on January 19, 1977, and a warehouse has been constructed.

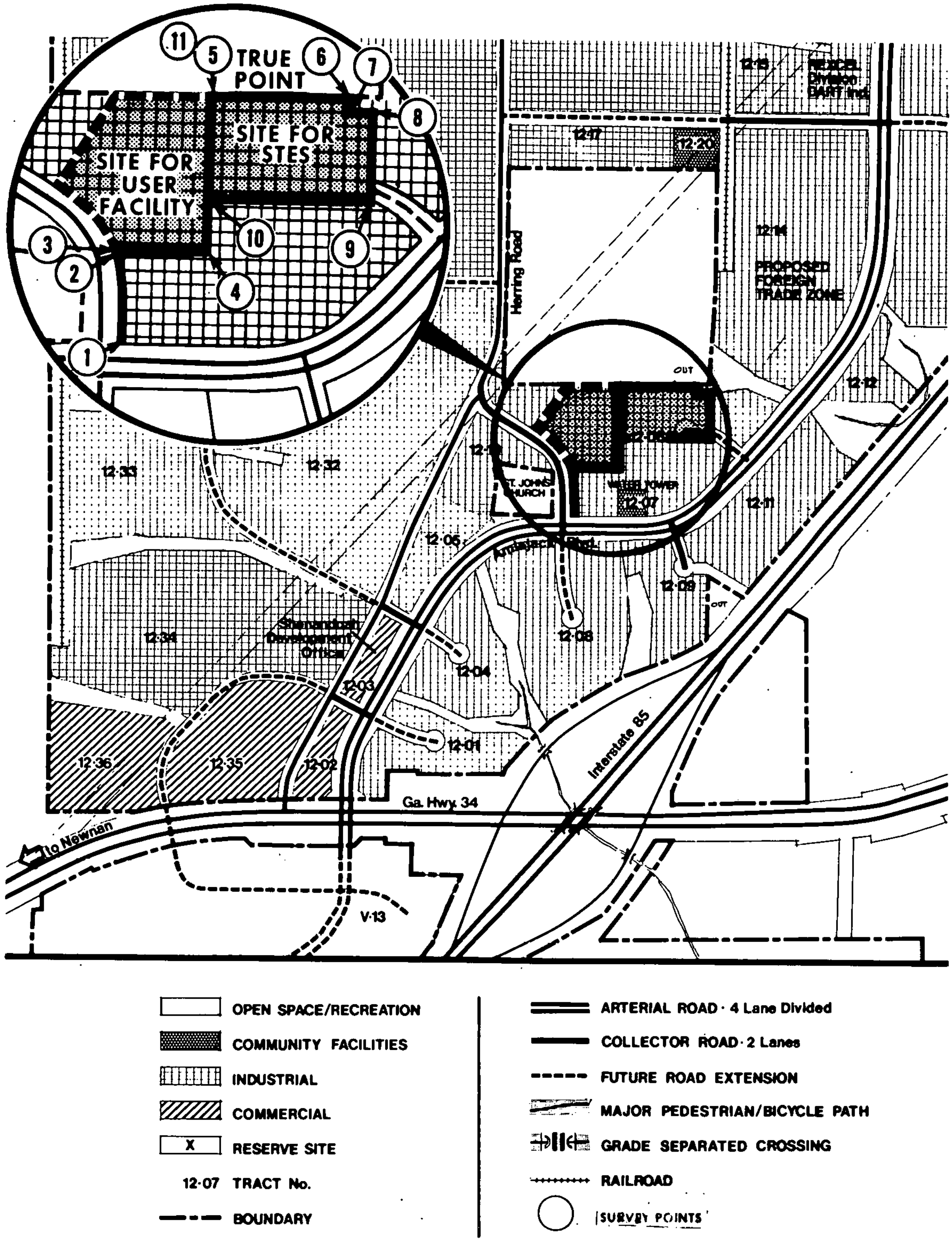


Figure 2.1-3. Shenandoah Site Map

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 has designed and built a manufacturing facility of 25,000 square feet, with plans for expansion to 42,000 square feet by 1981. Bleyle Knitwear Manufacturing has occupied the plant, and operations began in January, 1978. Each site in Shenandoah, including the site of the STES, is plotted to suit the needs of the user.

All utilities (water, sewage, electricity, gas, telephone) are available with lines running underground to ensure the beauty of Shenandoah and the dependability of service.

The STES site in the Shenandoah Industrial Park (Figure 2.1-3) is located northwest of Interstate 85. 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 Park, and then easy access to the STES site via Amlajack Boulevard. Figure 2.1-4 is a plot plan for the STES site, and Figure 2.1-5 is an artist's conception of the STES collector field, STES building, and the Bleyle knitwear manufacturing facility.

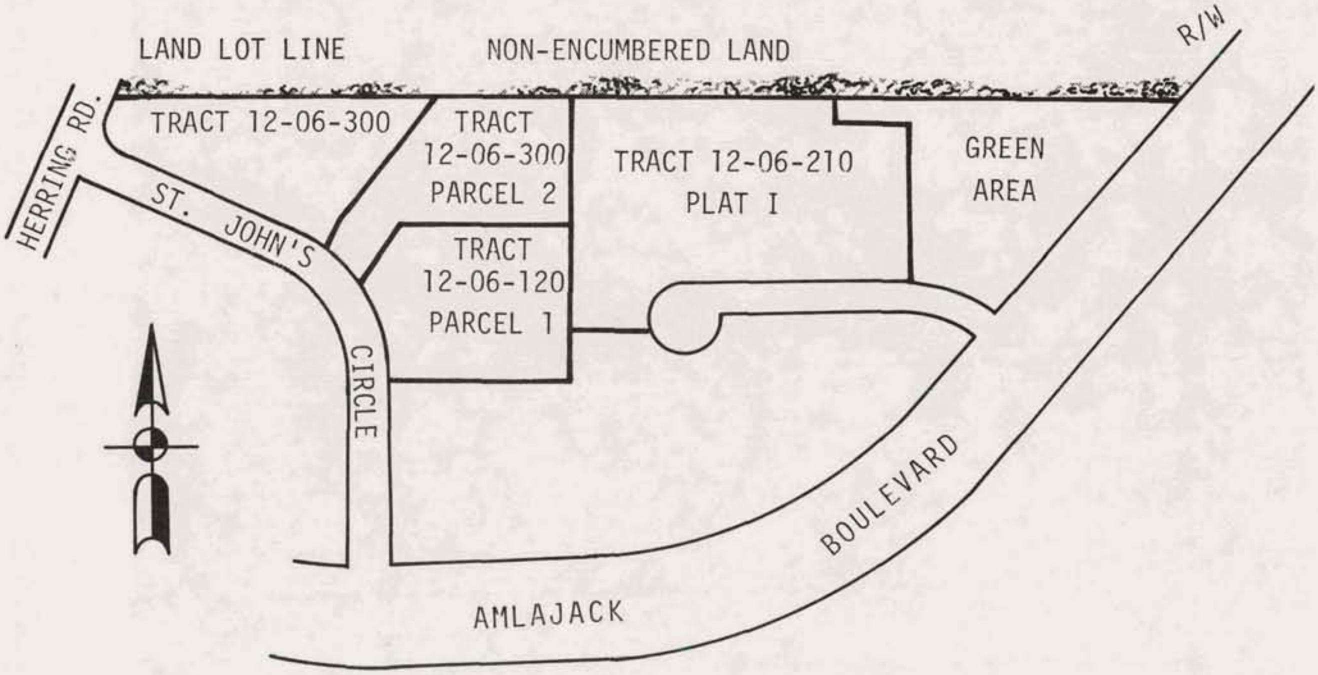


Figure 2.1-4. Plot Plan of STES Site

For the purpose of this program, the 5.72-acre site was selected on the assumption that up to 10,000 m^2 of collector area at 50 percent packing fraction may be desirable even though this appears to be more than adequate for the subject application.

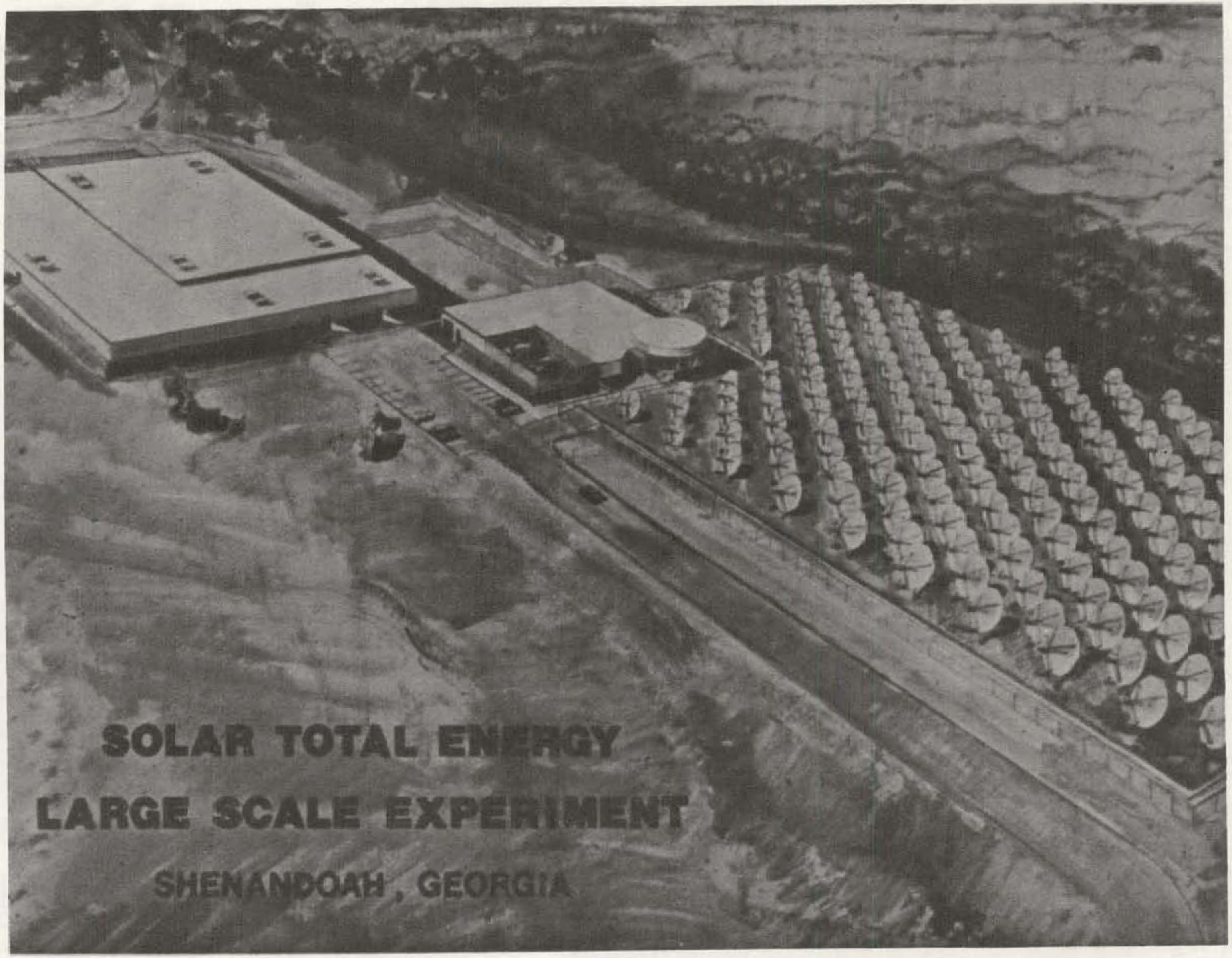


Figure 2.1-5. Artist's Conception of Bleyle Knitwear Facility with Solar Collector Field

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, as discussed later in this report, is relatively mild. The direct-normal insolation varies from about 4 kw hr/m^{2}D 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 would be 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 2.1-6 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.

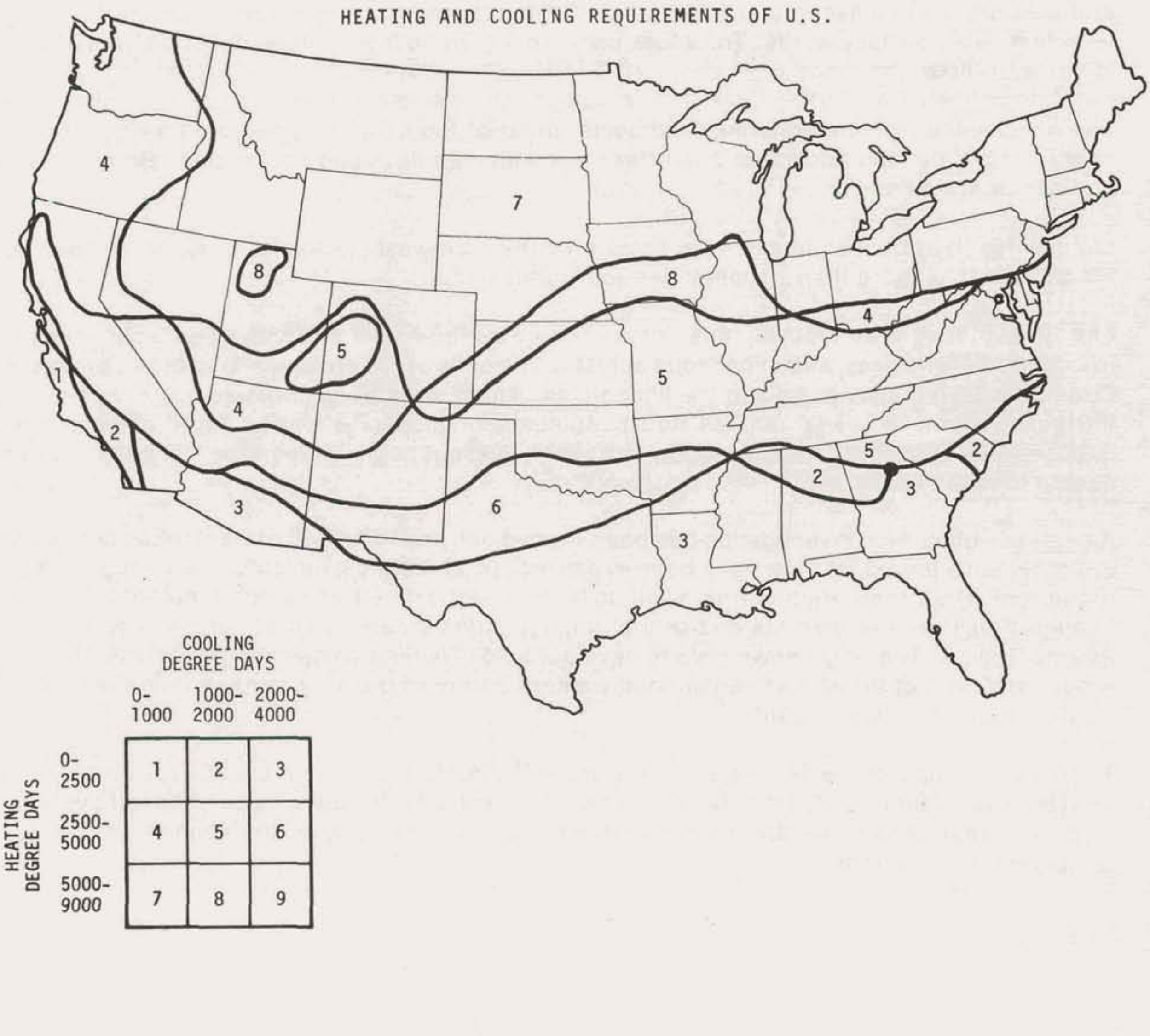


Figure 2.1-6. Shenandoah is Located Near Intersection of Climate Zones 2, 3 and 5

Atlanta receives as many total hours of sunshine per year as the east coast of Florida, notably 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, in langleys per minute.

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.

Meteorologists at the Atlanta Weather Station are of the opinion that Shenandoah will not have any measurable climatological changes directly attributable to Atlanta, because the New Town is 25 miles south of the airport and out of the path of the prevailing winds. Winds at higher altitudes are being measured at Athens and Waycross, and have, in general, been in the same direction as the surface winds. Therefore, concern regarding high altitude pollution from Atlanta is not warranted.

The occurrence of thunderstorms (and some threat of tornados) is greatest in spring. Fall is characterized by long periods of sunny weather with mild days and cool nights. Both summer and winter are mild.

Light winds (less than eight miles per hour) from the northwest predominate during all seaons. Steady winds of more than 21 miles per hour rarely occur.

The Shenandoah area typically has coarse, loamy surface soils and clayey subsoils, derived from granites, gneisses, and micaceous schists. The soils of the area belong to the Appling and Cecil Series, with alluvial soils in the floodplains. These soils do not present any problems for the construction of roads, utilities and buildings with moderate loads. High loads can be supported by underlying rock, generally more than five feet below the surface, but considerably deeper in many areas.

A detailed subsurface investigation has been carried out, and results of extensive soil borings in Shenandoah's Industrial Park have been excellent. Of 29 borings, up to 40 feet deep, only one found rock at 23 feet. High shrink-swell soils, normally defined as having a potential volume change (PVC) greater than six and/or a shrinkage index greater than 10, are very rare in the Atlanta Region. The only known area to have such soils is the ecologically delicate Soapstone Ridge area, east of the airport, in the southwestern corner of Dekalb County and in the center-north portion of Clayton County.

The area surrounding the STES site is fully under the control of Shenandoah Development, Inc., providing assurance to DOE that future construction will not interfere with operation of the STE-LSE. All solar easements are expected to be secured very early in the second year of the Cooperative Agreement.

The Industrial Park is well provided with utilities and services required for the STES. Numerous solar projects, in or near Shenandoah, have already established a growing resource of solar expertise readily available for use in the STE-LSE.

Shenandoah is following initial environmental guidelines set forth in a major study by the nationally recognized firm of Nicholas Quennel and Associates in 1971-1972. 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.

Shenandoah Development Guidelines

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 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 complimentary 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.

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 2.2-1, is a 25,000 square foot facility located at the Shenandoah, Georgia site for the DOE Solar Total Energy-Large Scale Experiment. The plant is now being run on a two-shift basis, and will be enlarged to 42,000 sq. ft. prior to beginning to utilize solar energy in the form of electricity, thermal energy for heating and cooling, and process steam for cutting, sewing, and pressing operations. At that time, the plant will employ more than 150 residents of Shenandoah and other nearby communities, with an ultimate goal of more than 300 local employes. A floor-plan for the 25,000 square foot building is shown in Figure 2.2-2.

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. These are 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 Taylor and Collum, 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 Heery & Heery, by request from Georgia Power Company, 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. If the insulation donated by Owens-Corning had been purchased, the first cost would have been reduced by $9,000.

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*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).

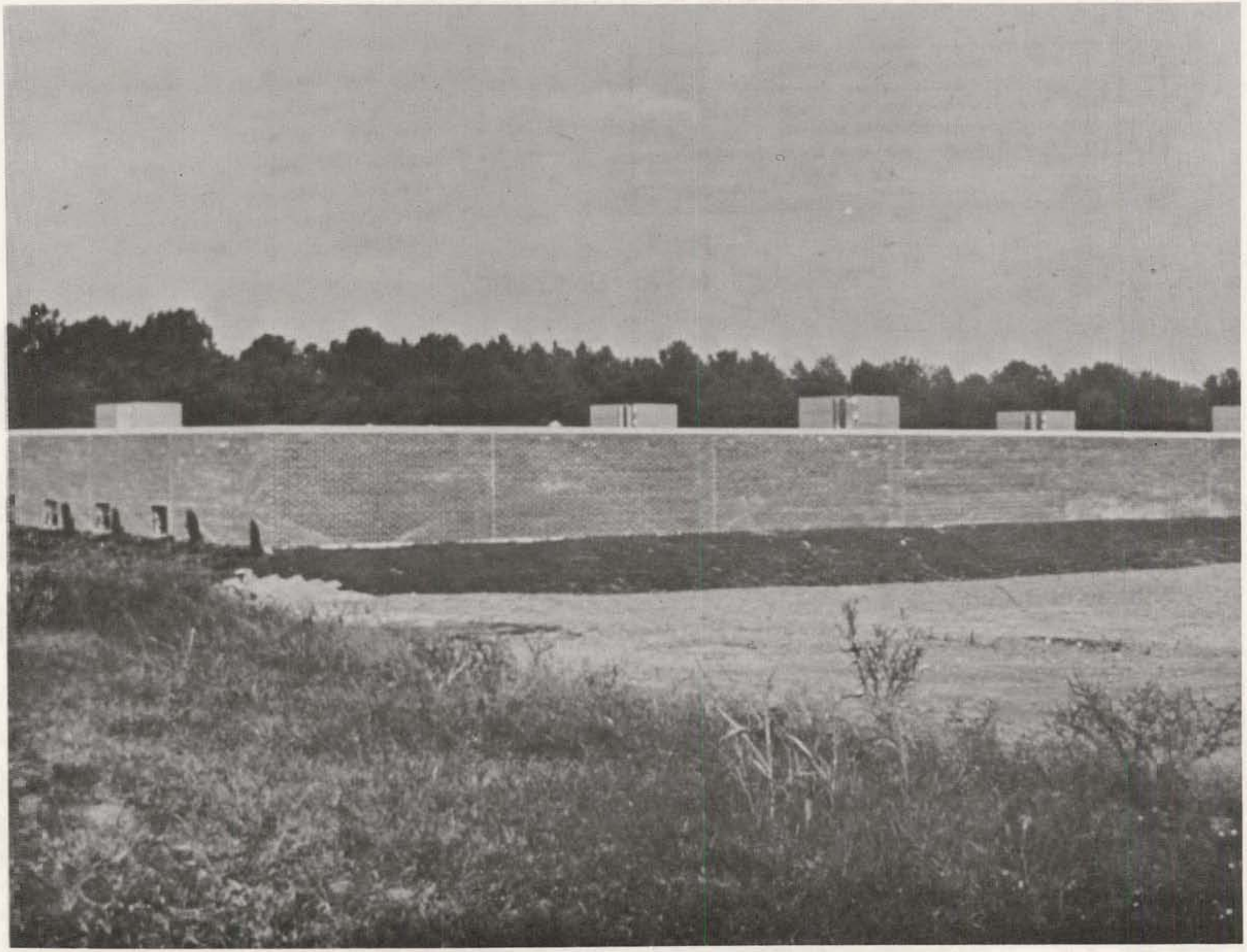
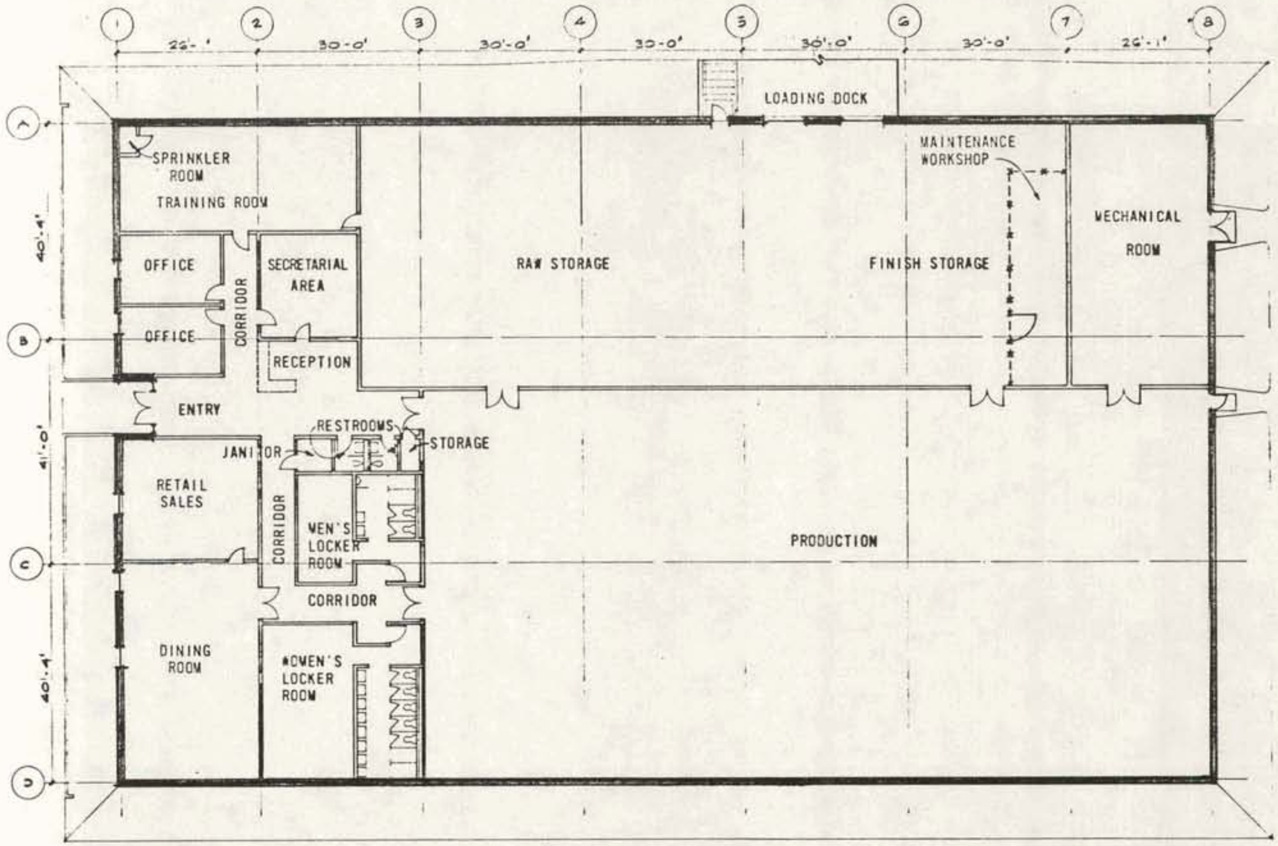


Figure 2.2-1. Bleyle Knitwear Plant



BUILDING THERMAL CHARACTERISTICS

WINDOWS – INSULATING GLASS – DOUBLE, ½" AIR SPACE

GLAZED ENTRY – SINGLE GLASS

ROOF – WITH 2 x 2½" OWENS-CORNING FURI ROOF INSULATION, U = .03

EXTERIOR WALLS – WITH 6" OWENS-CORNING UNFACED BATTS, U = .05

BUILDING 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.

DESIGN CONDITIONS

SPACE	SUMMER		WINTER	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE
PRODUCTION	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
OFFICE	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
EMPLOYEE SERVICE	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
STORAGE	VENTILATED ONLY	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
MECHANICAL	VENTILATED ONLY	95°F DB 78°F WB	NONE	18°F DB

Figure 2.2-2. Floor Plan for 25,000 sq. ft. Plant

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
- Selected fluorescent lighting
- Increased lighting and motor voltage
- Rotate building to east-west orientation
- Central hot water heating
- Reflective aluminum-painted roof
- Various process system refinements

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 the knitwear plant at 42,000 sq. ft. of floor area. Projections indicate a 46% 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 for $66,000/year to $41,000/year. Detailed formulas for estimating probable energy consumption, as well as other supporting data, are included in the referenced Sandia report on Energy Conservation Features of the Bleyle plant.

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. A detailed description of loads is found in Appendix B, Interface Control Drawings, Drawing L-1. 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 recording constant 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 constructed by Heery & Heery, with equipment and instrumentation designed and installed at the project site by Sandia, was intended to resolve these difficulties and to begin collecting high quality solar radiation data for the Total Energy System designers. 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 2.3-1, consists of a set of eight solar radiation and surface weather instruments, appropriate mounting or support structures, and a compact, portable, cassette tape data logger. The following table lists the various instruments and the variables they measure:

Instrument	Variable
1. Pyranometer (horizontal)	Global radiation
2. Pyrheliometer	Direct normal radiation
3. Pyrheliometer	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

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 eight instruments for a little more than five days before a cassette is filled.

Figure 2.3-1. Government-Supplied Weather Station

Section 3.2 of this report contains a chronological summary of the operation of the Meteorological Station from its installation to the present. The following table describes new equipment planned for the Meteorology Station as part of the Southeastern Regional Solar Meteorological Research and Training Project at Georgia Tech, and under subcontract to GPC.

Instrument	Variable
1. Pyranometer (unshaded)	Global Radiation
2. Pyranometer (shaded)	Diffuse Radiation
3. Pyranometer (tilted 34°)	Global Radiation on Lattice Plane
4. Pyranometer (CSIRO)	Net Radiation
5. Rain Gauge	Rainfall
6. UV Pyranometer	Ultra-Violet Radiation
7. Nephelometer	Turbidity

RELATED ACTIVITIES

In order to perform numerical modelling 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 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 was also 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 it becomes available.

TABLE 1

MODEL YEAR MONTHS SELECTED AND THEIR COMPARISON TO LONG TERM AVERAGES

Model	Year	Mean	Std.	Std. Dev.	
Month	**Selected**	**Mean***	**Ratio****	**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/ft^2/day

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

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, provis on for energy and environmental measurements can be made by zone. Vertical zoning through construction affects energy use, but does not apply in this case. 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.

Consideration of building occupancy and use, therefore, determines the equipment measurement points and environmental or production system applications to be instrumented. A listing of instrumentation equipment being used at Bleyle Plant is contained in Appendix B, Interface Control Drawings, Drawings I-1, I-2, I-3, I-4. Figure 2.4-1 shows the Mobile Instrumentation Center installed at the site, and Figure 2.4-2 shows the equipment installed in a console. Section 3.2 contains a detailed chronological description of the Data Acquisition effort conducted to date.

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*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.

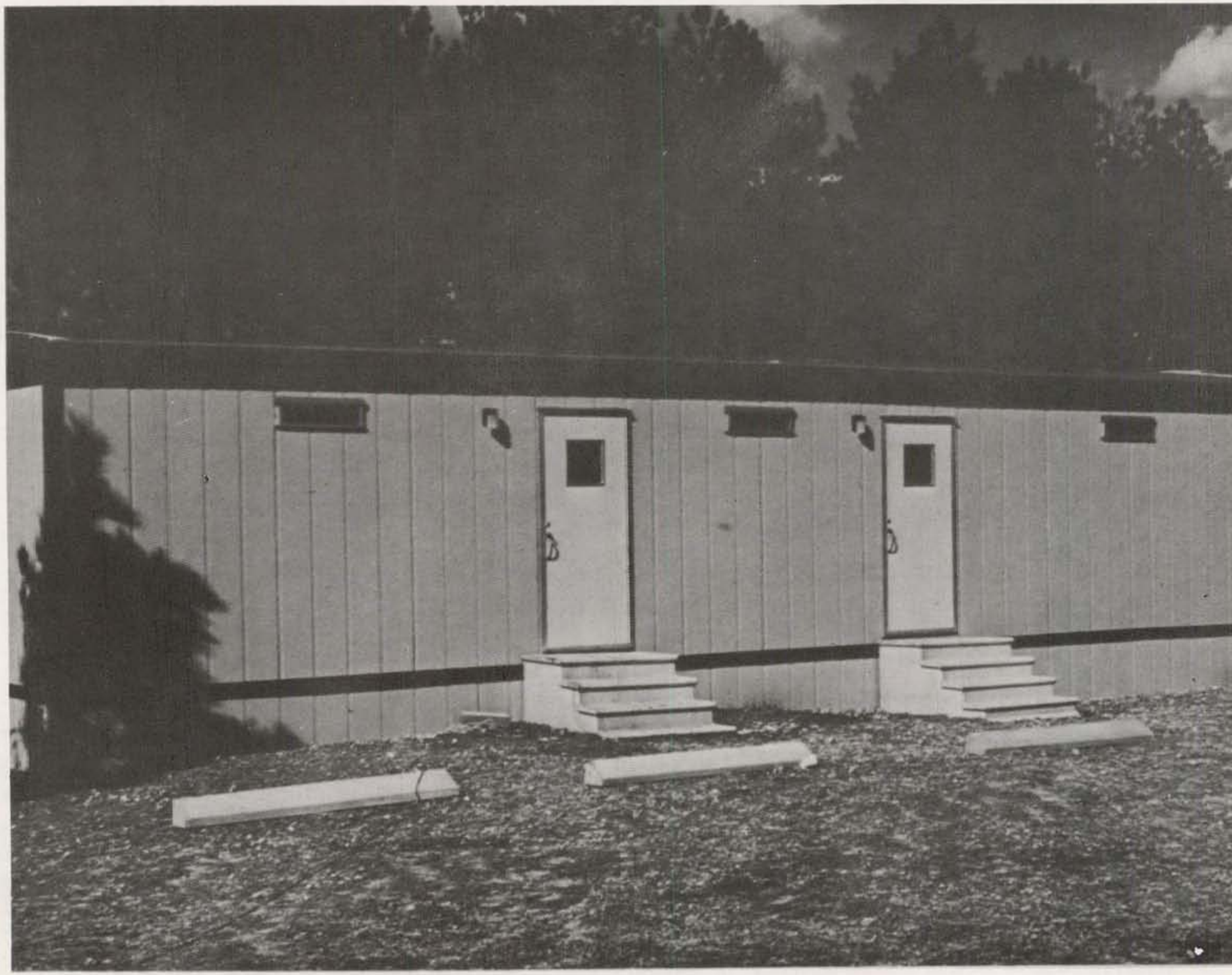


Figure 2.4-1. Mobile Data Acquisition Center

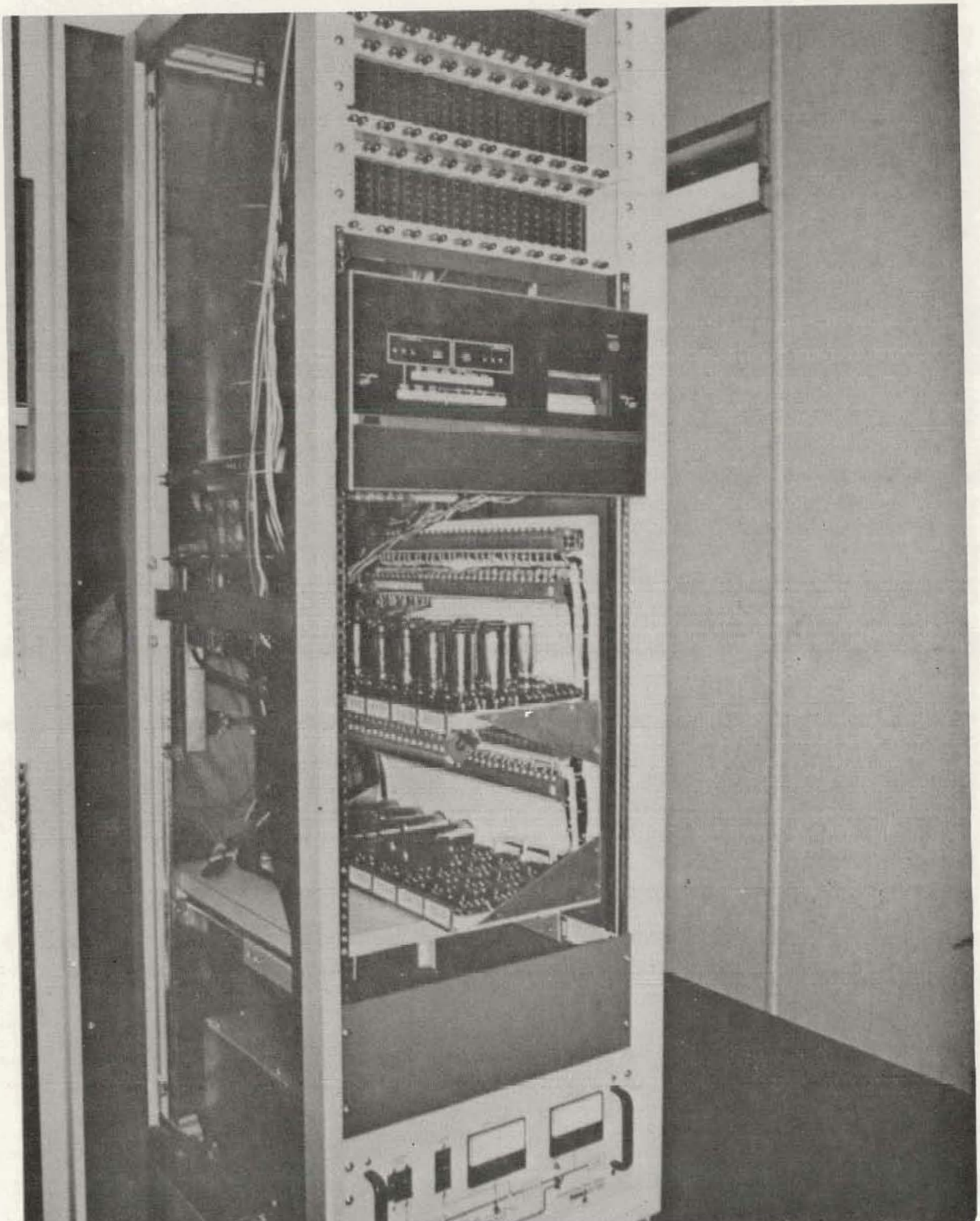
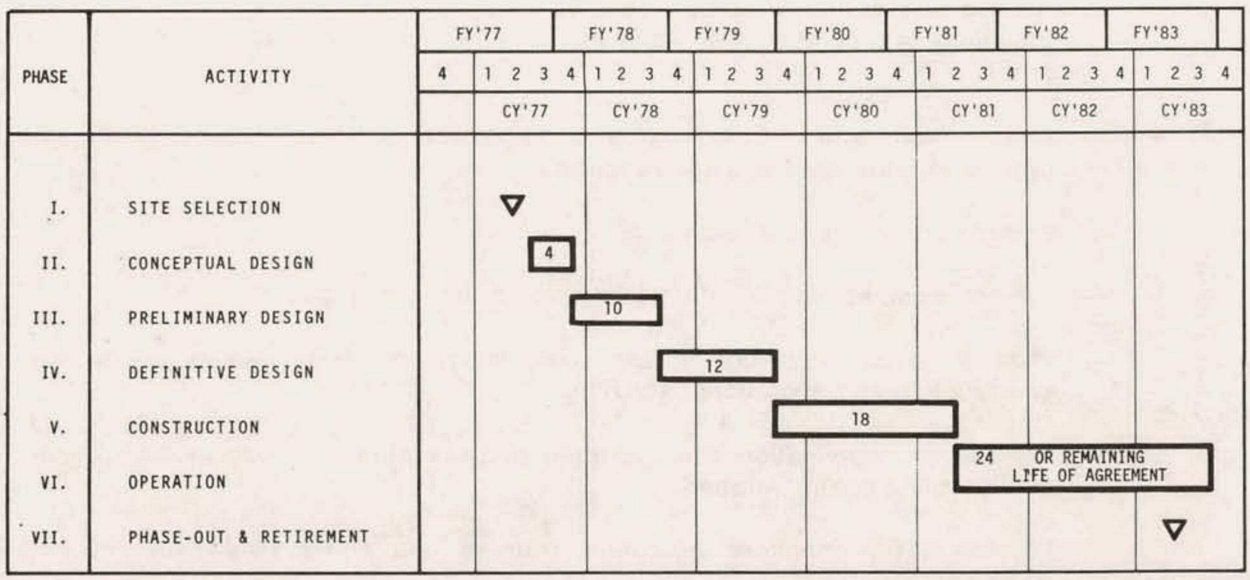


Figure 2.4-2. Data Acquisition Equipment in Mobile Center

3.0 DETAILED PROGRESS REPORT

As mentioned in the abstract introducing this volume, general progress exceeded expectations during the first 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, operation, and phase-out of a Solar Total Energy-Large Scale Experiment:



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 subject 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 additional 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 activitity.
  - 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 auxiliary turbine interface equipment.
  - Provide energy user conservation services.

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

- Information dissemination
- Rough grading of the site

The following sections comprise a detailed description of progress made at the Shenandoah STE-LSE site from May, 1977 through May, 1978. Progress is reported according to the following categories, which correspond to the major task areas of the Cooperative Agreement:

- Site/Application
- Meteorology Station
- Instrumentation/Data Acquisition
- Design Interface
- Information Dissemination (limited basis)

3.1 SITE/APPLICATION

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. 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.

In an effort to make the proposed site and application available ahead of schedule, Shenandoah Development, Inc. retained the Architectural Engineering firm of Taylor and Collum to provide the interface between H. Powell, the Bleyle plant constructor, and the Georgia Power Company Site Team. In a related effort, a meeting was held with Owens-Corning Fiberglas to determine the company's specific area of program participation and degree of interest. Several key issues, relative to insulating the Bleyle Plant, were resolved, and a follow-up meeting was scheduled.

In June, two formal meetings (one in Shenandoah and one in Albuquerque) were held with the Sandia Project Management Office and the conceptual design teams of General Electric, Stearns-Roger and Acurex-Aerotherm. These meetings, as well as numerous subsequent data transmittals, provided the designers with necessary characteristics of the physical site, projected Bleyle Plant load characteristics, and solar and meteorological data sufficient to initiate the conceptual designs.

All aspects of the Cooperative Agreement between DOE and Georgia Power Company were resolved early in June, 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.

A series of technical coordination meetings was held at about the same time with the Sandia Technical Program Manager, R. Hunke, in Shenandoah, with the following topics being discussed:

- Energy conservation features
- Interface control drawings
- Meteorologic station and data
- Instrumentation list

After numerous site visits by the conceptual designers, who requested information concerning environmental and load analysis issues, updated building and load data were provided. While the contract moved toward a final resolution, in terms of the site as well as the design, Mr. A. Simon of Shenandoah Development, Inc., and Governor Busbee of Georgia visited Germany to announce plans for the American solar knitwear plant to be leased by Bleyle, A German corporation. This trip was also used to obtain further photographs and technical data and operation characteristics to be incorporated into the Shenandoah facility.

By the end of June, detailed design work on the government-furnished meteorology station for the STE-LSE was in progress, and an area at the STE-LSE site was selected as a temporary location. The selected location fell within the boundaries of the area to be occupied by the solar collector field.

In July, Mr. Ed Houts, of the Georgia Power Company, attended a comprehensive, ten-day series of conceptual design reviews. The reviews covered system designs, power conversion concepts, optical systems, environmental aspects and other areas of design for both the Shenandoah and Fort Hood (Texas) Solar Total Energy-Large Scale Experiments. Back in Georgia, major decisions, recommendations, and changes were being made to allow better interrelationship between the Bleyle Plant and the STES, and significant energy-saving design features (discussed in Section 2.2.2) were incorporated into the building design, for which footers were being poured and steel structure was being erected.

In August, discussions continued with all the conceptual designers on sun rights, power system interface, and architectural and civil engineering aspects. Following these discussions, recommended evaluation criteria for use in selecting a designer for the Shenandoah STE-LSE were prepared by the Site Team and transmitted to Sandia. These criteria concerned only the Georgia Power Company's functional interfaces in the Project and were offered for incorporation into DOE's total selection process as appropriate. Don Bowen, of the Georgia Power Company, participated in design reviews at Albuquerque as a part of the program to use Georgia Power Company as a utility advisor in the design selection process at the Fort Hood site.

Meanwhile, Georgia Tech completed an analysis of horizon characteristics at the Shenandoah site, including the Bleyle plant, the water tower, trees, and other possible obstructions. A computer analysis of lost energy percentages for various degrees of solar field size, height of obstructions, and set-back distances was prepared. A letter report also was prepared to outline the sun rights clause to be included in the transfer of the 5.72-acre site from Shenandoah Development, Inc. to Georgia Power Company.

Change Notice Request No. 1 to the Cooperative Agreement between Georgia Power Company and DOE was submitted in August. This change provided for DOE-financed design and installation of interconnection piping, as shown in Figure 3.1-1, to accommodate the solar cooling system when it is ready to provide air-conditioning for the Bleyle Plant. The interconnection system was proposed to be 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 Plant continued on schedule. The concrete flooring was poured, and the roof (with the Owens-Corning donated insulation package) was in the final stages of assembly. Formal dedication of the plant took place on August 4, with the participation of Dr. Kurt Bleyle; officials of the State of Georgia, and the City of Newnan; Sandia; and members of the Georgia Power Company Site Team.

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

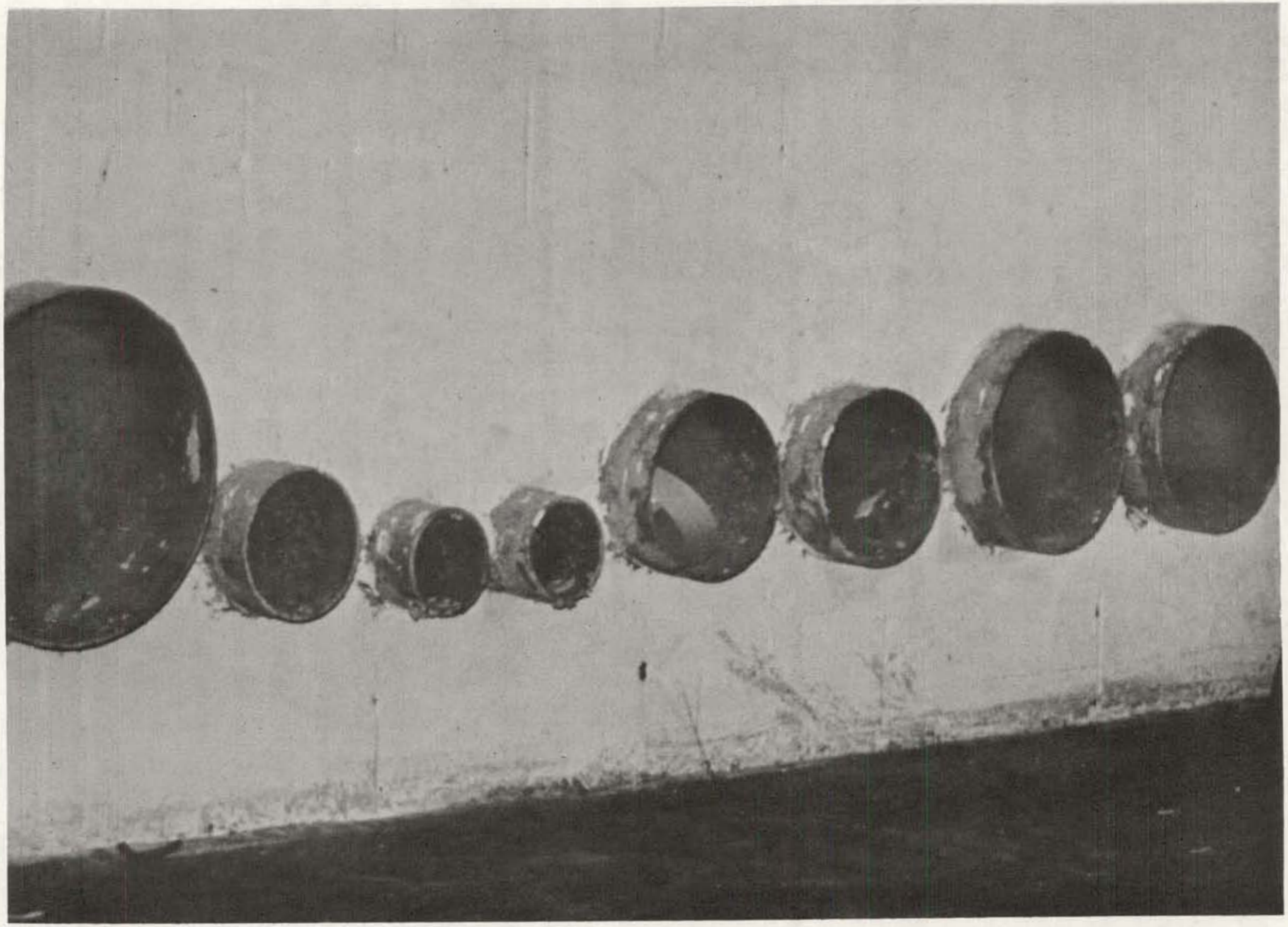


Figure 3.1-1. Interconnection Piping Installed in Bleyle Plant

use of solar energy, and it would preclude an undue encumberance on the adjacent property that might interfere with the marketability and use of this property. The easement is now in final draft form and is expected to be approved by all parties prior to the initiation of major earth moving activities in the summer of 1978. A copy of the Solar Easement Agreement is included in this report as Appendix A.

In September, the Georgia Power Company Team was represented in the five conceptual design reviews at Albuquerque for the Fort Hood and Shenandoah STE-LSE applications. The Georgia Power Company participants contributed significantly to the design assessments and provided a written report to Sandia for consideration in the technical evaluation of the conceptual design. These assessments were coupled with other programatic factors and assessments, resulting in the selection of General Electric (with Scientific-Atlanta and Lockwood Green as sub-contractors) as the Shenandoah STE-LSE solar plant designer by DOE.

In other developments more closely tied to the application, the change to the Cooperative Agreement to accommodate the design and installation of the interconnection piping for the solar cooling system was approved by DOE, and an installation contract was issued to Mechanical Services, Inc. It was approximately 80 percent complete by the end of September. Construction of the Bleyle Plant itself was 90 percent complete, and was significantly ahead of schedule. Lighting fixture delivery was a pacing item, but did not delay installation of knitwear manufacturing process equipment.

The key event for the Project in October was the first coordination meeting with the STES designer, General Electric Company. The meeting covered all aspects of the program, and detailed site and application material was transmitted. Comments on a Master Schedule prepared by G.E. were noted and transmitted to G.E. and Sandia.

Construction of the Bleyle Plant continued ahead of schedule in October, and the interconnection piping system proceeded to 95 percent completion. The boiler and related piping, shown in Figures 3.1-2 and 3.1-3, were in final stages of assembly. It was decided to color code the solar heating and cooling system for identification purposes, and Bleyle personnel arrived at the site to make the final selection of pipe fitters and plumbers to install the process steam and other auxiliary process systems.

During November, Heery & Heery, Architects and Engineers, Inc., continued work on a revised site plan to remedy an erosion problem along the gravel roadway installed to provide access to the site. The revised plan included locations for a proposed mobile data gathering office, a parking area, and a septic field. Construction activities continued well ahead of schedule for the Bleyle Knitwear Plant, and the energy conservation features outlined in Section 2.2.2 of this report were incorporated into the structure.

A coordination meeting was held in November in Atlanta, attended by represent- atives of the Site Team, the Design Team, and the Bleyle staff. The primary topic of discussion was the update by Bruce Hammock of the Load Requirements and Analysis presented during the October 20, 1977 coordination meeting. The data package was incorporated as a permanent part of the Interface Definition and Control Drawings, and a detailed discussion of the changes to the package followed. The revision was documented in accordance with formal change procedures adopted by all parties concerned. At the same meeting, shop drawings were furnished showing the proposed installation of the Process Equipment purchased by Bleyle, and G.E. presented an overview of its involve- ment in the STES. Milestones were established for the coming months.

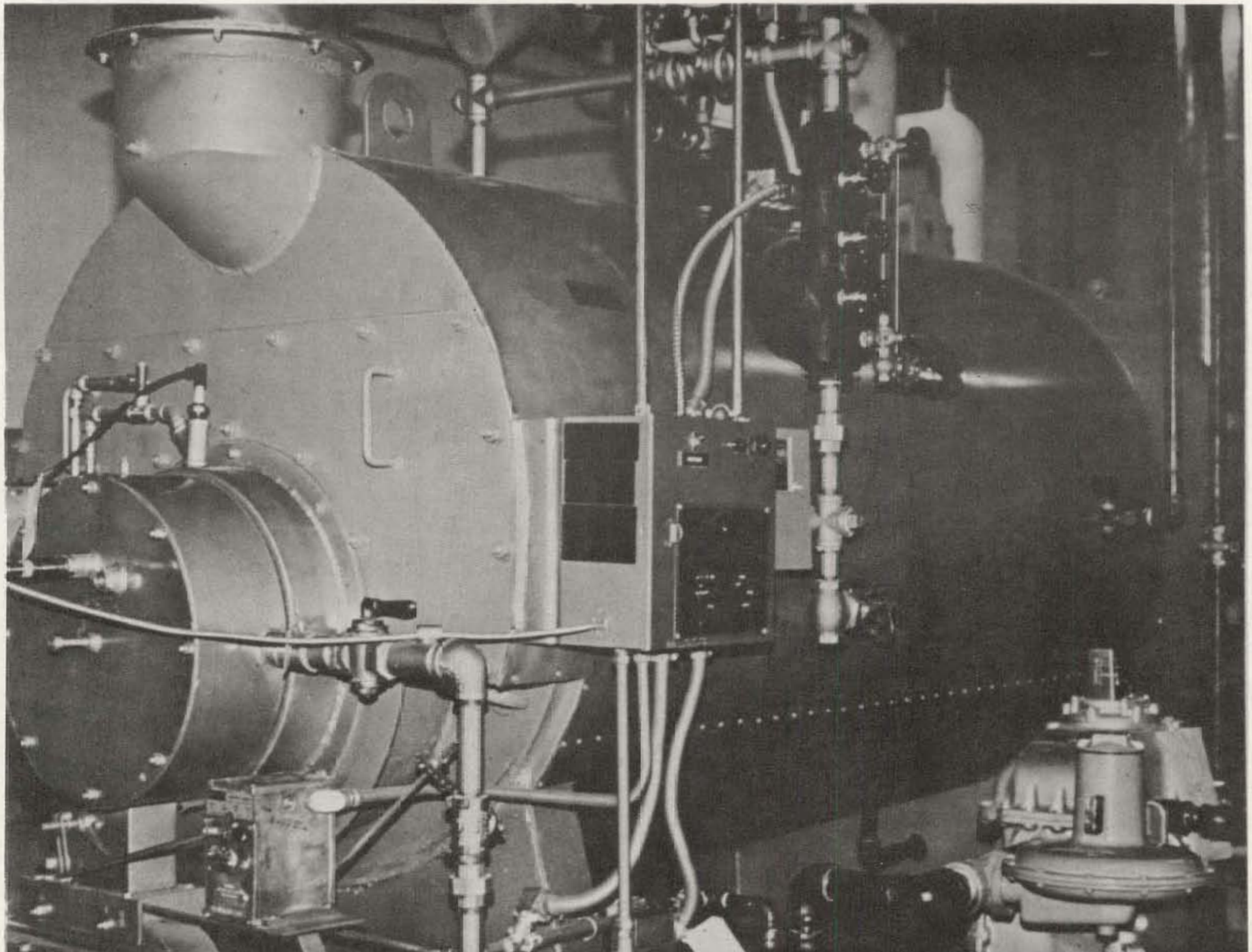


Figure 3.1-2. Boiler and Piping in Bleyle Plant

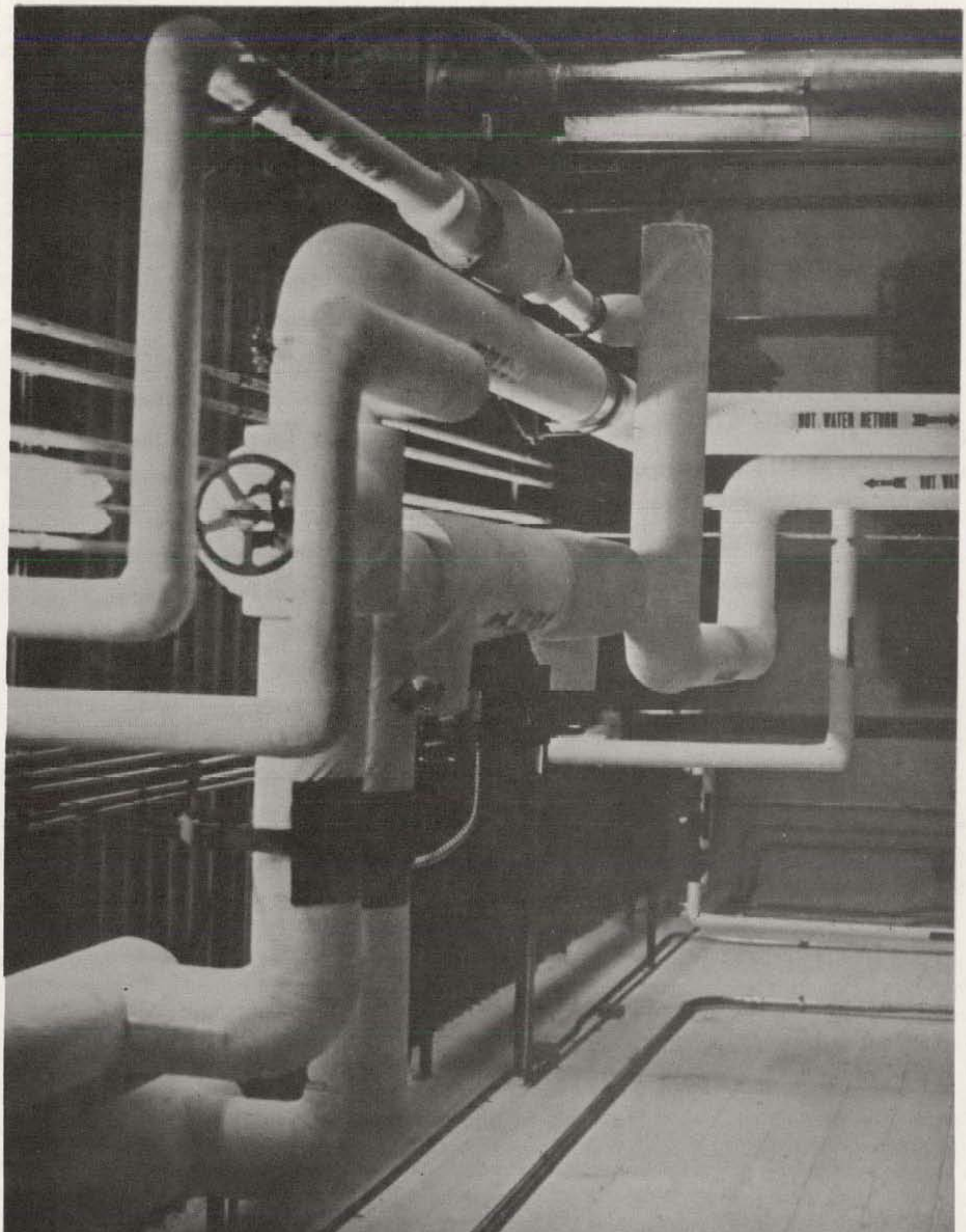


Figure 3.1-3. Piping in Bleyle Plant

At a subsequent meeting, design details of the electrical interface between GPC, STES and Bleyle were discussed. Georgia Power Company furnished General Electric a copy of its power quality requirements and a copy of the single line diagram of the STES Interface and GPC Substation, as well as a descriptive list of items shown on the electrical diagram. General Electric then furnished Georgia Power Company a copy of the G.E. single line diagram, and both were discussed at great length, especially concerning operating philosophies. Both parties agreed that more work was required on the diagrams, and an information exchange was scheduled for the December 16 meeting to finalize the electrical interface drawing.

An inspection of the Interconnection Piping System was conducted at the plant by Georgia Power Company, Mechanical Services, Scott Development, and Bleyle personnel. The System was 98 percent complete in November, with the following work still to be done:

- Installation of gas meters
- Boiler control wiring
- Boiler start-up and check-out

The month of December was noteworthy for activity at the STE-LSE site, with a variety of key milestones being achieved. Following is a list of these milestones:

- December 1 — The knitwear plant was completed and the keys were presented to Bleyle in an official ceremony.

- December 1 — The plant side of the Government-furnished interconnection system for the STES was completed and activated.

- December 16 — The process steam knitwear pressing system was completed to the point of boiler activation.

- December 27 — The interconnection piping system was inspected by Heery & Heery, and the valve operators were wired and operated upon signal from the thermostats. (A small amount of pipe insulation was found to be missing, but MSI was contacted and contractual approval of the system was expected after removal of this deficiency.)

The Bleyle Knitwear Plant initiated operations in January, 1978, by installing and operating sewing machines, presses, and support equipment. Interviews were held with prospective employes, and selected personnel began their training under the direction of Bleyle (Stuttgart) personnel. Expected initial production was planned for February 23, 1978, and a management meeting was held with Bleyle, DOE, Sandia, Shenandoah, General Electric and Site Team personnel at Newnan, Georgia. The G.E. design concept was reviewed for Walt Hensley of Georgia Power Company, and to Ingo Weber-Bleyle.

A site coordination review meeting and tour of the plant was conducted on January 10 for all program participants, and minutes and action required were prepared and transmitted. The preliminary design review was held in Valley Forge, Pennsylvania at the General Electric facility, with the Georgia Power Company Team in attendance. It was agreed at the meeting that the Georgia Power Company Team would do the following:

- Assist in the finalization of civil engineering details, sun rights, and ground cover for site and utility requirements.
- Accelerate and concentrate efforts to provide meteorology data.
- Define transient power requirements for the 25,000 ft^2 Bleyle Plant.
- Specify and begin obtaining instrumentation for the 42,000 ft^2 plant.
- Determine quality of steam required for Bleyle presses.
- Re-evaluate STES electrical protection requirements.
- Provide support to construction planning and total project schedule.
- Finalize a Technology Transfer Program for the site.

Energy usage and cost data for the Bleyle Plant after the incorporation of the energy conservation features were compared with data for a similar plant without the energy-conservation features, and it was found that significant savings in electricity and building heat boiler operation were realized.

Copies of current "sun rights easement" legislation under discussion in the Georgia State governing bodies were made available to project participants to allow them to evaluate the potential impact of the legislation on the STE-LSE. A revised site plan, including an area for a mobile office, was completed and presented to Georgia Power Company. The plan included locations for the trailer, parking area, and a septic field, and showed a sandbag headwall around the culvert under the Meteorology Station road, as well as a new swale south of the Station to correct existing erosion. A local contractor was selected to perform these services and the percolation tests required for the septic field.

The DOE interconnection piping system was approved in January and placed in operation, and plans were made to proceed with the color-coded pipe marking system.

Specific site information was generated during February in preparation for finalization of Lockwood Greene's site plan. Conversations with Shenandoah and Lowe Engineers confirmed that existing contours in the area of Amlajack Boulevard were not available. Because grading of the entire area north of Amlajack Boulevard was decided upon, this information was becoming increasingly important. For that reason, Heery & Heery recommended that a new survey of the area be made. The quality and quantity of this contour information was discussed with Lockwood Greene, and additional information regarding location of utilities around the site was sent to them in the form of Lowe Engineers' drawing, "Record Plan 12, Village South, Land Lots 76, 77, 78, 83 and 84, 6th Land District, Shenandoah, Coweta County, Georgia 8-25-77."

The Bleyle Plant continued startup operations, hiring and training several new employes. Mr. Ingo Weber-Bleyle returned to the plant in mid-February and initiated a plant management change, and a report by General Electric regarding use of solar energy in lower temperature textile processes was transmitted to the new Plant Manager.

On March 1, a major program participation meeting was held at the STE-LSE site in the newly installed and operational mobile Instrumentation and Visitor Facility, shown in Figure 3.1-4. Recommendations were finalized relative to requirements for establishing property transfer from Shenandoah to Georgia Power Company, and arriving at a set of standards for a legal preparation of a solar easement clause. Supporting survey data for HUD were collected as part of the topographical work required to finalize the engineering package for total site grading expected to be completed early in the summer of 1978.

The site and topographical surveys for the STES site were completed during April, and 56 feet of land were added along the east side for green area purposes. Additional property was added to the south side for building and site access purposes. In addition, the point of beginning (POB) was changed to a point along Amlajack Boulevard. The revised property description is illustrated in Figure 2.1-4 of this report.

Site boring and analysis also was completed in April without striking rock. Twelve holes were bored, 8 to 12 feet deep, starting at the east side of the water tower and Amlajack Boulevard. Holes were drilled at 100 ft. intervals in a north-south direction, and at 200 ft. intervals in an east-west direction.

Language for the solar easement covering the terms, exceptions, and enforcement paragraphs was revised. In addition, it was agreed that all property bounded by St. John's Circle, Herring Road, Land Lot line 77/84, and Amlajack Boulevard, excluding the water tower, would be encumbered by the solar easement. However, as some plots within the proposed encumbered area had already been sold by Shenandoah, the easement required concurrence of the additional parties having an interest in the encumbered land.

Heery & Heery continued with activities related to accomplishment of the STE-LSE site work, participating in meetings and supporting GPC in the management and procurement of this work. Heery & Heery suggested to Lockwood Greene two possible grasses for the steep slope areas on the site and two possible energy dissipators for use at the northwest corner point of drainage discharge. Available soil boring data were provided to Georgia Power Company.

An April interface meeting was held in the STES Visitor Center/Instrumentation Trailer, at which Ingo Weber-Bleyle introduced Mr. Andrew Cooper, the new Bleyle Plant Manager. At the meeting, Bleyle indicated that it would provide proposed drawings for the 42,000 $feet^2$ expanded plant, and that a slide show package for Bleyle management in Germany would be useful.

Heery & Heery assisted Georgia Power Company Engineering during May in the preparation of the rough grading bid package, providing additional site information, reviewing specifications, and interfacing with Shenandoah Development, Inc. and local authorities. Copies of the bid package were forwarded to General Electric Company and to Lockwood Greene. Application information for Shenandoah Development, Inc. approval and for a State sediment and erosion control permit was completed.

At a G.E. Phase III design review, updated material related to the STES design was provided. A final draft of the solar easement also was prepared, anticipating that Georgia Power Company could transfer the land and the easement could be signed in conjunction with a planned ground breaking ceremony.

The Technical Project Manager from Sandia reviewed technical progress and problems, noting that the major item of concern was timing of the engineering and procurement cycle for major power switch gear equipment. Discussions were initiated to provide possible solutions.

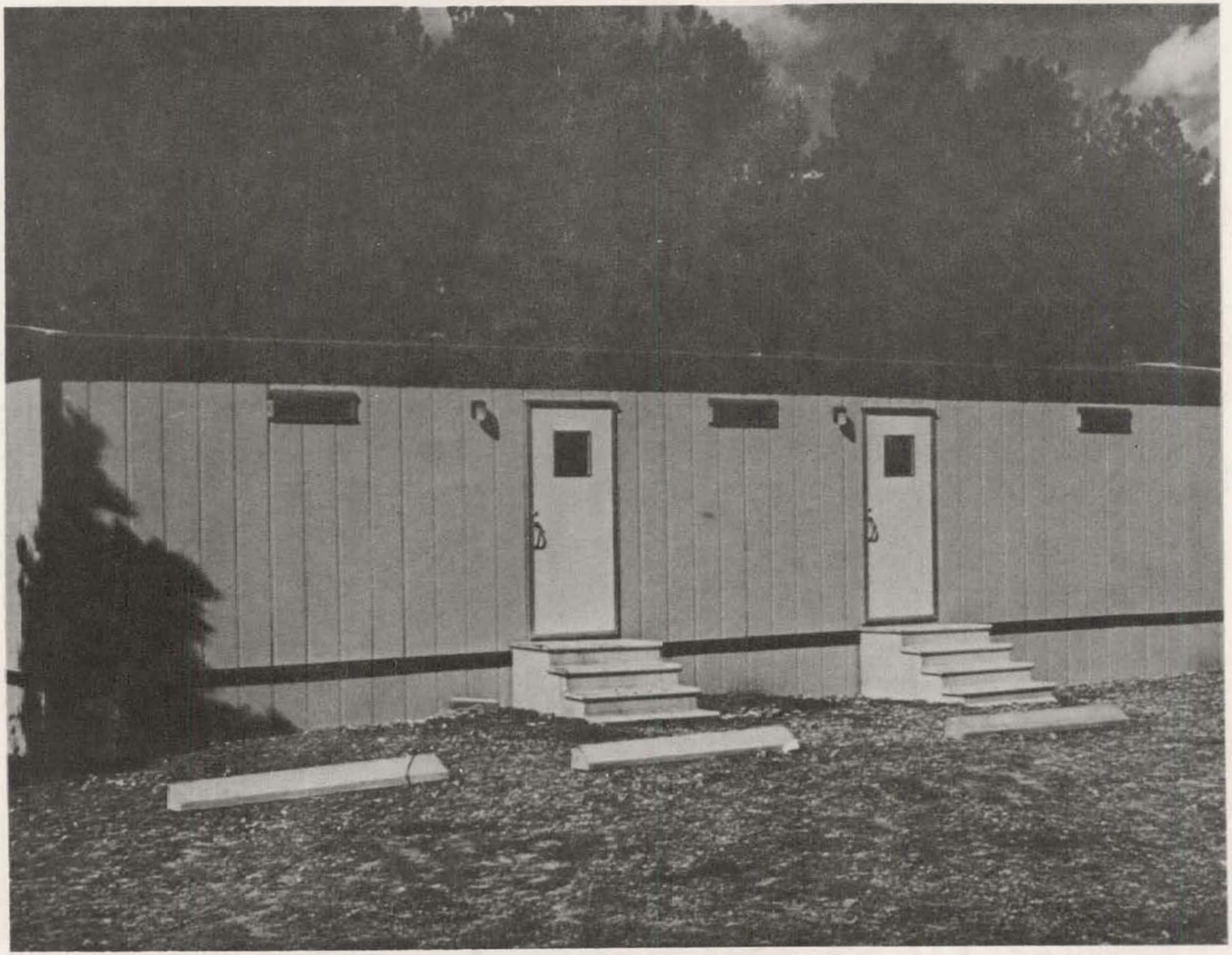


Figure 3.1-4. Mobile Instrumentation and Visitor Center

3.2 METEOROLOGICAL STATION

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 1 September 1977.

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 all required verification, analysis, and copying software were developed and in place at Georgia Tech, it was anticipated that this function would revert to Georgia Tech as soon as the transcription problems with the logger tapes were properly resolved.

The following is a summary of the station operation over the past year, including problems as well as prominent events.

September: The station was operated without incident, but problems were encountered in transcribing the data from the Datal Logger. Due to incompatibility with equipment available at Georgia Tech for transcription of the data, a special reader was ordered. In the meantime the cassette data tapes were accumulated. Georgia Tech personnel visited the site every Monday morning, Wednesday morning and Friday afternoon to collect and replace the data cassettes and maintain the equipment.

October: The temperature/humidity sensor aspirator fan failed, but no major problems were expected with continued operation while a replacement unit was sought. One pyrheliometer was replaced and the original unit shipped to Sandia for recalibration. Still no data was transcribed due to the delay in receiving the cassette reader.

November: An unusually large number of power failures was noted in November, resulting in a significant loss of data. Whereas the data logger continued to operate for up to one hour during the outages, the equitorial drive alignment with the sun was locked. Another pyrheliometer was replaced for recalibration. The Datal reader was further delayed and a December delivery date was promised. In order to permit data transcription for the large number of accumulated cassettes, a spare reader was shipped from EG&G and used to transcribe the data to one-half inch magnetic tape using a Kennedy recorder. At this time irregularities in the data were uncovered, and work began to determine whether the problems lay with the initial tape records or with some aspect of the transcription process.

December: Hardware problems with both the data logger and reader unit continued to prevent Georgia Tech's transcription of the data into a usable form. Since Georgia Tech's reponsibilities did not include hardware development or repair, arrangements were made for EG&G to take over the transcription process until compatible equipment could be made available to Georgia Tech. EG&G used a PDP-11 minicomputer to transfer the first three months of data onto 9-track tape, which they returned to Georgia Tech. Examination of these data at Georgia Tech revealed data irregularities which were determined to result from the Datal logger. EG&G determined that the humidity sensor was malfunctioning, and that most of the humidity data were questionable. In fact the humidity channel often exceeded full scale and cross-talk between this channel and other channels resulted in erroneous readings in other channels. Fortunately, since a number of channels were similarly affected this influence can be removed numerically and the data rehabilitated.

In the meantime Georgia Tech received a grant from DOE to develop a regional solar meteorological research and training site at the main campus with the Shenandoah station instruments serving as a remote rural site. Planning began for the installation of additional instruments and the procurement of a new EG&G logger which would accommodate these additional channels. The new EG&G recorder will also be compatible with the existing equipment at Georgia Tech to provide rapid and accurate data transcription and reduction.

January: EG&G repaired the malfunction in the data logger and the humidity sensor. Work continued on the development of software for rehabilitation of the previous data.

February: The large number of power outages was traced to the nature of the power distribution system in the area, and plans were made to alleviate this difficulty. Georgia Tech continued sending data cassettes directly to EG&G for transcription. EG&G continued to develop necessary software to convert the data into a usable form. Georgia Tech had continued to try to transcribe data using the Datal LPR-16 cassette reader with the Kennedy 9-track magnetic tape recorder. Resolution of the equipment problems would have required an expanded scope of work for Georgia Tech or utilization of EG&G's expertise in the area.

In response to instructions from Sandia, work was stopped at Georgia Tech on the reader interface problem. On February 10, the reader and all recorded cassettes, in addition to two transcribed 9-track tapes and two spare instrument base plates were shipped back to EG&G. A summary station data listing with selected computer plots of solar radiation and temperature measurements for September to December was also provided to EG&G by Georgia Tech for use at the DOE quarterly review in Washington. In addition, on February 27, summary data listings compiled at Georgia Tech, selected computer plots of solar radiation temperature, and SOLMET format data tapes covering station operation from September to December, 1977 were shipped to Sandia. Only this time period was covered because these were the data which EG&G had transcribed onto 9-track tape which Georgia Tech could utilize. Georgia Tech also provided to EG&G the completed data reduction and analysis software which had been developed, since EG&G had indicated that this information would be of value to their continued work in solving the data transcription and reduction problems.

March: The Georgia Power Company made more dependable power available to the site which considerably reduced previous problems of power outages. Plans for adding eight additional instruments to the station as part of the Southeastern Regional Solar Meteorological Research and Training Project at Georgia Tech were forwarded to Sandia. May was established as the target; Georgia Tech is required under contract to have the equipment operating by October, 1978. Georgia Tech continued to collect data cassettes and send them to EG&G by registered mail. Work began on the replacement logger which would provide an additional eight channels and would be compatible with Georgia Tech's equipment which could read the cassettes immediately upon their return from the site. Some of the additional eight channels of information will also be useful for validating the data from the STEP Meteorological Station.

April: No additional electrical problems were encountered. On April 19, it was discovered that excessive mechanical play had developed in the equitorial drive for the pyrheliometers. This was traced to a set screw that had loosened and the assembly was retightened. This may have degraded some of the direct insolation data during early April. Station cassettes and copies of the log book pages continued to be sent to EG&G.

May: It was determined that the new EG&G logger would not be available until late July, later than origianlly anticipated. Georgia Power Company arranged to have power brought from the station to the trailer in order to avoid interruption of data gathering during site grading.

June: Cassettes continued to be collected and sent to EG&G. Georgia Tech arranged to have its personnel on the site daily while grading was underway in order to keep the instruments clean. EG&G reported that their development of software to permit transcription of the data into usable form was 90% complete and should be completed in July. They also anticipated that the new logger would be available late in July, however, a similar unit being developed for IEA will precede the Georgia Tech unit, and the IEA unit would be completed some time in July. The EG&G unit is expected to be vastly superior to the Datal unit in terms of reliability and performance.

Summary: The Government meteorology station was installed with little difficulty and no significant problems have been encountered in maintaining it. Useful data has been collected better than 95% of the time since the station was put into operation. Occasional problems with maintaining pyraheliometer alignment have pointed the desirability of having a pyranometer with a shadow band for diffuse radiation measurements; the measurements of total radiation and diffuse are insensitive to alignment problems and would permit estimation of the direct component during periods when the pyraheliometer was misaligned.

The chronic difficulty in transcribing the cassettes stems from the Datal logger and incompatible readers. Considerable effort outside the original scope of the project was made by Georgia Tech to transcribe the tapes. Because of continuing equipment difficulties, these functions were transferred to EG&G because of their superior hardware expertise. However, EG&G's lack of software for its transcription equipment and its busy schedule have as of early July resulted in a complete lack of data which could be used for analysis. When the new EG&G logger is installed at the meteorological station, Georgia Tech will be able to immediately transcribe and reduce the data to a usable format. At that time, it is anticipated that the tape transcription, verification and distribution functions associated with the station operation will return to Georgia Tech. At the present time, however, since Georgia Tech is unable to transcribe the data and since EG&G has not completed the software it needs to reduce the data, no directly usable data currently exists.

Georgia Tech, under a separate contract to Sandia, has developed a Solar Year Model for Shenandoah using Atlanta solar radiation data. Total horizontal solar radiation values were separated into direct and diffuse components by Aerospace Corporation. This tape is now available in SOLMET format to permit system modelling studies. This contract with Sandia also calls for Georgia Tech to utilize direct solar radiation measurements from the STEP meteorological station to update the Solar Year Model. It is anticipated that these problems will be resolved this summer and that direct solar radiation data for nearly a full year will be available in August.

3.3 INSTRUMENTATION/DATA ACQUISITION

Significant progress was made during August toward finalizing the design requirements and installation steps required to provide data recording for the energy utilization of the Bleyle plant. Plans indicated 32 digital channels of electric usage and 41 analog channels of thermodynamic information, but a recording system had not yet been selected from the three systems being considered.

Due to difficulty in the selection of data recording equipment and thermodynamic sensors, the energy measurement instrumentation program ran slightly behind schedule in September. Doric Systems finally was selected as a supplier, allowing for final selection of the sensors themselves. Electric meters were ordered, a supply requisition for electric systems installation was prepared, and a complete budget was submitted to the Georgia Power Company for the instrumentation program.

The energy measurement program was fully defined by October with the selection of temperature, humidity, flow, and steam pressure data collection points, selection of equipment, and finalization of key measurement function decisions. All thermal and mechanical system instrumentation equipment was ordered from Honeywell for 45 data channels, including necessary engineering and shop drawings, wiring diagrams, and full instructions for installation and calibration for operating personnel. It was decided that Honeywell would coordinate location of instruments with Heery & Heery, and would be responsible for proper operation of the instruments.

Final specifications were outlined for ordering the data recording equipment and tape drive, and Scientific-Atlanta's Optima Division cabinetry. As a follow-up, a Doric representative demonstrated the Doric Digitrend 240, and several revisions were made to the Doric order. A proposal for the Topaz 500 VA uninterruptable power system for the data recorder and tape drive also was initiated.

The only remaining part of the program still to be resolved was the location of the energy monitoring equipment. Proposals were considered for a mobile unit on the site, and verbal agreement was secured from Dieter Franz, Executive Vice-President of Shenandoah Development, to allow location of such a structure on the solar site. Georgia Power Company management showed interest in this plan, since the mobile office could be used to test the Halstead-Mitchell experimental heat pump. Champion Mobile Homes of Ellavile, Georgia was contacted to provide a solar heating system as a test project.

All data acquisition equipment for the Bleyle Plant was on order in November except the AGM signal conditioning module. AGM, Inc. was aware of all requirements, and had the necessary components ready to be delivered within 48 hours.

Georgia Power Company received excellent cooperation from all its equipment manufacturers and their representatives who made every effort to ensure correct shipments. Limited modification of the data recorder specifications was required as a result of redefinition of process loads by Hanno Meier and Stevenson Associates, but the modification presented no significant problems.

It was decided in December that the data acquisition center would indeed be located in a 12 ft. by 50 ft. mobile office, as previously discussed, installed on the west boundary of the STES site, approximately 30 feet south of the meteorology station road. The unit was scheduled to remain in place for two years or until STES construction required that it be moved.

The data base structure design for the energy instrumentation measurement program was completed in December, providing an economical method for access, and minimizing storage space. Specifications were developed for the validation of the data acquired from Shenandoah and for the Management Reporting Analysis. Both validation and Management Reporting specifications were reviewed for final approval before development of the required programs.

By early January, 1978, all data acquisition equipment purchased for the energy measurement system was being manufactured, and the Doric Digitrend 220 Data Logger with tape deck was scheduled to be shipped on January 12, with other related equipment scheduled to arrive during the second or third week of January. The custom-built power meter relay module was completed by the Georgia Power Company Meter Lab, and 90 percent of the meter bases were installed. Figure 3.3-1 illustrates the meter bases and power distribution panel on the north wall of the Bleyle Plant.

Most of the data acquisition equipment, except the AGM Signal Conditioner, was delivered to the GPC meter laboratory in January. Since the AGM required a non-standard three-wire, Form D Contactor, some additional engineering also was required. The Georgia Power Company meter lab shipped the required contactors to AGM for installation. The entire data handling and reporting program was defined and presented by GPC at the Solar Total Energy Project Coordination Meeting.

Discussions with General Electric indicated that a detailed coordination effort between Georgia Power Company and G.E. was required to define system data compatibility and report requirements. Documentation of the data handling program was included in a technical paper presented to the American Institute of Constructors 1978 Forum.

All data equipment was received at the site by February, including AGM signal conditioning devices and most Honeywell equipment. Because of heavy storms in the Northeast, some delay was experienced in shipping of orifice plates, but the delay did not cause a serious scheduling problem. Wiring of the meter relay module was completed, wiring of the AGM rack adapters was in progress, and a test data tape was created to be utilized for software development of the data handling and reporting function. A validation procedure for handling the data base had already been conceptually designed, and awaited the output of the test data tape. A formal presentation of the data handling and reporting scheduled was made at the March 1 Coordination Meeting held at Shenandoah.

All data recording equipment was tested at the Georgia Power Company Central Meter Laboratory during March, with satisfactory results. A test computer tape was generated for 69 data points to be used for validation and management report software development. Some difficulty with recorder and tape drive shutdown was experienced, due to electrical noise and voltage transients on the branch circuit supplying power to the recorder, but installation of an isolation transformer corrected the problem. Figure 3.3-2 illustrates wiring of the relays for the Energy Recording System in the GPC Meter Lab.

Electric power meters were installed on March 29, with the exception of nine units that required major modification by GPC meter technicians. A total of 12 meters had not been built as specified. Since factory correction of the order require 60 days, GPC technicians proceeded to rebuild the meters for use in the Bleyle Plant. All electrical data lines were installed and connected in the Bleyle Plant by March 21, and all recording equipment, signal conditioners, UPS system, and cabinets were delivered and installed in the Shenandoah Data Center on March 29. Figures 3.3-3 and 3.3-4 illustrate the Electrical Transient Test conducted at the Bleyle Plant.

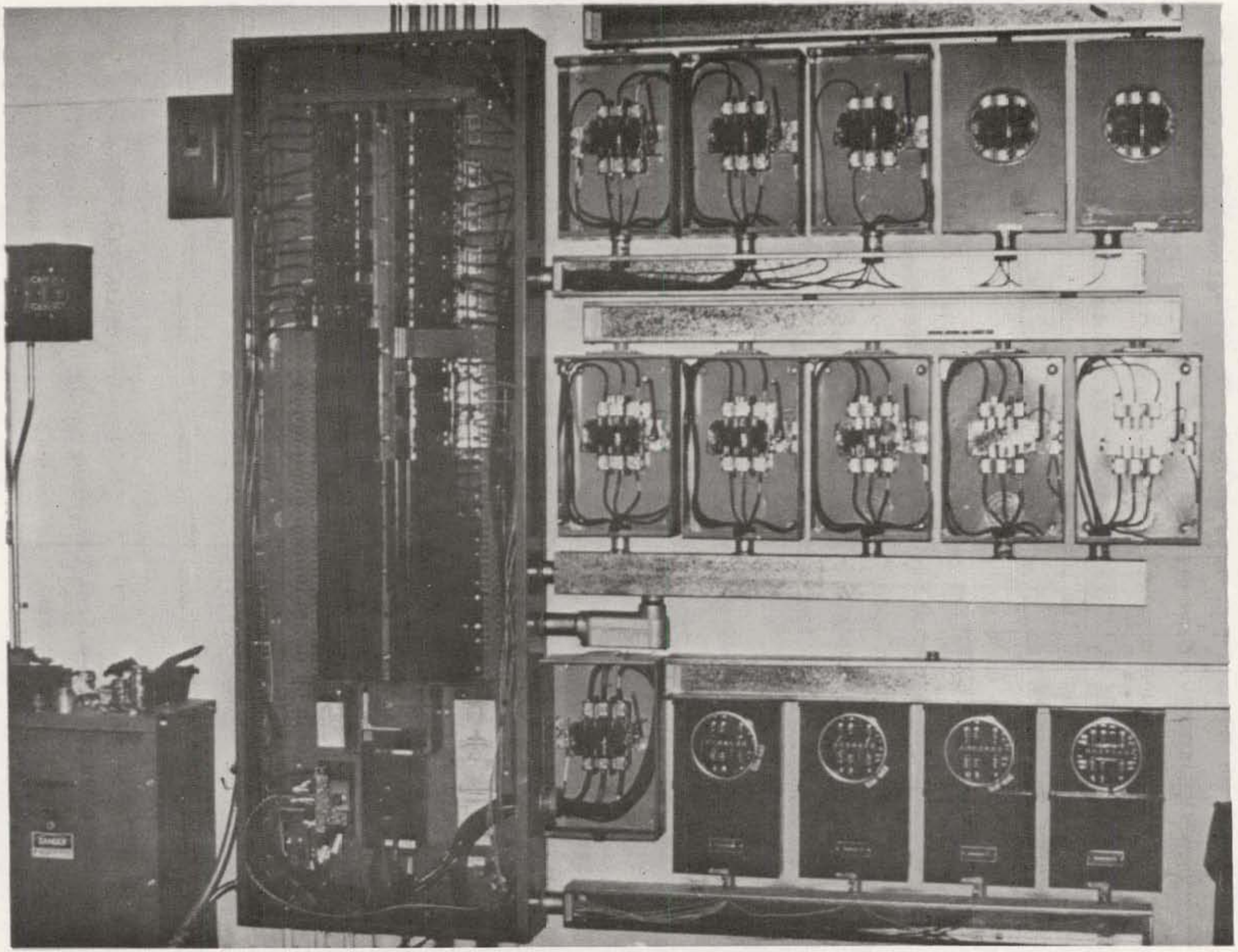


Figure 3.3-1. Electric Power Metering Bases

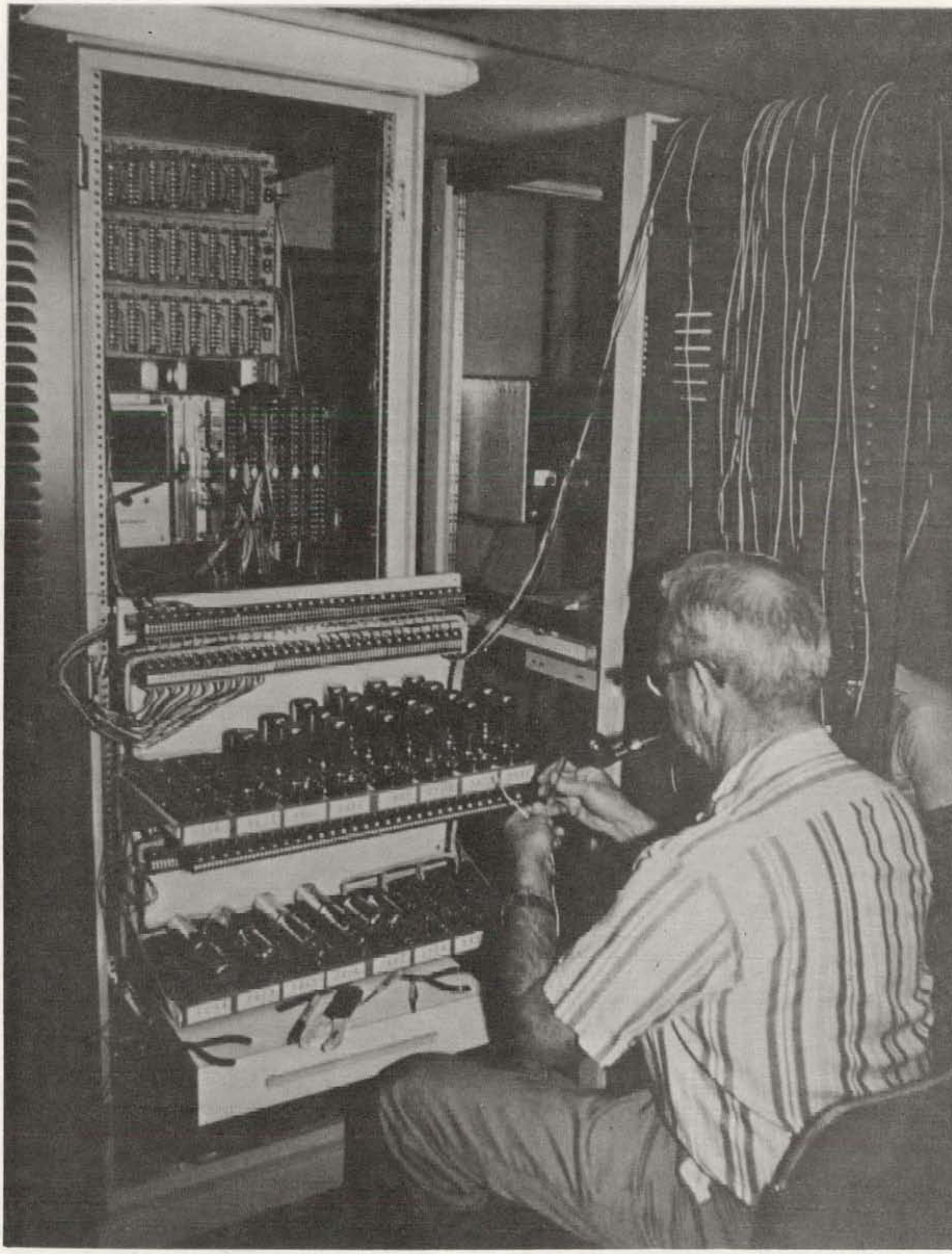


Figure 3.3-2. Wiring of Relays and Energy Recording System

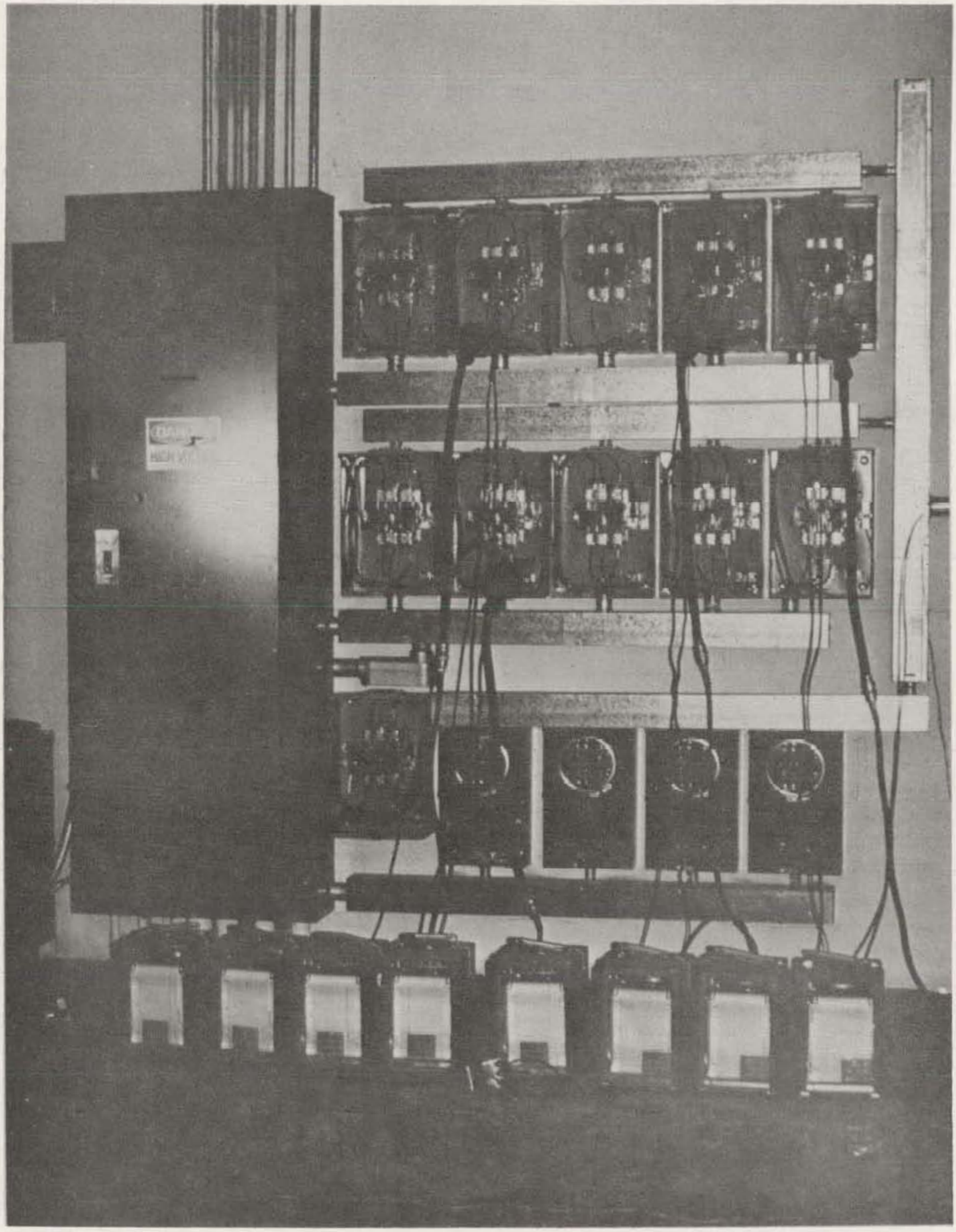


Figure 3.3-3. Electrical Transient Test at Bleyle Plant

Figure 3.3-4. Power Transient Test Current Recorder

70 percent of the water thermocouples were installed in the thermal and mechanical system instrumentation during March, and all flanges and orifice plates were installed for flow measurements (except domestic hot water). Honeywell installers were slowed by the absence of condensate pots and water manifolds lost in shipment, but new components were shipped March 26.

Collection of electrical data was expected to begin on April 6 since the necessity of rebuilding the meters, which required the same technicians needed for wiring the data system, cost 12 man-days of effort. Although this loss of time occurred, meter lab management displayed commendable ingenuity in their efforts.

At a meeting on March 15 between General Electric and Georgia Power Company personnel, various alternatives to the Data Base being supplied to General Electric were discussed. An agreement was reached in which G.E. would accept a monthly tape consisting of 15 minute intervals validated per specifications agreed upon by both G. E. and Georgia Power, and would receive upon request a non-validated version of the monthly data.

The following aspects of the data system also were explored:

- A telephone alarm system to notify Georgia Power personnel when the recording system was inoperative
- An error analysis study to determine the accuracy of collected data
- Calculations involving various channels to be supplied by General Electric
- A description of a data base format on all tapes supplied by Georgia Power Company
- Total system documentation to be supplied by Georgia Power Company

On April 7, a milestone was achieved in the energy measurement program with the first recording of kilowatt hour data. All channels of electric energy measurement were functional except one metering the air dryer. This required complete rebuilding of the single phase meter at the GPC meter lab.

In addition to making the kWh channels active, all 56 thermal sensor devices were installed in the Bleyle Plant. Although 11,000 feet of three-conductor shielded cables were required for power meter recording, 21,000 feet of Type "T" thermocouple wire and about 7500 feet of stranded copper wire were pulled from the thermal measurement sensors to the trailer. This required the installation of four new conduits and the use of a second flange opening into the Bleyle boiler room. Termination and calibration of the thermal, flow, and pressure channels was expected by May 10.

During April, six workdays were lost because of a mishandled order for thermocouple wire by Honeywell. Although another supplier filled the order within four days, additional time was lost in the rescheduling of contractors. Total system installation neared completion early in May, and computer software development was progressing on schedule. Southern Company Services Data Center had no problems in reading and converting test tapes.

All instrument wiring was completed and tested in mid-May, and calibration of thermocouple and flow transmitters was started. Initial results showed acceptable accuracy, with the exception of one T/C that required replacement.

Data collection during May was interrupted a number of times due to instability of the Input/Output circuit board of the Doric 220 recorder, but Doric agreed to send another circuit board as an interim replacement, while one of its technicians field tested the troublesome unit.

3.4 DESIGN INTERFACE

Specific procedures have been defined to address the GPC/DOE interface control drawings which reflect 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 of an item which 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, system switching, etc., as necessary. The interface control drawings addressed herein are between GPC, GE, and SLA involved in the establishment of the STE-LSE, Shenandoah. ICDs will be initiated and released whenever two or more participants have established their first 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. 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 issue drawings as a set only. It was agreed that drawings would be reissued upon receipt of an Electrical Load Distribution drawing from the Bleyle electrical contractor, and that Load Analysis and Requirements would be made a part of the Interface Drawing set, scheduled to be revised and be discussed at a November 30 meeting.

During December, additions and corrections to the Interface Definition and Control Drawings were continuing, and several new drawings were scheduled for release at the January 10 meeting. Change and acceptance procedures were to be resolved at that time. A location drawing of the Georgia Power Company substation for permanent service to Bleyle, a revised loads analysis, and an interface drawing cover sheet and index were distributed to program participants.

At the G.E. design review meeting in Philadelphia (January 25-26), the drawing set included 19 drawings. Several areas were pointed out in which the Georgia Power Company Team would have to provide further development efforts for G.E. These areas included electrical transients and power factors and a further definition of steam quality. The review further emphasized the need to obtain more specifications from Bleyle relative to current requirements and future plans.

The GPC single-line diagram was issued in February to be incorporated into the interface set and was the subject of much discussion between GPC and GE. Further operational procedures were discussed, agreed upon, and initiated relative to drawing approval. Complete sets were issued to all parties on February 8 and a sign-off sheet was circulated to formalize acceptance and change procedures.

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

Drawings T-1 and T-2 were newly issued with the sign-off set, but all parties were instructed to disregard these drawings, as they were to be reissued as comment items following complete sign-off of the interface set.

Answers continued to be generated during March in response to action items from January and February meetings. Research on steam quality, both chemical and thermodynamic, yielded little useful information, but data on natural conditions at Shenandoah (seismic, snow, wind, flood, lightning, and hail) were provided to G.E. This information was not to be incorporated into the set. Original source material also was sent to G.E. for confirmation.

Many trips continued to be made to Shenandoah to update information as the Bleyle plant became fully operational. Interface Control culminated with an Interface Control Working Group meeting at Valley Forge, March 24. SLA, GE, LG and H&H participated in a productive day-long meeting. Additional drawings were signed off, a list of ICALS was generated, and new drawings, to be issued for comment, were discussed. Operational procedures for development of the drawing set were definitively set down in "Operational Interface Control Drawing Procedures for STE-LSE, Shenandoah," available earlier in the month. This document established CDDR's (Coordinated Design Data Required), several of which were incorporated into the drawing set by the March 24 Interface Control and Working Group Meeting at Valley Forge.

Drawings S-4, A-1, A-3, MS-1, M-1, M-2, M-3, M-3a, M-5, E-3 and E-4 were issued. The Heery & Heery proprietary notice was removed, and all drawings were provided to Sandia and to G.E. as reproducible sepias. Comment Issues T-1, T-2, T-3 and E-5 were re-issued April 25, for review by all parties, as was an updated Loads Analysis and Requirements. The most recent Interface Control Working Group Meeting was held following the GE design review in Albuquerque, May 1. Additional drawings were reviewed and signed-off, and the mechanics of signing-off CDDR's and of reissuing already signed off drawings was discussed. March 24 and May 1 were established as issue dates for drawings signed-off on those respective dates. This avoided having to reconstruct changes made to drawings prior to their actual sign-off in the way of ICAL's and CDDR's. Instrumentation drawings were scheduled to be re-issued following completion of installation. CDDR Status Lists are to be issued for each drawing category.

A complete set of interface drawings, the result of seven iterations, is contained in this report as Appendix B. These drawings represent the results of one of the most intense efforts in the program to date.

3.5 INFORMATION DISSEMINATION

An executive briefing document was prepared in August, 1977 and used in various staff meetings. The material was also used for other technology information dissemination presentations for Georgia Power Company and local community organizations.

Technology dissemination efforts were significant during September, especially during the DOE Concentrating Collector Conference held at Georgia Tech. More than 170 people toured the Shenandoah STE-LSE site and were given a briefing on major program facets. In addition, the following visitors were accommodated:

- Florida Power Corporation
- Sverdrup and Parcel, A&E
- Fort Hood Management
- ATU Science Personnel
- Westinghouse AESD and WRL
- Dr. H. Marvin
- J. Rannels

A first draft of a Technology Transfer and Information Dissemination Program Plan was prepared, and submitted in October to Sandia and DOE for review and comments. Interim efforts in information dissemination continued on a regular basis, however, with several tours being conducted and many presentations being made to a wide variety of noteworthy visitors to the Shenandoah Site. Included among those receiving briefings during October were:

William Croft	—	Marketing Vice President for Heery & Heery, Inc.
Robert Cole	—	Solar Project Manager, General Electric
C. Brusalis	—	U. S. Department of Housing and Urban Development
J. Cordova and	—	GPC, Valdosta District Management
G. Brandvold	—	Sandia Advanced Energy Projects Department
G. Rhodes	—	Department of Energy
Japanese Industries	—	(See below)

At the request of the U. S. Department of Commerce, Georgia Power Company personnel gave a slide presentation and Bleyle Plant tour to 40 members of the Energy Conservation Committee representing the Japanese Government. Included in this group were members of the Japanese Government's Energy Office and representatives of industry and utilities. English-to-Japanese translation was furnished by the U. S. Government.

It was decided in November that Heery & Heery and Georgia Power Company would write a technical paper on the energy conservation aspects of the Bleyle Knitwear Facility, and the first draft was prepared. Continued public, industrial and commercial interest in the program was exhibited through numerous requests for information and presentations. Major information dissemination efforts in November included the following:

- Drew Associates For Westinghouse Electric Corporation TV Advertising
- U. S. News and World Report For December 1977 Energy Issue
- Public Service of New Mexico Energy Information Exchange
- Newnan, Georgia Kiwanis Club Public Forum
- Los Alamos Scientific Laboratary Energy Information Exchange
- State of Georgia Energy Office Industrial Advisory Committee
- Stephenson Associates, Mechanical Engineers and Contractors
- Sizemore Associates, Architecture Planning and Programming

Interviews were held in December with Newsweek and with U. S. News and World Report for the January 2, 1978 Issue, and the Shenandoah Solar Total Energy Project was described in Southern Living, a regional publication.

The STES Model was displayed at Dalton (Georgia) Junior College for an Energy and Textile Economics Seminar. Featured speakers included the Honorable George Busbee, Governor of Georgia, and Edgar L. Jenkins, U. S. Representative from the 9th Congressional District of Georgia.

Georgia Power Company Team members spoke at the December 12 meeting of the Institute of Electrical and Electronics Engineers (IEEE). The slide presentation they used emphasized the DOE Solar Total Energy Program, the LSE at Shenandoah, and particularly Energy Conservation Features of the Bleyle Plant.

Numerous discussions were held with personnel attending the Miami International Conference on Alternative Energy Sources and 200 brochures were distributed. Project personnel also presented programmatic material and guided tours on the STE-LSE to approximately 200 persons attending the DOE-sponsored Professional Introduction to Solar Power Conference at Shenandoah. Inquiries from several Industries regarding business opportunities relative to the Project were either answered or forwarded to the design team.

A GPC technical paper entitled "Energy Measurement and Data Management Program - Solar Total Energy Large Scale Experiment, Shenandoah, Georgia" was written and presented in January as part of a three-hour symposium at the American Institute of Constructors 1978 Forum in Lake Buena Vista, Florida. The paper documents the energy measurement program to date, and was written as part of the system documentation of the program.

Heery & Heery also presented a technical paper, "A Case Study of Shenandoah Conservation Features in Connection with Solar Total Energy - Large Scale Experiment Performed Under Cooperative Agreement No. EG-77-A-04-3994 between United States Department of Energy and Georgia Power Company." This paper was well received and generated discussion. 20 requests for copies were received and acknowledged.

Other activities included presentations to the Rotary Clubs of Cuthbert and Dawson, Georgia. Subsequent discussions at these meetings revealed considerable interest in the Williard and Gila Bend irrigation projects, and requested literature was furnished. General Electric press releases relative to the design contract were distributed to Georgia Power Company Team members.

The following activities took place in February toward the installation of the DOE/GPC Data and Visitors Center and the completion of the data acquisition system:

- The site was graded in accordance with the Heery & Heery site and drainage plan.
- The gravel road and culvert were reconstructed, including expansion of the visitors parking area and automobile turn around.
- The mobile office unit was delivered and installed, including blocking, tie-down and skirting, and all utility services, including the data line conduits from the Bleyle Plant.

The Technology Transfer Program was in the final stages of discussion, and approval was expected to be part of a change order to Georgia Power, which would include other management, operational and reporting requirements. Meanwhile, information dissemination activities included:

- Tour of STES and Shenandoah for GPC Executive Management
- Presentation to College Park, Georgia, Old National Highway Businessmen's Association
- Presentation on Bleyle Plant energy conservation to Dr. Paul Eaton's Life Enrichment Services (educational program for retirees)
- Presentation to Atlanta's DOE Public Affairs Office
- STES project status presentation to Atlanta's local ASHRE Monthly Meeting
- Presentations to various industrial and architectural firms interested in STES
- A Newnan Times Herald interview with Mr. Ingo Weber-Bleyle
- Assessment by Shenandoah relative to the press exposure from the Spring and Summer of 1977

The Georgia Power Company Team participated in a project display at "Solar Outlook, The National Conference on Solar Energy" in Washington, D. C., March 10-12. Questions were answered informally around a display booth, and project brochures were distributed. Plastic laminated 20" x 30" display cards were provided. Military personnel, along with personnel from DOE and OMB, spent considerable time at the booth inquiring about the cost and status of the STES.

The original STES model was displayed at the Shenandoah Recreation Center in conjunction with an industrial development "Red Carpet Tour" on April 5th.

A slide presentation was given at the Georgia Institute of Technology to a Short Course in Solar Heating and Cooling for Homes and Buildings.

New STES model and DOE/STES signs were displayed at the newly furnished Visitor Center and Instrumentation Trailer. Team personnel supported preparation for "SUN DAY" displays in the Georgia Power Company lobby.

Highlights of site and design progress were presented to the Georgia Tech student chapter of ASHRAE on May 4, and highlights of STES progress were presented to the Rates & Research Department of Georgia Power Company. Rewriting of a technical paper on energy measurement at Shenandoah was begun.

The STES model and slide show was displayed in the Georgia Power Company lobby during the week of "sun day," and six other significant presentations were made. During the first year of the Cooperative Agreement, even without a formal Technology Transfer Office, more than 50 tours and presentations were conducted relative to activities at the Shenandoah Site.

4.0 ANTICIPATED SECOND YEAR PROGRESS

During the coming contract year, site and application development will continue, as will energy data acquisition and analysis, recording and interpretation of weather data, and information dissemination. Grading efforts on the STES site are expected to be underway early in the summer of 1978, and signing of the Solar Easement Agreement (Appendix A) and property transfer from Shenandoah Development, Inc. to the Georgia Power Company is expected at about the same time. The addition of a Technology Transfer Office to maintain a full-scale Information Dissemination Program is also planned for 1978-79. Final Utility Interface Definition, scheduled to begin at the end of July, 1978 should be completed by mid-December. Operation of the Government-owned Meteorology Station will continue throughout the year.

APPENDIX A

SOLAR EASEMENT AGREEMENT

(Provided for Information Only)

APPENDIX A: SOLAR EASEMENT AGREEMENT

Article IV of the Shenandoah Site Cooperative Agreement states that "the participant shall obtain comments, acceptable to the ERDA which provide an unobstructed view of the sun from any and all points within the STES Site, excepting only obstruction existing on the effective date of this agreement."

In August of 1977, Georgia Tech personnel made an assessment and established a method of quantifying the effort of shadows on the STES Collector field by Future Structures which may be built on nearby properties.

In November of 1977, General Electric personnel summarized the work of Georgia Tech into a table that showed minimum setback and maximum building height on property adjacent to the STES Field. Minimum setback is defined as the closest distance between the proposed structure and a point on the perimeter of the solar field, and maximum height is defined as the highest point of the proposed structure above the solar field reference height of 944 feet.

On March 1, 1978 during a major program participation meeting, G.E. personnel were assigned an Action Item to define the solar easement requirements in terms conventionally employed by surveyors. This meant that specific height restrictions would appear as straight lines on a contour site plan and be referenced to straight lines defined from a reference point in terms of absolute angles from north.

In April, 1978 the G.E. work was further refined to eliminate the use of complex equations to determine the setback distance from the reference lines. The complex equations were reduced to a simple series of consecutive height restrictions, depending upon the setback distance of a proposed improvement.

During May, the Solar Easement Agreement was modified several times to clarify several of the paragraphs and to provide language acceptable to the parties involved. A draft of the Agreement is included here with current wording, defining the parties who will have to approve or consent to the easement.

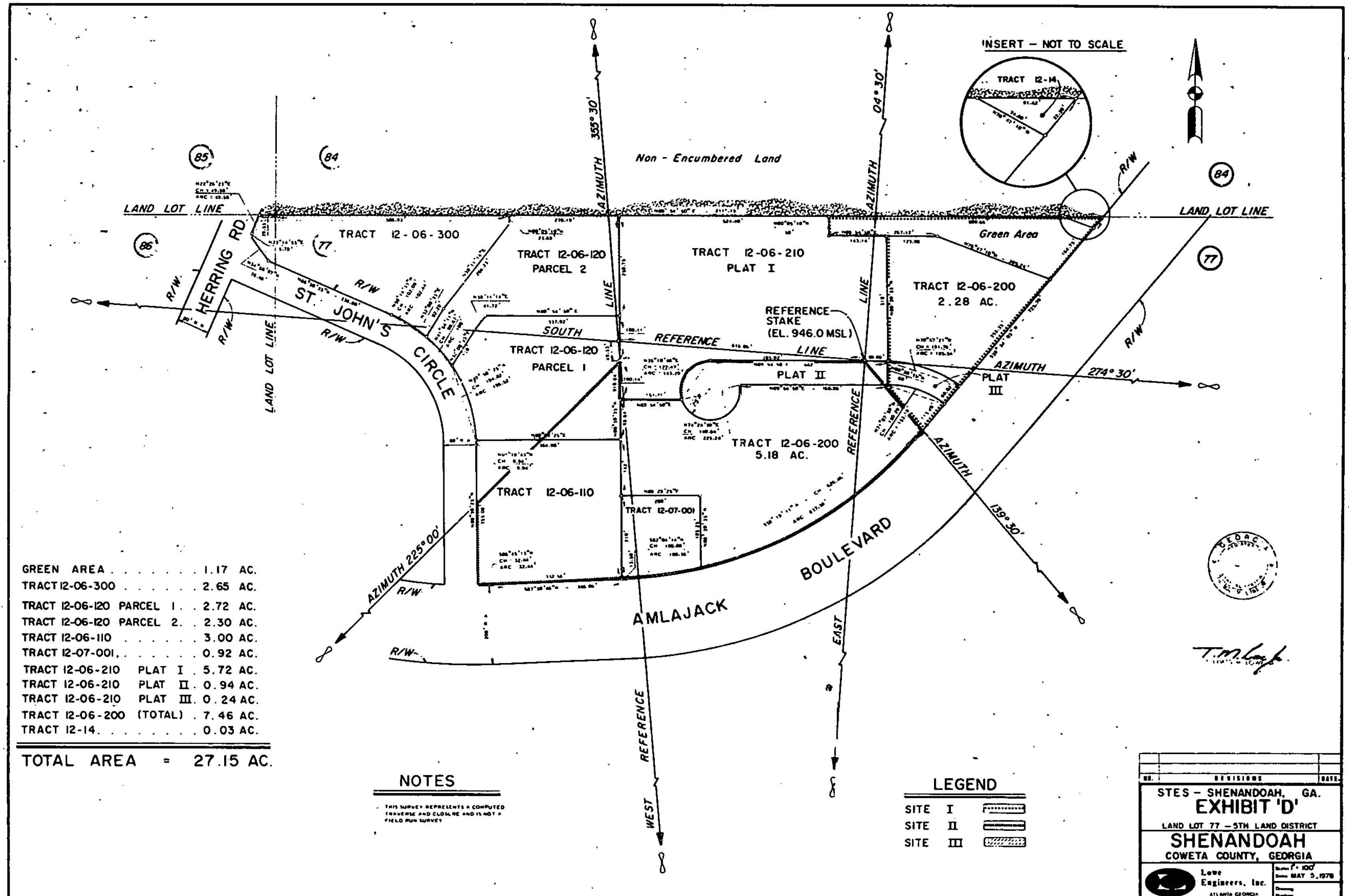

Exhibit D from Solar Easement Package

STATE OF GEORGIA; COUNTY OF FULTON; MAY 10, 1978

THIS SOLAR EASEMENT AGREEMENT (hereinafter referred to as the "Agreement"), made and entered into as of the ______ day of ______, 1978, by and among SHENANDOAH, LTD., a Georgia Limited Partnership, acting by and through its Sole Corporate General Partner, Shenandoah Development, Inc., a Georgia corporation (herein called "Shenandoah"), Development Authority of Coweta County (herein called "Authority"), D. SCOTT HUDGENS, JR., and HERMAN J. RUSSELL doing business as HUDGENS-RUSSELL JOINT VENTURE, NO. 1 (herein called "Hudgens-Russell"), BLEYLE OF AMERICA, INC., a Georgia corporation (herein called "Bleyle"), and GEORGIA POWER COMPANY, a Georgia corporation (herein called "Georgia Power").

W I T N E S S E T H :

WHEREAS, Shenandoah has this date, simultaneously with the execution of this Agreement, sold to Georgia Power, and Georgia Power has purchased from Shenandoah, all that tract or parcel of land lying and being in Land Lot 77, of the 5th District, Coweta County, Georgia, being more particularly described on Exhibit "A" attached hereto and made a part hereof, and shown as "Plat I-5.72 acres" on survey prepared for Georgia Power Co. by Lowe Engineers, Inc., dated March 24, 1978, and last revised ________, 1978, said survey being attached hereto as Exhibit "B" and made a part hereof, (said land being herein called the "Georgia Power Land"); and

WHEREAS, Shenandoah is the owner of fee simple title to certain land adjacent to or near the Georgia Power Land and more particularly described on Exhibit "C" attached hereto and made a part hereof, and shown on Exhibit "D" hereof less and except those parcels of land marked "Out" thereof (said land being herein called the "Shenandoah Land"); and

WHEREAS, Authority is the owner of certain land adjacent to the Georgia Power Land and more particularly described on Exhibit "E" attached hereto and made a part hereof, and shown on Exhibit "D" hereof as "12-06-120 - Parcel 1", (said land being herein called the "Authority Land"); and

WHEREAS, Authority has leased the Authority Land to Hudgens-Russell by Lease Agreement dated as of November 15, 1977, recorded in Deed Book 283, Page __, Clerk's Office, Superior Court of Coweta County, Georgia; and

WHEREAS, Bleyle is a subtenant of the Authority Land by Lease dated May 17, 1977, recorded in Deed Book 280, Page 351, aforesaid records, the landlord's rights under such Lease having been assigned to Hudgens-Russell; and

WHEREAS, solar collection and energy conversion equipment is intended to be installed on the Georgia Power Land for the purpose of converting solar energy into thermal energy; and

WHEREAS, continued access to sunlight and sun rays over and across the Encumbered Land and the Authority Land is necessary to accomplish the foregoing purpose; and

WHEREAS, Georgia Power wishes to obtain from the remaining parties hereof and such remaining parties hereof are willing to grant to Georgia Power an easement for the uninterrupted passage of sunlight and sun rays over and across the Encumbered Land and the Authority Land to the extent and subject to the terms and conditions set forth herein.

NOW, THEREFORE, in consideration of the purchase of the Georgia Power Land by Georgia Power from Shenandoah, the mutual covenants and agreements hereinafter set forth, the sum of $10.00 in hand paid by Georgia Power to Shenandoah, Authority, Hudgens-Russell and Bleyle, and each of them, at and before the sealing and delivery of these presents, and for other good and valuable consideration, the receipt, adequacy and sufficiency of which are hereby expressly acknowledged by Shenandoah, Authority, Hudgens-Russell and Bleyle, and each of them, the parties hereto hereby mutually covenant and agree as follows:

1. DEFINITIONS.

For purposes of this Agreement, the following definitions shall apply:

A. "South Reference Line" — shall mean that certain line identified as such and depicted on Exhibit "D" attached hereto and made a part hereof.

B. "East Reference Line" — shall mean that certain line identified as such and depicted on Exhibit "D" attached hereto and made a part hereof.

C. "West Reference Line" — shall mean that certain line identified as such and depicted on Exhibit "D" attached hereto and made a part hereof.

D. "Easement Areas" — "Easement Area I", "Easement Area II", and "Easement Area III" mean the areas identified as such and depicted on Exhibit "D" attached hereto and made a part hereof.

E. "Appropriate Reference Line" — shall mean the reference line to be used in calculating the "Allowed Maximum Height" (as that term is hereinafter defined) of any buiding, improvement, construction, built-up ground, tree or other vegetation (herein called the "Improvement") located or to be located on the Encumbered Land or the Authority Land. If the Improvement is or is to be located in Easement Area I, the Appropriate Reference Line is the East Reference Line. If the Improvement is or is to be located in Easement Area II, the Appropriate Reference Line is the South Reference Line. If the Improvement is or is to be located in Easement Area III, the Appropriate Reference Line is the West Reference Line.

F. "Allowed Maximum Height" — shall mean the maximum height in feet above mean sea level (as determined by means of a U.S. Geodetic Survey) of buildings, improvements, construction, built-up ground, trees and other vegetation on the Encumbered Land and on the Authority Land, which can be built or allowed to grow without violation of this Agreement. The Allowed Maximum Height for any improvement is determined in accordance with Paragraph 5 hereof, which takes into consideration certain factors including the distance of any such Improvement from the Appropriate Reference Line.

G. "Easement Air Space" — shall mean all air space above the Allowed Maximum height.

2. GRANT OF SOLAR EASEMENT.

Shenandoah does hereby establish, give, grant and convey to Georgia Power, its successors, successors-in-title and assigns, an easement over, across and through the Easement Air Space and all portions thereof over and above the Shenandoah Land for the free and uninterrupted passage of direct sunlight and sun rays for the benefit of the Georgia Power Land and any improvement now or hereafter thereon. Authority, Hudgens-Russell and Bleyle do hereby establish, give, grant and convey to Georgia Power, its successors, successors-in-title and assigns, an easement over, across and through the Easement Air Space and all portions thereof over and above the Authority Land for the free and uninterrupted passage of direct sunlight and sun rays for the benefit of the Georgia Power Land and any improvements now or hereafter thereon. For purposes of this Agreement, these easements shall herein be called the "Solar Easements".

3. PURPOSE OF SOLAR EASEMENTS.

The Solar Easements granted hereunder shall be solely for the purpose of permitting the free and uninterrupted passage of sunlight and sun rays so that the energy therein may be collected on the Georgia Power Land; provided, however, that the Solar Easements granted hereunder may not be used in connection with the bio-conversion of solar energy.

4. NON-INTERFERENCE WITH SOLAR EASEMENTS.

Shenandoah, Authority, Hudgens-Russell and Bleyle, jointly and severally agree that neither they nor their assigns or successors-in-title, shall in any way cause or permit an obstruction, reduction, deflection or shading of sunlight and sun rays flowing, passing over, across or through the Easement Air Space over their respective lands except as may be caused by the following (herein called the "Permitted Exceptions"):

A. Improvements now or hereafter located on the Shenandoah Land or the Authority Land, which do not exceed the Allowed Maximum Height (except as is permitted in Paragraph 8 hereof);

B. Trees and other vegetation now or hereafter located on the Shenandoah Land or the Authority Land, which do not exceed the Allowed Maximum Height (except as is permitted in Paragraph 8 hereof); and

C. Clouds, rain, fog, haze, smoke, steam or other similar conditions over which Shenandoah, Authority, Hudgens-Russell and Bleyle and their assignees have no control;

Provided, however, the Permitted Exceptions shall not include any height additions to the improvements described in subparagraph 4 A. above or any additional height growth to the trees or other vegetation described in subparagraph 4 B. above into the Easement Air Space.

5. ALLOWED MAXIMUM HEIGHT.

For purposes of determining the Allowed Maximum Height, the Base Height of the East Reference Line shall be 946 feet above sea level; the Base Height of the South Reference Line shall be 946 feet above sea level; and the Base Height of the West Reference Line shall be 953 feet above sea level.

In order to determine the Allowed Maximum Height of any portion of any building, improvement, construction, built-up ground, trees or other vegetation on the Shenandoah Land or the Authority Land, first determine the horizontal distance in feet (herein called the "Set Back Distance" or "SBD") from that portion of the Improvement whose height is being determined to the Appropriate Reference Line, as measured along a line perpendicular to the Appropriate Reference Line from that portion of the Improvement whose height is being determined. Then:

A. If the SBD is 100 feet or less, the Allowed Maximum Height shall be the Base Height of the Appropriate Reference Line plus thirty percent (30%) of the SBD.

B. If the SBD is greater than 100 feet, but less than 300 feet, the Allowed Maximum height shall be the Base Height of the Appropriate Reference Line plus thirty (30) feet plus fifteen percent (15%) of the SBD that is greater than 100 feet.

C. If the SBD is greater than 300 feet, the Allowed Maximum Height shall be the Base Height of the Appropriate Reference Line plus sixty (60) feet plus ten percent (10%) of the SBD that is greater than 300 feet.

6. NON-EXCLUSIVE EASEMENT.

The Solar Easements herein granted are non-exclusive easements in that all parties hereto and their successors and assigns can also use and enjoy the sunlight and sun rays in the Easement Air Space above their respective lands, but such right to use this sunlight and sun rays does not permit Shenandoah, Authority, Hudgens-Russell or Bleyle, their successors or assigns to shade, deflect or prevent Georgia Power's access to sunlight and sun rays over, across and through the Easement Air Space for the purposes set forth herein.

7. TERM.

The term of this Solar Easement Agreement shall be from the date hereof through June 14, 1987, and continuing thereafter until such time as the Georgia Power Land, or improvements now or hereafter constructed thereon, shall not, for a period of twelve (12) consecutive months, be used to collect sunlight, sun rays or solar energy for the purpose of converting solar energy into thermal energy.

8. EXCEPTIONS TO SOLAR EASEMENTS.

Anything provided hereto the contrary notwithstanding, Shenandoah, Authority, Hudgens-Russell, Bleyle and their successors or assigns shall not be prohibited from building or allowing any Improvement on the Shenandoah Land or the Authority Land which exceeds the Allowed Maximum Height of such Improvement if such Improvement, together with all other Improvements on the Shenandoah Land and the Authority Land, will in fact not cause, durino any portion of any day, an obstruction, reduction, deflection or shading of sunlight and sun rays on more than one foot in total width across any consecutive 100 feet in width, measured along the western, southern or eastern property line of the Georgia Power Land. To illustrate: a pole on the Shenendoah Land casting a shadow of 6 inches in width on the western boundary line of the Georgia Power Land and a pole on the Authority Land casting a shadow of 7 inches in width on said western boundary line would be in violation of this exception if such shadows were within 100 feet of each other.

9. AMENDMENTS.

The Solar Easements granted hereunder and all rights, and interests, set forth in this Agreement may be altered, amended, modified, cancelled or terminated only by means of an instrument executed solely by all parties hereto or their respective successors and assigns.

10. WARRANTIES.

Shenandoah does hereby warrant its fee simple title to the Shenandoah Land and its right, power and capacity to create and convey the Solar Easements granted hereunder by it and to execute this Agreement.
Authority does hereby warrant its fee simple title to the Authority Land and Hudgens-Russell and Bleyle do hereby warrant their leasehold interests in the Authority Land, and all such parties do hereby warrant their right, power and capacity to create and convey the Solar Easements granted hereunder by them and to execute this Agreement.

11. RIGHTS OF SUCCESSORS.

This Agreement shall insure to the benefit of, and shall be binding upon, the parties hereto and their respective successors and assigns.

12. RUNNING WITH THE LAND.

This Agreement shall run with the land and shall be binding upon and encumber the Shenandoah Land and the Authority Land until terminated pursuant to the terms hereof.

13. ENFORCEMENT.

Violation or breach of any agreement or covenant herein contained shall give Georgia Power, its successors and assignees, the right, without notice, to prosecute a proceeding at law or in equity against any person or entity who has violated or is attempting to violate or is building any Improvement which will violate any provision hereof, and to enjoin or prevent them from doing so, or to cause said violation to be remedied, or to recover damages for such violation.

Any failure of Georgia Power to enforce any covenant or agreement herein contained shall in no event be deemed to be a waiver of its right to do so thereafter, nor of its right to enforce any other covenant or agreement hereof. All remedies provided for herein or at law or in equity shall be cumulative and not exclusive.

14. LIABILITY.

No covenants, stipulations, obligations or agreements of Shenandoah, Ltd., acting by and through Shenandoah Development, Inc. shall be deemed to be the covenants, stipulations, obligations or agreements of any partner, general or limited, of Shenandoah, Ltd. or officer or director of Shenandoah Development, Inc. in such officer's or director's individual capacity, nor shall any covenants, stipulations, obligations or agreements of Shenandoah, Ltd. be binding upon or create a liability of any individual general partner or any limited partner of Shenandoah, Ltd. except to the extent of such individual general partner's or such limited partner's interest in such partnership.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed and sealed the day and year first above written.

Signed, sealed and delivered in the presence of:

____
Witness

____
Notary Public

____
Witness

____
Notary Public

____
Witness

____
Notary Public

____
Witness

____
Notary Public

SHENANDOAH, LTD., acting by and through its Sole Corporate General Partner, Shenandoah Development, Inc.

By: ____________________
Dieter Franz, Chief Executive Officer/General Manager

DEVELOPMENT AUTHORITY OF COWETA COUNTY

By: ____________________

D. SCOTT HUDGENS, JR. and HERMAN J. RUSSELL d/b/a HUDGENS-RUSSELL JOINT VENTURE, NO. L

By: ____________________
D. Scott Hudgens, Jr.

By: ____________________
Herman J. Russell

Signed, sealed and delivered in the presence of:

____
Witness

____
Notary Public

GEORGIA POWER COMPANY

By: ____________________

Its: ____________________

(CORPORATE SEAL)

APPROVED, JOINED AND CONSENTED TO by THE FIRST NATIONAL BANK OF ATLANTA, as Trustee under that certain Indenture and Deed of Trust dated as of March 15, 1974, recorded in Deed Book , page 333, Coweta County, Georgia Records.

Signed, sealed and delivered in the presence of:

____
Witness

____
Notary Public

THE FIRST NATIONAL BANK OF ATLANTA, as Trustee

By: _______________________________
Trust Officer

(Attach Seal)

APPROVED, JOINED IN AND CONSENTED TO by DECATUR FEDERAL SAVINGS AND LOAN ASSOCIATION, as Grantee under that certain Deed to Secure Debt from Development Authority of Coweta County (for the Authority Land) recorded in Book 283, Page 813, aforesaid records (affecting the Authority Land).

Signed, sealed and delivered in the presence of:

____
Witness

____
Notary Public

DECATUR FEDERAL SAVINGS AND LOAN ASSOCIATION

By: _______________________________

(Attach Seal)

APPENDIX B

INTERFACE CONTROL DRAWINGS

(Provided for Information Only)

STE-LSE-SHENANDOAH

INTERFACE DRAWING SIGN-OFF SHEET

MAY 1, 1978

DWG NO	TITLE	DATE OF ISSUE	NO OF ISSUE	APPROVALS SLA	GE	GPC (H&H)
S-1	EXISTING SITE PLAN	5/30/78	CI			
S-2	STE-LSE SITE PLAN		CI			
S-3	STE-LSE BOUNDARY SURVEY	5/30/78	CI			
S-4	HORIZON LINE AND SUN POSITION	5/1/78	2	Gpk	RLM	BBC
S-5	SUN RIGHTS	5/30/78	CI			
A-1	BUILDING PLAN	5/1/78	2	Gpk	RLM	BBC
A-2	BUILDING ELEVATIONS	5/1/78	2	Gpk	RLM	BBC
A-3	TYPICAL WALL SECTION	5/1/78	2	Gpk	RLM	BBC
A-4	POSSIBLE 42,000 SQ.FT. EXPANSION PLAN		CI			
MS-1	METEOROLOGY STATION	5/1/78	2	Gpk	RLM	BBC
M-1	HEATING/COOLING SYSTEM PIPING LAYOUT	5/1/78	2	Gpk	RLM	BBC
M-2	HEATING/COOLING SYSTEM DETAILS	5/1/78	2	Gpk	RLM	BBC
M-3	PROCESS PIPING AND EQUIPMENT	3/24/78	1	Gpk	RLM	BBC
M-3a	PROCESS PIPING AND EQUIPMENT DETAILS	3/24/78	1	Gpk	RLM	BBC
M-4	INTERCONNECTION PIPING AND DESCRIPTION	5/1/78	1	Gpk	RLM	BBC
M-5	PLUMBING	5/1/78	2	Gpk	RLM	BBC
M-6	MECHANICAL ROOM	5/1/78	1	Gpk	RLM	BBC
M-7	MECHANICAL ROOM ISOMETRIC	5/1/78	1	Gpk	RLM	BBC
L-1	LOAD REQUIREMENTS AND ANALYSIS(8½x11)	3/24/78	2	Gpk	RLM	BBC
T-1	PROCESS BOILER REQUIREMENTS (8½x11)	4/13/78	CI			
T-2	HEATING DESIGN LOADS(8½x11)	4/13/78	CI			
T-3	COOLING DESIGN LOADS(8½x11)	4/13/78	CI			
E-1	ELECTRICAL LOAD PROFILE	3/24/78	1	Gpk	RLM	BBC
E-2	BLEYLE PLANT WIRING DIAGRAM	5/30/78	CI			
E-2a	BLEYLE PLANT LIGHTING PLAN	5/30/78	CI			
E-3	ELECTRICAL LOAD INTERCONNECTION	5/1/78	1	Gpk	RLM	BBC
E-4	ELECTRICAL LOAD INTERCONNECTION DETAILS AND POWER QUALITY	5/1/78	1	Gpk	RLM	BBC
E-5	STATION SERVICE THROWOVER SCHEME	4/4/78	CI			
I-1	DATA GATHERING SYSTEM	3/24/78	1	Gpk	RLM	BBC
I-2	ELECTRIC METER LOCATIONS AND DESCRIPTIONS	5/30/78	CI			
I-3	MECHANICAL INSTRUMENTATION	3/24/78	1	Gpk	RLM	BBC
I-4	MECHANICAL INSTRUMENTATION	3/24/78	1	Gpk	RLM	BBC

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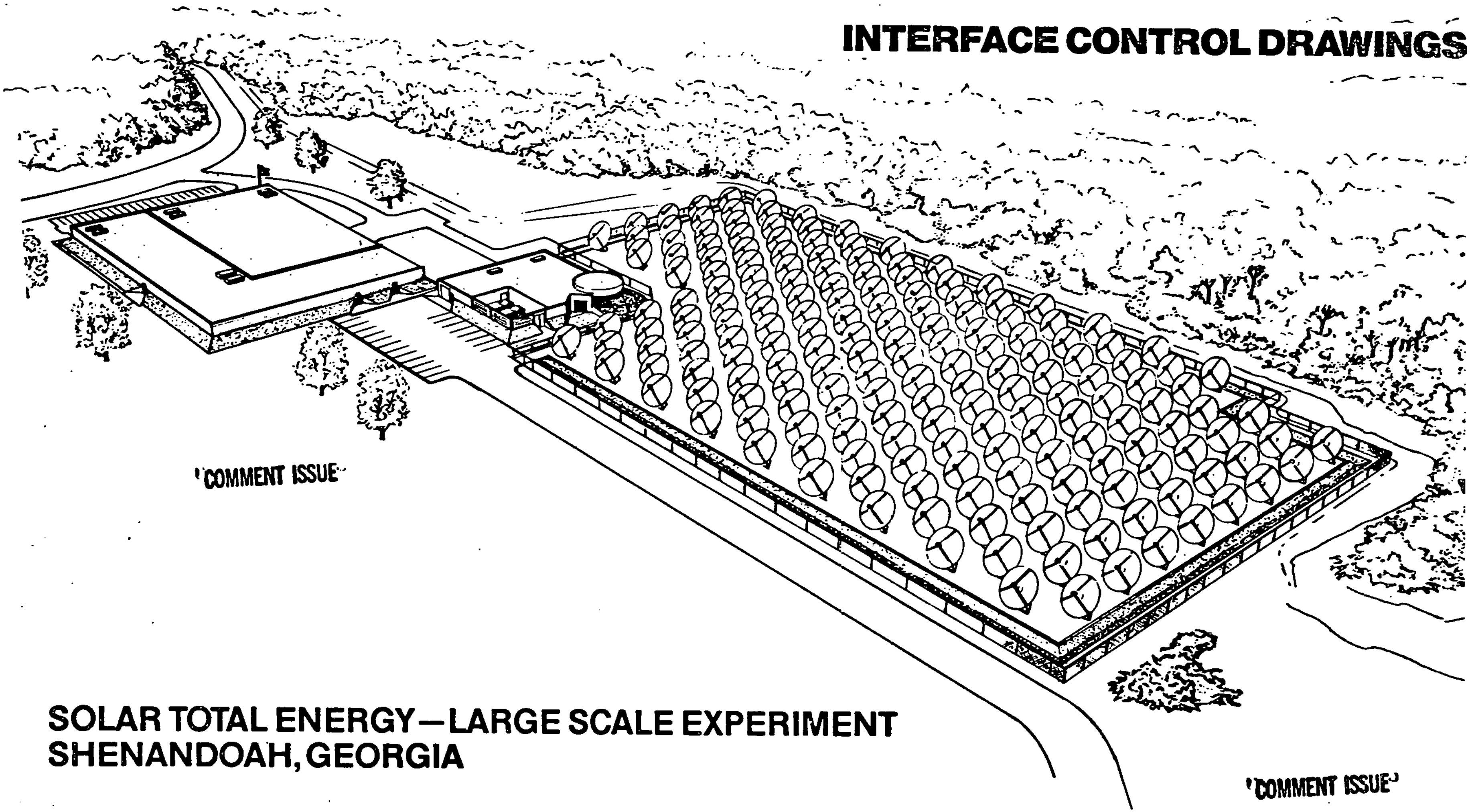
INTERFACE CONTROL DRAWINGS



'COMMENT ISSUE'

SOLAR TOTAL ENERGY—LARGE SCALE EXPERIMENT
SHENANDOAH, GEORGIA

'COMMENT ISSUE'

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

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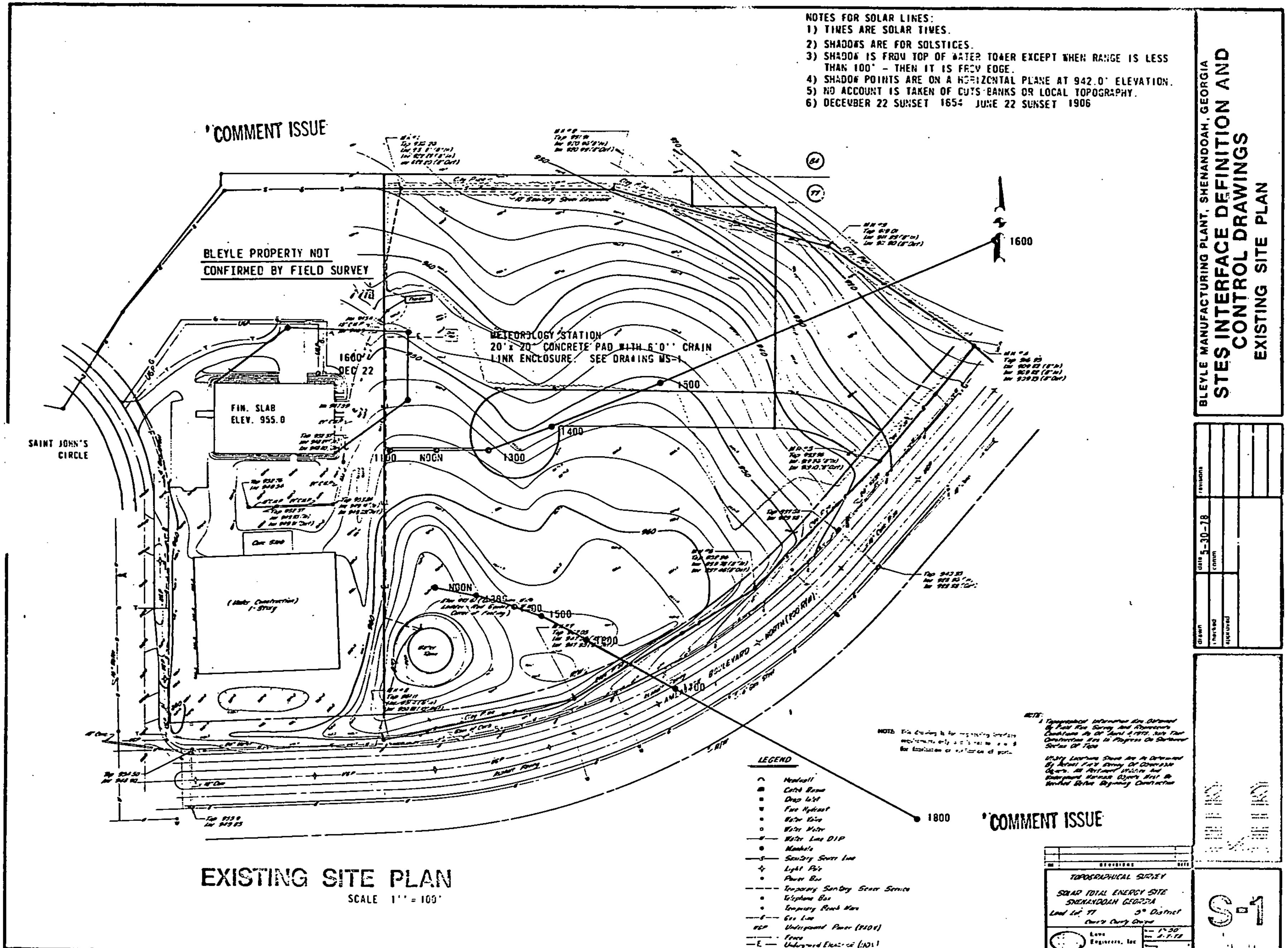
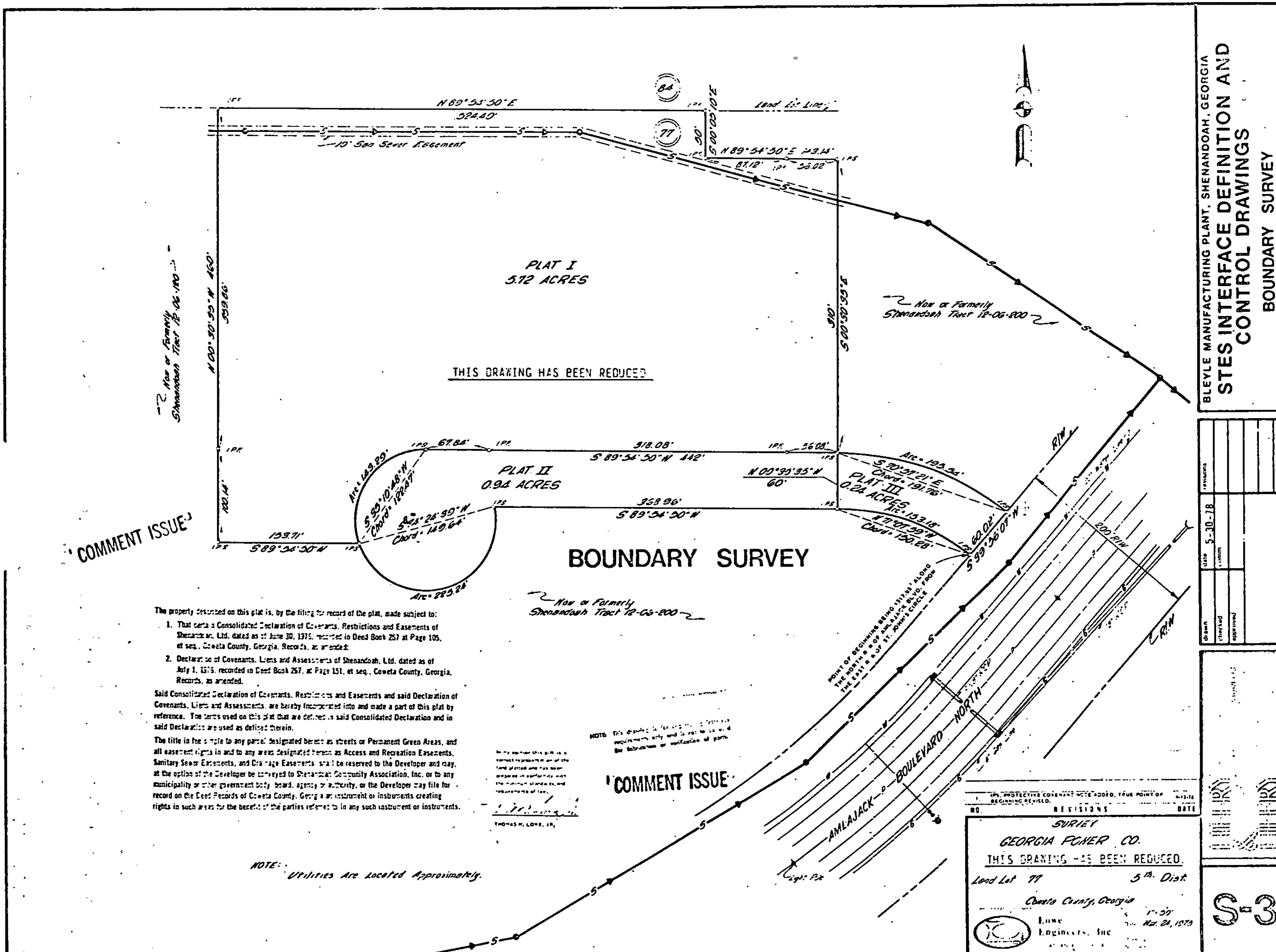
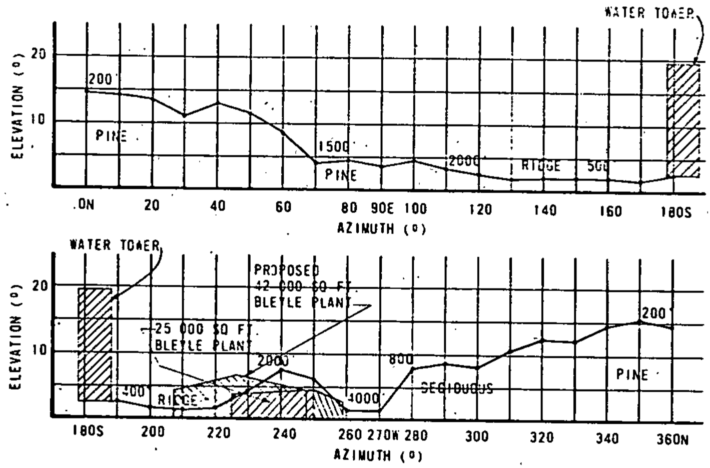


NOTES FOR SOLAR LINES:
1) TIMES ARE SOLAR TIMES.
2) SHADOWS ARE FOR SOLSTICES.
3) SHADOW IS FROM TOP OF WATER TOWER EXCEPT WHEN RANGE IS LESS THAN 100' - THEN IT IS FROM EDGE.
4) SHADOW POINTS ARE ON A HORIZONTAL PLANE AT 942.0' ELEVATION.
5) NO ACCOUNT IS TAKEN OF CUTS BANKS OR LOCAL TOPOGRAPHY.
6) DECEMBER 22 SUNSET 1654 JUNE 22 SUNSET 1906
COMMENT ISSUE
BLEYLE PROPERTY NOT CONFIRMED BY FIELD SURVEY
METEOROLOGY STATION
20' x 20' CONCRETE PAD WITH 6'0'' CHAIN LINK ENCLOSURE. SEE DRAWING MS-1
1600
DEC 22
FIN. SLAB
ELEV. 955.0
SAINT JOHN'S CIRCLE
1100
NOON
1300
1400
1500
1600
1800
AMLAJACK BOULEVARD NORTH
LEGEND
COMMENT ISSUE
EXISTING SITE PLAN
SCALE 1'' = 100'
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND CONTROL DRAWINGS
EXISTING SITE PLAN
5-30-78
TOPOGRAPHICAL SURVEY
SOLAR TOTAL ENERGY SITE
SHENANDOAH GEORGIA
S-1



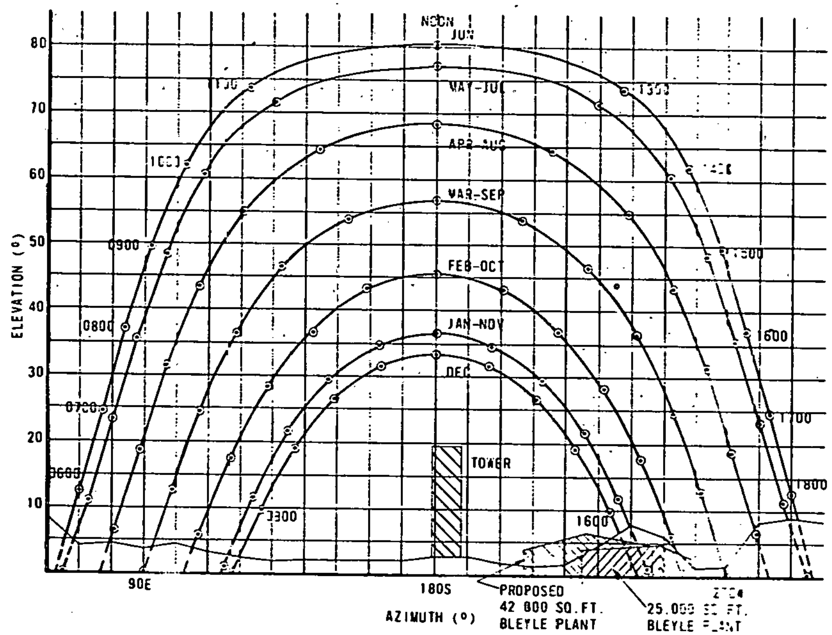
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND CONTROL DRAWINGS
BOUNDARY SURVEY
BOUNDARY SURVEY
PLAT I
5.72 ACRES
PLAT II
0.94 ACRES
PLAT III
0.24 ACRES
THIS DRAWING HAS BEEN REDUCED
COMMENT ISSUE
COMMENT ISSUE
N 89°54'50" E
524.49'
10' San Sewer Easement
Land Lot Line
S 00°05'10" E
N 89°54'50" E
87.12'
56.02'
S 00°05'55" E
910'
N 00°30'35" W
399.86'
100.14'
S 89°54'50" W 442'
318.08'
67.84'
N 00°30'35" W
60'
56.08'
358.96'
S 89°54'50" W
153.71'
S 89°54'50" W
Arc = 149.89'
Chord = 149.64'
Arc = 285.24'
Arc = 193.54'
Chord = 191.76'
Arc = 153.18'
Chord = 150.28'
60.02'
S 39°36'07" W
Now or Formerly Shenandoah Tract 12-06-200
Now or Formerly Shenandoah Tract 12-06-200
Now or Formerly Shenandoah Tract 12-06-180
AMLAJACK BOULEVARD NORTH
200' R/W
R/W
R/W
Light Pole
NOTE: Utilities Are Located Approximately.
The property described on this plat is, by the filing for record of the plat, made subject to:
1. That certain Consolidated Declaration of Covenants, Restrictions and Easements of Shenandoah, Ltd. dated as of June 30, 1975, recorded in Deed Book 257 at Page 105, et seq., Coweta County, Georgia, Records, as amended.
2. Declaration of Covenants, Liens and Assessments of Shenandoah, Ltd. dated as of July 1, 1975, recorded in Deed Book 267, at Page 151, et seq., Coweta County, Georgia, Records, as amended.
Said Consolidated Declaration of Covenants, Restrictions and Easements and said Declaration of Covenants, Liens and Assessments, are hereby incorporated into and made a part of this plat by reference. The terms used on this plat that are defined in said Consolidated Declaration and in said Declaration are used as defined therein.
The title in fee simple to any parcel designated hereon as streets or Permanent Green Areas, and all easement rights in and to any areas designated hereon as Access and Recreation Easements, Sanitary Sewer Easements, and Drainage Easements shall be reserved to the Developer and may, at the option of the Developer be conveyed to Shenandoah Community Association, Inc. or to any municipality or other government body, board, agency or authority, or the Developer may file for record on the Deed Records of Coweta County, Georgia an instrument or instruments creating rights in such areas for the benefit of the parties referred to in any such instrument or instruments.
THOMAS H. LOWE, JR.
IPS, PROTECTIVE COVENANT NOTE ADDED, TRUE POINT OF BEGINNING REVISED.
NO.
REVISIONS
DATE
SURVEY
GEORGIA POWER CO.
THIS DRAWING HAS BEEN REDUCED.
Land Lot 77
5th. Dist.
Coweta County, Georgia
Mar. 24, 1975
Lowe Engineers, Inc
S-3

96



. NOTE: TYPE OF HORIZON AND APPROXIMATE RANGE ARE SHOWN.

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

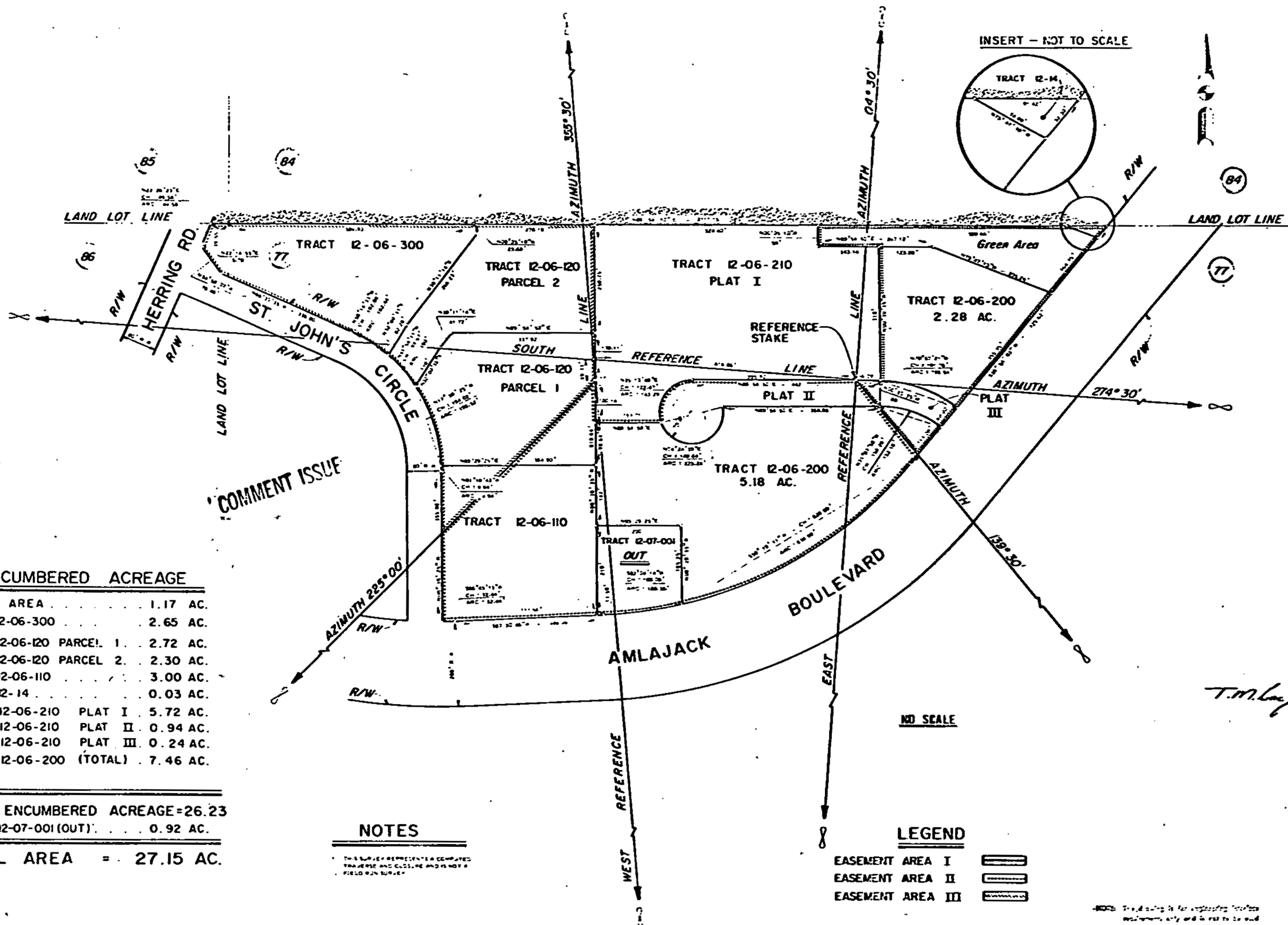


SHENANDOAH STE-LSE SOLAR POSITION
(FROM CENTER OF METEOROLOGY STATION PAD)
ELEVATION 946.5'±

HORIZON LINE AND SUN POSITION

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

S-4



'COMMENT ISSUE

ENCUMBERED ACREAGE

GREEN AREA	1.17 AC.
TRACT 12-06-300	2.65 AC.
TRACT 12-06-120 PARCEL 1	2.72 AC.
TRACT 12-06-120 PARCEL 2	2.30 AC.
TRACT 12-06-110	3.00 AC.
TRACT 12-14	0.03 AC.
TRACT 12-06-210 PLAT I	5.72 AC.
TRACT 12-06-210 PLAT II	0.94 AC.
TRACT 12-06-210 PLAT III	0.24 AC.
TRACT 12-06-200 (TOTAL)	7.46 AC.
TOTAL ENCUMBERED ACREAGE	26.23
TRACT 12-07-001 (OUT)	0.92 AC.
TOTAL AREA	27.15 AC.

NOTES

LEGEND

- EASEMENT AREA I
- EASEMENT AREA II
- EASEMENT AREA III

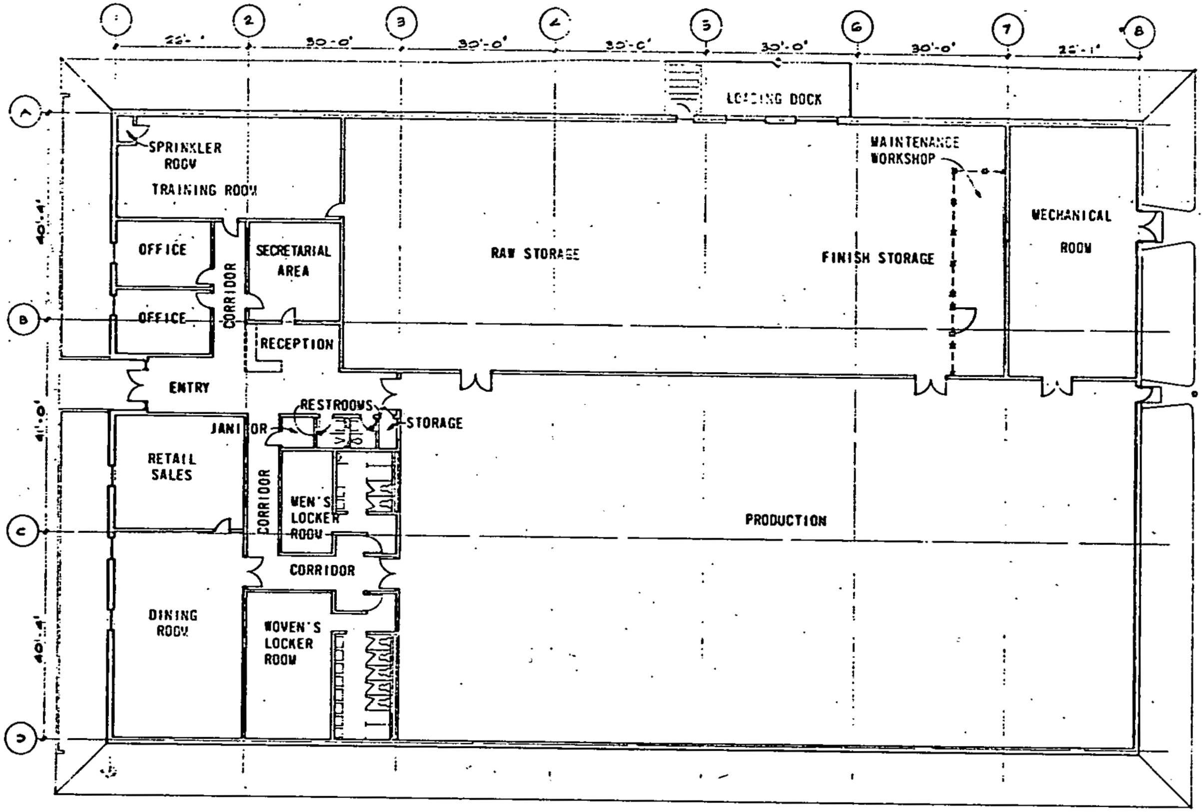
'COMMENT ISSUE

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

date 5-30-78

S-5



BUILDING THERMAL CHARACTERISTICS

WINDOWS – INSULATING GLASS – DOUBLE, ½" AIR SPACE

GLAZED ENTRY – SINGLE GLASS

ROOF – WITH 2 x 2½" OWENS-CORNING FURI ROOF INSULATION, U = .03

EXTERIOR WALLS – WITH 6" OWENS-CORNING UNFACED BATTS, U = .05

BUILDING 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.

DESIGN CONDITIONS

SPACE	SUMMER		WINTER	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE
PRODUCTION	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
OFFICE	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
EMPLOYEE SERVICE	78°F DB 50%RH	95°F DB 78°F WB	65°F DB 30%RH	18°F DB
STORAGE	VENTILATED ONLY	95°F DB 78°F WB	65°F DB 30%RH	16°F DB
MECHANICAL	VENTILATED ONLY	95°F DB 78°F WB	NONE	18°F DB

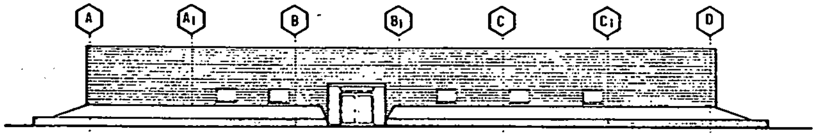
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

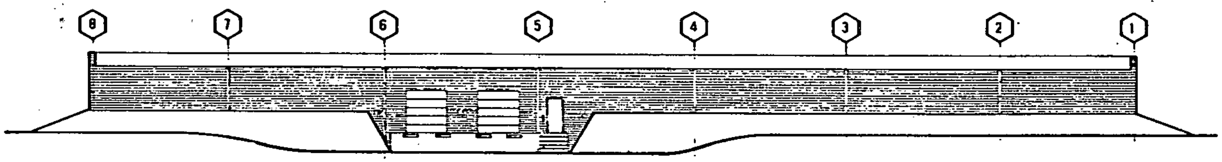
BUILDING PLAN

date 10/20/77 revised 1/10/78 4/1/78

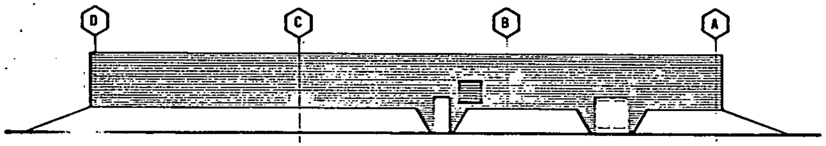
A-1



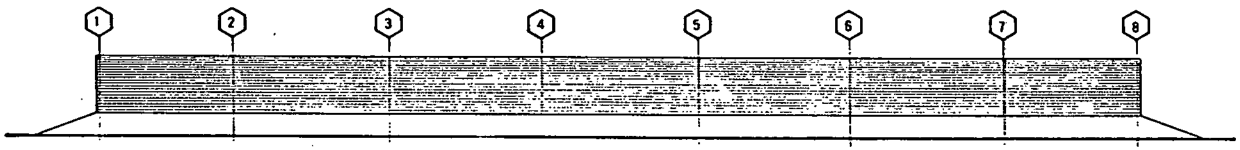
WEST ELEVATION
SCALE: 1/16" = 1'-0"



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



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



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

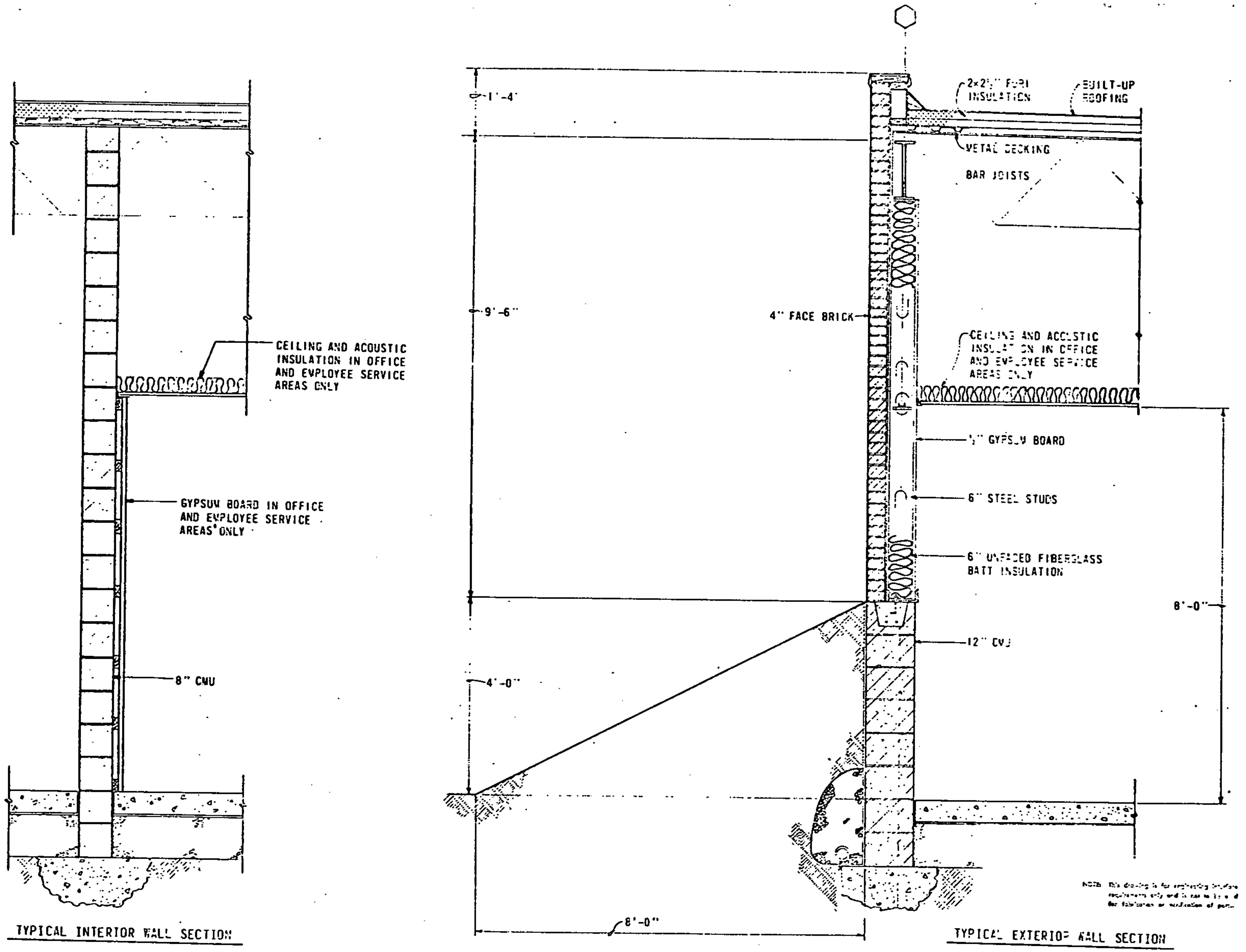
ARCHITECTURAL ELEVATIONS (25,000 SQ. FT.)

NOTE: [illegible] requirements only and [illegible] for fabrication or verification of parts.

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

10/20/77
4/7/78

A-2



TYPICAL WALL SECTIONS

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

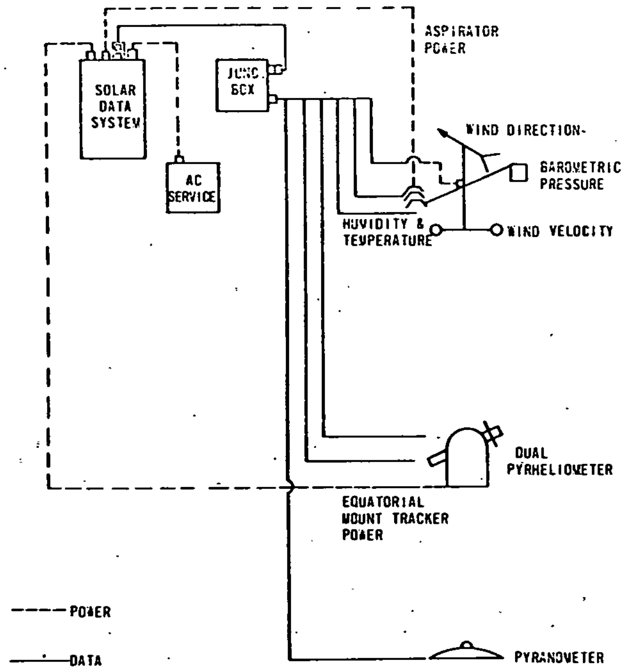
STES INTERFACE DEFINITION AND CONTROL DRAWINGS

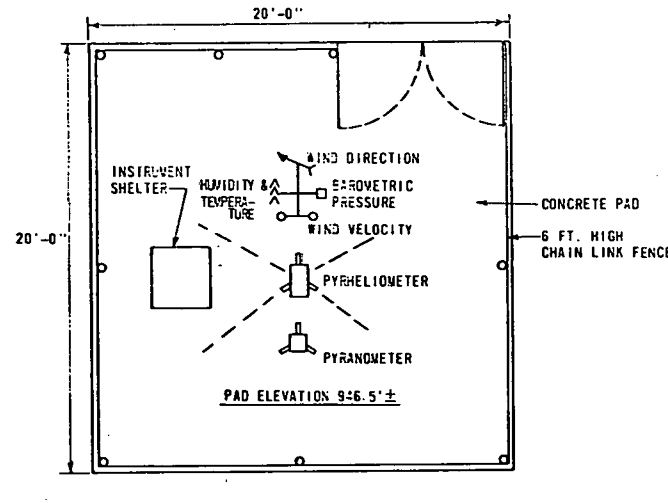
TYPICAL WALL SECTIONS

1-10-78

Revisions 2/8/78, 4/7/78

A-3





METEOROLOGY STATION PLAN

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

1/10/78
4/7/78
10/20/77

METEOROLOGY STATION

METEOROLOGICAL DATA

PRESENT	FUTURE INSTRUMENTS TO BE INSTALLED
PYRHELIOMETER (2)	SPECTRAL PYRHELIOMETER
PYRANOMETER	DIFFUSE PYRANOMETER
DB TEMPERATURE	PYRGEOMETER (INCOMING & OUTGOING)
PRESSURE	PYRANOMETER (REFLECTED VISIBLE)
RELATIVE HUMIDITY	45° PYRANOMETER
WIND DIRECTION	RAIN GAUGE
WIND VELOCITY	VISIBILITY
	DUSTFALL

METEOROLOGY STATION ACCESS

J. CRAIG

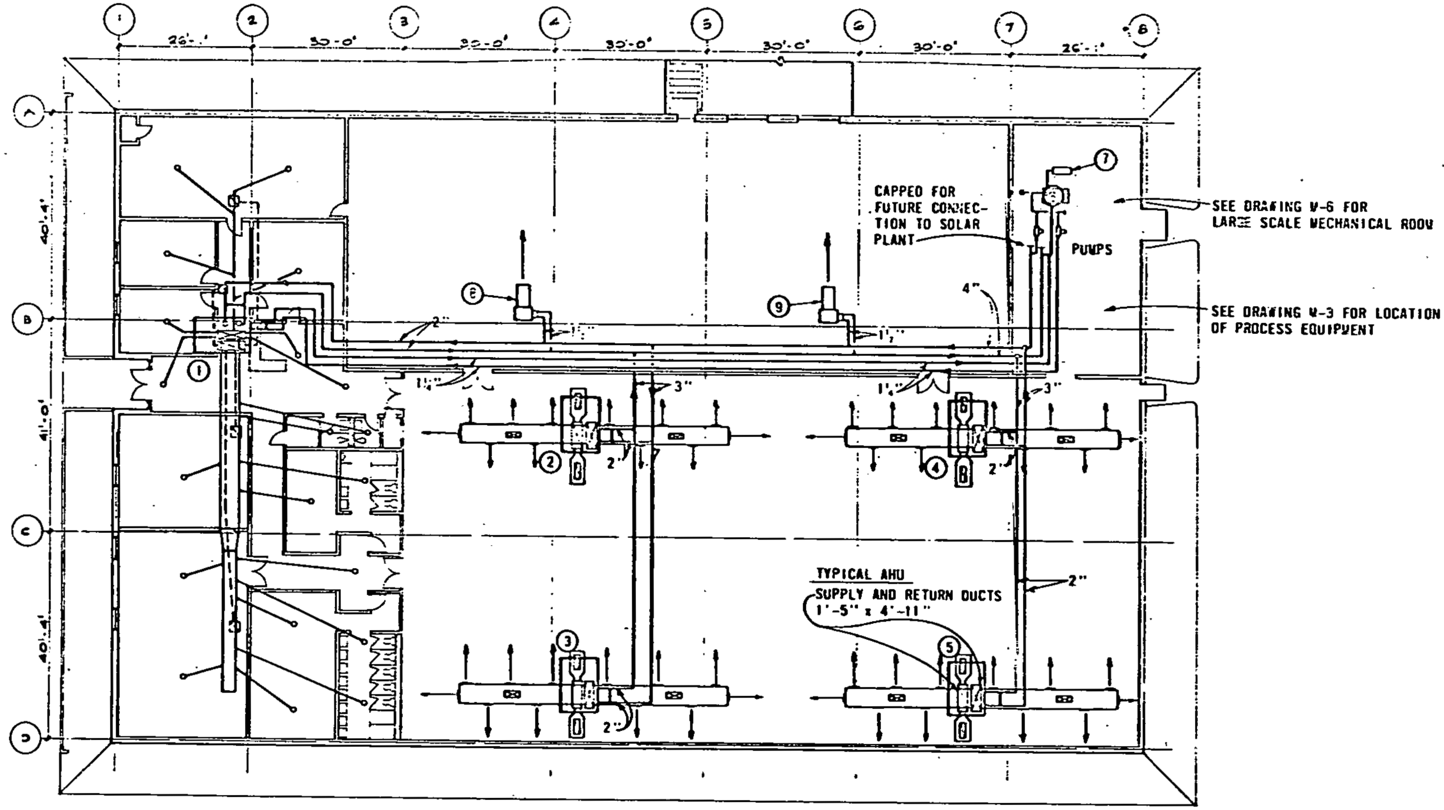
E NEY
SHEN PEACH BARN

INSTRUMENT MAINTENANCE

PYRHELIOMETER AND EQUATORIAL MOUNT – 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 ONE MINUTE INTERVALS. AT THIS RATE A CASSETTE WILL REQUIRE CHANGING APPROXIMATELY EVERY 6.3 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 MAILED (BY REGISTERED MAIL) TO EG & G, LAS VEGAS, NEVADA, AS SOON AS POSSIBLE.

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

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 48DD024 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 BC-10A

REHEAT COIL IN UNIT (1) ONLY. REHEAT COIL TO BE USED WHEN PRODUCTION AREA REQUIRES COOLING WHILE OFFICE AREA REQUIRES HEATING. HALSTEAD MITCHELL SW2 24" x 48" 8 ROW.

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

HEATING/COOLING SYSTEM PIPING LAYOUT

drawn	date 10/20/77	revisions 1/10/78
checked		2/8/78
approved		4/7/78

M-1

OUTLINE SPECIFICATIONS

PIPE - SCHEDULE 40 BLACK STEEL
2" AND SMALLER - SCREWED
2½" 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 (HA & CA) 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
2½" AND LARGER - IRON BODY BRONZE MOUNTED WITH FLANGED ENDS

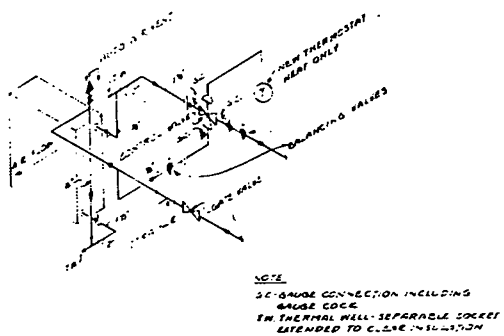
HEATING/COOLING COILS - HALSTEAD & MITCHELL SPECIFICATIONS:
SURFACE TYPE: 6210 1½ x 1.3 C C
FIN: .006 ALUMINUM AT 8 PER INCH
FIN SURFACE: CORRUGATED FIN EDGE: STRAIGHT
TUBING: 5/8 O D COPPER x .023 WALL
RETURN BENDS 5/8 O D x .032 WALL
CASING: 16 GA. GALV. STEEL
ROWS DEEP 4 x ROWS HIGH 22
22 CIRCUITS AT 4 TUBES EACH

REHEAT COIL - HALSTEAD MITCHELL S#2 24" x 48" 8 ROW

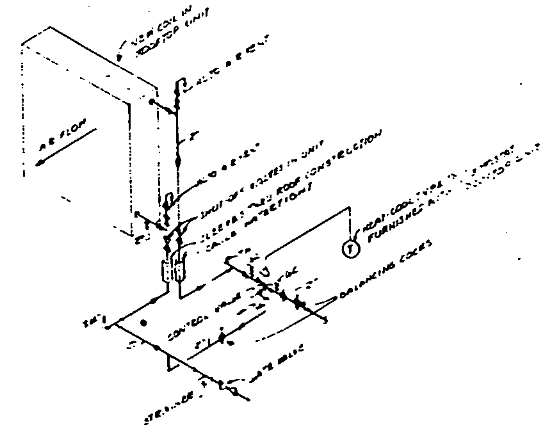
EXPANSION TANK - PRESSURIZED, DIAPHRAGM TYPE, AMTROL OR EQUIVALENT: SIZE EXTROL AX-200 24" DIA. BY 62½" LONG HORIZONTAL.

CIRCULATING PUMPS - INLINE TYPE IRON BODY, BRONZE FITTED ARMSTRONG
P-1: 102 GPM vs. 18 FT HEAD MOTOR ¾ HP - ARMSTRONG S57 3" SIZE
P-2: 8 GPM vs. 11 FT. HEAD MOTOR 1/6 HP - ARMSTRONG S35 2" SIZE

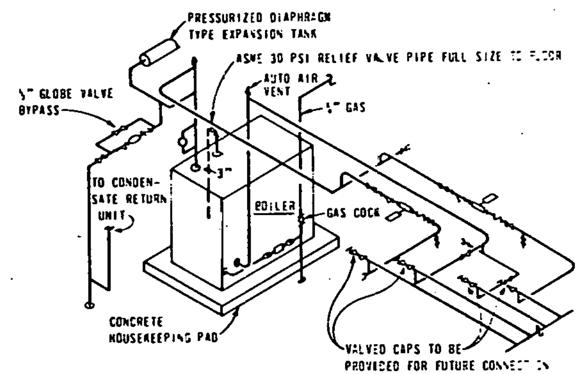
BOILER - GAS-FIRED CAST IRON TYPE WEIL-McLEAN MODEL VGB-7. 1 020 000 BTU INPUT (919 000 MIN) ATMOSPHERIC BURNER WITH FM CONTROLS PROVIDE TEMPERATURE CONTROLS. LOW-WATER CUT-OFF DRAFT HOOD 14" DIA TYPE "B" VENT THROUGH ROOF TO BREIDERT GAS CAP



DETAIL - REHEAT COIL
NO SCALE

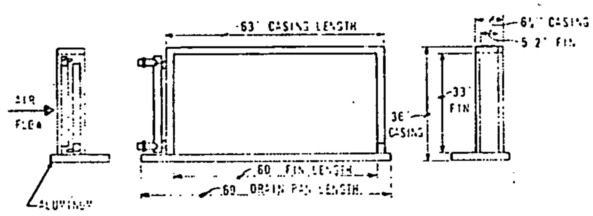


DETAIL - NEW COIL IN ROOF TOP UNIT
NO SCALE



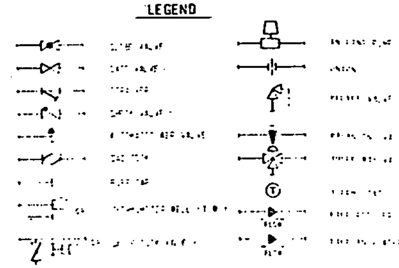
DETAIL - PIPE CONNECTIONS TO BOILER
NO SCALE

HEATING / COOLING SYSTEM DETAILS



DETAIL - HEATING/COOLING COIL
NO SCALE

LEGEND



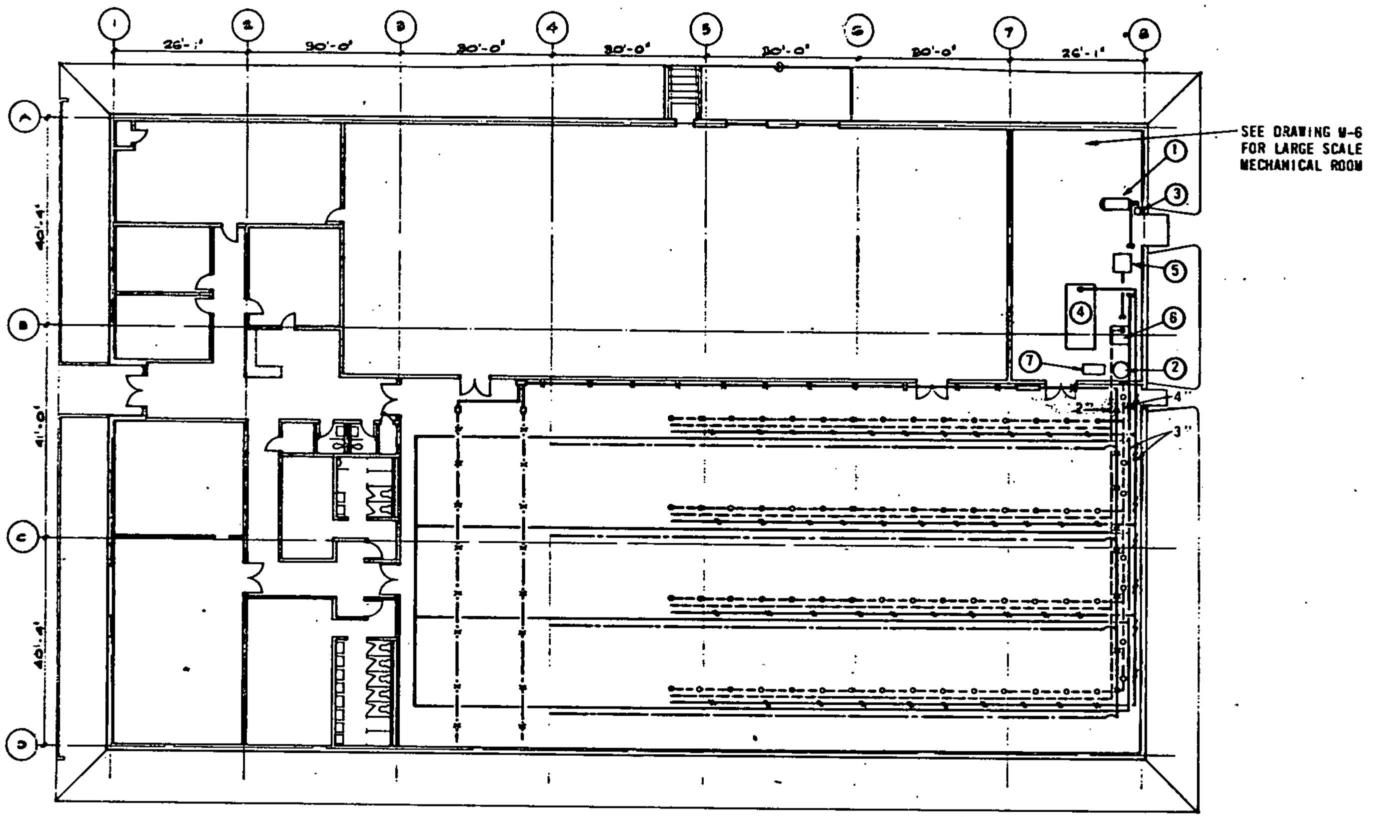
NOTE: This drawing is for engineer's interface requirements only and is not to be used for fabrication or construction of parts.

BLEYLE MANUFACTURING PLANT SHENANDOAH GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

HEATING/COOLING SYSTEM DETAILS

M-2



PROCESS PIPING and EQUIPMENT

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

- —o—o— 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 B352AO, 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 AHB-3

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

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

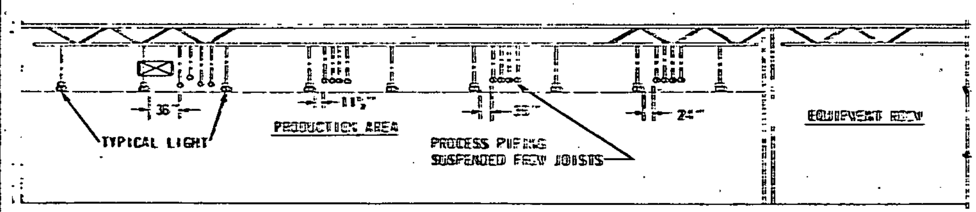
STES INTERFACE DEFINITION AND CONTROL DRAWINGS

PROCESS PIPING AND EQUIPMENT

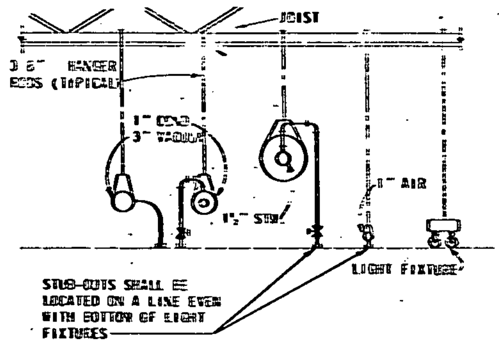
drawn	date 10/20/77	revisions 1/10/78
checked		
approved		

HEERY & HEERY

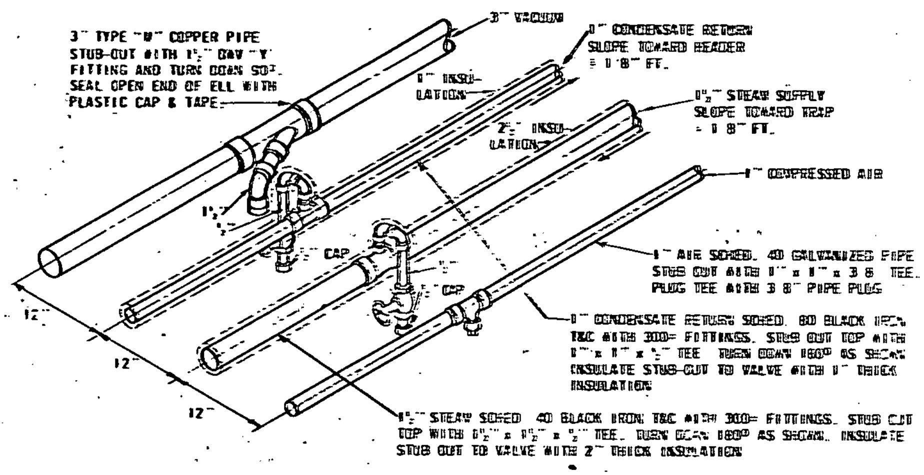
M-3



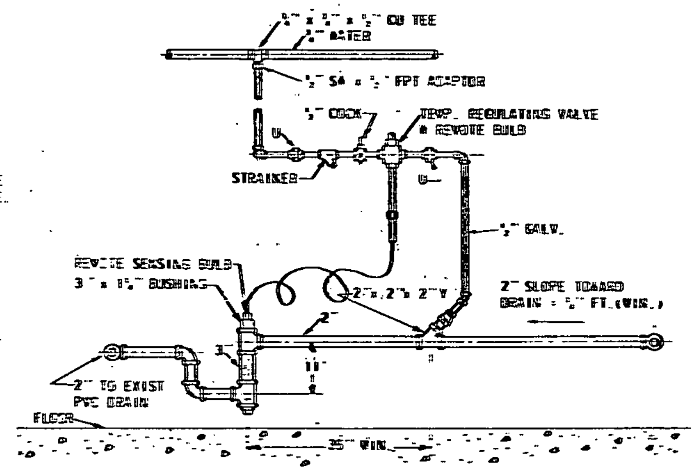
SECTION THROUGH PRODUCTION AREA
NO SCALE



DETAIL - SUPPLY LOCATIONS
NO SCALE



DETAIL OF STEAM, CONDENSATE, AIR AND VACUUM CONNECTIONS
NO SCALE



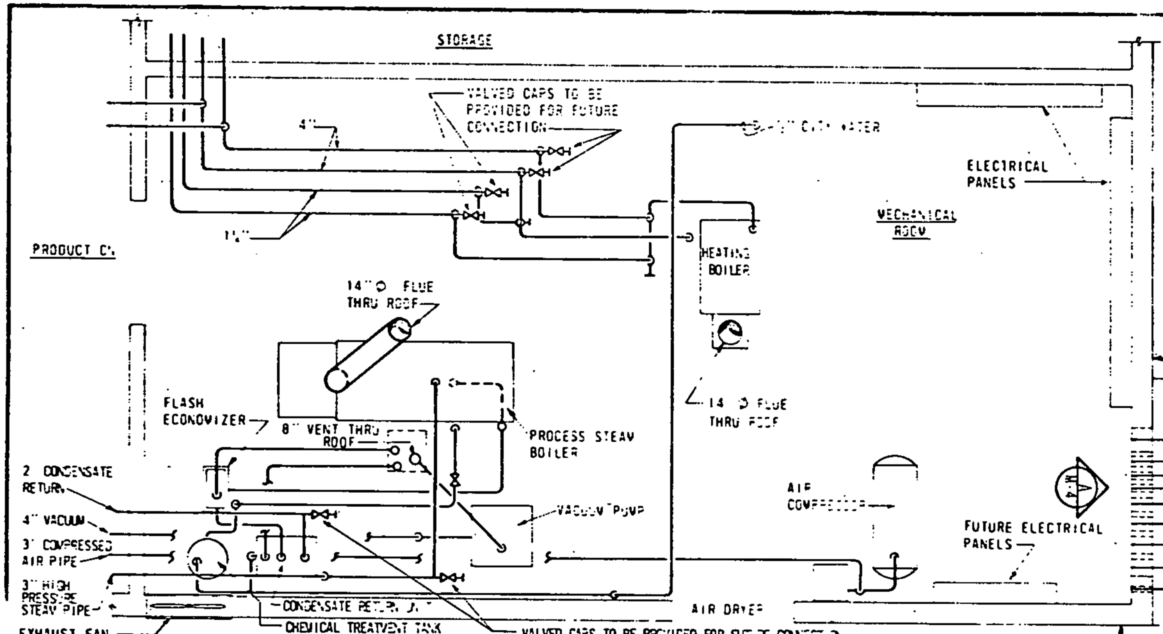
BLOWDOWN WATER COOLING SYSTEM DETAILS
NO SCALE

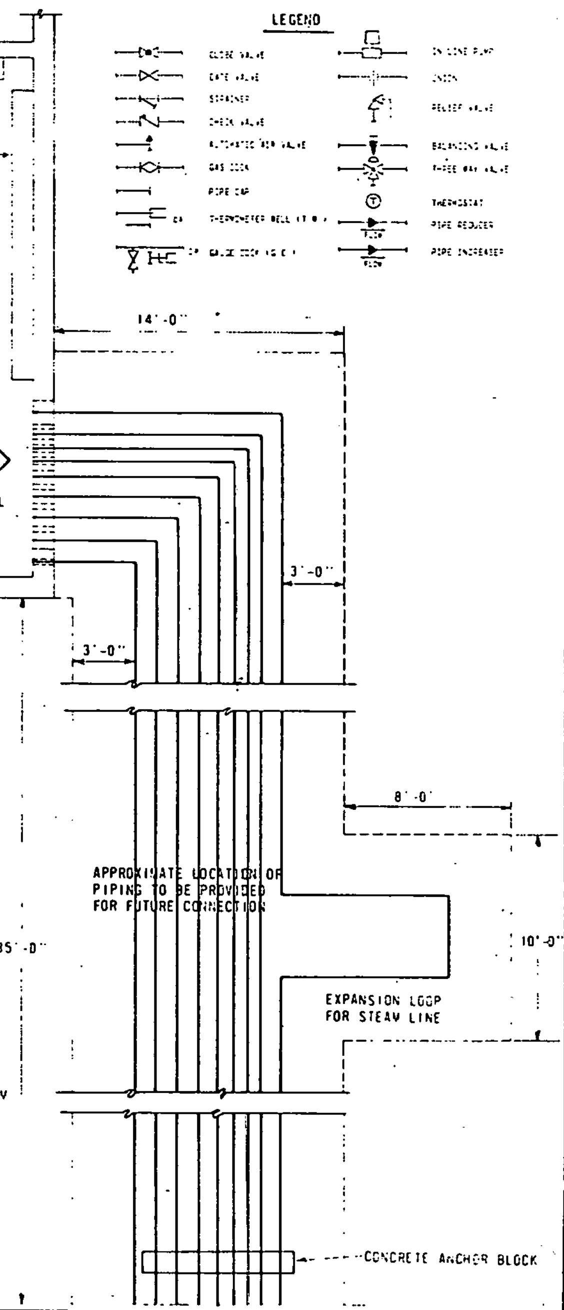
PROCESS PIPING AND EQUIPMENT DETAILS

PIPE INSULATION SIZES		
PIPE DIAMETER	INSULATION THICKNESS FOR STEAM PIPING	INSULATION THICKNESS FOR CONDENSATE PIPING
1" AND SMALLER	2"	1"
1¼" TO 2"	2½"	1½"
2½" TO 4"	3½"	2"

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

Date 1-10-78





INTERCONNECTION PIPING AND DESCRIPTION

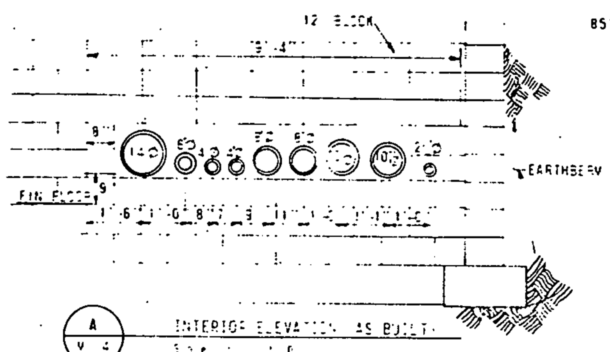
SCALE

PROPOSED DESCRIPTIONS (WEST TO EAST)

SERVICE	INSULATION	RIC-WIL TYPE
4" STEAM SCHED 40	3" FIBER GLASS	12½" 10 GA GALVA-GARD
2" CONDENSATE FIBER REINFORCED PLASTIC	1" URETHANE	4" DUAL-GARD
¾" HW REC R ¾" K COPPER	1" URETHANE	3" COPPER-GARD
1¼" DOMESTIC HW 1¼" K COPPER	1" URETHANE	3½" COPPER-GARD
3" HEATING WATER RETURN SCHEDULE 40	1½" URETHANE	6" STEEL-GARD
3" HEATING WATER SUPPLY SCHEDULE 40	1½" URETHANE	6" STEEL-GARD
5" CHILLED WATER RETURN POLYVINYL CHLORIDE	1½" URETHANE	10" CHIL-GARD
5" CHILLED WATER SUPPLY POLYVINYL CHLORIDE	1½" URETHANE	10" CHIL-GARD
2½" SLEEVE FOR CONTROL WIRING	----	----

PIPE SLEEVES

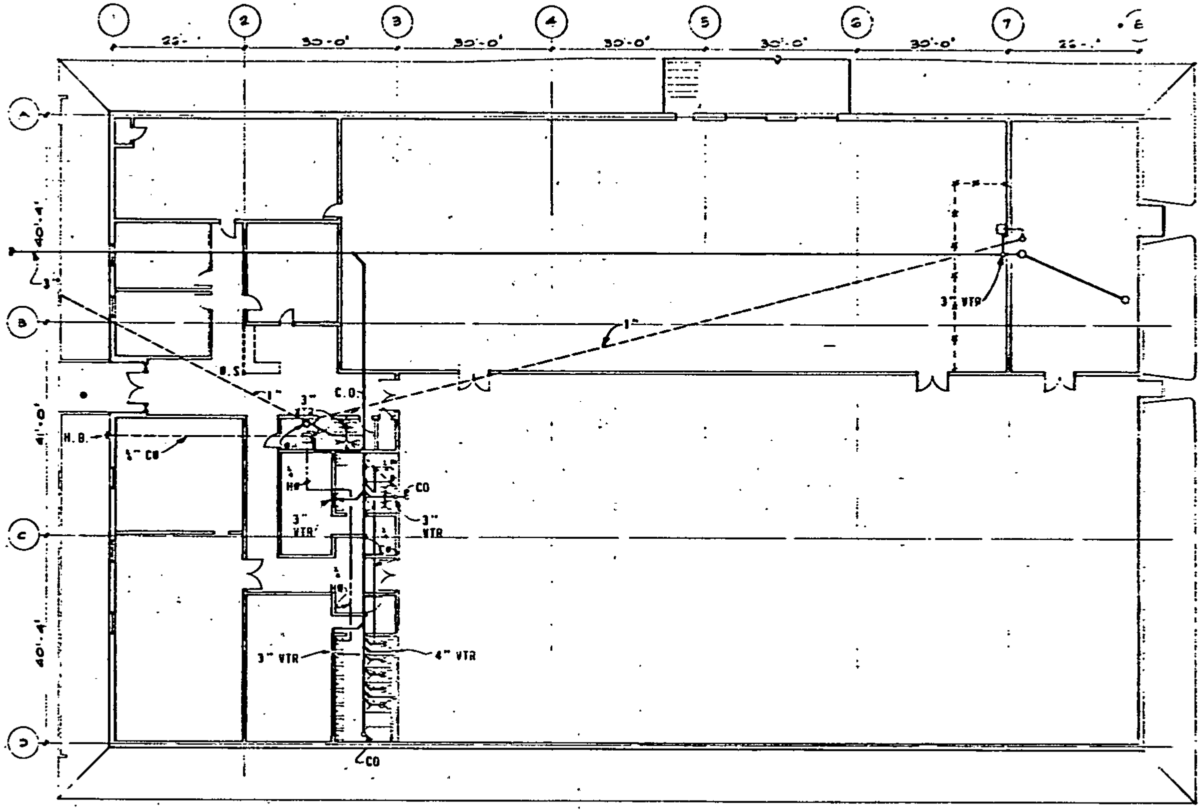
1) SIZE AS SHOWN x 3/16" WALL THICKNESS
2) GALVANIZED AND CAPPED OUTSIDE
3) 2" PROJ. EACH SIDE OF WALL
4) INSTALLATION DETAILS TO BE PROVIDED LATER



A
M-4
INTERIOR ELEVATION AS BUILT

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND CONTROL DRAWINGS
INTERCONNECTION PIPING AND DESCRIPTION

M-4



PLUMBING

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

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

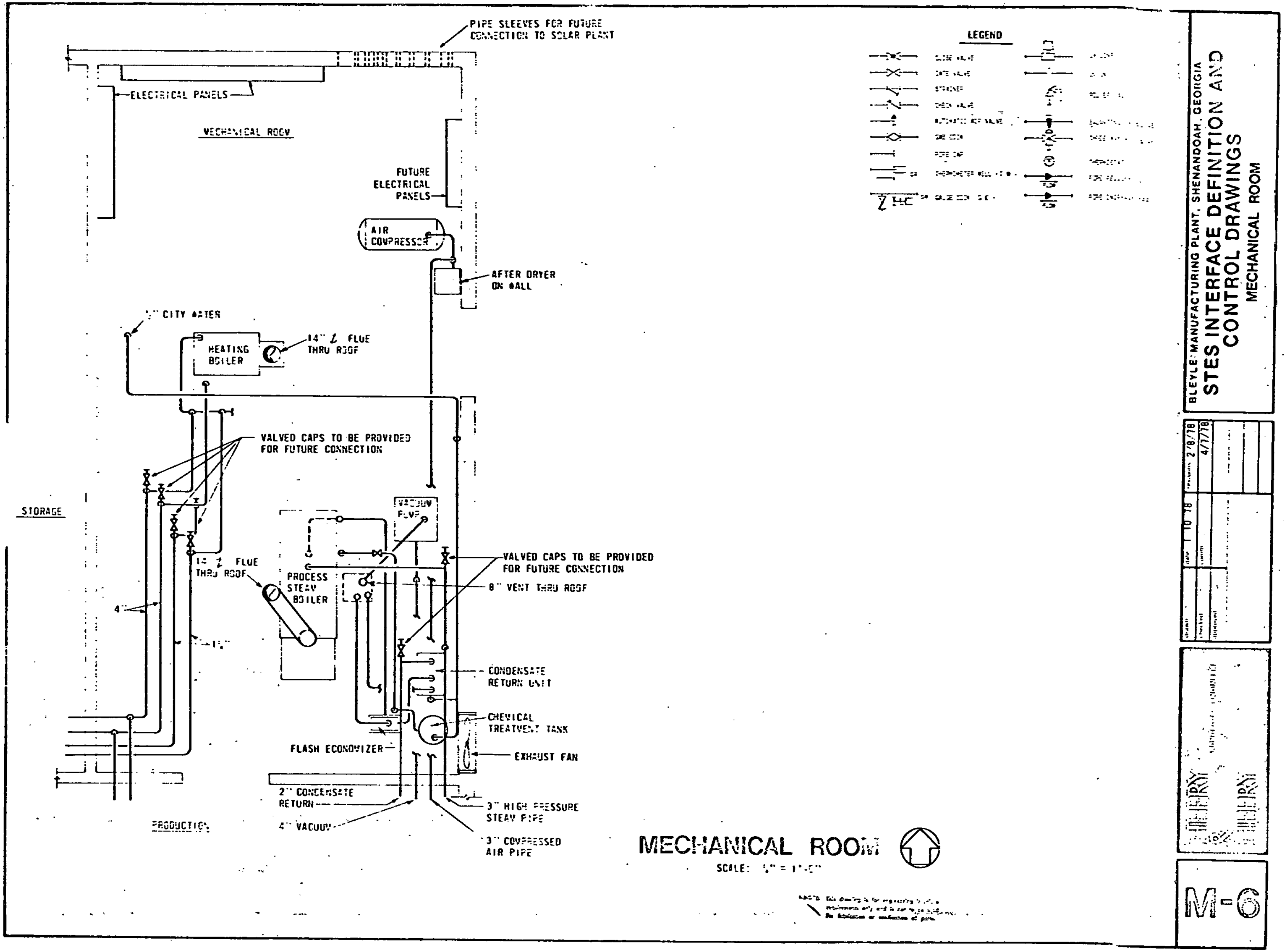
PLUMBING

10/20/77

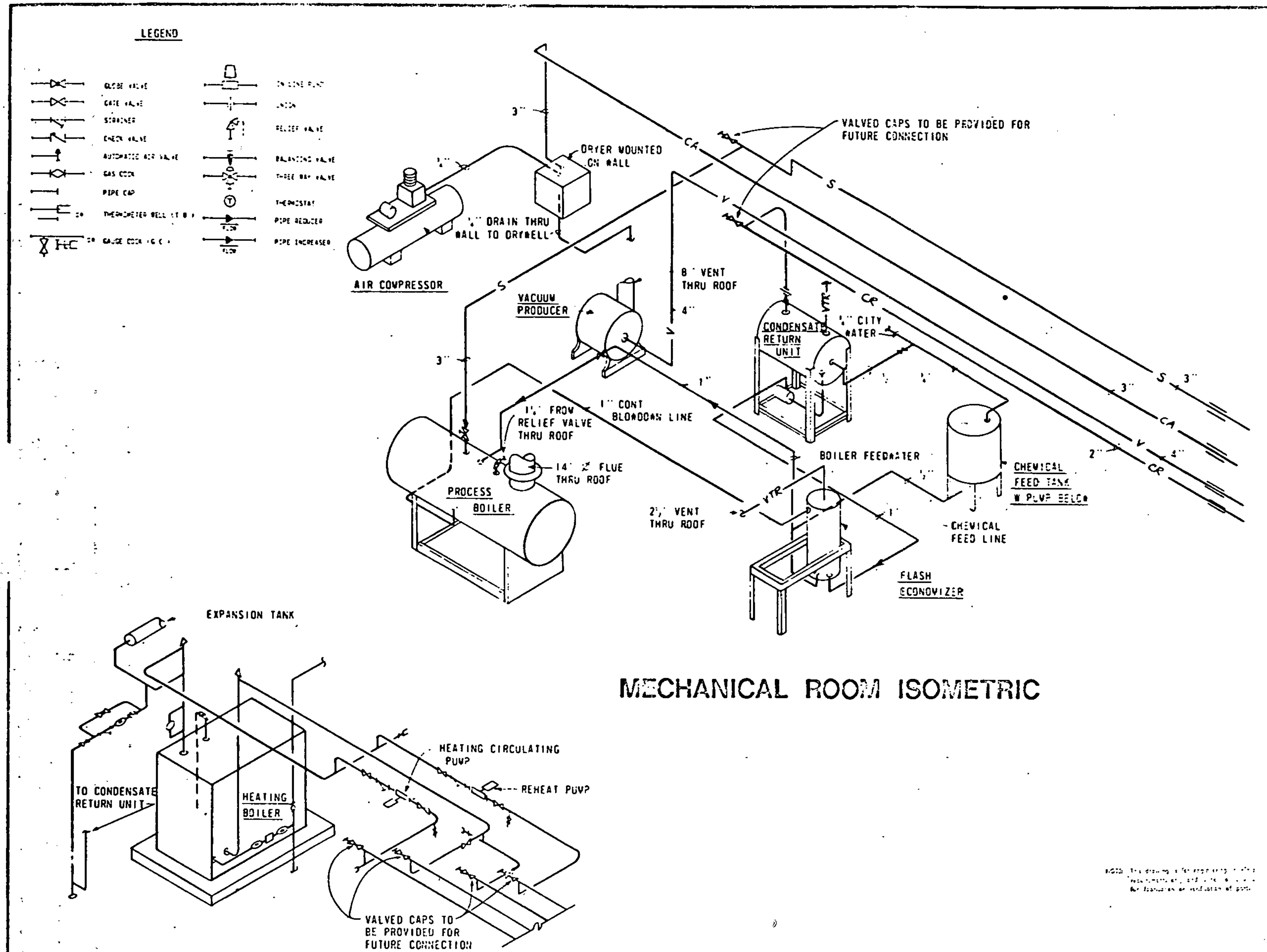
2/8/78

4/7/78

M-5



PIPE SLEEVES FOR FUTURE CONNECTION TO SOLAR PLANT
ELECTRICAL PANELS
MECHANICAL ROOM
FUTURE ELECTRICAL PANELS
AIR COMPRESSOR
AFTER DRYER ON WALL
CITY WATER
HEATING BOILER
14" FLUE THRU ROOF
VALVED CAPS TO BE PROVIDED FOR FUTURE CONNECTION
STORAGE
VACUUM PUMP
14" FLUE THRU ROOF
PROCESS STEAM BOILER
VALVED CAPS TO BE PROVIDED FOR FUTURE CONNECTION
8" VENT THRU ROOF
4"
CONDENSATE RETURN UNIT
CHEMICAL TREATMENT TANK
FLASH ECONOMIZER
EXHAUST FAN
2" CONDENSATE RETURN
4" VACUUM
3" HIGH PRESSURE STEAM PIPE
3" COMPRESSED AIR PIPE
PRODUCTION
LEGEND
MECHANICAL ROOM
SCALE:
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND CONTROL DRAWINGS
MECHANICAL ROOM
2/8/78
4/7/78
M-6



MECHANICAL ROOM ISOMETRIC

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

MECHANICAL ROOM ISOMETRIC

drawn	date 1 10 78	revisions 2/8/78
checked	comm	4/1/78
approved		

M-7

LOAD REQUIREMENTS

AND

ANALYSIS

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

L - 1

BUILDING AND EQUIPMENT DATA REQUIRED TO PERFORM BLEYLE

PLANT LOAD ANALYSIS

I. PROCESS MACHINERY (Xzs, 20.6.77, Sch/Ge)

machine	kw	operating factor	number machines 25,000	number machines 42,000
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.)

machine	hp	Volt
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 25,000sq.ft. building only.)

III. PIPING AND INSULATION (As proposed to Bleyle by Stephenson Assoc.)

system		pipe size	insulation thickness
steam:	header	3"	3½"
	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, 2-4500w elements, 18 gallon recovery per hour at 100°F rise, demand 1.086×10^4 Btu/hr.

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

First shift: 6:30am - 3:00pm w/ lunch 11:30am - Noon.
Second shift: 3:30pm - midnight w/ dinner 7:30pm - 8:00pm.

Two additional breaks per shift also assumed. Process machinery shut off during meals with load drop on process equipment; steam pressure maintained.

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 PSIA (311°F, 79.5 PSIA at press steam branches)

VIII. LIGHTING

area	level	kw
office	75fc	11.3
storage & equipment	25	3.6
production	75	32.4
exterior	--	1.5
		48.8

(All interior light- flourescent.)

IX. AIR HANDLING EQUIPMENT

2 fan coil units in storage room, each unit: 10 ton nominal, 220V - 3 ph
1hp fan motor, 3.6 FLA
5 roof-top DX units, each unit: 20 ton nominal, 460-3-60,
compressor: 37.0FLA
2 indoor fans: 6.6 FLA (1) 5 HP motor
Toilet Exhaust Fans: 4 @ 1/25 HP 150W each, 115V - 1 ph

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

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: ¼" 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

	25,000	42,000
Gross heat loss:	323,464 Btu/hr	526,807 Btu/hr
Net loss:	- 284,328	- 464,763
Tons of air conditioning (With economizer)	94.2	144.8

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

function	existing	future expansion
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	1,364	1,364
TOTAL	25,031 sq.ft.	42,031 sq.ft.

XIII.BUILDING OCCUPANTS AND THEIR DISTRIBUTION

	25,000		42,000	
type	first shift/	second shift	first shift/	second shift
production	86	64	150	150
visitors/office	10	2	14	2
TOTAL	96	66	164	152

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 0.6kw x 0.7DF = 25
fuser 1 x 5.0kw = 5
hand irons: 6 x 2.0kw = 12
presses: 13 x 0.1kw = 1.3
cutting equipment: 0.6
TOTAL 43.9 kw

b. Lighting: 48.8 kw

c. Air handling equipment, fan coil fans: 2 x 3.6FLA = 2.7 kw
compressors: 5 x 37.0FLA = 147.4 (1)
indoor fans: 5 x 2 x 6.6 FLA = 26.3
TOTAL 176.4

d. Process equipment, boiler fan: 1.8FLA = 1.4kw (1)
boiler feed/return pump: 2.6FLA = 2.0
vacuum pump: 27FLA = 21.5
compressor: 11FLA = 8.8
TOTAL 33.7kw x 0.75DF = 25.3kw

e. Heating/cooling system pumps: 2.8FLA = 1.1kw
4.4FLA = 0.5
1.6kw

f. Domestic hot water heater: 2 - 4500w elements: 4.5kw

g. Miscellaneous fans 2.0kw
TOTAL ELECTRICAL LOAD + 302.5kw

II. PROCESS STEAM

a. Steam flow, 40hp 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) = 1.42×10^6 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.

25,000 sq.ft.

III. COOLING CALCULATIONS

a. Cooled space, (equipment and storage rooms not included) 17,077 sq.ft.

b. Roof/ceiling: 17,077 sq.ft. x 0.03 x 52°F = 26,640 Btu/hr

c. Walls, ext. N: 46' x 9' x 0.05 x 14°F =
E: 72.5' x 9' x 0.05 x 14°F =
S: 203.5' x 9' x 0.05 x 20°F =
W: 123' x 9' x 0.05 x 28°F = 4,128
int. N: 157.5' x 13' x 0.31 x 17°F =
E: 50.5' x 13' x 0.31 x 17°F = 14,250 *

d. Glass, windows, W: 5 x 12 sq.ft. x 0.9 x 148 Btu/hr/sq.ft. 7,992
5 x 12 sq.ft. x 0.58 x 17°F = 592
entry, W: 88 sq.ft. x 0.95 x 148 Btu/hr/sq.ft. = 12,373
88 sq.ft. x 1.13 x 17°F = 1,910

e. *

f. Lighting: 43.7 x 3413 Btu/hr/kw = 149,148

g. People: (86 x 275) + (10 x 250) = 26,150

h. Process machinery: 43.9 x 3413 Btu/hr/kw = 149,830

i. Pipe gains, steam: 60' x 46 Btu/ft. = 2,760
4 x 90' x 37 = 13,320
13 x 10' x 28 = 3,640
19,720

condensate: 60' x 18 Btu/ft. = 1,080
4 x 90' x 15 = 5,400
13 x 10' x 12 = 1,560
8,040

Total pipe gains = 27,760 *

j. Presses, sensible:
3.09 Btu/hr/sq.ft. °F x 6 sq.ft. x 220°F = 4,079
2.79 x 6 x 220 = 3,683
2.06 x 6 x 140 = 1,730
2.61 x 6 x 140 = 2,192
11,684 x 13 = 151,892

k. Fan heat: 26.3 x 3413 Btu/hr/kw = 89,762

l. Domestic hot water heater: 0.10* x 1.09 x 10 Btu/hr 1,090
* (Est.)

TOTAL ROOM SENSIBLE HEAT = 663,517 *

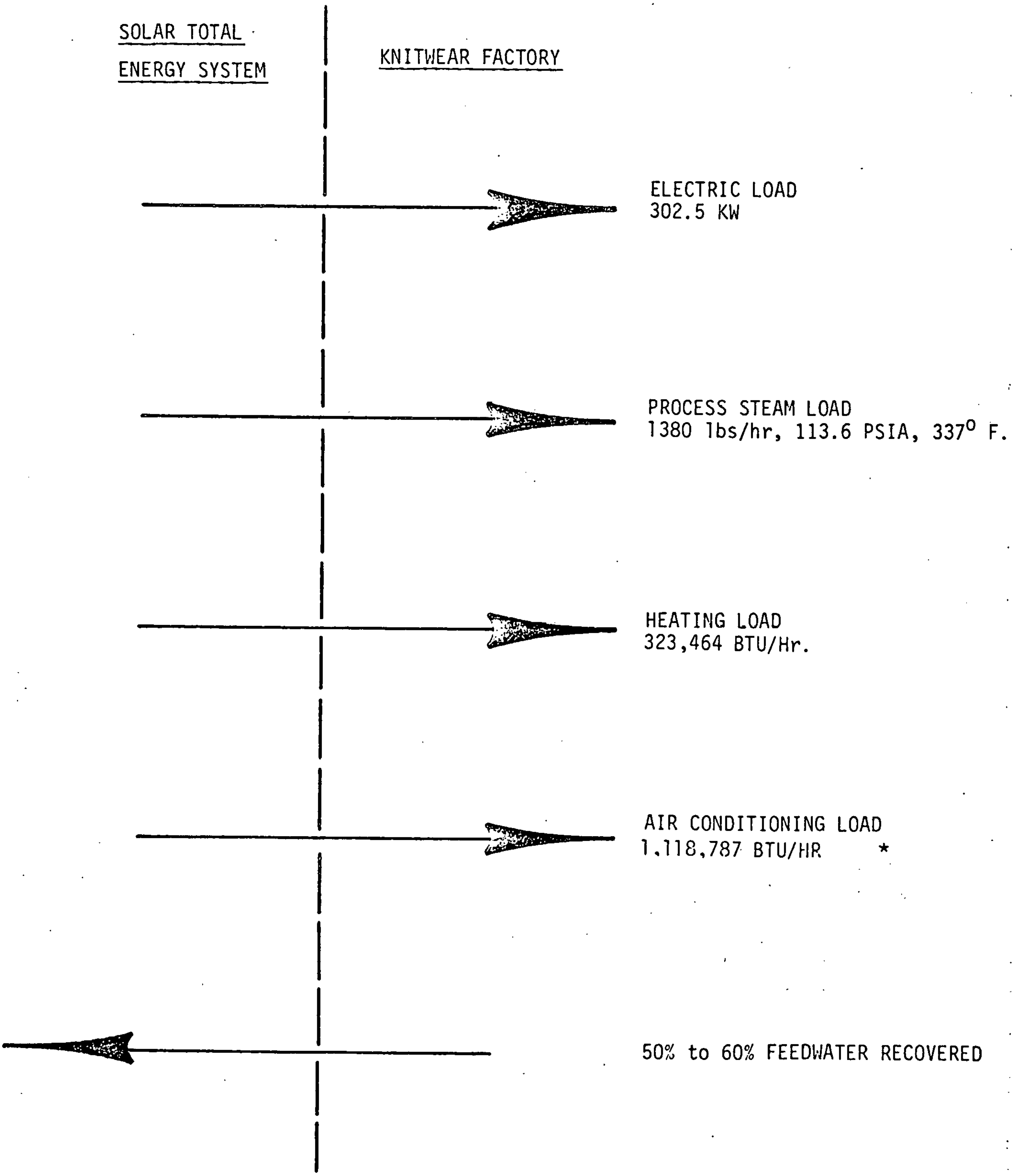
COOLING CALCULATIONS (Cont'd.)

m.	People, latent: (86 x 475 + (10 x 200)	=	42,850	
n.	Process steam, latent (est.): 1380#/hr x 0.10 x 1190	=	164,220	
	TOTAL ROOM HEAT	=	870,587 Btu/hr.	*
O.	Ventilation and infiltration, sensible: 5000 (95^oF - 78) x 1.08	=	91,800	
p.	Ventilation and infiltration, latent: 5000 (118 grns./# - 72) x 0.68	=	156,400	
	GRAND TOTAL HEAT	=	1,118,787 Btu/hr. or 93.2 tons	* *

IV. HEATING CALCULATIONS

a. Heated space, (equipment room not included) 23,677 sq. ft.

b.	Roof/ceiling: 23,677 sq.ft. x 0.03 x 47^oF	=	33,385 Btu/hr.	
c.	Walls: 653' x 10' x 0.05 x 47^oF	=	15,345	
d.	Glass, windows: 5 x 12 sq.ft. x 0.58 x 47^oF	=	1,636	
	entry: 88 sq.ft. x 1.13 x 47^oF	=	4,674	
e.	Loading dock doors: 2 x 100 sq.ft. x 1.0 x 47^oF	=	9,400	
f.	Perimeter: 653' x 4' x 2 Btu/hr/sq.ft.	=	5,224	
g.	Ventilation and infiltration: 5000 x 47^oF x 1.08	=	253,800	
	GROSS HEAT LOSS	=	323,464 Btu/hr	
h.	Internal gains, lighting:		149,148	
	people:		26,150	
	machinery:		149,830	
	pipe gains :		27,760	*
	presses:		151,892	
	fans:		89,762	
	water heater:		1,090	
			595,632	*
	TOTAL HEAT LOSS (GAIN)	=(-)	272,168	*



25,000 sq ft KNITWEAR FACTORY
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: = 0.6
TOTAL 81.1 kw

b. Lighting:
12.8 kw + 32.4 kw (22,621/10,621) + 3.6kw(11,590/6,590) = 88.1 kw

c. Air handling equipment, fan coil fans:
2.7 kw (11,590/6,590) = 4.8
indoor fans:
26.3 kw (29,077/17,077) = 44.8
TOTAL 49.6 kw

d. Process equipment, boiler feed/return pump: 2.6 FLA = 2.0 kw
vacuum pump: 27 FLA = 21.5
compressor: 11 FLA = 8.8
TOTAL 32.3 kw

e. Heating/cooling system pumps: 1.6

f. Miscellaneous fans 2.0

g. Water Heater 4.5
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) = 1.42×10^6 Btu/hr.

f. Lost fluid, 0.25 x 1380#/hr = 345#/hr

42,000 sq. ft.

III. COOLING CALCULATIONS

a.	Cooled space, (equipment and storage rooms not included)	29,077 sq.ft.
b.	Roof/ceiling: 29,077 sq. ft. x 0.03 x 52^{o}F =	45,360 Btu/hr
c.	Walls, ext. N: 46' x 9' x 0.05 x 14^{o}F =	
	E: 77' x 9' x 0.05 x 14^{o}F =	
	S: 268.5' x 9' x 0.05 x 20^{o}F =	
	W: 156.5' x 9' x 0.05 x 28^{o}F =	5,164
	int.N: 222.5' x 13' x 0.31 x 17^{o}F =	*
	E: 77' x 13' x 0.31 x 17^{o}F =	20,518 *
d.	Glass, windows, W: 5 x 12 sq.ft. x 0.9 x 148 BTU/hr.sq.ft=	7,992
	5 x 12 sq.ft. x 0.58 x 17^{o}F =	592
	entry: W: 88 sq.ft. x 0.95 x 148 Btu/hr/sq.ft. =	12,373
	88 sq.ft. x 1.13 x 17^{o}F =	1,910
e.		*
f.	Lighting: 81.8 kw x 3413 Btu/hr/kw =	279,183
g.	People: (150 x 275) + (14 x 250) =	44,750
h.	Process machinery: 81.1 kw x 3413 Btu/hr/kw =	276,794
i.	Pipe gains: 27,760 Btu/hr (22,621/10,621) =	59,124 *
j.	Presses, sensible =	151,892
k.	Fan heat: 89,762 Btu/hr (29,077/17,077) =	152,838
l.	Domestic hot water system: 0.10(est.) x 1.09 x 10^{4} Btu/hr=	1,090
	TOTAL ROOM SENSIBLE HEAT =	1,059,580 Btu/hr. *
m.	People, latent: (150 x 475) + (14 x 200) =	74,050
n.	Process steam, latent (est.): 1380#/hr x 0.10 x 1190 =	164,220
	TOTAL ROOM HEAT =	1,297,850 *
o.	Ventilation and infiltration, sensible: 8400(95^{o}F - 78) x 1.08 =	154,224
p.	Ventilation and infiltration, latent: 8400(118 grns./# - 72) x 0.68 =	262,752
	GRAND TOTAL HEAT =	1,714,826 Btu/hr or * 142.9 TONS*

42,000 sq.ft.

IV. HEATING CALCULATIONS

a. Heated space, (equipment room not included) 40,667 sq.ft.

b. Roof/ceiling: 40,667 sq.ft. x 0.03 x 47^{O}F = 57,340 Btu/hr.

c. Walls: 869' x 10'x 0.05 x 47^{O}F = 20,421

d. Glass, windows: 5 x 12 sq.ft. x 0.58 x 47^{O}F = 1,636
entry: 88 sq.ft. x 1.13 x 47^{O}F = 4,674

e. Loading dock doors: 2 x 100 sq.ft. x 1.00 x 47^{O}F = 9,400

f. Perimeter: 869' x 4' x 2 Btu/hr/sq.ft. = 6,952

g. Ventilation and infiltration: 8400 x 47^{O}F x 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 *

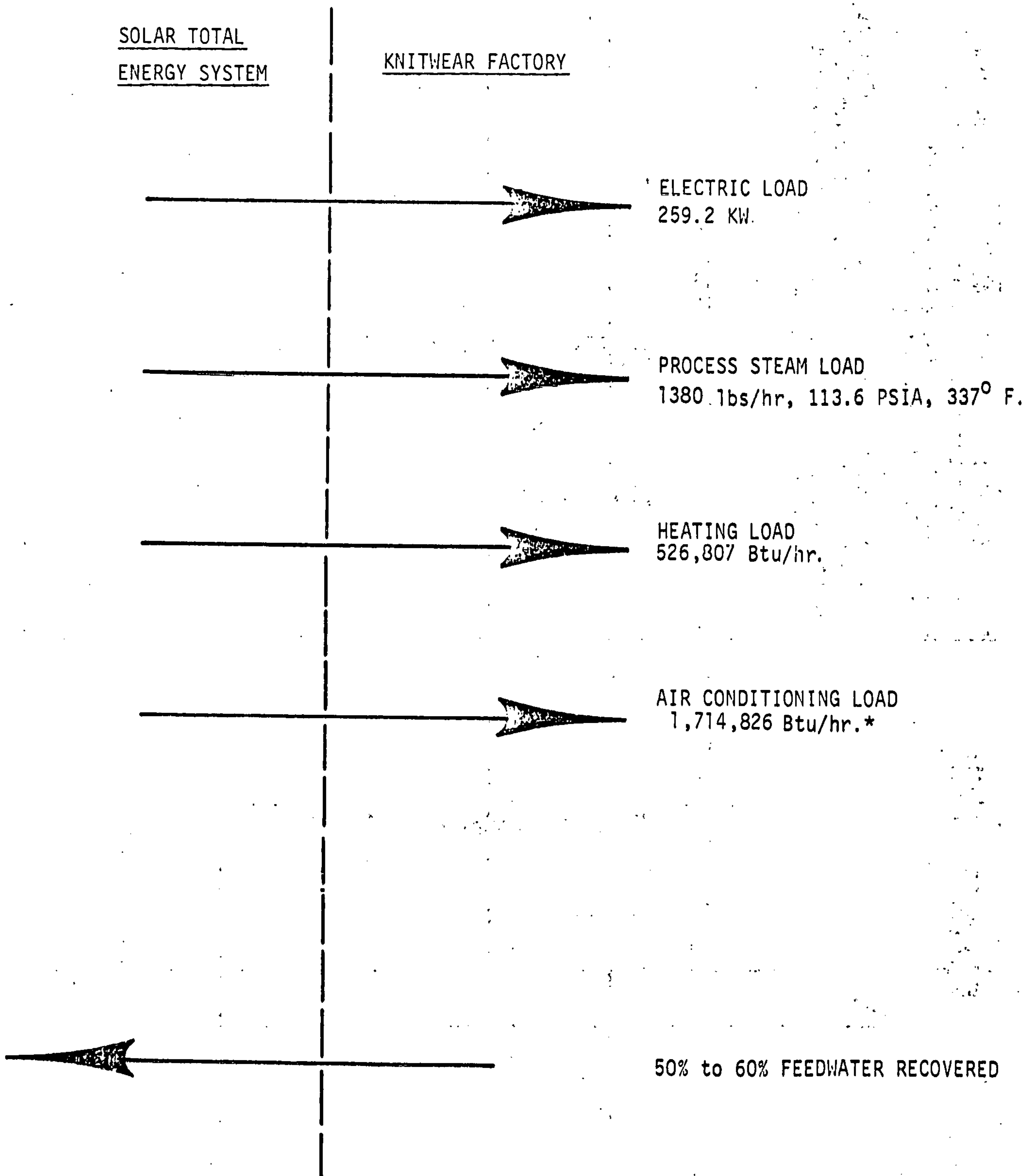
V. DOMESTIC HOT WATER

a. Minimum storage: 35 gallons

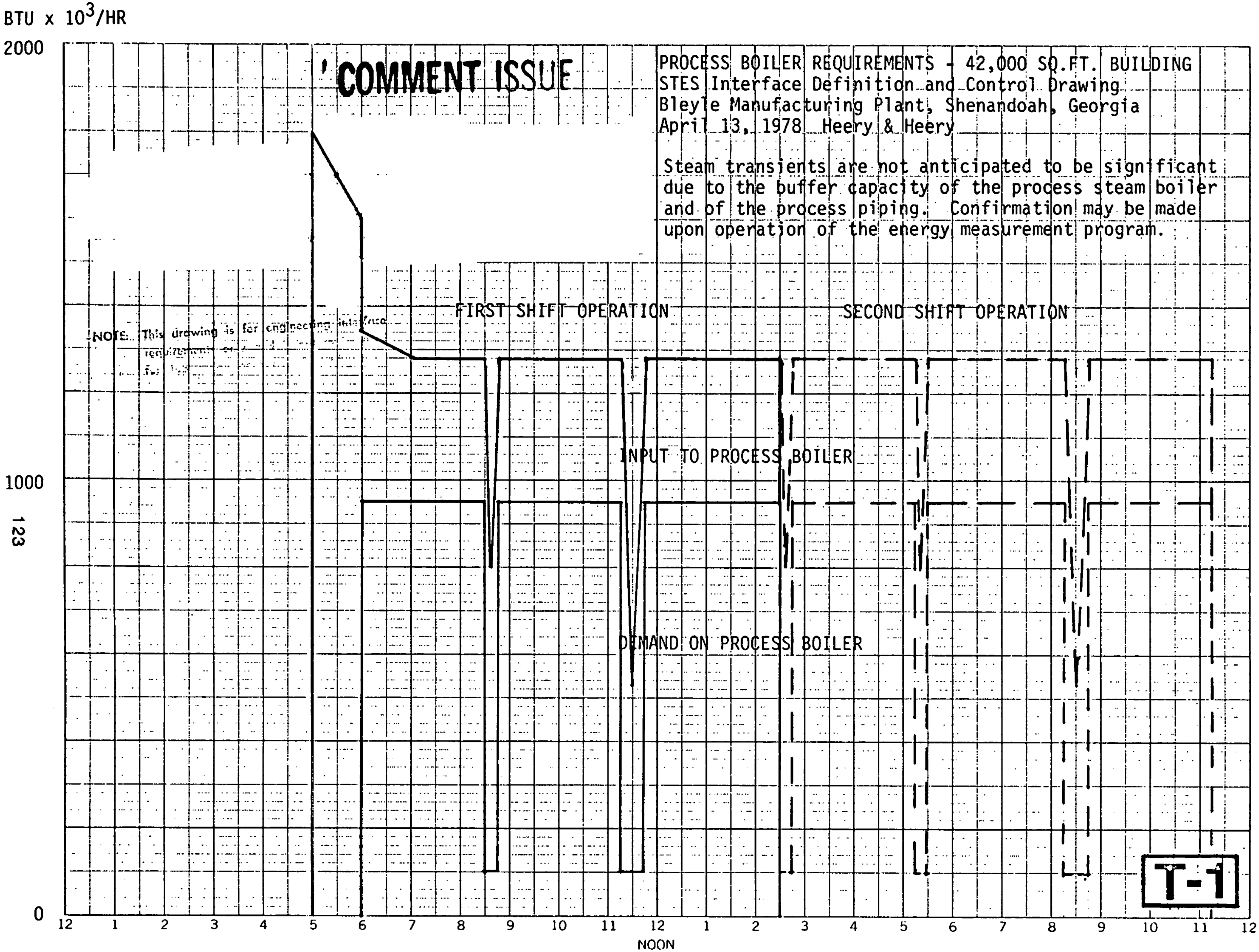
b. Minimum demand: 26 GPH

c. Temperature, 110^{O}F (hand washing only)

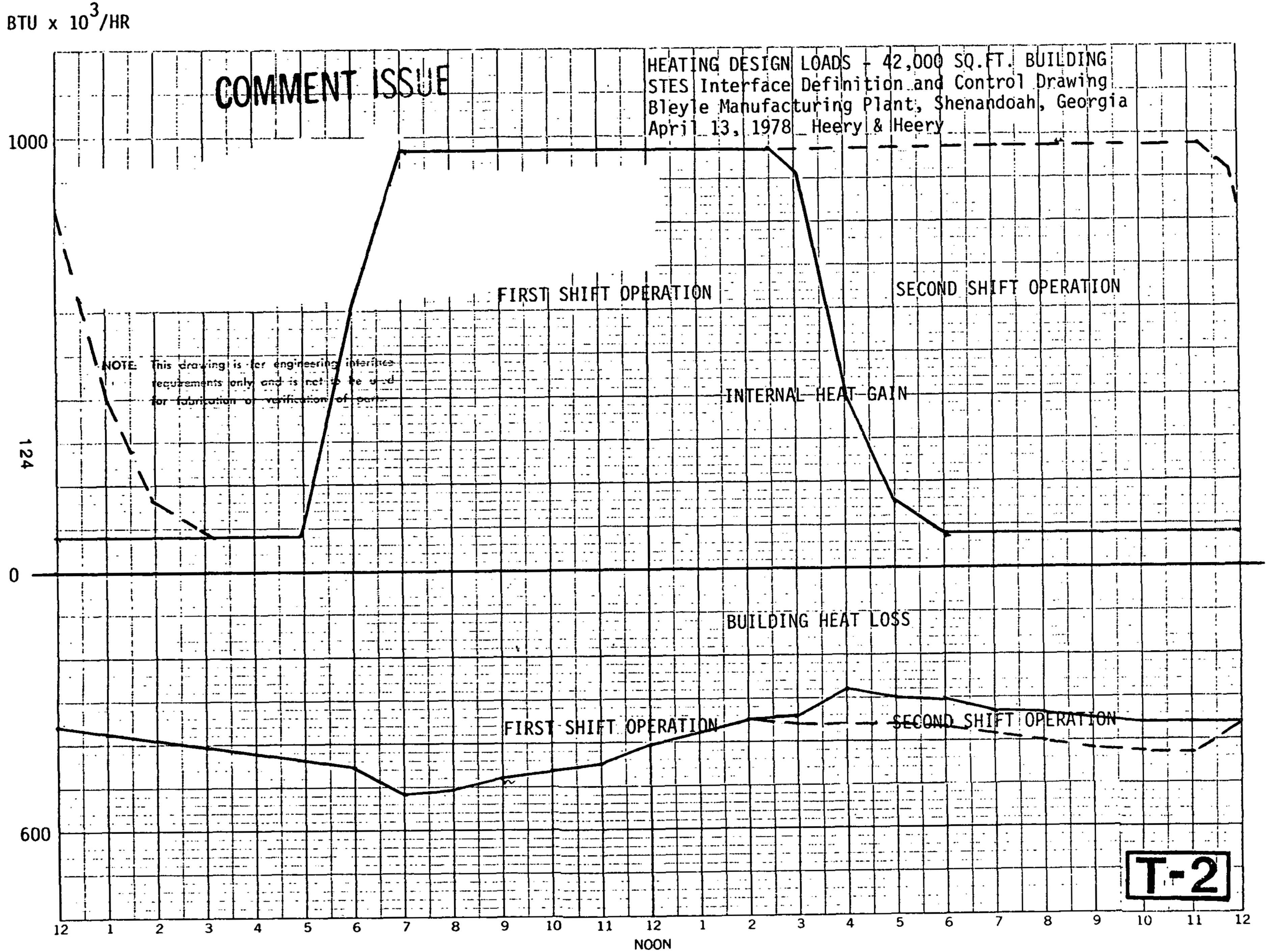
d. Demand: 26 GPH x 8.35#/gal(110^{O}F - 60^{O}F) x 1.0 = 1.086×10^4 Btu/hr

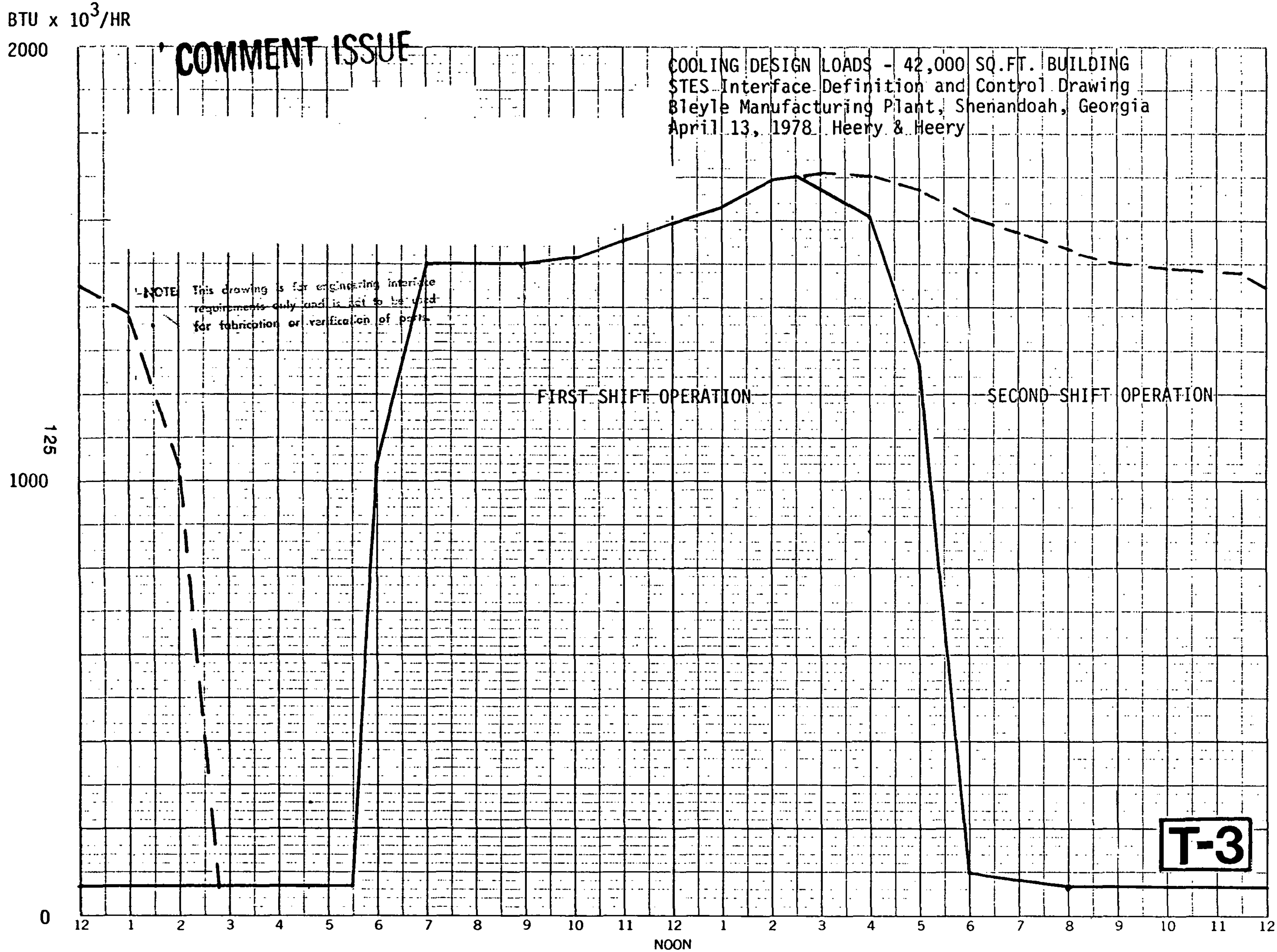


42,000 sq ft KNITWEAR FACTORY
ANTICIPATED LOADS

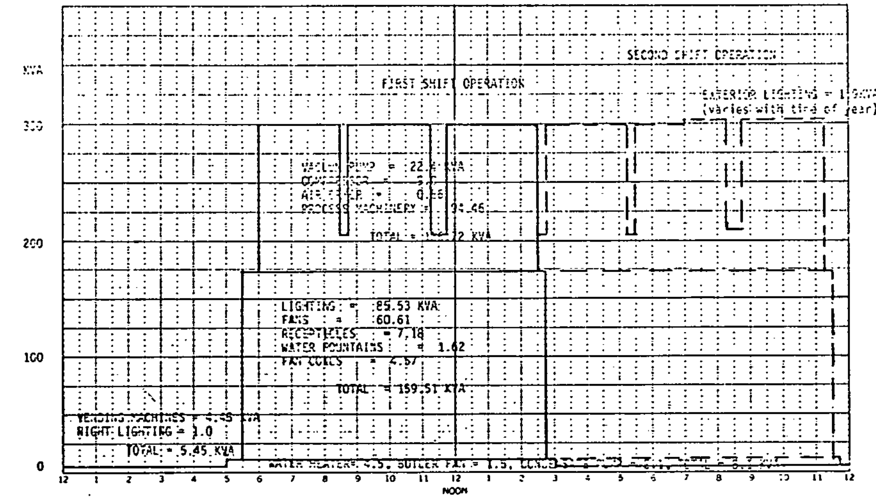


BTU x 10³/HR
2000
1000
0
' COMMENT ISSUE
PROCESS BOILER REQUIREMENTS - 42,000 SQ.FT. BUILDING
STES Interface Definition and Control Drawing
Bleyle Manufacturing Plant, Shenandoah, Georgia
April 13, 1978 Heery & Heery
Steam transients are not anticipated to be significant due to the buffer capacity of the process steam boiler and of the process piping. Confirmation may be made upon operation of the energy measurement program.
NOTE: This drawing is for engineering interface
FIRST SHIFT OPERATION
SECOND SHIFT OPERATION
INPUT TO PROCESS BOILER
DEMAND ON PROCESS BOILER
T-1
12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
1
2
3
4
5
6
7
8
9
10
11
12


BTU x 10^3/HR
COMMENT ISSUE
HEATING DESIGN LOADS - 42,000 SQ.FT. BUILDING
STES Interface Definition and Control Drawing
Bleyle Manufacturing Plant, Shenandoah, Georgia
April 13, 1978 Heery & Heery
1000
FIRST SHIFT OPERATION
SECOND SHIFT OPERATION
INTERNAL HEAT GAIN
0
BUILDING HEAT LOSS
FIRST SHIFT OPERATION
SECOND SHIFT OPERATION
600
T-2
12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
1
2
3
4
5
6
7
8
9
10
11
12



BTU x 10^3/HR
COMMENT ISSUE
COOLING DESIGN LOADS - 42,000 SQ.FT. BUILDING
STES Interface Definition and Control Drawing
Bleyle Manufacturing Plant, Shenandoah, Georgia
April 13, 1978 Heery & Heery
NOTE: This drawing is for engineering interface requirements only and is for fabrication or verification of parts.
FIRST SHIFT OPERATION
SECOND SHIFT OPERATION
2000
1000
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
NOON
T-3



TYPICAL ELECTRICAL LOAD PROFILES WITH TWO SHIFTS (STEADY STATE)

42 000 SQ.FT. BUILDING

TOTAL LOAD 301.68 KVA

'COMMENT ISSUE

OPERATING SCHEDULE

FIRST SHIFT: 6:00 AM - 2:30 PM
BREAK: 6:30 - 8:45 AM
LUNCH: 11:15 - 11:45 AM

SECOND SHIFT: 2:45 - 11:15 PM
BREAK: 5:15 - 5:30 PM
DINNER: 8:15 - 8:45 PM

TYPICAL ELECTRICAL LOAD TRANSIENTS

CODR - E-1-1 GPC WHEN AVAILABLE

'COMMENT ISSUE

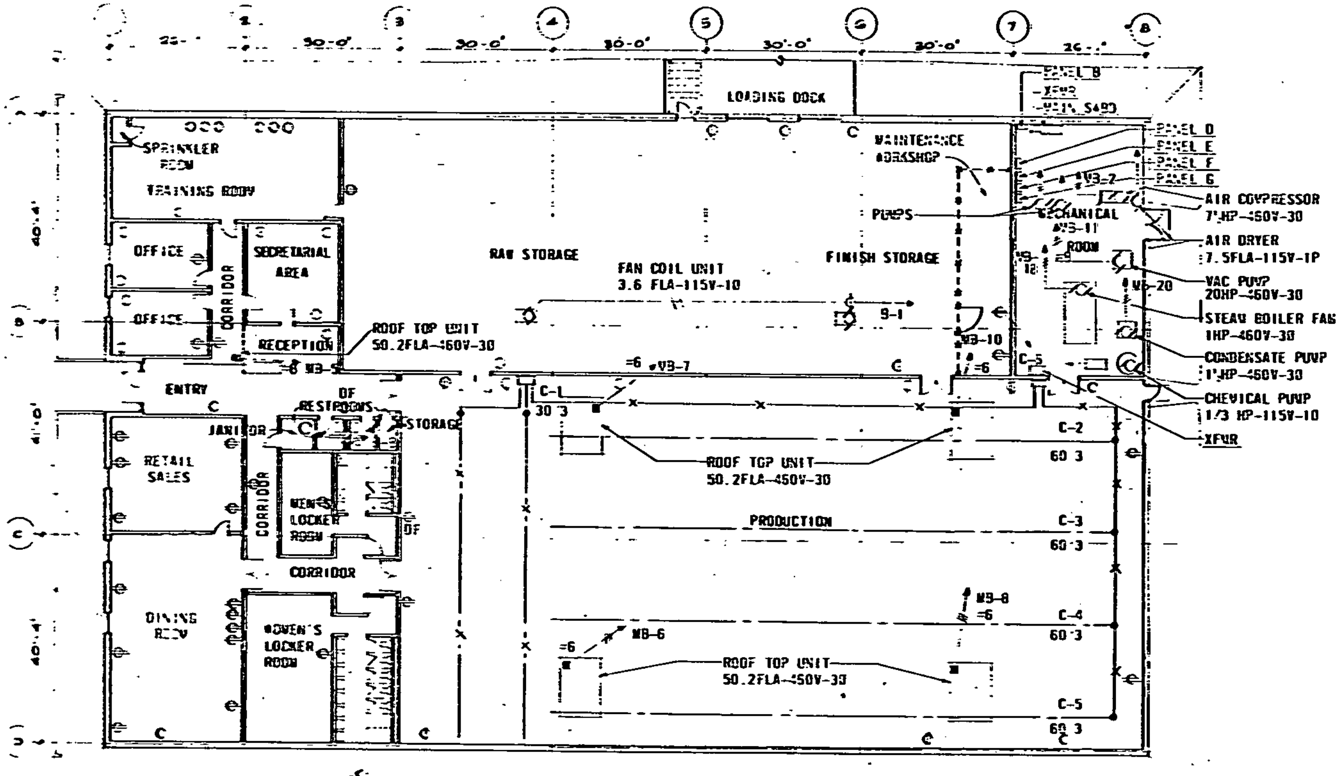
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

ELECTRICAL LOAD PROFILE

10/20/77
1/10/78
2/8/78
4/7/78

E-1



COMMENT ISSUE

ELECTRICAL WIRING DIAGRAM

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

COMMENT ISSUE

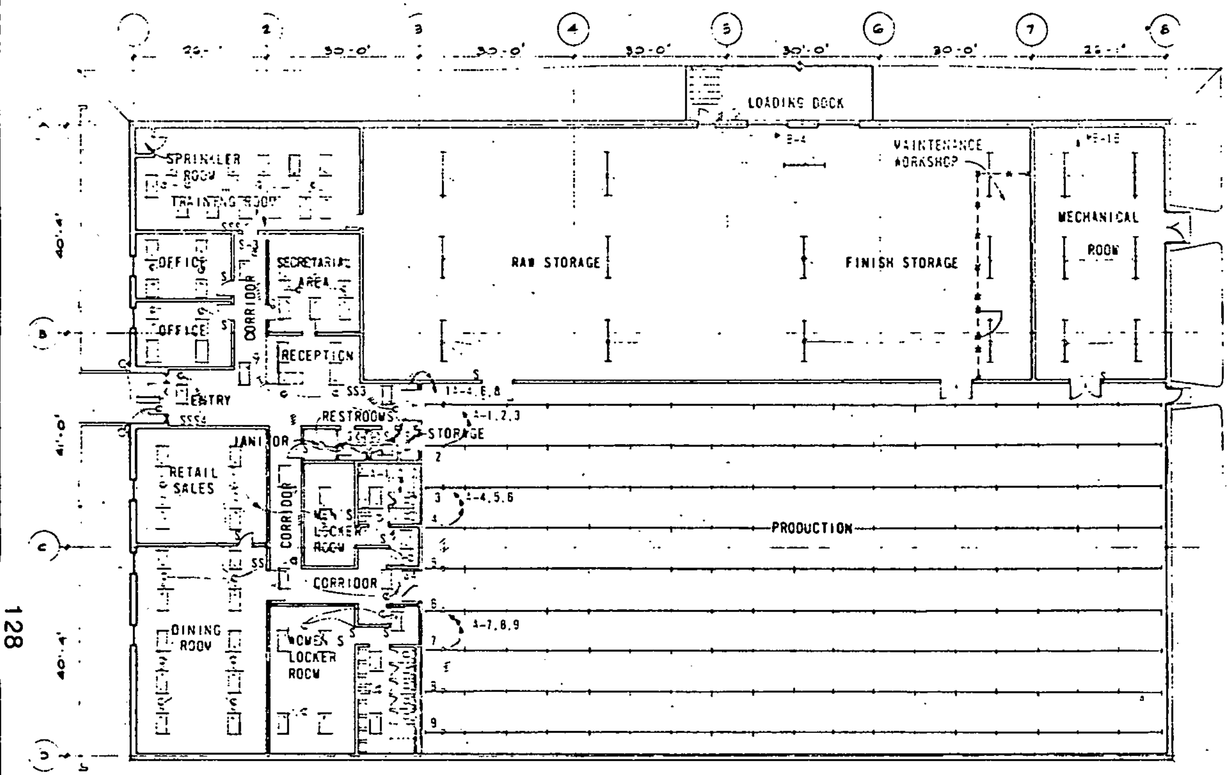
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

ELECTRICAL WIRING DIAGRAM

5-30-78

E-2



COMMENT ISSUE

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

COMMENT ISSUE

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

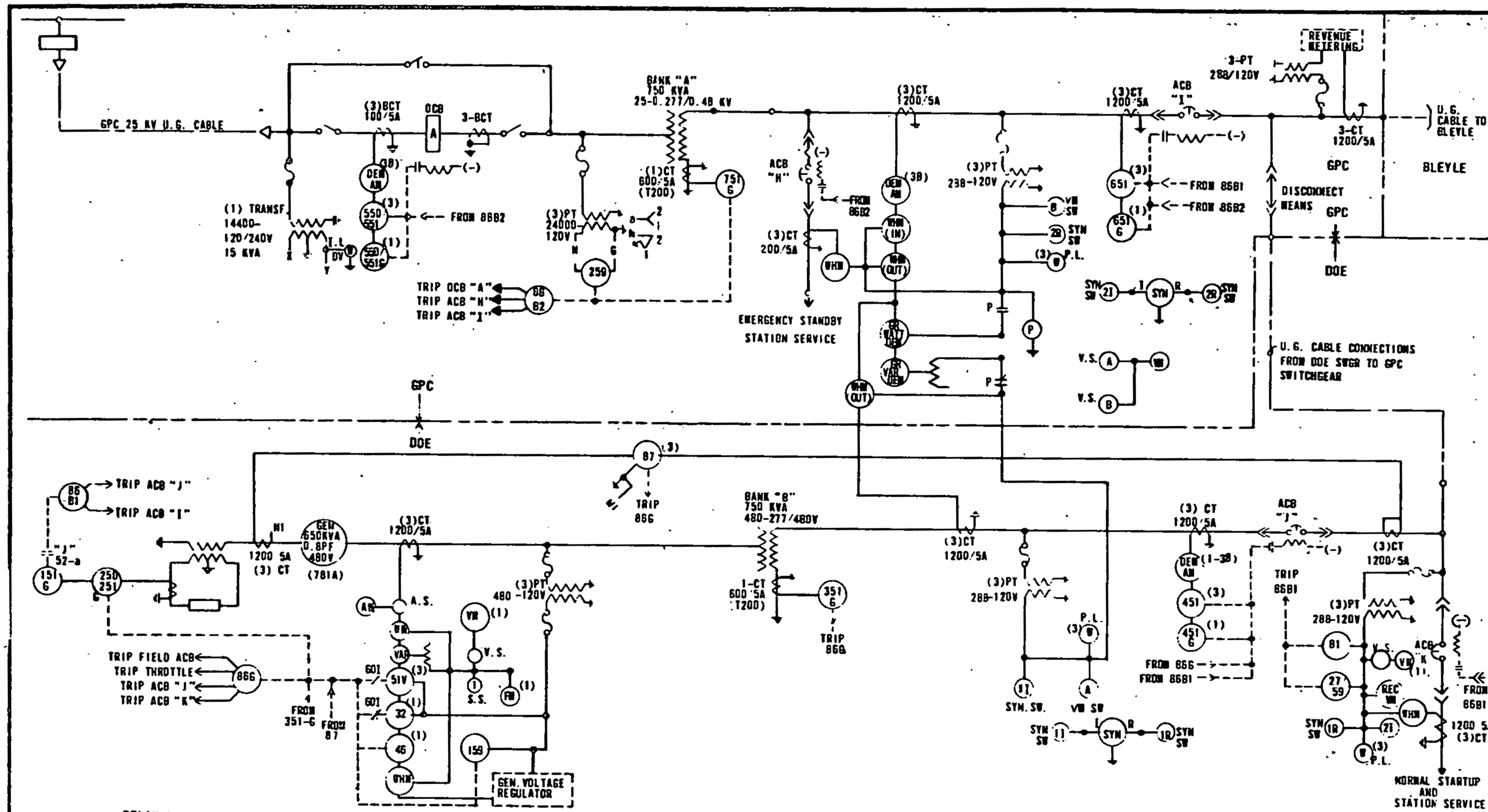
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

LIGHTING PLAN

5-30-78

E-2a



RELAY LIST

DEVICE NO.	QUAN.	MODEL NO. AND RANGE	FUNCTION
550/551	3	WHSE CAT #CO-9H1111N(1-12T)(6-144I)	H.S. BUOC BANK A
550/551-G	1	WHSE CAT #CO-9H1111N(1-12T)(6-144I)	H.S. BU GND BANK A
259	1	GE MOD #12IAV51D1A(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"
86B2	1	GE MOD #12HEA61B236(6-NO.4-NC)	AUX. LOCKOUT RELAY
27/59	1	GE MOD #12IAV69A1A(55-140V)	UNDER- & OVER-VOLTAGE
32	1	GE MOD #12GGP53B1A(0.025-3A)(1.5-30 SEC)	ANTI-MOTORING RELAY
46	1	GE MOD #12INC77B3A(WITH ALARM UNIT)	NEG. SEQUENCE RELAY
51V	3	GE MOD #12IJCV51A18A(2-8T)	VOLT RESTR PHASE O.C. POTENTIAL INTERLOCK
86B1	1	GE MOD #12HEA61B236(6-NO.4-NC)	AUX. LOCKOUT RELAY
86G	1	GE MOD #12HEA61B236(6-NO.4-NC)	AUX. LOCKOUT RELAY
87	3	WHSE STY #HU- #290B346A21(HU-2 REST.)	UNIT DIFFERENTIAL
81	1	GE MOD #12SFF21A1A(4-80 CY)	UNDERFREQUENCY
151-G	1	WHSE CAT #CO-9L1101N(0.5-2.5T)	GEN GND -B.F. "J"
159	1	GE MOD #12IAV51A1A(55-140V)	GEN OVERVOLTAGE
250/251-G	1	WHSE CAT #CO-9L1111N(0.5-2.5T)(2-48)	GEN. GROUND
351-G	1	WHSE CAT #CO-9H1101N(1-12T)	L.S. B.U GND-BANK B
451	3	WHSE CAT #CO-9H1101N(1-12T)	PHASE O.C.-ACB "J"
451-G	1	WHSE CAT #CO-9H1101N(1-12T)	GND O.C.-ACB "J"

SINGLE LINE
ELECTRICAL LOAD INTERCONNECTION

NOTES:

1) ALL CURRENT TRANSFORMERS USED FOR RELAYING SHALL BE RATED "C" OR T200 OR BETTER.
2) STES GENERATOR AND TRANSFORMER SIZES MAY BE CHANGED SUBJECT TO GPC REQUIREMENTS. DETAILED ON DRAWING E-4.

NOTE: This drawing is for engineering interface 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
SINGLE LINE ELECTRICAL LOAD INTERCONNECTION

10/20/77 — 1/25/78 — 2/8/78 — 4/7/78

HIBBERY & HIBBERY

E-3

130

GEORGIA POWER REQUIREMENTS ON STES ELECTRICAL INTERFACE AT THE BLEYLE PLANT

1. 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 SEE 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 ±5%
      UNDER TRANSIENT LOAD CHANGES OF ±10% THE VOLTAGE REGULATION WILL BE ALLOWED TO BE ±7½% WITH FREQUENCY REGULATION OF ±½%

FREQUENCY REGULATION	– 60 Hz ±½%
MAXIMUM VOLTAGE WAVEFORM DISTORTION	– 5%
REQUIRED POWER OUTPUT (MINIMUM NET PEAK TO BLEYLE AT GPC 480 VOLT BUS)	– 300 KW @ 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.

"COMMENT ISSUE"

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

A. POWER CIRCUIT BREAKER, RATED 25kV, 1200A, 500 MVA, 3Ø, USED TO PROTECT THE TRANSFORMERS (XX), (F) AND THE 25kV DISTRIBUTION LINE (UD) FROM FAULTS, ETC. QUANTITY – 1

B. BREAKER ISOLATING SWITCHES RATED 23kV (NOM.), 1200A, SPST, GANG OPERATED, USED TO ISOLATE THE BREAKER (BK-A) FOR MAINTENANCE PURPOSES. QUANTITY – 6

C. BREAKER BYPASS SWITCH, RATED 23kV (NOM.), 1200A, 3 PST, GANG OPERATED, 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 LOAD 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, 1Ø, 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 1–3Ø, 750kVA, 25–277/480kV, 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 1–3Ø

G. POWER CIRCUIT BREAKER, 3Ø, 480V. USED TO PROVIDE STATION SERVICE TO THE SOLAR TURBINE GENERATOR AND SOLAR FURNACE INSTALLATION DURING STARTUPS. QUANTITY – 1

H. POWER CIRCUIT BREAKER, 3Ø, 480V. USED TO CONNECT THE TRANSFORMER TO THE LOWSIDE IN THE SUBSTATION AND TO PROTECT THE LOWSIDE BUS AND THE SUBSTATION FROM FAULTS. QUANTITY – 1

I. POWER CIRCUIT BREAKER, 3Ø, 480V. USED TO SYNCHRONIZE AND CONNECT AND DISCONNECT THE STES GENERATOR-TRANSFORMER TO THE GPC BUS AND PROTECT THE GENERATOR AND GSU TRANSFORMER AND GPC BUS FROM FAULTS. QUANTITY

K. POWER CIRCUIT BREAKER, 3Ø, 480V. USED TO SUPPLY STATION SERVICE TO THE STES GENERATOR AND SOLAR FURNACE INSTALLATION DURING RUNNING CONDITIONS AND PROTECT THE GENERATOR-TRANSFORMER FROM FAULTS. QUANTITY – 1

L. POTENTIAL TRANSFORMERS RATED 480–120V. CONNECTED GROUNDED WYE-GROUNDED WYE. USED TO SYNCHRONIZE THE GENERATOR WITH THE GPC BUS, ETC. QUANTITY – 3

M. POWER TRANSFORMER, 3–1Ø, 480–480V, 750kVA. CONNECTED DELTA-WYE GROUNDED. USED TO PROVIDE SHORT CIRCUIT PROTECTION FOR THE GENERATOR AND REDUCE HARMONICS. QUANTITY – 3–1Ø

N. TURBO-GENERATOR, WYE GROUNDED, 3Ø, 650kVA, 0.8 PF, 480 VOLTS. USED TO GENERATE ELECTRICAL POWER FROM THE STES SYSTEM. QUANTITY – 1

O. GENERATOR NEUTRAL GROUNDING TRANSFORMER WITH RESISTOR. USED TO PROVIDE GROUND FAULT PROTECTION TO THE GENERATOR AND SUPPRESS UNWANTED RESONANCES. TRANSFORMER AND RESISTOR RATING TO BE AS SPECIFIED BY THE GPC SYSTEM PROTECTION ENGINEER AFTER SELECTION OF THE GENERATOR AND TRANSFORMER (GSU). QUANTITY – 1 EACH

P. POTENTIAL TRANSFORMERS RATED 208–120V. CONNECTED WYE GROUNDED-WYE GROUNDED. QUANTITY: DOE SIDE 6, GPC SIDE 6

Q. POTENTIAL TRANSFORMERS RATED 24000–120 VOLTS. USED ON THE HIGH SIDE OF THE GPC SUBSTATION. QUANTITY – 3

R. CURRENT TRANSFORMERS, RATED 1200/5 AMPERE, RELAYING ACCURACY C200, T200 OR BETTER. QUANTITY DOE SIDE 15, GPC SIDE 3.

S. CURRENT TRANSFORMER, RATED 600/5 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 B0.1 THROUGH B2.0. QUANTITY, DOE SIDE 3, GPC SIDE 3.

U. CURRENT TRANSFORMER, RATED 200/5 AMPERE, METERING ACCURACY CLASS 0.3 FOR BURDENS B0.1 THROUGH B2.0. QUANTITY, DOE SIDE 3, GPC SIDE 3.

V. CURRENT TRANSFORMER, RATED 1200/5 AMPERE, METERING ACCURACY CLASS 0.3 FOR BURDENS B0.1 THROUGH B2.0. FOR REVENUE METERING BY GPC. QUANTITY – 3

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

ELECTRICAL LOAD INTERCONNECTION DETAILS AND POWER QUALITY

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

date	revisions
1/28/78	2/6/78
	4/7/78

drawn | checked | approved

HEERY & HEERY

E-4

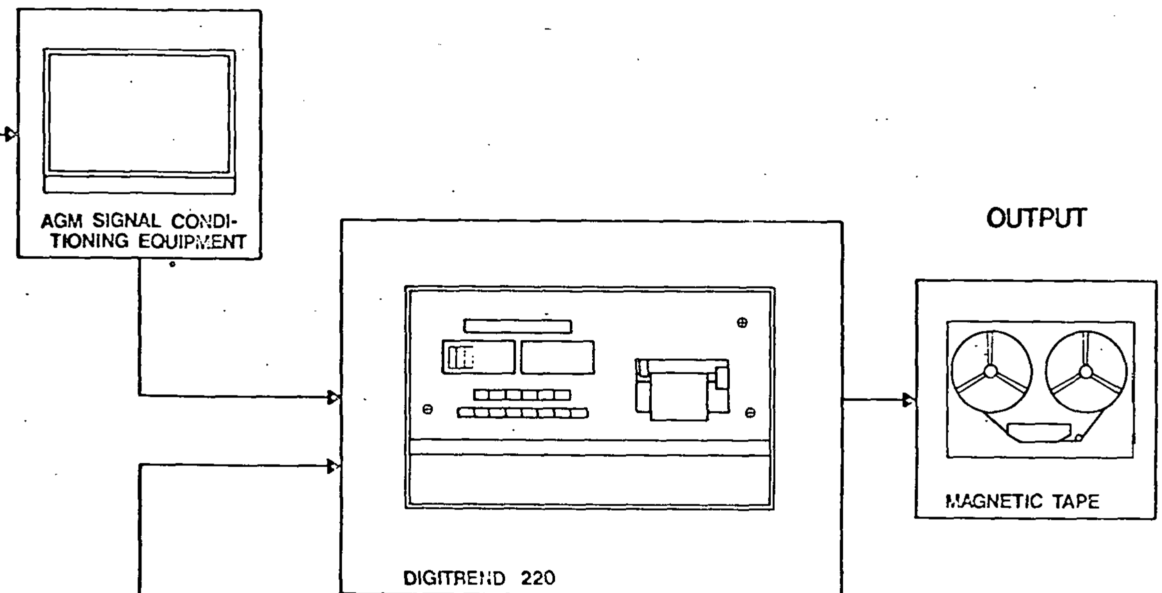
[4]

INPUTS

CHANNEL

0 SELF TEST OF DORIC DIGITREND 220
1 MAIN BUILDING SERVICE
2 INTERIOR LIGHTING (OFFICE)
3 INTERIOR LIGHTING (PRODUCTION)
4 INTERIOR LIGHTING (STORAGE)
5 RECEPTACLES/OFFICE MACHINES
6 RECEPTACLES/PRODUCTION AND STORAGE
7 FOOD SERVICE/VENDING MACHINES
8 BATTERY CHARGER
9 SEWING MACHINES-PRESSES/HANDIRONS/FUSER (BUS DUCT)
10 CUTTING KNIVES (TROLLEY DUCT)
11 VACUUM PUMP
12 FEED WATER PUMP-PROCESS BOILER
13 HOT WATER PUMP-DUAL TEMPERATURE BOILER
14 REHEAT PUMP (HOT WATER) OFFICE AREA
15 AIR COMPRESSORS (1) AND AIR DRYER
16 BOILER FAN (PROCESS)
17 WATER SOFTENER
18 DOMESTIC WATER HEATER
19 AIR HANDLING FAN (OFFICE)
20 AIR HANDLING FANS (PRODUCTION)
21 COMPRESSOR/CONDENSER FANS (OFFICE)
22 COMPRESSOR/CONDENSER FANS (PRODUCTION NE)
23 COMPRESSOR/CONDENSER FANS (PRODUCTION SE)
24 COMPRESSOR/CONDENSER FANS (PRODUCTION SW)
25 COMPRESSOR/CONDENSER FANS (PRODUCTION NW)
26 FAN COIL UNITS (STORAGE) (2)
27 EXHAUST FAN (BOILER ROOM)
28 HEAT TRANSFER FANS (2)

29-33 SUPPLY AIR TEMPERATURE-A/C UNITS
34-38 RETURN AIR TEMPERATURE-A/C UNITS
39-43 ENTERING TEMPERATURE-WATER COIL (5)
44-48 LEAVING TEMPERATURE-WATER COIL (5)
49-50 SUPPLY AIR TEMP-STORAGE FAN COIL UNITS
51-52 RETURN AIR TEMP-STORAGE FAN COIL UNITS
53-54 ENTERING COIL TEMP-STORAGE FAN COIL UNITS
55-56 LEAVING COIL TEMP-STORAGE FAN COIL UNITS
57 DUAL-TEMP BOILER SUPPLY TEMP
58 DUAL-TEMP BOILER RETURN TEMP
59 DOMESTIC HOT WATER TEMPERATURE
60 PROCESS STEAM TEMPERATURE
61 PROCESS BOILER CONDENSATE RETURN TEMP
62 PROCESS BOILER MAKE UP TEMP
63 PROCESS BOILER BLOW DOWN TEMP
64-67 SPACE TEMP (PROD-2, OFFICE AND STORAGE AREAS)
68 ENTERING TEMPERATURE-REHEAT COIL
69 LEAVING TEMPERATURE-REHEAT COIL
70-73 SPACE HUMIDITY (PROD-2, OFFICE, STORAGE AREAS)
74-75 DX COOLING COIL ENTERING HUMIDITY
76-77 DX COOLING COIL LEAVING HUMIDITY
78 FOSSIL FUEL FLOW TO HOT WATER BOILER
79 FOSSIL FUEL FLOW TO PROCESS BOILER
80 HEATING/COOLING CIRCUIT FLOW
81 REHEAT COIL FLOW
82 DOMESTIC HOT WATER FLOW
83 PROCESS STEAM FLOW
84 PROCESS BOILER MAKE UP FLOW
85 PROCESS BOILER BLOWDOWN FLOW
86 PROCESS STEAM PRESSURE



DATA GATHERING SYSTEM

AGM PULSE ACCUMULATOR TO ANALOG CONVERTOR TA 4000 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

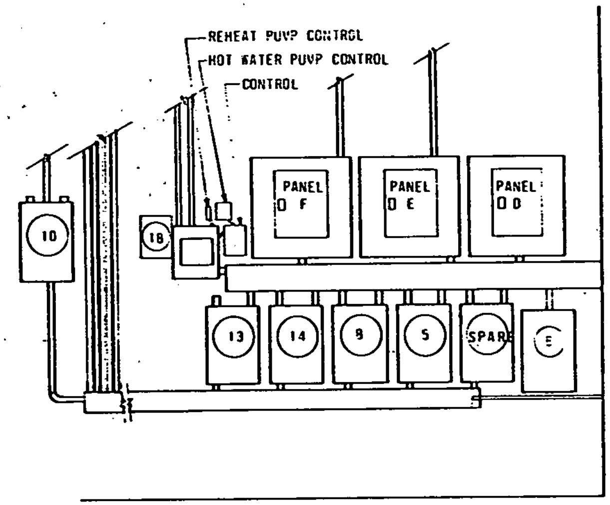
- FRONT PANEL PUSH BUTTON CONTROLS
- VISUAL DISPLAY
- TIME-OF-DAY AND DATE CLOCK
- UP TO [illegible] INPUT SENSORS
- CHOICE OF UP TO 6 MEASUREMENT FUNCTIONS AND POINT [illegible]
- SINGLE POINT, SINGLE SCAN, PERIODIC SCAN, CONTINUOUS SCAN, FIRST/LAST POINT SELECTION, ALARM MODES
- MAXIMUM SCAN RATE – EXISTING CAPABILITY – 2 POINTS PER SECOND
  – FUTURE OPTIONAL HIGH SPEED PRINTER – 20 POINTS PER SECOND

KENNEDY MAGNETIC TAPE RECORDER

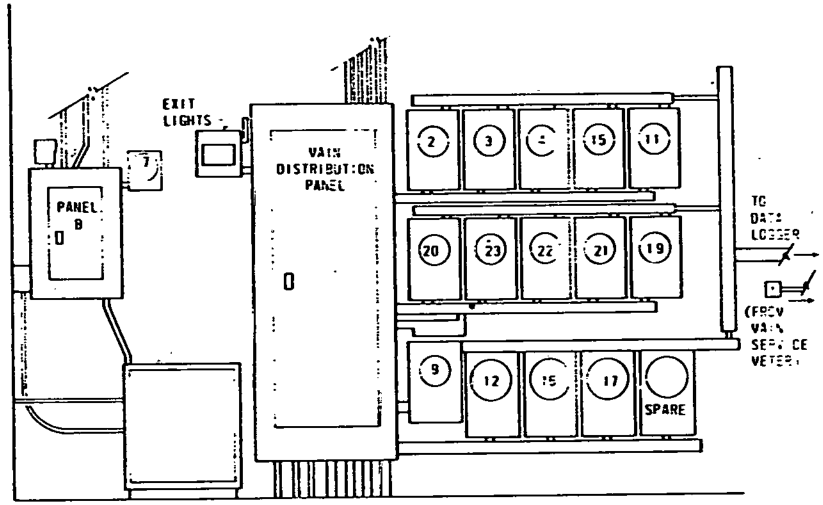
WRITE RATE: 0 TO 300 CHARACTERS PER SECOND
DENSITY: 555 CPI ± 3
INTER-CHANNEL DISPLACEMENT ERROR: 555 ± 200 MICROINCHES
TAPE FORMAT: 7-TRACK IBM COMPATIBLE NRZI
CODE: BCD (IBM 6-BIT)
REEL SIZE: 8½" 21 SCM, 1600/5
½" STANDARD COMPUTER TAPE 1.5 MIL.
TAPE LENGTH: 1200' [illegible] 1650/5
REWIND TIME: LESS THAN 2 MINUTES
TAPE TENSION: 2 OUNCES

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

I-1



WEST WALL



NORTH WALL

COMMENT ISSUE

COMMENT ISSUE

ELECTRIC METER LOCATIONS AND DESCRIPTIONS

CHANNEL	METERED EQUIPMENT	GPC METER NUMBER
1	MAIN BUILDING SERVICE (ON SERVICE TRANSFORMER	B - 53381
2	INTERIOR LIGHTING (OFFICE)	E - 13253
3	INTERIOR LIGHTING (PRODUCTION)	E - 13252
4	INTERIOR LIGHTING (STORAGE/MECHANICAL ROOM)	E - 13254
5	RECEPTACLES (OFFICE/FOOD VENDING MACHINES)	E - 13259
6	RECEPTACLES PRODUCTION AND STORAGE	E - 13228
7	DOMESTIC WATER HEATER	L- C5228
8	FAN COIL UNITS (STORAGE)	E - 20096
9	SEWING MACHINES PRESSES HAND IRONS FUSER (BUS DUCT)	D - 45095
10	CUTTING KNIVES (TROLLEY DUCT)	E- 2[illegible]75
11	VACUUM PUMP	E - 13226
12	FEEDWATER PUMP - PROCESS BOILER	E - 13255
13	HOT WATER PUMP - DUAL TEMPERATURE BOILER	E - 2[illegible]095
14	REHEAT PUMP - HOT WATER (OFFICE)	E - 2[illegible]374
15	AIR COMPRESSOR	E - 19251
16	BOILER FAN (PROCESS)	E - 19134
17	EXHAUST FAN (MECHANICAL ROOM)	E - 19145
18	WATER SOFTENER AND AIR DRYER	E - 21874
19	COMPRESSOR/CONDENSER FANS (PRODUCTION NE)	D - 46102
20	COMPRESSOR CONDENSER FANS (OFFICE)	C - 86982
21	COMPRESSOR CONDENSER FANS (PRODUCTION SE)	E - 19454
22	COMPRESSOR CONDENSER FANS (PRODUCTION SW)	E - 19250
23	COMPRESSOR CONDENSER FANS (PRODUCTION NW)	D - 46092
24	AIR HANDLING FAN (OFFICE)	TIME CLOCK
25	AIR HANDLING FAN (PRODUCTION NW)	TIME CLOCK
26	AIR HANDLING FAN (PRODUCTION NE)	TIME CLOCK
27	AIR HANDLING FAN (PRODUCTION SE)	TIME CLOCK
28	AIR HANDLING FAN (PRODUCTION SW)	TIME CLOCK

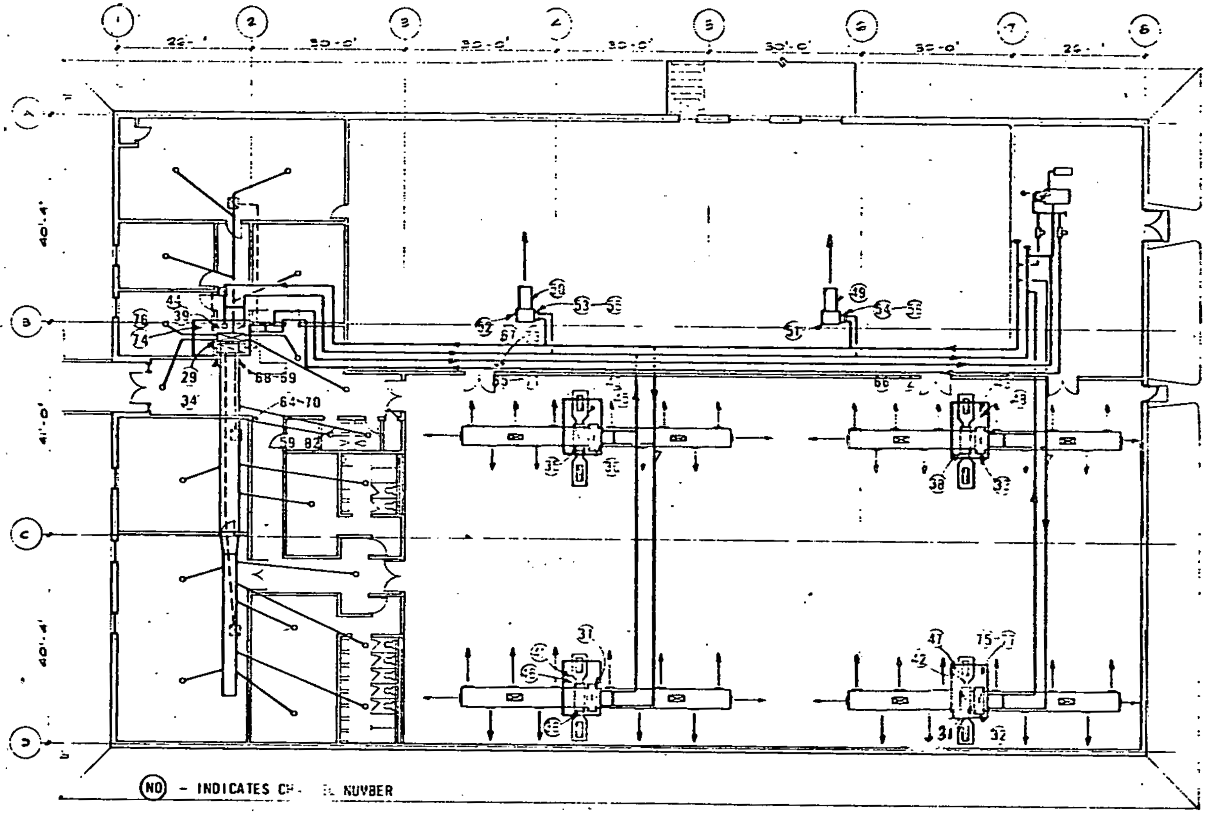
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

ELECTRIC METER LOCATIONS AND DESCRIPTION

date 5-30-78

I-2



MECHANICAL INSTRUMENTATION

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

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
34-38	RETURN AIR TEMPERATURE-A C UNITS	50-100 F	AIR	"	RETURN DUCT MAIN
39-43	ENTERING TEMPERATURE-WATER COIL 5	40-150 F	WATER	"	COIL INLET
44-48	LEAVING TEMPERATURE-WATER COIL 5	40-150 F	WATER	"	COIL OUTLET
49-50	SUPPLY AIR TEMP-STORAGE FAN COIL UNITS	50-100 F	AIR	"	SUPPLY DISCHG
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
58	DUAL-TEMP BOILER RETURN TEMPERATURE	50-200 F	WATER	"	SEE DRAWING
59	DOMESTIC HOT WATER TEMPERATURE	80-150 F	WATER	"	HW SUPPLY PIPE
60	PROCESS STEAM TEMPERATURE	300-350 F	STEAM	"	SEE DRAWING
61	PROCESS BOILER CONDENSATE RETURN TEMP	60-240 F	WATER	"	SEE DRAWING
62	PROCESS BOILER MAKE UP TEMP	40-100 F	WATER	"	SEE DRAWING
63	PROCESS BOILER BLOW DOWN TEMP	300-350 F	WATER	"	SEE DRAWING
64-67	SPACE TEMP (PROD-2 OFFICE & STORAGE)	40-100 F	AIR	"	SEE DRAWING
68	ENTERING TEMPERATURE-REHEAT COIL	40°-100° F	WATER	"T" THERMOCOUPLE	COIL INLET
69	LEAVING TEMPERATURE-REHEAT COIL	40-150 F	WATER	"	COIL OUTLET
70-73	SPACE HUMIDITY (PROD-2 OFFICE, STORAGE)	0-100	AIR	0-100 MILLIVOLTS	SEE DRAWING
74-75	DX COOLING COIL ENTERING HUMIDITY 1-PRODUCTION, 1-OFFICE	0-100	AIR	0-100 MILLIVOLTS	UPSTREAM COIL FACE
76-77	DX COOLING COIL LEAVING HUMIDITY 1-PRODUCTION, 1-OFFICE	0-100	AIR	1-100 MILLIVOLTS	DOWNSTREAM COIL FACE
78	FOSSIL FUEL FLOW TO HOT WATER BOILER	0-100 FT³	NAT. GAS	40 MILLIVOLTS	SEE DRAWING
79	FOSSIL FUEL FLOW TO PROCESS BOILER	0-100 FT³	NAT. GAS	40 MILLIVOLTS	SEE DRAWING
80	HEATING COOLING CIRCUIT FLOW	75-300 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
81	REHEAT COIL FLOW	0-10 GPM	WATER	4-20 MILLIAMPS	HW SUPPLY PIPE
82	DOMESTIC HOT WATER FLOW	0-10 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
83	PROCESS STEAM FLOW	0-2000 LBS HR	STEAM	4-20 MILLIAMPS	SEE DRAWING
84	PROCESS BOILER MAKE UP FLOW	0-10 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
85	PROCESS BOILER BLOWDOWN FLOW	0-10 GPM	WATER	4-20 MILLIAMPS	SEE DRAWING
85	PROCESS STEAM PRESSURE	75-200 PSI	STEAM	4-20 MILLIAMPS	SEE DRAWING

BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA

STES INTERFACE DEFINITION AND CONTROL DRAWINGS

MECHANICAL INSTRUMENTATION

2/8/78

1/10/78

I-3

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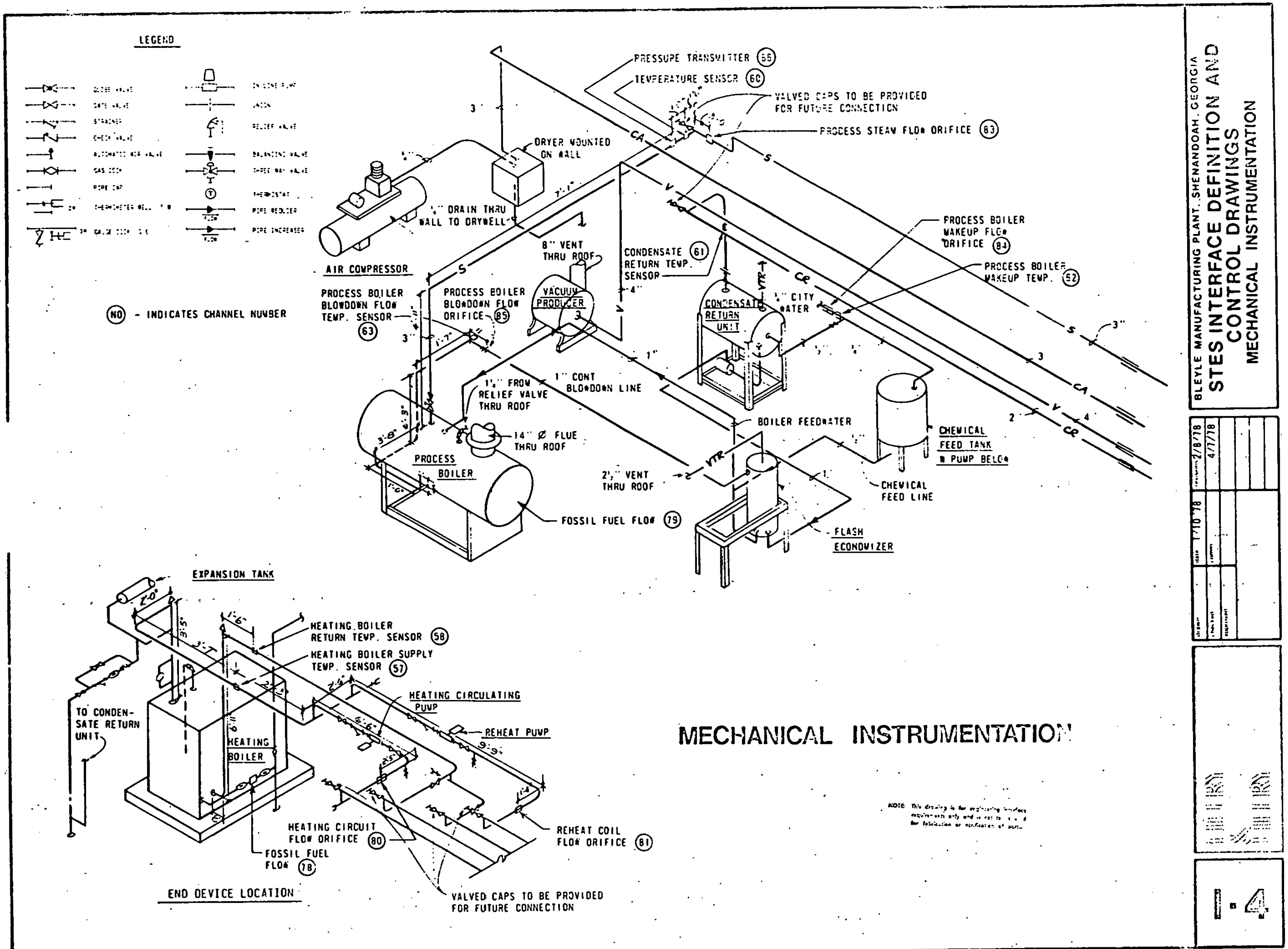
LEGEND
(NO) - INDICATES CHANNEL NUMBER
PRESSURE TRANSMITTER 65
TEMPERATURE SENSOR 60
VALVED CAPS TO BE PROVIDED FOR FUTURE CONNECTION
PROCESS STEAM FLOW ORIFICE 63
DRYER MOUNTED ON WALL
AIR COMPRESSOR
DRAIN THRU WALL TO DRYWELL
8" VENT THRU ROOF
CONDENSATE RETURN TEMP. SENSOR 61
PROCESS BOILER MAKEUP FLOW ORIFICE 84
PROCESS BOILER MAKEUP TEMP. 52
PROCESS BOILER BLOWDOWN FLOW TEMP. SENSOR 63
PROCESS BOILER BLOWDOWN FLOW ORIFICE 85
VACUUM PRODUCER
CONDENSATE RETURN UNIT
CITY WATER
1" CONT BLOWDOWN LINE
FROM RELIEF VALVE THRU ROOF
14" Ø FLUE THRU ROOF
PROCESS BOILER
BOILER FEEDWATER
CHEMICAL FEED TANK & PUMP BELOW
CHEMICAL FEED LINE
VENT THRU ROOF
FOSSIL FUEL FLOW 79
FLASH ECONOMIZER
EXPANSION TANK
HEATING BOILER RETURN TEMP. SENSOR 58
HEATING BOILER SUPPLY TEMP. SENSOR 57
HEATING CIRCULATING PUMP
REHEAT PUMP
TO CONDENSATE RETURN UNIT
HEATING BOILER
HEATING CIRCUIT FLOW ORIFICE 80
FOSSIL FUEL FLOW 78
REHEAT COIL FLOW ORIFICE 81
VALVED CAPS TO BE PROVIDED FOR FUTURE CONNECTION
END DEVICE LOCATION
MECHANICAL INSTRUMENTATION
BLEYLE MANUFACTURING PLANT, SHENANDOAH, GEORGIA
STES INTERFACE DEFINITION AND CONTROL DRAWINGS
MECHANICAL INSTRUMENTATION
2/8/78
4/7/78
1/10/78
I-4

APPENDIX C

ADDITIONAL SITE BACKGROUND INFORMATION

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C.1 SURROUNDING AREA

The area immediately surrounding Shenandoah, shown in Figure C-1, contains the following:

Newnan

Newnan, the City of Homes and Shenandoah's historic neighbor, has distinguished itself as the first city in the state of Georgia to receive the Silver Award of the Certified City Program. Presented by the Georgia Municipal Association, this is the highest award ever achieved by any city in Georgia.

A certified city is judged by a set of standards indicating that the city has the physical resources and service capabilities to attract and keep industry. The following categories are included:

- Industrial development
- Transportation
- Utilities
- Fire and police protection
- Traffic enforcement
- Community appearance
- Municipal administration
- Schools and libraries
- Streets
- Housing
- Commercial development
- City planning and recreation

A city of 13,000, Newnan dates to 1823 when it was founded and named for General Daniel Newnan, a Georgia statesman and veteran of the War of 1812. Newnan grew and thrived as a textile center, ideally situated only 30 miles from Atlanta at the Intersection of the Central of Georgia and the Atlanta & West Point Railroads, both of which border Shenandoah industrial property and still provide vital rail service for industries in the area.

In recent years, completion of Interstate 85, the major highway between Atlanta and the Gulf Coast, through Coweta County, has stimulated new economic growth and provides excellent transportation access for the area. Shenandoah has nearly six miles of frontage on this interstate expressway.

A temperate climate adds to the desirability of the Coweta County area. There are four distinct seasons, but extremes in temperature are rare. Average minimum and maximum temperatures are 34 degrees and 55 degrees in January; 67 degrees and 89 degrees in July. Average annual rainfall is 52 inches.

Newnan, centered around a tree-lined town square that serves as the city's main shopping area, continues to maintain its record of progress. During its 150 year history, the city has been recognized as a prosperous textile and manufacturing center.

For several years during the 1930's, Newnan residents were reported to have the third highest per capita income in the United States. Its city and county governments have always been receptive to new industry and planned growth, so the city and county continue to prosper. More than 30 industries, with an annual payroll of more than $20 million, operate in Coweta County. Largest of these is the William L. Bonnell Company, founded in 1953 and one of the nation's largest independent extruders of architectural aluminum.

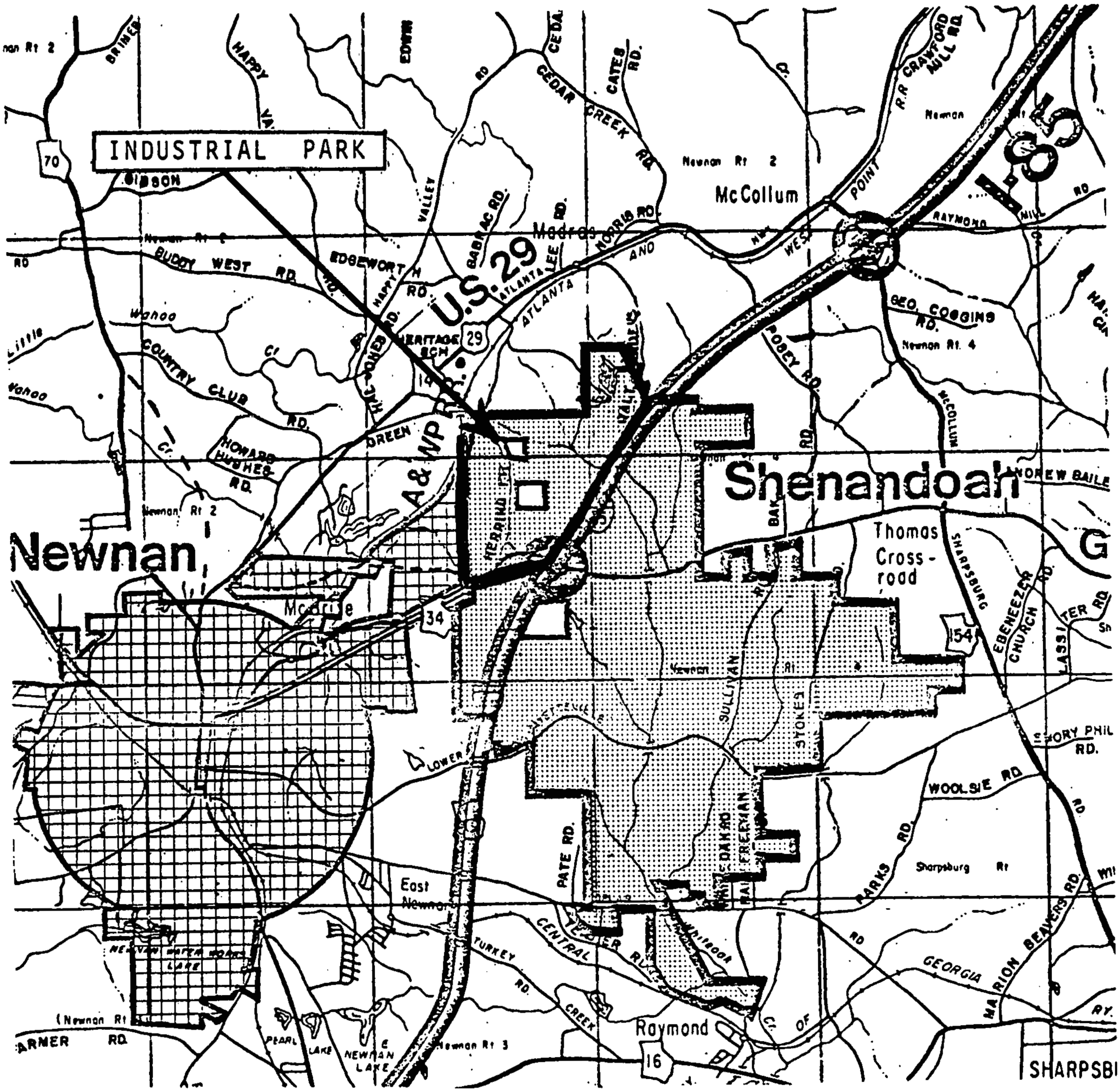


Figure C-1. Shenandoah Vicinity Map

Brown Steel (formerly R. D. Cole Manufacturing Co.) is the county's oldest industry. It has grown during the past 121 years from a small wood and iron works to one of the South's outstanding metal fabricators.

This sound industrial base provides an excellent foundation upon which the 1200 acre Shenandoah Industrial Park will grow to complement the existing industrial community.

The O. P. Evans Junior High School, an ultramodern educational facility built at a cost of more than $1 million, operates on the open classroom/cluster concept. Two well-staffed and well-equipped hospitals with 250 beds are located in Coweta County, both offering excellent medical attention.

The award winning Newnan Times-Herald, published since 1865, is a constant source of pride to the city and county.

The Powers' Crossroads County Fair and Art Festival has attracted more than 150,000 annually to Coweta County. This well known arts and crafts exhibition has exceptional recognition and has received awards as a "Stay and See Georgia" attraction.

Newnan has long been recognized as the "City of Homes" because of an abundance of well preserved ante-bellum homes that embellish the more contemporary residential sections of this beautiful city. Tree-lined boulevards, which reach out from Newnan Square, are elegantly adorned with magnificent historical residences. Owners of these beautifully restored homes open their doors and welcome the public once each year during the "Newnan Tour of Homes."

Shenandoah and Newnan are carving the tomorrows of Coweta. The New Town and the seasoned city are working together to preserve the past and build the future of Coweta County, Georgia.

Medical Facilities

Coweta County is served by two accredited hospitals located in the city of Newnan. The Newnan Hospital is a private non-profit hospital of 105 beds; the Coweta General Hospital is operated by the Coweta County Hospital Authority and has 140 beds. Both are accredited and offer a full range of short-term acute medical, surgical, obstetrical, pediatric and emergency services. Both hospitals have social service departments and full laboratory and radiology facilities. Coweta General has an arrangement with West Georgia College to train student nurses.

There are two nursing homes in Newnan for extended care patients, with a combined total of 120 beds. In addition, there are twelve general hospitals in Atlanta as well as numerous specialized facilities for psychiatric, pediatric, and eye, ear, nose and throat care. Adjoining South Fulton County has two general hospitals and nearby Clayton County has one.

There are twenty-two private physicians and surgeons and seven dentists in the county. As Shenandoah develops, doctors and dentists will be encouraged and assisted in establishing practices in the new town. A major health center is planned for the regional center with smaller centers in each village. Cable television could become a valuable asset to health education.

The Coweta County Health Department provides preventive, as well as environmental and mental health care and health education.

The Georgia Warm Springs Foundation, approximately 45 minutes from Shenandoah, consists of multiple hospital units for the intensive rehabilitative care of patients with chronic disease and conditions following catastrophic illness or injury. The Georgia Rehabilitation Center is a residential center adjacent to the Georgia Warm Springs Foundation Hospital, which provides vocational evaluation and training units for the physically handicapped. The Center and the Foundation are under the administration of the Division of Vocational Rehabilitation, State Department of Human Resources. Emory University Medical School in Atlanta is in the process of constructing a $7.5 million rehabilitation center which, when completed, will work with the other two institutions in providing superior comprehensive care to the physically handicapped.

Extensive medical facilities staffed by qualified personnel make Atlanta a recognized major medical center. In addition, 82 nursing homes and related institutions are located in the Atlanta metropolitan area, with a nursing home capacity of 6667 beds (1975). Atlanta physicians were estimated to number almost 2900 in 1974, and there were more than 800 dentists.

The Atlanta medical complex includes extensive research educational facilities. The Emory University School of Medicine includes over 1500 faculty members and 900 medical students, interns, and residents. Also located in Atlanta are schools of dentistry, pharmacology, dental hygiene, hospital administration, medical technology, premedicine, physical therapy, nursing, public health, and medical and dental assistance. Atlanta is the national headquarters of the Center for Disease Control of the U. S. Public Health Service.

Educational Advantages

Because of its proximity to Atlanta, residents of Shenandoah have an opportunity to take advantage of the cultural, educational and recreational benefits available in a large metropolitan area. Some of these facilities are indicated in Figure C-2.

The diversity of Atlanta's educational institutions offers a source of trained personnel with various skills from numerous disciplines. Many opportunities exist for advanced education of Shenandoah residents and for meeting the educational requirements of their children. Some of the major higher education facilities geographically convenient to Shenandoah are listed in the table in Figure C-3.

Atlanta's leadership as a center of education is a cultural and economic asset of major proportion. 25 degree-granting colleges and universities and four junior colleges offer more than 200 programs of study to nearly 75,000 students. 12 of the Atlanta area colleges and universities offer graduate degrees - 100 fields at the master's level, and 60 at the doctor's. Together with the area's vocational-technical schools and dozens of private business and career schools, these institutions provide business and industry with a large and continuing supply of skilled graduates. In addition, extensive educational opportunities are available for employed individuals, and research and training services are provided for business and industry.

Higher education in Atlanta includes major institutions of engineering and of medicine, as well as a large downtown university offering undergraduate and graduate liberal arts and business degrees to both day and evening students. There is also a theological center and a seminary, liberal arts residential colleges, a four-year fine arts college, a school of pharmacy, law schools, and junior colleges. The University of Georgia is located in Athens, about 60 miles east of Atlanta.

LEGEND	MILES FROM SHENANDOAH
1. Hartsfield International Airport	25
2. Towns Elementary School	32
3. Georgia Institute of Technology	35
4. State Capitol — Georgia State University	33
5. Central Business District	33
6. Atlanta Stadium	32
7. Omni International — World Congree Center	33
8. Cultural Arts Center	36
9. Atlanta Civic Center	34

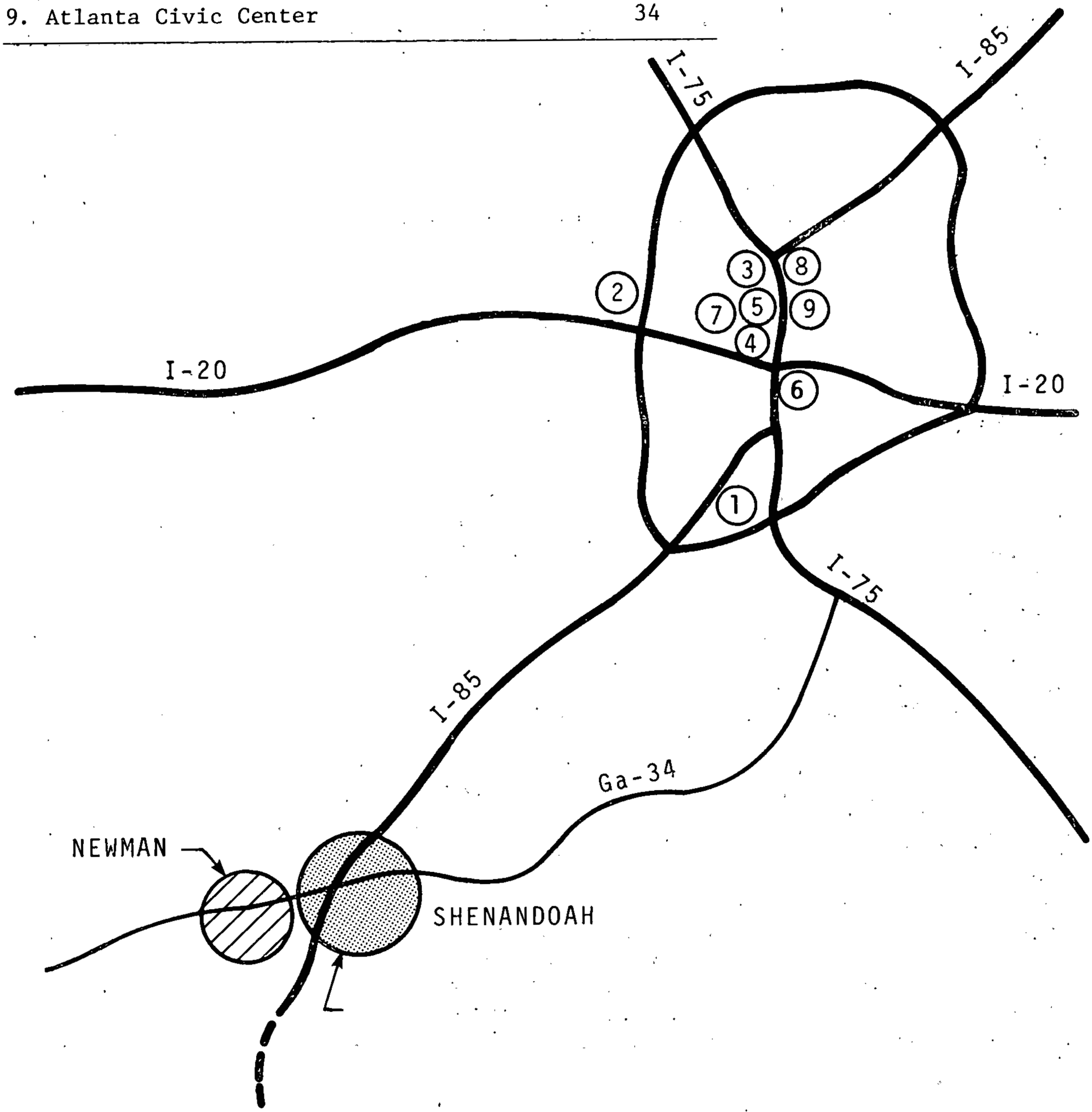


Figure C-2. Facilities of Interest to Shenandoah Residents

Athens, Georgia

University of Georgia

Atlanta, Georgia

Georgia Institute of Technology
Georgia State University
Atlanta University Complex (4 liberal arts and 4 theological colleges)
Atlanta Community College
Atlanta Area Technical School

DeKalb County, Georgia

Oglethorpe University
Emory University
Agnes Scott College
Mercer University in Atlanta
DeKalb Community College
DeKalb Vocational-Technical School

Cobb County, Georgia

West Georgia College
Carroll County Vocational-Technical School

LaGrange, Georgia

LaGrange College

Alabama

Auburn University
Tuskegee Institute

Griffin, Georgia

Griffin-Spalding Vocational-Technical

Macon, Georgia

Mercer University

Clayton County, Georgia

Clayton Junior College
Clayton County Vocational-Technical School

Figure C-3. Educational Facilities

Atlanta also qualifies as a major center of vocational-technical training. Four public vocational-technical schools, operated in conjunction with the Georgia Department of Education, offer over 60 programs, tuition-free, to Georgia residents. These, plus Atlanta's private trade schools and smaller public facilities, offer specialized training in such fields as air conditioning and refrigeration, drafting, auto mechanics, electronics technology, welding and medical assistance.

Complementing Atlanta's schools and universities is its intellectual stimulation. A rich historical background is preserved by the Georgia Department of Archives and History and by the Atlanta Historical Society. The Fernbank Science Center in DeKalb County includes 70 acres of virgin forest, an electron microscope laboratory, an observatory, a major science reference library, a meteorological laboratory, and a planetarium. An unusual resource available to the public is the Union Catalog of some two-million cards, which is a location tool for over four-million books and serials in 36 libraries in the Atlanta-Athens area.

Cultural Advantages

Nearly 50 galleries now operate with exhibits varying from contemporary graphics and photography to the fine art of the Renaissance. The Atlanta Memorial Arts Center offers a cosmopolitan exposure to the arts by combining facilities for drama, dance, symphony, a museum, and an art college in one $13-million complex. The Atlanta Civic Center gives further stimulus to performing arts by serving as a home for concerts, Broadway plays, and the Metropolitan Opera during its one-week annual visit. The High Museum of Art, housed in the memorial Arts Center, hosts a permanent collection, special exhibitions, and a major gallery for children.

The Atlanta Arts Festival, held annually in Piedmont Park, is a community project that offers everything from competitive exhbitions to dance, drama, and musical performances. It is a traditional week of cultural enjoyment.

Music in Atlanta ranges from Robert Shaw's 89-piece Atlanta Symphony and the Atlanta Chamber Opera Society to over 24 community, church, and collegiate groups. The Atlanta Symphony has 250 annual concerts, including regular, touring, youth, seasonal, and family performances. Music lovers are further enriched by the Atlanta Music Club's offerings of various semi-classical concerts and the annual All-Star Concert Series. The Atlanta Boys Choir adds variety to the calendar.

The Alliance Theater, housed in the Atlanta Memorial Arts Center, has six productions annually. Theater of the Stars attracts big Broadway names with six winter plays and six summer musicals. Over the past five years, the Academy Theater, an experimental dramatic company, has received substantial grants, as has the Atlanta Children's Theater, which plans to "develop the imagination" of more than 143,000 children through a touring program.

The Atlanta Ballet, the oldest civic ballet company in the nation, offers over 30 major performances each season plus lecture demonstrations in public schools. The Atlanta Concert and Contemporary Dance Group, the Southern Ballet of Atlanta, the Marietta Civic Ballet, and the Decatur-DeKalb Civic Ballet further complement the arts in Atlanta.

The Atlanta College of the Arts and the Academy Theater School of Performing Arts continue to expand their artists-in-residence programs. Twelve Atlanta colleges and universities offer degrees in art, eleven in music, and five in drama. Atlanta has 28 dance academies varying from ballet to jazz and contemporary studies.

Recreation and Sports

Located at an elevation of 1000 ft. in the foothills of the Appalachians, Atlanta has a topography well suited for recreational purposes: a rolling terrain, lakes and streams, large areas of forest and parkland, and a moderate climate that permits year-round outdoor activity. Atlanta offers all forms of sports and outdoor recreation associated with a major metropolitan area: major league professional sports, parks, golf, tennis, bowling, rugby, polo, boating and sailing, camping and hiking, hunting and fishing, and skiing, as well as three major "whole-family" entertainment and recreational attractions.

Atlanta's position in major league sports began with the completion of Atlanta Stadium, home of the Atlanta Falcons (football) and the Atlanta Braves (baseball). The Omni, Atlanta's new $17-million area, was completed in October 1972 and is the home of the Atlanta Hawks (basketball) and the Atlanta Flames (hockey).

Other spectator sports include collegiate athletic competitions; auto races held at the Atlanta International Raceway and road racing at Road Atlanta; golf tournaments, incuding the PGA Atlanta Golf Classic and the LPGA Lady Tara Open; several major tennis tournaments; an annual steeple-chase and hunter-jumper horse show; and professional motorcycle and motorcross events.

The Atlanta area has a variety of outdoor recreational opportunities. Lake Lanier and Lake Allatoona are two of the most popular near-by weekend recreation areas; both are within an hour's drive of the city. The Chattahoochee River is the western boundary of the City of Atlanta and provides rafting, tubing, and canoeing.

Atlanta's climate permits at least 225 good golfing or tennis days every year. There are over 40 golf courses in the area, including municipal courses, private courses, and commercially operated courses.

Although Georgia is not usually considered a mountain state, Shenandoah residents are only a short drive from the North Georgia mountains and the beginning of the famous Appalachian Trail. The mountain-forest region of the lower Appalachians is excellent for mountain climbing, spelunking, white-water canoeing, camping and hiking.

For campers, some of the best and most scenic camping is available in public Georgia State Parks. The 49 parks in the system cover nearly 40,000 acres and are well distributed throughout the state. Nearly 3000 campsites are available. The Cohutta Wilderness Area in Northern Georgia comprises 34,000 acres of land relatively untouched by modern civilization.

The Atlanta Ski Club is one of the largest and most active in the nation. Over a dozen winter ski resorts dot the five-state region around Atlanta, including one in Georgia only 115 miles north of Atlanta. On the other hand, the beaches of the Atlantic and Gulf of Mexico are within a day's drive of the city (about 300 miles). Georgia's coast is lined with islands varying in size and extent of development. The Golden Isles, located off the coast of Brunswick in south Georgia, are the state's most popular beach resort areas.

Hunters and fishermen find Georgia rich in wildlife and all species of popular game fish. Almost one million acres of public hunting land are within easy access of Shenandoah, and all the popular major game fish in America can be found in the state.

Newspapers

Metropolitan Atlanta has seven daily newspapers, including the Atlanta Constitution and the Atlanta Journal, which have daily circulations of 214,300 and 259,300, respectively. The Sunday combined Journal-Constitution reaches 579,800 subscribers. The Atlanta Daily World is one of two predominantly black-oriented daily newspapers in the United States.

All major news services, trade publications, and international bureaus (such as Reuters) have news gathering offices in Atlanta. These include local offices of McGraw-Hill World News, Fairchild Publications, Business Week, New York Times, Los Angeles Times, Wall Street Journal, Christian Science Monitor, Newsweek, Time, U. S. News and World Report, Associated Press, and United Press International, as well as NBC, CBS, and ABC News.

C.2 EASEMENTS/UTILITIES/SERVICES

Easements

The Shenandoah site area carries four easements as shown in Figure C-4: two underground pipelines and two overhead powerlines. None of these will interfere, in any way, with the STES. In fact, their existence demonstrates the suitabilty of the site. These easements, in general, can be crossed by all utilities and roads and the area can be landscaped as long as access to the easements is not impaired. The use of easement land directly is limited and is based upon the specific use intended and the easement involved. However, it qualifies as open space. The easements and their uses are as follows:

- Transcontinental Gas Pipe Line Corporation. This easement has a width of 150 feet and runs through the property diagonally in a northeasterly direction. It transports natural gas from Texas to the northeastern United States.

- There is one 30", two 36" and one 42" line carrying the gas at pressures of 600 to 700 psi. The lines have been hydrostatically tested at a minimum of 1114 psi. The pipe materials are AP1 - 5XL - X52 and X60 steel.

- Since the line is being used for interstate transmission, it is regulated by the U. S. Department of Transportation (DOT) and the Federal Power Commission (FPC). It meets safety standards of the Pipeline Safety Act of 1968 (DOT - OPS 192).

- Plantation Pipeline Company. This easement has a width of 50 feet and traverses the property from west to east. It transports petroleum products in interstate commerce.

  The easement contains an 8-inch pipe carrying products ranging from No. 2 fuel oils to gasoline at an operating pressure of 1100 psi. The line has been tested at 2300 psi. The pipe material is AP1 - 5XL - X52 steel.

  The use of this line is regulated by U. S. DOT and meets all safety standards according to DOT 49 CFR-195 regulations.

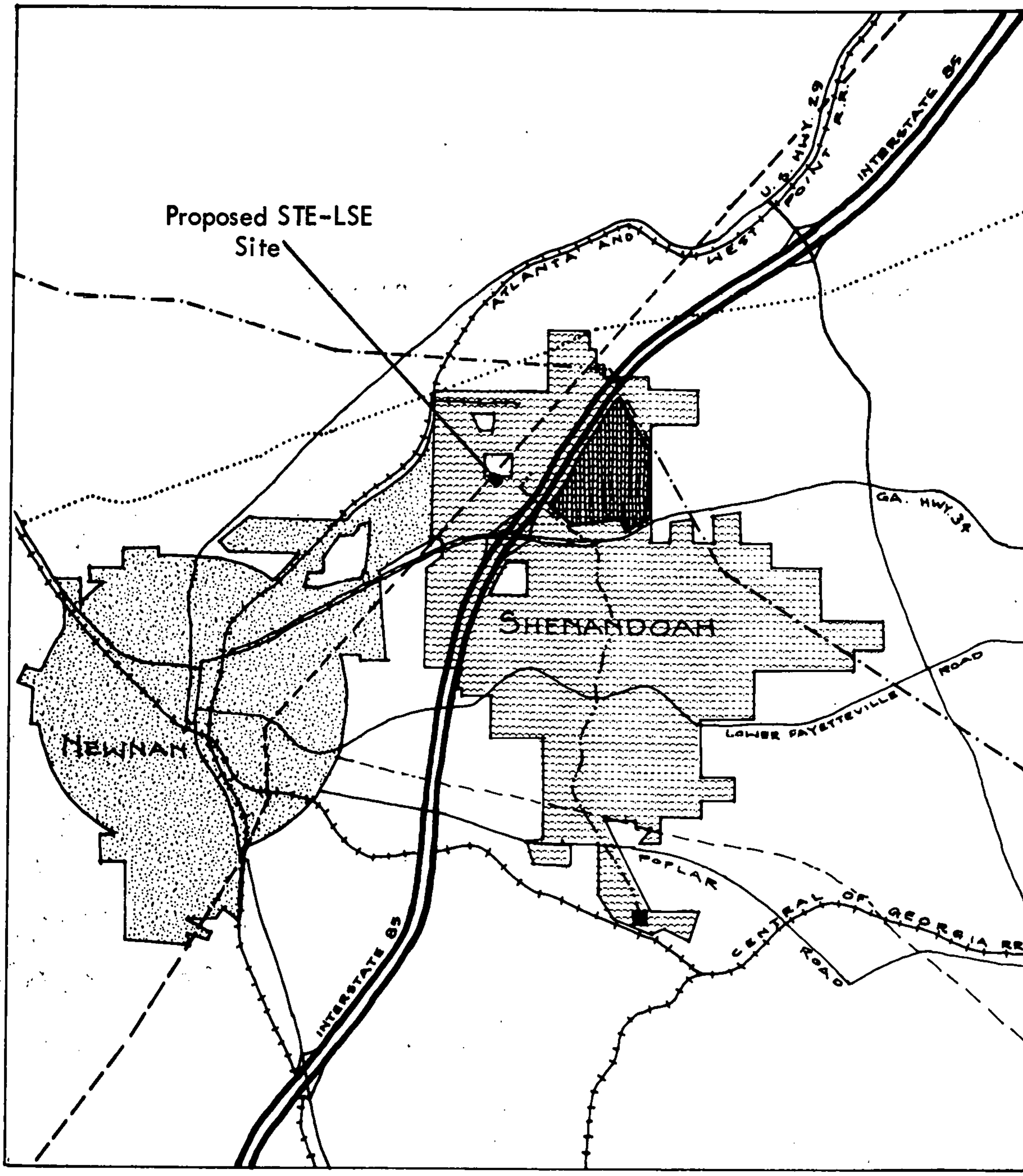
- Georgia Power Company. One easement crosses the property parallel to the projected extension of Amlajack Boulevard and has a width of 100 ft. It is an overhead powerline, being referred to as the Newnan-Fairburn Line, and uses 46 KV for transmission.

- Georgia Power Company. The second power easement crosses the property parallel to the Plantation Pipeline easement and is 200 feet wide. This line is referred to as the Yates-Griffin Line, utilizing 115 KV.

  Georgia Power encourages beautification of their easements using any plants except trees. However, access has to be provided.

Water

Water and sewer service in Shenandoah will be provided by a wholly-owned utility company. Initially, the Newnan Water and Light Commission will furnish Shenandoah with up to 500,000 gallons of water per day. All legal steps have to be completed to ensure this amount of water, which is sufficient to serve approximately 1200 dwelling units and 240 acres of industrial land.



UTILITIES AND EASEMENTS

—·—·—·— PLANTATION PIPE LINE CO. & GEORGIA POWER CO.
·················· TRANSCONTINENTAL GAS PIPELINE CORP.
– – – – – – GEORGIA POWER CO.
—··—··— WHITE OAK CREEK INTERCEPTOR (SEWER)
■ SHENANDOAH SEWAGE TREATMENT PLANT

Figure C-4. Existing Easements in Shenandoah

Shenandoah and Newnan have contracted for Newnan to construct a 24" water line from Line Creek. That source is sufficient to meet the needs of both Newnan and Shenandoah throughout the new town's 20-year development period. The system will include a 400-acre reservoir, Lake Shenandoah, and the full system is scheduled for completion in 1981. Newnan's filter system has been enlarged to include the most modern equipment.

The water analysis conducted by the Georgia Environmental Protection Division of the Department of Natural Resurces indicates that the water is potable, pure, clear, and soft. In addition, it has low levels of iron, manganese, magnesium and other metals. The alkalinity of the water also is low. The water purity makes it ideally suited for research an experimentation since it will not excessively corrode metals or cause scaling.

The Project Manager for Surface Water Programs at the State EPD has indicated that the water is as pure and clear as the water found at the Savannah River Nuclear Plant outside Augusta, Georgia, and the high quality and purity of the water at Augusta is one reason that site was chosen for the nuclear facility.

Sanitary Sewer

Sanitary sewer service has been available as of December, 1975. The intial phase of the treatment plant has a capacity of 300,000 gallons per day.

Solid Waste Disposal

Coweta County operates a sanitary landfill in compliance with the 1972 Solid Waste Management Act. This landfill is accessible to all Coweta County citizens. Collection of solid waste is by private contractors. Innovative systems of solid waste disposal have been studied and are still under investigation. However, the near-term disposal method will be conventional.

C.3 SUBSURFACE CONDITIONS

Georgia lies within two nearly-equal sized major physiographic divisions: the Atlantic Plain on the southeast and the Appalachian region on the northwest. The Atlantic Plain in this state consists entirely of the Coastal Plain Province, which extends as far west as Texas and as far north as Long Island, New York. The Appalachian region consists of four provinces: the Piedmont Province, the Blue Ridge Province, the Ridge and Valley Province, and the Appalachian (Cumberland) Plateau Province. The geology, soils, drainage and general topography of each province are different and distinct, and a detailed description of each is provided in the Environmental Assessment Study prepared by the Georgia Department of Natural Resources for the proposed SERI.

Geologic Conditions

Georgia contains rocks of all three major types: sedimentary, metamorphic, and igneous. These rocks range in age from Precambrian to the Recent. The outcrop patterns of the rocks of various types and ages correspond roughly to the outlines of the different physiographic provinces.

The STE-LSE Shenandoah site is situated in the Greenville Slope District of the Midland Georgia Subsection of the Piedmont Physiographic Province. Differential erosion of the underlying rock has created a gently rolling topography. Relief within this general area is normally 40 to 50 feet (12 to 15 meters) with 2 to 10 percent slopes.

Proximate to the proposed site, underlying bedrock consists of interbedded sillimanite schist and amphibolite of Precambrian/Paleozoic age which have been intruded by a fine-grained biotite granite. The bedrock is covered by a thick layer of in-situ weathered material called saprolite, which still retains the original structure but has a different chemical and mineralogical composition. Layers of more resistant, partially weathered rock, principally amphibolite, are present in the saprolite. In general the aprolite consists of sandy silt or silty sand with a small amount of clay that occurs as bands and lenses reflecting the original rock structure. The depth to bedrock is highly variable but is often 50 to 75 feet (15.2 to 22.8 meters) under hilltops and slopes. Bedrock exposures are present at several locations in streambeds proximate to the site and in road embankments. The floodplains along the streams in the Shenandoah development area are covered with alluvium of recent age.

In conjunction with the planned development of the industrial park, subsurface investigations were conducted by a private enginering testing company. The method of testing was auger boring. Field investigation and laboratory analysis of these borings indicated stiff to very stiff brown fine sandy silty clay, stiff to very stiff purple micaceous fine sandy clayey silt. No ground water was encountered.

Seismologic Conditions

The existence of major faults or other major geologic structures is unknown with reference to the Shenandoah site. This portion of Georgia lies within an area of moderate seismic risk, as indicated in Figure C-5. The regional trend of the layered schist and gneiss is northeast with a dip to the southeast at moderate to steep angles. The proposed site is located in a portion of the state that has experienced only very limited historic earthquake activity, and it appears unlikely that a major event capable of producing ground rupture will originate on or near the site.

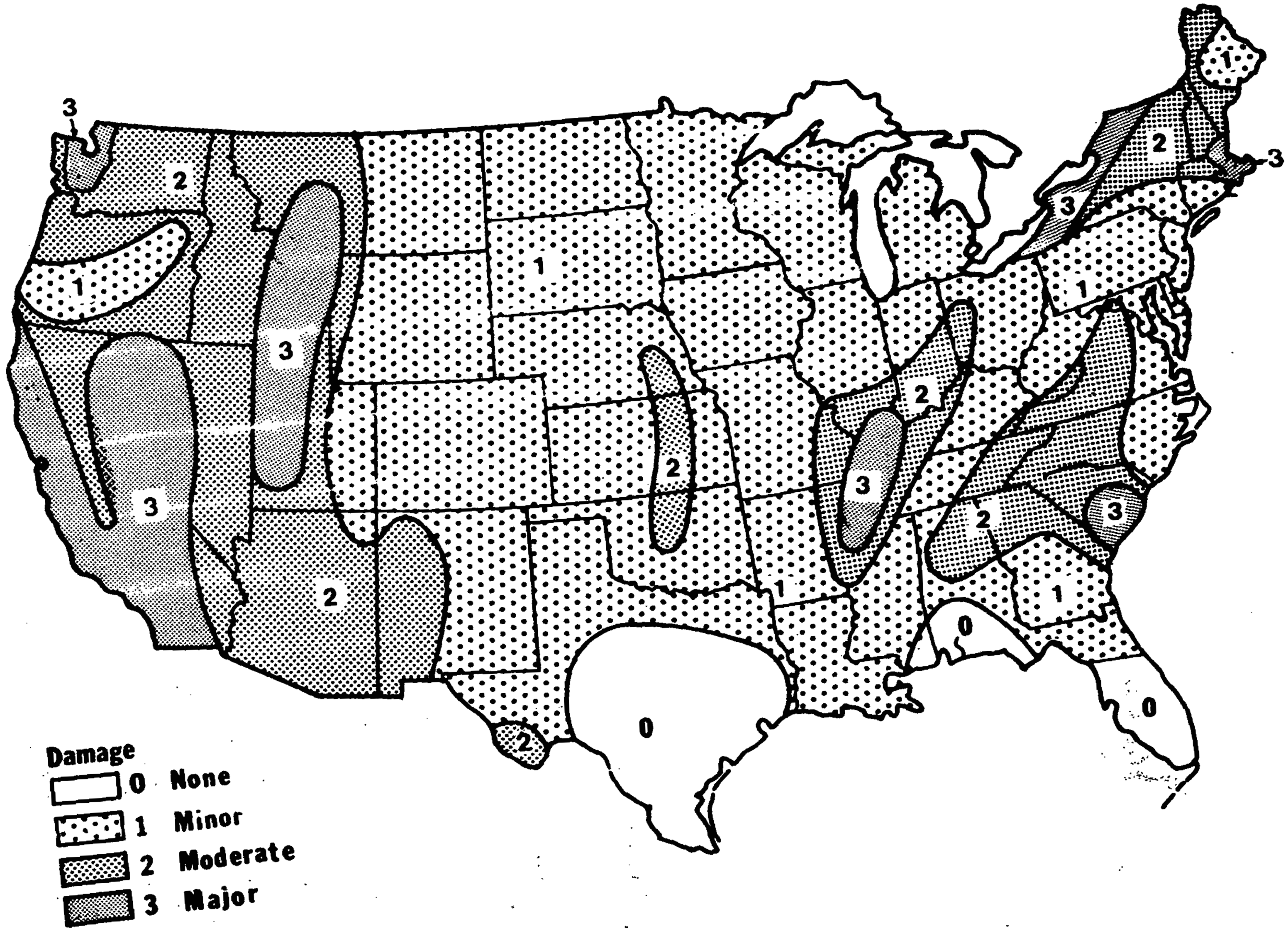


Figure C-5. Seismic Risk Map

Effects on Design and Projected Costs

General characteristics of the region, specific soils investigation data, and experience gained during construction of the Bleyle Plant indicate that the Shenandoah site is compatible to the construction of the STES. No topographic, geologic or subsurface factors will complicate construction, and no conditions exist that will necessitate special structure or foundation designs.

C.4 METEOROLOGY

The Shenandoah site, located near Newnan in west central Georgia, is 25 miles southwest of Atlanta in the Piedmont Plateau. The elevation is nearly 1000 feet above sea level, and the terrain ranges from rolling to slightly hilly. The climate of the west central section of Georgia is classified as subtropical humid. This area is influenced by its location near the foothills of the southern Appalachain Mountains to the north and the Gulf of Mexico to the south, with the total effect being slight modification of winter and summer temperatures, and ample precipitation.

In summer, the weather is dominated by unstable or neutral maritime tropical air masses within the western parts of the Bermuda subtropical anticyclone. Here subsidence is weak, and accounting for the prevalence of convective progress of maritime tropical air inland is more sporadic than in summer. Occasionally, severe invasions of unmodified continental polar air will reach this area, but rarely do these outbreaks dominate the weather for an extended period.

Solar Radiation/Insolation

Mean daily solar radiation has been recorded at three stations near Shenandoah: the Atlanta Airport, Griffin and Auburn University. Griffin station data are more representative of Shenandoah because of similar latitudes and similar rural settings. The period of record for these insolation observations at Griffin is April 1950 through March 1966.

Some records are missing and no attempt was made to estimate the missing data in computing the means. The daily measurements included both direct and diffuse sky radiation received on a horizontal surface. The table in Figure C-6 shows the mean daily solar radiation in langleys (gram calorie per square centimeter) at Griffin, Georgia.

A recent Sandia report[1] presented data gathered throughout the United States on the total horizontal and direct normal insolation over a five-year period. These results for the Shenandoah area are tabulated in Figure C-7.

Temperature

Summers are warm, but long periods of excessive heat are rare. The maximum is 90° or higher on about half the days from June through August, but a temperature as high as 100° occurs in only about one summer out of three. There is usually a 20 to 25 degree drop from maximum to minimum during the summer months, resulting in rather pleasant mid to high 60's for morning low temperatures. The average minimum recorded during June through August is 66.7°.

Winters are not severe, but moderately cold temperatures can be expected. Freezing temperatures occur on about one-half the days from December through February, and on about one-fifth of the days during November and March. Due to an abundance of solar radiation, wintertime maximums are modified greatly and normally result in temperatures of 50's and 60's with 70° temperatures not at all unusual, even in mid-winter. The average maximum temperature for the winter months is 56.8°

Spring is a season of frequent weather changes. The threat of tornadoes is greatest in spring, and thunderstorm activity increases. In contrast, fall is characterized by long periods of sunny weather with mild days and cool nights.

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[1]Boes, E. C.; Hall, I. J.; Praire, R. R; Stromberg, R. P.; and Anderson, H. E., "Distribution of Direct and Total Solar Radiation Availabilities for the USA," SAND76-0411, August 1976.

Lat. 33° 16' N., Long. 84° 17' W.											Elev. 925 ft.
Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept.	Oct	Nov	Dec
1	204	234	318	491	578	647	585	581	528	323	327	311
2	231	268	341	508	570	695	625	613	502	341	376	259
3	265	288	289	487	568	632	541	626	524	336	391	195
4	252	328	325	426	636	614	595	549	512	377	311	262
5	235	314	350	390	603	586	612	529	465	426	306	202
6	165	234	352	426	596	603	577	581	460	386	325	219
7	260	308	378	514	621	541	573	559	459	432	363	277
8	260	362	467	555	661	597	521	501	466	400	340	235
9	261	307	385	475	612	559	573	597	510	475	343	204
10	257	317	423	499	575	564	592	567	489	476	299	239
11	263	329	337	518	557	610	560	578	433	470	309	192
12	268	321	363	515	538	607	565	553	443	449	319	222
13	230	301	374	511	592	613	557	566	549	410	290	257
14	216	353	350	569	614	595	515	492	394	386	276	180
15	213	276	379	484	648	541	515	505	403	363	296	212
16	267	295	471	614	677	515	560	536	444	373	229	245
17	258	371	453	645	661	528	561	520	430	379	278	245
18	243	325	341	556	606	583	539	520	455	396	280	256
19	242	329	380	565	567	558	580	514	448	342	307	250
20	228	341	440	593	528	525	583	499	470	364	261	208
21	255	331	410	550	571	569	605	543	457	310	267	221
22	253	389	474	544	615	577	578	517	465	375	289	259
23	196	343	473	631	593	573	585	527	480	349	225	228
24	195	277	424	532	639	571	566	532	542	418	251	205
25	279	233	439	496	556	563	537	497	405	417	233	172
26	300	376	442	550	527	531	565	458	378	361	253	218
27	255	320	480	481	674	543	534	496	381	367	241	204
28	298	340	399	541	654	585	532	546	370	354	239	210
29	245		436	601	576	641	579	537	408	351	287	171
30	251		511	575	583	638	568	531	351	290	330	228
31	249		431		637		535	464		311		234
Avg.	245	314	401	529	601	583	565	537	448	381	294	226

Figure C-6. Mean Daily Solar Radiation

Month	Direct-Normal	Total Horizontal
January	4.0	2.9
February	4.1	3.5
March	4.9	4.2
April	6.1	5.8
May	6.5	6.5
June	6.0	6.0
July	6.0	6.0
August	5.5	5.5
September	5.4	5.0
October	5.2	4.4
November	4.6	3.2
December	3.9	2.8

Figure C-7. Total Horizontal and Direct Normal Insolation

The weather station at Newnan, about five miles from the Shenandoah site, was established in April of 1882, but during the early years observations were taken only during the growing season. However, year-round observations have been taken at radio station WCOH. Besides the weather station at Newnan, there are four other weather stations within 30 miles of Shenandoah:

Atlanta Hartsfield Airport	Griffin
Carrollton	LaGrange

Between 30 and 60 miles from Shenandoah, there are six additional weather stations:

Columbus	Talbotton
Covington	Tallapoosa
Monticello	West Point

The highest temperature ever recorded at Newnan was 108° in September, 1925. However, the highest temperature recorded in the last 30 years was 104° in 1952. The lowest temperature on record is -9° in February, 1899. Only three times before have sub-zero temperatures been recorded: -3° in January, 1963; and -2° in December, 1962; and -2° in January, 1966. The mean annual temperatures for the period of 1941-1970 are shown in Figure C-8.

Month	Newnan	Atlanta	Carrollton	Griffin	LaGrange
January	44.7°	42.4°	43.1°	44.3°	45.6°
February	47.6	45.0	45.9	46.5	48.3
March	53.6	51.1	51.8	52.6	54.5
April	63.1	61.1	61.9	62.5	63.6
May	70.7	69.1	69.0	70.3	70.9
June	76.8	75.6	75.5	76.6	76.8
July	78.8	78.0	77.9	78.6	79.1
August	78.3	77.5	77.0	78.3	78.3
September	73.1	72.3	71.6	73.1	73.1
October	63.5	52.4	61.5	63.3	63.3
November	52.8	51.4	50.7	53.0	52.9
December	45.5	43.5	44.0	45.4	46.0
Annual	62.4°F	60.8°F	60.8°F	62.0°F	62.9°F

Figure C-8. Mean Annual Temperatures

C.5 PRECIPITATION

The annual rainfall for Newnan averages about 53.5 inches but has varied from 74.97 inches in 1961 to 28.99 inches in 1954. The total is between 50 and 60 inches during one-half the years. March is normally the wettest month, and October is the driest month. The greatest amount of rainfall in one month was 18.46 inches in February 1961, while no rainfall at all occurred during the month of October, 1963. Snow flurries occur in most winters, but appreciable accumulations are rare. Four inches fell in January 1940. Precipitation totals for the period 1941-1970 are shown in Figure C-9 and the mean precipitation for the State of Georgia is shown in Figure C-10.

Winds

No wind observations have been taken at the Newnan station. However, wind data from the Atlanta Airport station provide an acceptable substitute in describing the Shenandoah site. There the winds average about nine m.p.h. during the year, and the most frequent direction is from the northwest. East winds produce the most consistently humid weather. The wind roses of the mean annual frequencies of wind directions and average wind speeds for a period 1941-1970 are shown in Figure C-11.

The seasonal surface wind roses for Atlanta, Georgia, are taken from the weather records of the National Weather Service Station at the Hartsfield International Airport, Atlanta, Georgia, and are shown in Figure C-12. The wind direction that predominates during all seasons is from the northwest. Light winds (less than eight miles per hour) predominate during all seasons; and steady winds of more than 21 miles per hour rarely occur.

Shenandoah is relatively unaffected by major cyclonic activity. Winds containing an easterly component are at a minimum for all seasons except the fall months when the easterly winds make up a secondary maximum frequency. The minimum frequencies for all seasons are from the southerly and northerly quadrants. The seasonal wind roses observed during stable and unstable conditions for Atlanta, Georgia, are taken from the weather records of the National Weather Service Station at the Hartsfield International Airport, Atlanta, Georgia and are presented in Figure C-13 and C-14. The definition of stability in this case is that condition in the lower atmosphere where the temperature increases with height. Instability is defined as a decrease of temperature with height. The wind speeds in the analysis are divided into four classes: calm; 1 to 5 miles per hour; 6 to 10 miles per hour; and 11 to 15 miles per hour.

The predominant feature of wind characteristics under differing atmospheric conditions is the similarity of the wind patterns by seasons. The outstanding difference is the much larger percentage of calm and light winds under stable conditions. The following information can be extracted from these wind roses concerning the surface wind flow during stable and unstable conditions in the low levels.

- The most common wind direction during winter, spring, and fall is from the northwest.
- Winds less than six miles per hour associated with stable conditions are encountered approximately 40 percent of the time.
- Winds are seldom from the north, regardless of season.

Month	Newnan	Atlanta	Carrollton	Griffin	LaGrange
January	4.79 in.	4.34 in.	4.44 in.	4.30 in.	4.65 in.
February	4.64	4.41	4.84	4.65	5.12
March	5.94	5.84	6.05	6.07	6.33
April	4.94	4.61	4.71	4.50	5.15
May	3.81	3.71	4.18	3.92	3.56
June	4.07	3.67	3.92	4.65	4.08
July	5.19	4.90	4.90	5.11	5.59
August	4.17	3.54	3.02	4.08	4.11
September	3.44	3.15	3.71	3.84	3.83
October	2.71	2.50	2.54	2.53	2.51
November	3.71	3.43	3.78	3.41	3.67
December	4.43	4.24	4.88	4.48	4.96
Annual	51.84 in.	48.34 in.	50.97 in.	51.54 in.	53.56 in.

Figure C-9. Precipitation Totals

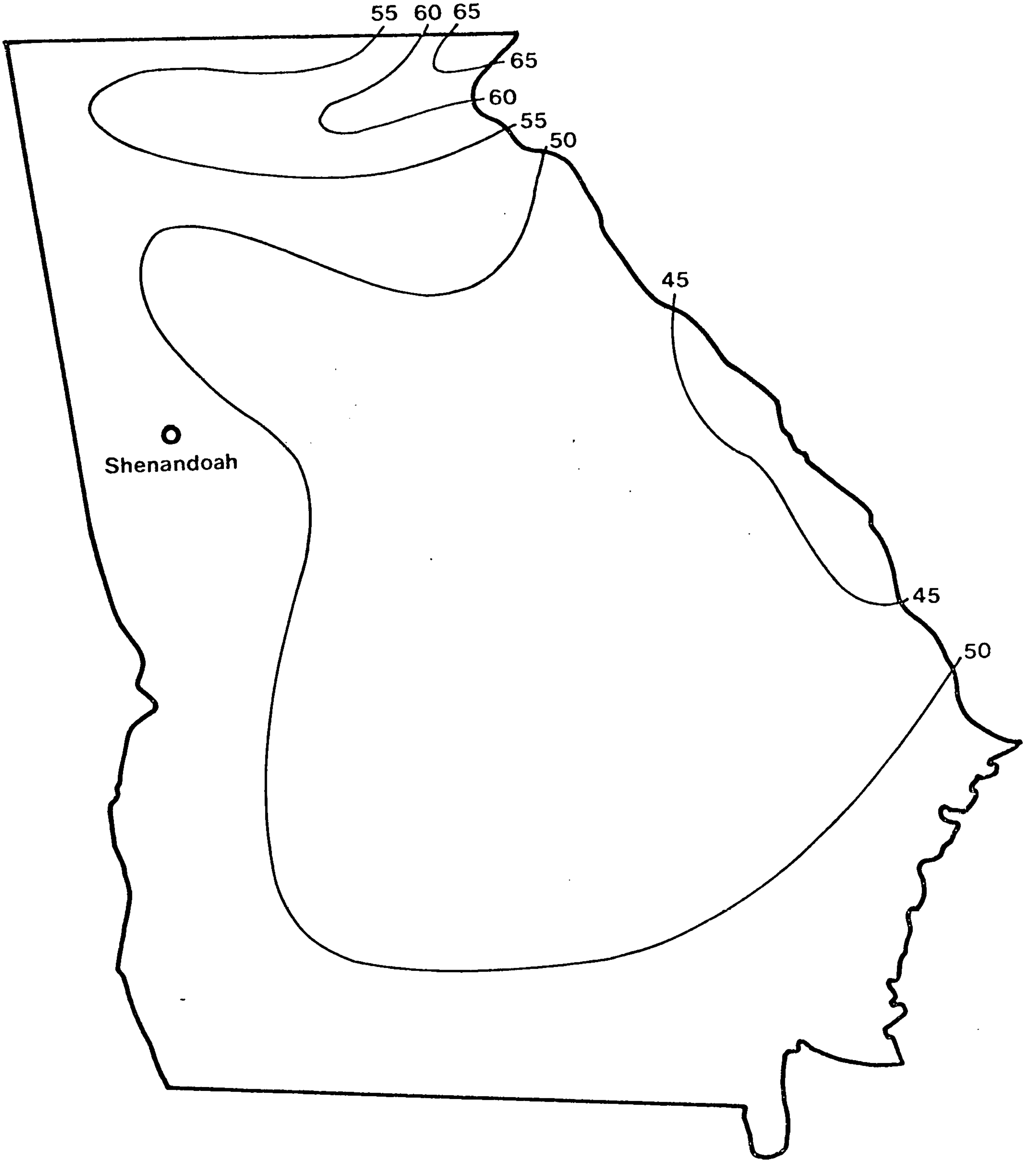

Figure C-10. Mean Annual Precipitation Totals

ATLANTA, GEORGIA
ANNUAL

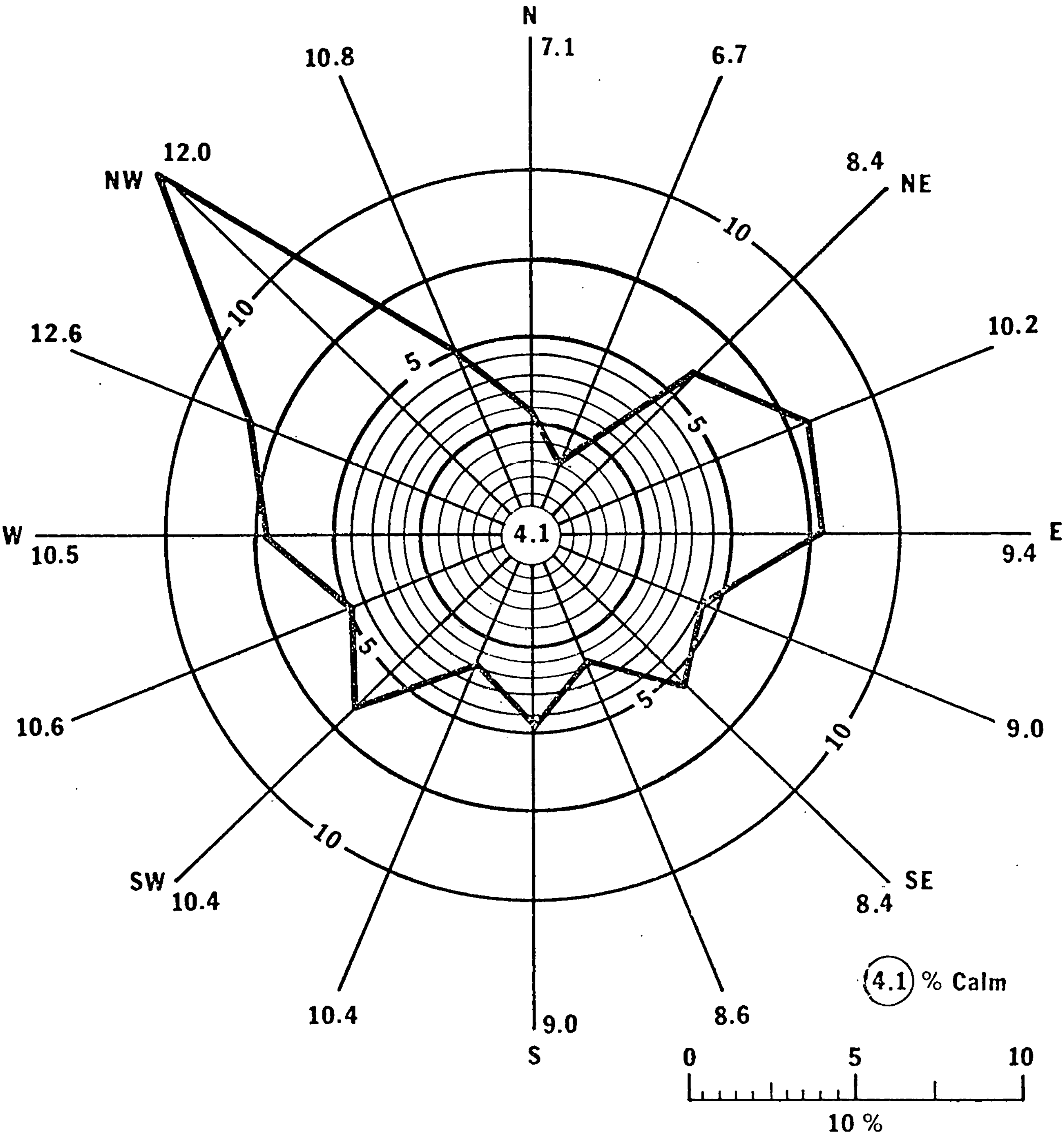

Figure C-11. Percentage Frequencies of Wind Directions

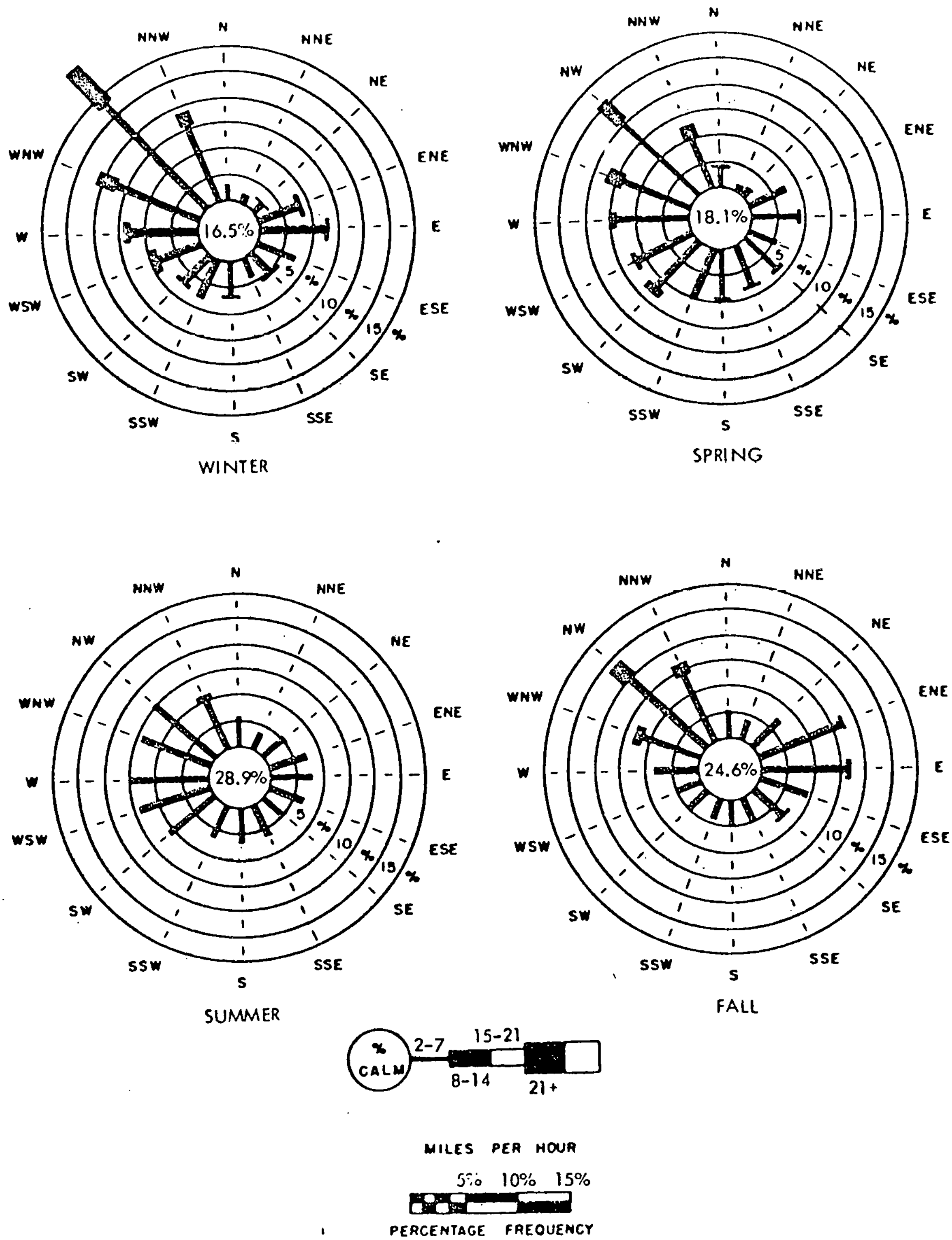

Figure C-12. Seasonal Surface Wind Roses

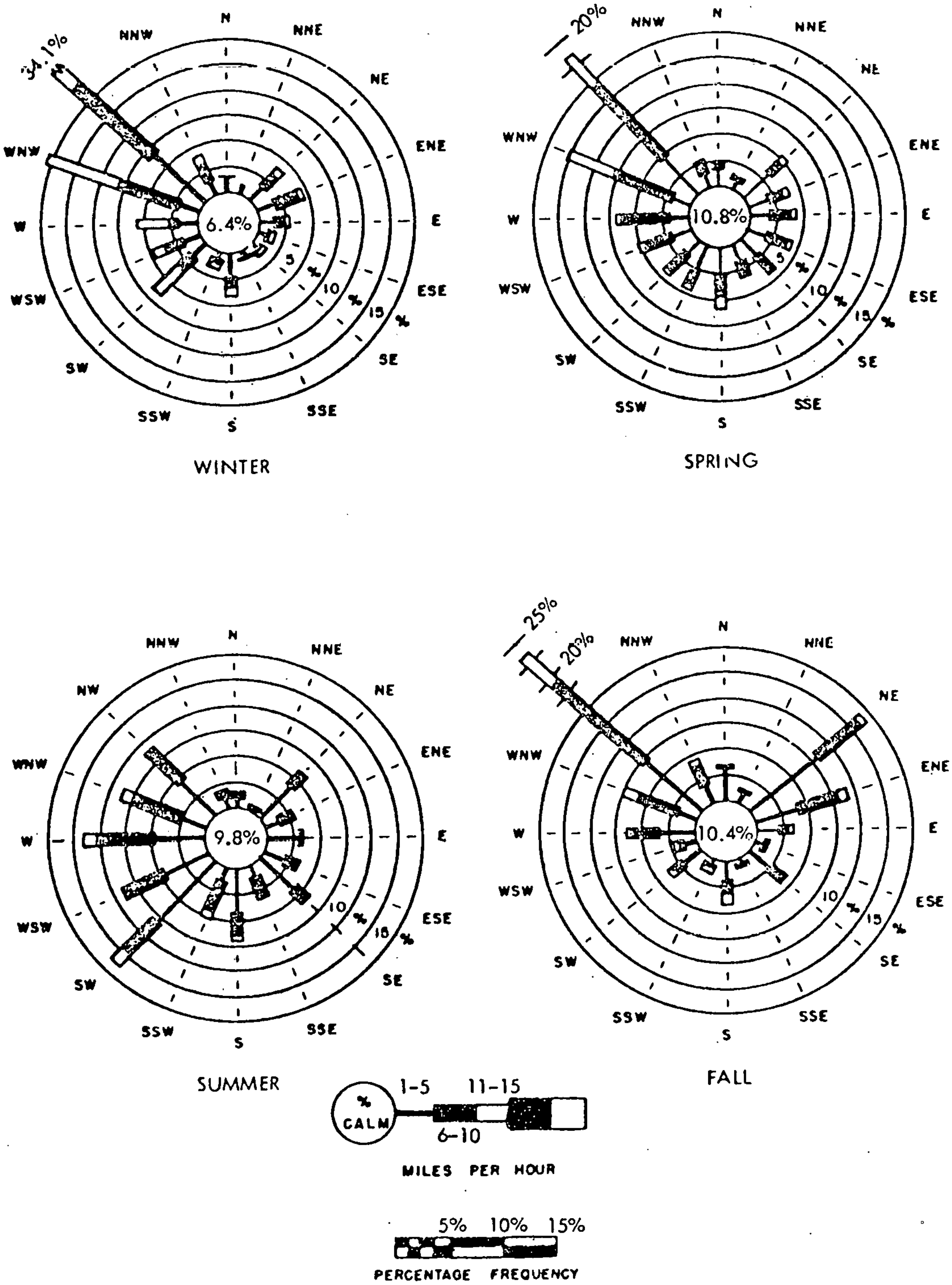

Figure C-13. Stable Wind Roses

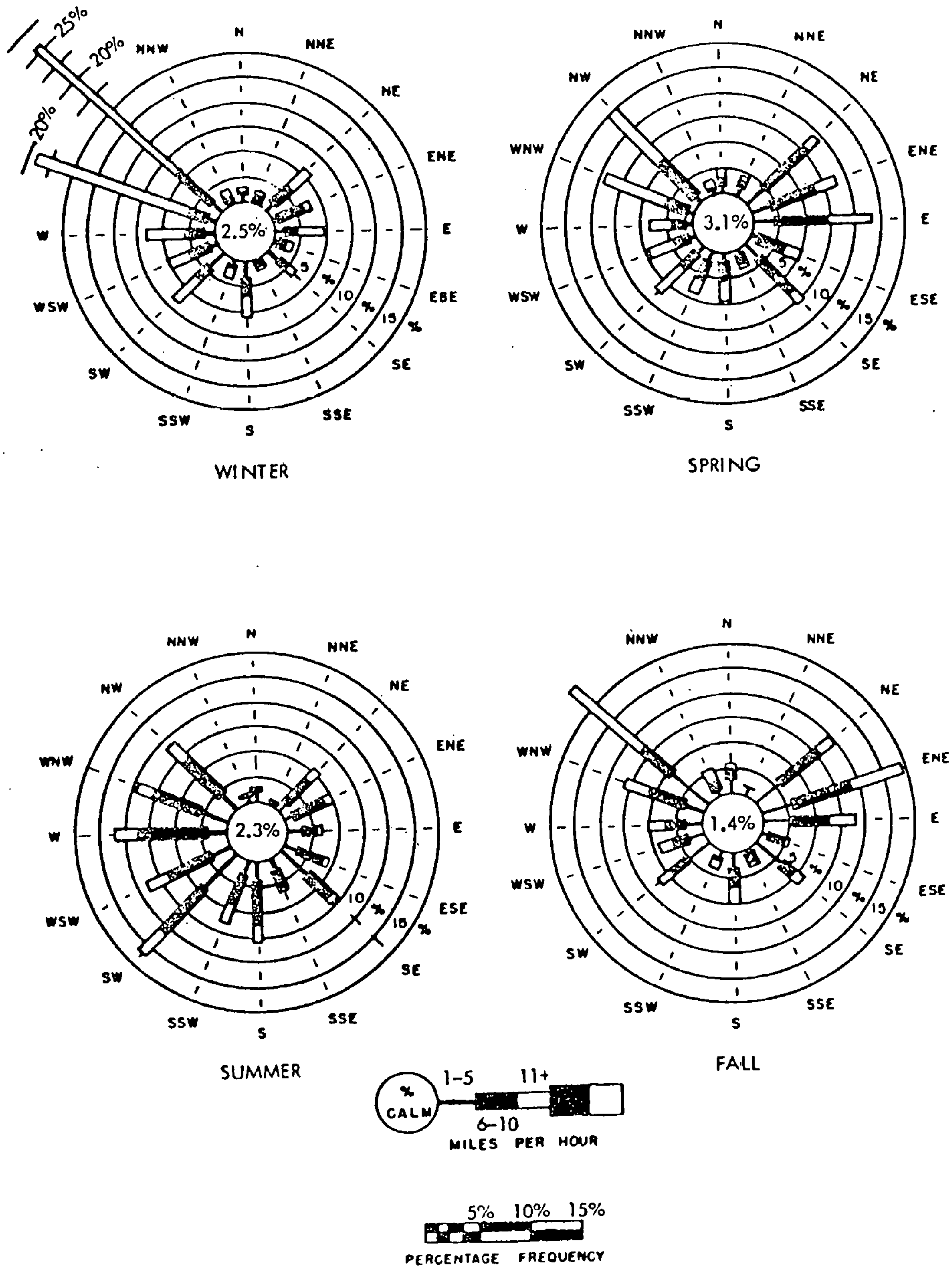

Figure C-14. Unstable Wind Roses

The precipitation wind roses for Dobbins Air Force Base, Georgia, are presented by season in Figure C-15. The spring and fall seasons show an easterly maximum directional frequency that indicates a high probability of easterly quadrant winds whenever continuous precipitation occurs. Spring and summer months continue to maintain an easterly maximum but show secondary maximums from the southwest. Showery precipitation is commonly encountered with these southwesterly winds.

Heating/Cooling Ratio - Average Year

The monthly and annual mean heating degree days for the period 1941-1970 are shown in Figure C-16.

The annual cooling degree days are not available for any of the stations except the Atlanta Airport. There the annual total is 1589 cooling degree days. The maximum monthly total is 403 for July with 388 and 321 for August and June respectively. Since absorption cooling equipment appropriate for the STE-LSE has a COP of about 0.65, the thermal energy required for heating and cooling in this area is about the same.

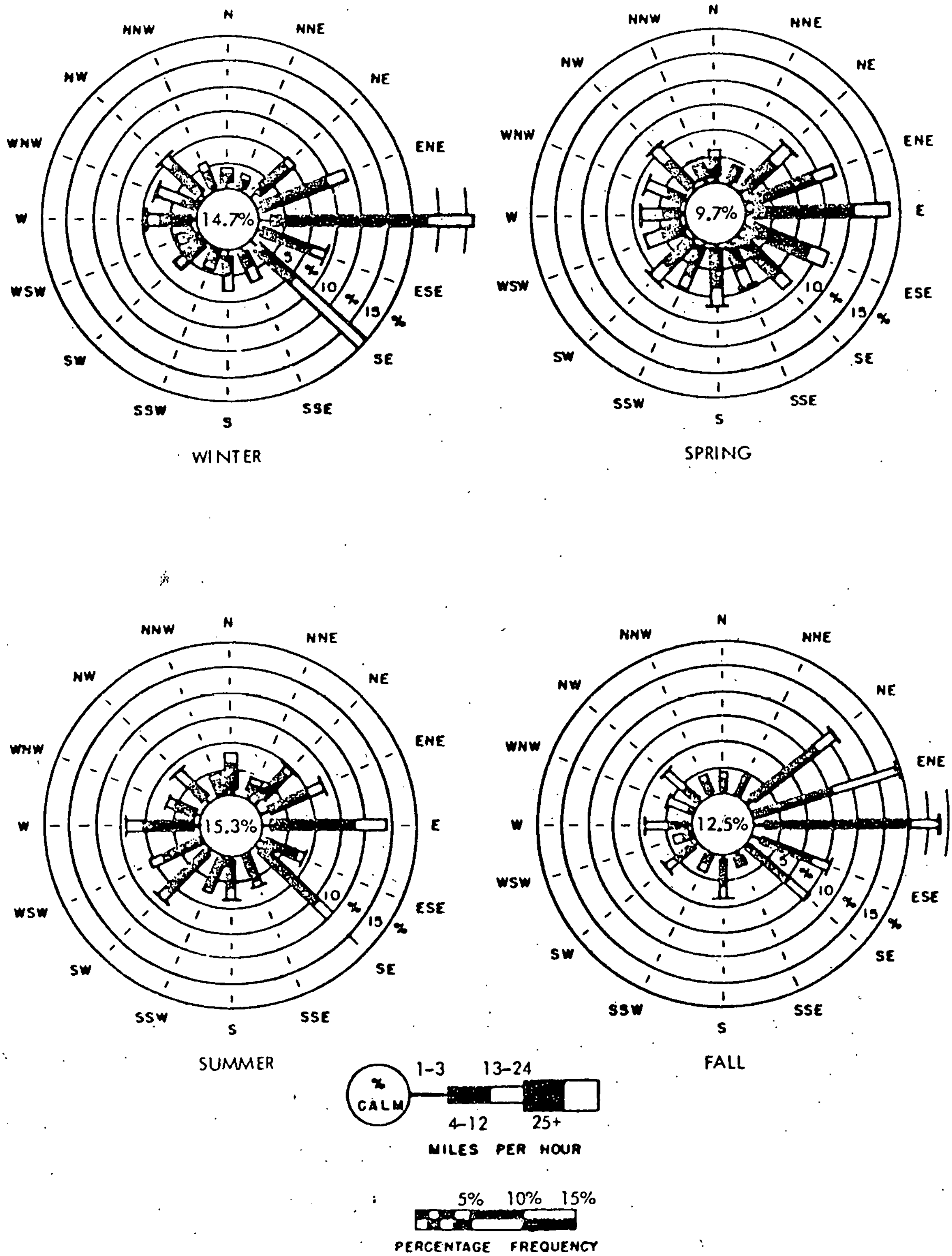

Figure C-15. Precipitation Wind Roses

Month	Newnan	Atlanta	Carrollton	Griffin	LaGrange
January	630	701	680	640	600
February	500	560	540	520	490
March	380	443	430	410	360
April	110	144	130	110	90
May	20	27	30	20	10
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	10	8	10	20	10
October	110	137	140	110	110
November	370	408	430	360	360
December	700	667	650	610	590
Annual	2,730	3,095	3,040	2,800	2,620

Figure C-16. Mean Heating Degree Days

C.6 HEALTH AND SAFETY CONSIDERATIONS

Appropriate Georgia Power Company personnel will measure and monitor the project to ensure a safe and healthy environment for employes and visitors at the site. The following precautions will be taken:

- If toxic or hazardous fluids are used, respiratory protective equipment is available.
- Employes will be trained in the safe use of all equipment, as well as in First Aid Procedures and Cardio-Pulminary Resuscitation (CPR).
- All safety regulations pertaining to Company and Governmental Procedures will be complied with.
- Safety and Health will monitor the design specifications and construction of the project to ensure the safety of employes.
- If employes and public are exposed to areas with high temperature piping or duct, these will be insulated to prevent thermal burns.
- A fire protection system will be provided to protect the equipment and personnel on the site.

C.7 ENVIRONMENTAL ASSESSMENT

Concurrent with the STE-LSE program, the community of Shenandoah had been selected by the Governor's Site Selection Commission as a potential site for the Solar Energy Research Institute (SERI). In conjunction with that proposal, a detailed environmental assessment study was conducted by a team of 14 technical specialists from the Georgia Department of Natural Resources. The aerial view in Figure C-17 indicates the close proximity of the STE-LSE application site and the proposed SERI site. As a result of this proximity (less than one mile), the information presented in the SERI environmental study is applicable to the STE-LSE site.

The detailed report is organized in accordance with the typical seven chapters of an Environmental Impact Statement, but the following Summary Statement encompasses four categories that can be scanned quickly:

- Site areas of investigation
- Adverse impacts of proposed development
- Irreversible/irretrievable commitment of resources
- Overall benefit statement

SITE AREAS OF INVESTIGATION

Location

The STE-LSE site consists of five acres in an industrial park in the Shenandoah New Town of Coweta County, Georgia. It is 25 miles south of the Hartsfield International Airport outside Atlanta, and is within one mile of the intersection of Interstate Highway 85 and Georgia Route 34.

Geology

The STE-LSE site is situated in the Greenville Slope District of the Midland Georgia subsection of the Piedmont Physiographic Province. The topography is gently rolling with 2-10 percent slopes. The depth of weathered material is variable and ranges from 10 to 70 feet. The site is located in a low seismic risk zone. The only significant impact on the geology of the site will occur during the clearing of vegetation from the area, which will expose the soil to the forces of erosion. The rate and degree of erosion both during and after construction can be controlled by following accepted engineering procedures.

Soils

There are four different series of soils on the site. In general, sandy and sandy-loams are characteristic. The soils have low to moderate shrink-swell potentials, implying relatively stable soil conditions for foundations. The soil erosion potential and impact have already been discussed in the Geology Section of this statement.

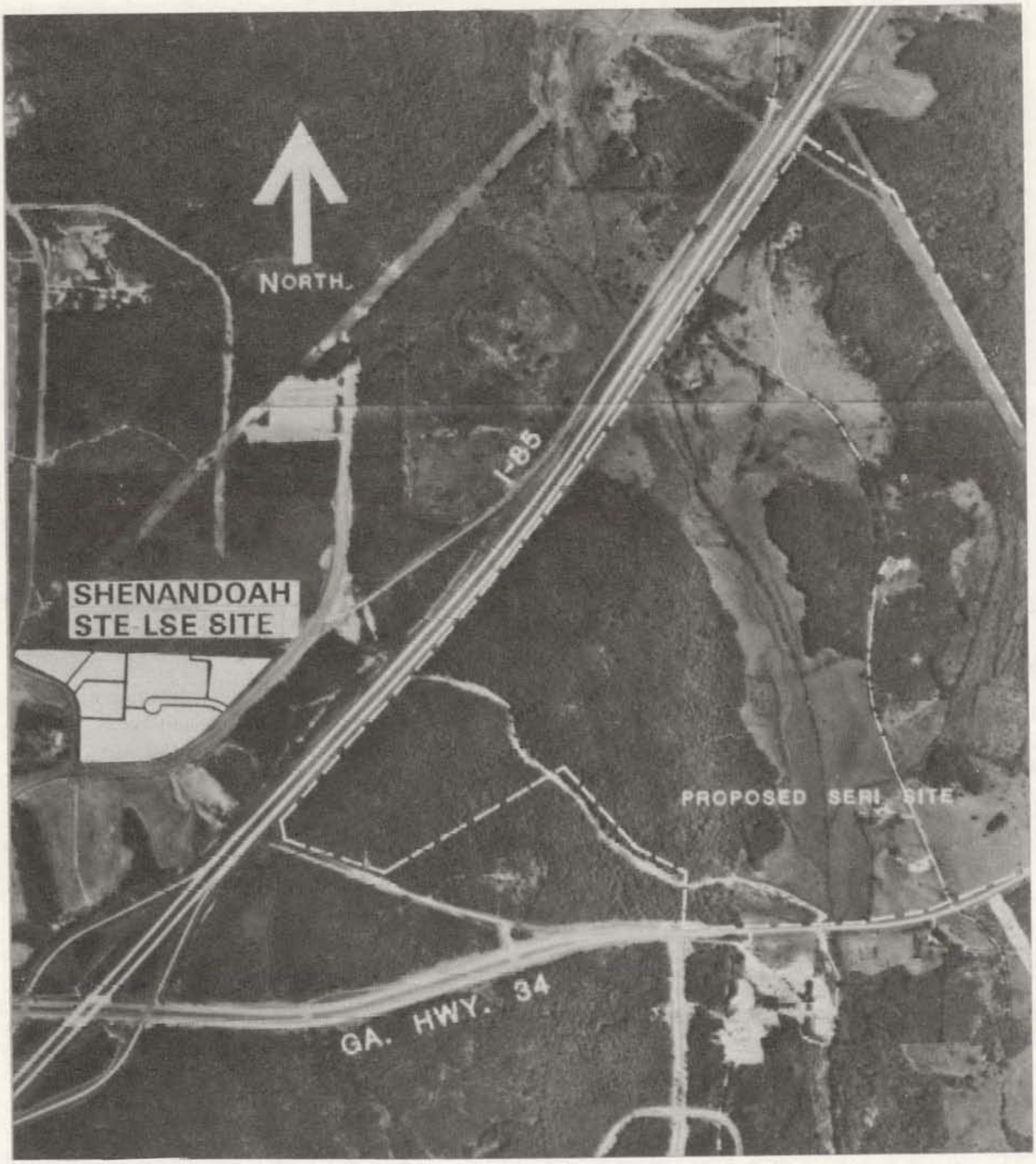

Figure C-17. Proximity of STE-LSE and Proposed SERI Site

Climate

The climate of the west-central section of Georgia is classified as "subtropical-humid." There are four distinct seasons, with summer being warm and having a maximum temperature occurrence of 90°F or higher on about half the days from June through August. The average minimum temperature during the summer is 66.7°F, and the average maximum for winter is 56.8°F. Freezing conditions occur infrequently during the winter. The highest temperature recorded near the site was 108°F in 1925, and the lowest on record was -9°F in 1899. The mean annual precipitation is 51.8 inches, and the average mid-day relative humidity if 56 percent. Data over a 16-year period taken at Griffin, Georgia, indicate a mean daily solar radiation value of 254 langleys in January and 601 langleys in May, with April through August being about the same as May.

It is not expected that there will be any impact on the climate outside the property lines. With respect to the site itself, microclimatological effects will take place with the clearing of vegetation and the construction of the facility. These effects, which will occur on a small scale up to 20 meters in height, are as follows: decrease in relative humidity; decrease in surface roughness; increase in average windspeed; increase in turbulence; increase in albedo; and increase in the sensible heat at the expense of latent heat.

Surface Water Hydrology

The proposed site lies within the headwaters of the White Oak Creek Watershed of the Flint River Basin. The average annual runoff in the watershed is about 1.2 cubic feet per second per square mile. During the most severe drought on record, which occurred in 1954, the minimum one-day streamflow in the vicinity of the project site was less than 0.2 cubic feet per second. The creeks in and around the STE-LSE site are small streams of limited capacity, mainly because they are headwaters of the drainage basin. Some accumulated runoff will occur as a result of the devegetation and development. Any possible stream bank overflow will not be detrimental to the proposed development, which will be well outside any flood hazard area.

Ground Water Hydrology

The availability and quality of ground water in the Piedmont Province is complex. In general, the yield of water wells constructed to obtain their maximum yield will average about 30 gallons per minute. Extreme yields range from 0 to 500 gallons per minute. There are several producing wells on or near the Shenandoah New Town; however, many attemps at drilling wells in certain areas, such as for single-family residential use, have not produced water in sufficient quantity and quality. Depending on the location in the aquafier from which water is taken, iron may be present and, thus, require treatment for removal. There is not expected to be any significant impact on the ground water resources of the area. However, there will be a slight decrease in the amount of recharge, due to decreased vegetation and the impervious condition of the soil in some areas of the site.

Flora

About 35 percent of the site is cleared land: abandoned pastures, fields and farm land. In the past, it has been maintained in stands of Fescue and Bahia grasses. The rest of the proposed site is covered with varying densities of second-growth mixed pine-hardwood canopy, with pines predominating. Scattered individual trees represent ages beyond 30 years. The site does not contain any rare or endangered species. It is assumed that a large part of the canopy vegetation will be removed. This will result in a permanent impact to the trees and also the the understory plant species, which have limiting factors such as nutrients, pH and quantity of light.

Fauna

A faunal inventory was prepared from field observations made on the STE-LSE site in each representative habitat, and from a literature research for the habitats common to the Georgia Piedmont. Among the mammals found, the most numerous were white-tailed deer, rabbits, squirrels and cotton rats. Most birds on the site are songbirds, but there is also a dense population of quail. Several snakes, lizards, frogs and turtles were observed on the site. There are no known endangered species present, nor is the acreage at this site likely to be designated critical habitat for any endangered species.

Habitat alteration in any area may prove to be harmful or beneficial to fauna, depending upon the extent, character, and permanence of alteration. It is possible that alteration will be beneficial to some species while detrimental to others. If one assumes that five acres of land will be cleared for the STES and that little consideration will be given to wildlife, then the net impact of the project will be negative upon existing wildlife population. However, certain actions are being taken by planners and developers of the STE-LSE site to preserve and establish certain other habitats, which will enhance the wildlife on the site.

Archaeology and History

A preliminary survey of the site was conducted in order to determine if any archaeological or historical resources were evident on the project site, but no unique historical evidence was found. The general site area shows some remnants of land-use practices as exhibited by road networks, town sites and farming. A preliminary survey of the site did not reveal any archaeological resources. If any such resources exist, they are probably well below the surface since most of the area has undergone extensive farming in the past. Since Georgia has been occupied for about 10,000 years, there is a possibility of archaeological resources occurring all over the state.

In regard to impacts of the proposed STE-LSE project on the archaeology and history of the area, the construction of the facility will alter the physical record of land-use practices and patterns undertaken since the land cession of 1825. However, land-use patterns can be preserved via photographs and study reports. If anything of archaeological significance is below the surface, it would be studied and reported in accordance with Federal procedures.

Air Quality

The existing particulate and sulfur dioxide concentrations in the ambient atmosphere at the site are well below the Georgia State Air Quality Standards. There are existing emission sources within several miles of the project site, but they have a negligible effect in the vicinity of the site and are not expected to impact the STE-LSE. The STE-LSE facility is not contributing enough particulate, sulfur dioxide, nitrogen oxides, oxidants or total hydrocarbons to make a significant change in the existing air quality. The impact of any support or spin-off industries that occur in the vicinity of the site should be negligible because of the State of Georgia's Environmental Protection Division's authority to influence the location of industries through various regulations. In particular, the State of Georgia has been delegated the authority to conduct the required program to prevent significant deterioration of air quality. Finally, with respect to mobile sources, considering the location of the STE-LSE site and the existing conditions, it can be assumed that the impact of the carbon monoxide from the residents' and/or employees' vehicles will not produce a violation of the State carbon monoxide air quality standard.

Water Supply

Since the city of Newnan, Georgia serves Shenandoah through a 20-inch water main, there is abundant water supply for the STE-LSE site. Shenandoah has a one-million-gallon storage tank and a contract with Newnan to supply the water. Shenandoah plans to build a three-million-gallons-per-day water treatment plant by 1981, which will be supplied by Lake Shenandoah and a 24-inch main line from Line Creek.

Water Quality

Shenandoah New Town and the STE-LSE site are located in the White Oak Creek Watershed of the Flint River Basin. All streams in this area are classified as "fishing," in accordance with Georgia Environmental Protection Rules and Regulations. The STE-LSE site lies adjacent to existing interceptor sewers. The sewage treatment facility is designed for 300,000 gallons per day, and current projections indicate only about 10-15 percent use of that capacity for the STE-LSE.

There is some minor potential for detrimental impact to water quality from erosion during any development. Coweta County has adopted and implemented a soil erosion and sediment control resolution applicable to developments such as the STE-LSE. The ordinance conforms to the requirements of the Georgia Erosion and Sedimentation Control Act of 1975. Since these guidelines are being implemented at the site during all construction activities, the water quality impact is being minimized.

Solid Waste

All solid waste produced by the STE-LSE can be handled off-site, most probably at Coweta County's Ishman Ballard Road Disposal site, which is currently operated in accordance with a Georgia-approved Solid Waste Management Plan. There are also several private disposal sites within a radius of 35 miles that are readily accessible by I-85 or Georgia State Routes 34 and 54. In addition, several companies in Atlanta are in the waste reprocessing and recycling business. There has been a small increase in solid waste production in the area due to the construction of the STE-LSE on the site, but adequate facilities are available to handle it.

Land Use and Zoning

Coweta County is essentially an undeveloped area. Out of some 284,000 acres, only approximately 10,000 acres are incorporated. Of the remaining 274,000 unincorporated acres, only 4.3 percent is developed. Shenandoah New Town is a 7,400-acre tract within Coweta County adjacent to Newnan, Georgia. Before the Shenandoah project was undertaken, the land was mostly agricultural and wooded, bisected by I-85 and State Route 34. Several industrial, residential and service-related facilities are being constructed at Shenandoah, and the developers expect to build a complete community.

The development is taking place in accordance with guidelines established for the development of new communities by the Coweta County Zoning Commission. The site for the STE-LSE had already been removed from forestry and agricultural use by the developers of Shenandoah long before its selection by DOE for the experiment. However, persons employed by STE-LSE who elect to live outside Shenandoah may cause small amounts of land to be converted from agricultural to residential use.

Socio-Economic

Any evaluation of the socio-economic impact of the site must include the Atlanta metropolitan area. Atlanta is one of the most rapidly growing metropolitan areas in the United States, and it currently serves as the hub of the entire southeastern part of the nation. The educational, technological, and cultural bases existing in the area are particularly suited for the support of the STE-LSE.

The population will increse in Coweta County and surrounding areas when the STE-LSE is operational. Rapid increases in population require intense planning to avoid detrimental effects, and the site capitalizes on the intensive planning already completed by Shenandoah and evidenced in the proposed Coweta County Land Use plan.

There will be a positive fiscal impact on the county and on surrounding areas. The economic spin-offs of the STE-LSE are impossible to measure at this time, but they will have a positive impact. The increase in population will cause a minimal increase in the demand for schools, but the net effect will be beneficial because of the increase in the tax base from the industry.

Public Safety

Police, fire protection, hospital and health services are currently available in Coweta County. In addition, Shenandoah is supported by other resources in Atlanta, particularly in the hospital and health services area. Coweta County also maintains a Civil Defense and Disaster Protection Program, which consists of 250 volunteers, a 30-man auxiliary police force, and a 30-man special rescue unit. The development of the STE-LSE will have an impact on public safety, but the impact should be minimal since the developers of Shenandoah have been working closely with Coweta County to ensure the county's capabilities for expansion. The Shenandoah project is planned to serve 40,000 to 45,000 people, so there will be no problem accommodating the STE-LSE employees and their families.

Energy

Both the Georgia Power Company and Coweta County's Electric Membership Cooperative distribute electricity to Shenandoah. Georgia Power currently operates Plant Yates, just eight miles north of Newnan, which generates 1.25 million kilowatts of electricity. Power lines are in existence along Amlajack Boulevard, which is adjacent to the southern boundary of the site. Natural gas is supplied to the Shenandoah area by Atlanta Gas Light Company.

Communication

Southern Bell Telephone Company serves the Coweta County area, including Shenandoah, out of an office at LaGrange, Georgia. All phone lines are underground in Shenandoah, and service lines run along Amlajak Boulevard.

Newspapers prominent in the area include the Atlanta Journal-Constitution and the Newnan Times-Herald. Shenandoah is served by 32 radio stations in Atlanta and two local stations in Newnan. More than a dozen public, private and educational television stations are based in Atlanta and the surrounding area. The STE-LSE will increase the daily demand on existing communication facilities, but adequate resources are available to handle this increase. There will be a need to upgrade the postal service in this area.

Transportation

The STE-LSE site is located proximate to I-85, a major highway that connects the site to Atlanta and to other interstate highway networks of the Southeast. There is a direct exit from I-85 to Georgia State Route 34, a four-lane divided highway that goes to Newnan, Georgia. Atlanta's Hartsfield International Airport is located 25 miles from the STE-LSE site via I-85. This airport is the nation's second most active passenger terminal and the fifth most active air freight terminal. A small local airport with a 3,500 foot lighted asphalt runway, rotating beacon, and unicom radio is located six miles from Shenandoah. This small airport is jointly operated by Coweta County and the City of Newnan.

Rail service is provided to Shenandoah via the main line of the Atlanta and West Point Railroad, a Southern Railroad affiliate, which adjoins an industrial district on the southern boundary of the new town.

Georgia provides deepwater ports in Brunswick and Savannah, and inland-barge terminals in Augusta and Columbus. Savannah is the most modern port in the South Atlantic, offering more than four million square feet of warehouse space and service by more than 100 steamship lines. The Central of Georgia Railroad provides direct service to Savannah.

The impacts on transportation will occur mostly in the local area. The urbanization of the site and the development of adjacent properties will lead to a substantial increse in the number of automobiles. The location of the STE-LSE at Shenandoah has had negligible impact on Hartsfield Airport during the initial construction phase, but the airport is carrying some cargo and passengers bound for the Knitwear Plant. However, with the airport's existing size and capacity, no significant impact has been felt. Rail, air, and private carriers will realize some increase in cargo during later construction and equipping stages of the development, and the long-range impact may be significant depending on the future needs of the industrial application.

Recreation

A large inventory of recreational facilities exists throughout the immediate area, the metropolitan Atlanta complex, and the State of Georgia. It is conceivable that the increase in population may cause some additional facilities to be built in the general vicinity of the new town.

Site Aesthetics

Aesthetics of a site cannot be mathematically measured or defined. It is the result of what a viewer sees and his response to the scene. The STE-LSE site, as viewed from the highways adjacent to it, is a rather pleasant, gently rolling piedmont area with low-lying sections previously cleared for pasture, and with higher sections covered with pine stands. This means that there is an existing resource with which a landscape architect can work in the planning and development stages to fit all components of the STE-LSE into an attractive setting. Construction of industrial facilities, roads, parking areas, and offices, together with the erection of outdoor experiments has and will require the removal of trees on the site. Degradation will depend upon the amount of land to be cleared; the sensitivity of designers, planners and contractors; and the number of trees to be left standing. Every effort is being made to maintain Shenandoah standards applicable to minimum green areas required for industrial constructions.

Adverse Impacts

All adverse impacts caused by the development of STE-LSE can be mitigated if laws, regulations, codes or resolutions are followed and if standard engineering precautions are taken.

Siltation and sedimentation appear in many of the environmental investigations as adverse impacts. Soils, geology, water quality, surface hydrology and fauna investigators have all identified this problem, which usually results from earth-moving operations. Increased runoff and decreased infiltration of rainwater resulting from paving and building construction are related problems that contribute to sedimentation. All can be and are being mitigated.

It is anticipated that site and regional aesthetics will be degraded by the facility itself, by the traffic moving to and from the site, and by disposal sites in the area that will handle STE-LSE solid waste. A design solution, both architectural and on the landscape, is being applied to these problems.

The loss of plant and animal life on the site is an impact that, over the short term, cannot be avoided or mitigated. However, no rare or endangered species are involved, and no species will be jeopardized by the project. Furthermore, a long-term solution, where areas that cannot be developed are allowed through natural succession to revert to low-land hardwood forest, can result in a more productive and diverse plant and animal community without interference with research activities. The net result would be a long-term positive impact requiring little, if any, investment.

The State of Georgia has an active program of pollution abatement implemented through the Department of Natural Resources, Environmental Affairs Division (EPD). This division has been delegated the responsibility for implementing various sections of the Clean Air Act and the federal Water Pollution Act by the federal Environmental Protection Agency.

Should the project require any facilities that might result in air or gaseous pollution, then a preconstruction review, construction permit, and operating permit may be required from the EPD. New fossil-fuel-fired steam generators must meet federal performance standards if larger than 250,000,000 Btu/hr input. Operating permits are required of larger sized heating boilers. The STES boilers (backup and auxiliary), with a combined rating of about 3,500,000 Btu/hr, pose no problem. If the project should result in liquid effluent discharges, then the discharge must be approved if made to a stream. If the discharges are directed into a municipal type sewage system, pretreatment might be required.

If toxic or other hazardous fluids are used in the cycle, then specific concern will be shown to prevent spills, releases, or other discharges to the environment.

A site power generation of approximately 250 kw is relatively small, so no unusual enrironmental effects are expected.

Irreversible and Irretrievable Commitments of Resources

Most irreversible and irretrievable commitments of resources resulting from the implementation of the project will involve natural resources from other areas of the state, the nation or the world that will be expended on the site. Human and financial resources will also be involved. Off-site resources include building materials (whether mineral or timber) needed to construct buildings, roads, utility lines and pipes, employee residences and offices or research equipment; fossil fuels for energy; human labor to construct the facility, to provide labor for the research project and to provide police protection and community services; and money to pay for construction, maintenance, operations, and salaries. Water used by the site will not be available to other users; it will be treated and returned to the streams. Chemicals involved in treatment will be lost. Solid waste generated on the site will be placed in landfills and may or may not be irretrievably lost.

The only irreversible commitment of on-site resources will be the loss of animal and plant life when the site is totally cleared for development. Lives of individual plants and animals will be lost, but no species will be threatened, and no rare or endangered species are involved.

Overall Benefit Statement

The construction of the STES at the Shenandoah site and the attainment of STE-LSE objectives will produce significant socio-economic, technological and environmental benefits to the State of Georgia, to the nation, and to the world. Short-term socio-economic benefits will accrue to the region and the state as a result of increased economic activity. Long-term environmental and technological benefits will result from the solar energy related research.

There will be less dependence on fossil fuels and, therefore, a reduction in extraction operations, as well as less flooding associated with the development of power-generation dams. Consequently, there will be less destruction of the natural environment. Technological benefits of the research are certain, the results of which may be the development of an alternative energy source for worldwide use.

C.8 COMPATIBILITY OF THE SITE

The selected site and application have energy requirements commensurate with DOE STE-LSE requirements, based on double shift operation at the 42,000 sq. ft. facility. These energy requirements can be supplied directly from the STES from approximately 8:00 a.m. to 4:00 p.m. Additional energy will be fed to thermal storage (high or low temperature as appropriate) to support operation beyond 4:00 p.m. to the extent needed to optimize operation between 60 and 90 percent of the total annual requirement.

Within the overall energy requirements, the electric, heating/cooling and process heat requirements are also compatible. A 4160 volts to 25 kv transformer and GPC switchgear will properly interface with the STES generator to the application. Careful attention has been given to a system that will allow switchover to or from IES without adverse impact on the knitwear manufacturing facility.

The heating/cooling interface will be straightforward, since appropriate connection flanges have been provided during construction of the manufacturing facility through DOE funding. The design will accommodate hot and/or cold water from 40° to 180°F. The process steam requirement is 1000 lb/hr of 150 psia, 300°F quality. This temperature is also well within the 150° to 350° range specified by DOE.

As mentioned previously, the Bleyle Knitwear Manufacturing facility has been in operation since January, 1978, well ahead of the required October 1, 1978 date when operational data are desired for use by DOE and design contractor General Electric. Instrumentation to record these data has been provided by the Georgia Power Company. The equipment has been installed in the Office/Trailer at the site and has been recording all power usage within the plant for several months.

The meteorological station, funded by DOE, also has been installed at the site and is operating around the clock to provide the most detailed meteorological data available.

Continuing liaison with DOE and DOE contractors throughout the design, construction and operation of the STES will be provided by GPC to ensure the timely coordination of the STES design with the application.

C.9 ACCESSIBILITY OF THE SITE

As mentioned in Section 2.1.1, the Shenandoah Site is located within one mile of the intersection of Interstate 85 and Georgia Route 34, where an Interstate exit provides easy access to the State route. A four-lane industrial/business boulevard offers excellent access to Shenandoah Industrial Park where the Bleyle Knitwear Plant is located.

The following transportation facilities are available to Shenandoah residents and commercial/ industrial tenants:

- Air — Atlanta's Hartsfield International Airport, second busiest passenger and fifth busiest freight terminal in the nation, is only 25 miles from Shenandoah via I-85. A local airport is located six miles from Shenandoah in Newnan.

- Rail — The main line of the Atlanta and West Point Railroad (a Seaboard Coastline affiliate) adjoins Shenandoah's primary industrial district. The main line of the Central of Georgia (a Southern Railroad affiliate) adjoins an additional industrial district on the southern boundary of the new town. Piggyback trailer pools are locally available for all rail plans such as TOFC and COFC.

- Truck — Four regular-route, general-commodity carriers serve Shenandoah on both an intrastate and an interstate basis. Interstate 85, which bisects Shenandoah, intersects two major interstates, I-20 and I-75 in Atlanta and also intersects I-285, Atlanta's circumferential interstate by-pass, less than 25 miles from Shenandoah.

Accessibility of Atlanta to major U. S. cities by air is shown in Figure C-18. Atlanta is the home of the world's second busiest airport, is corporate headquarters for two airlines, and is one of the

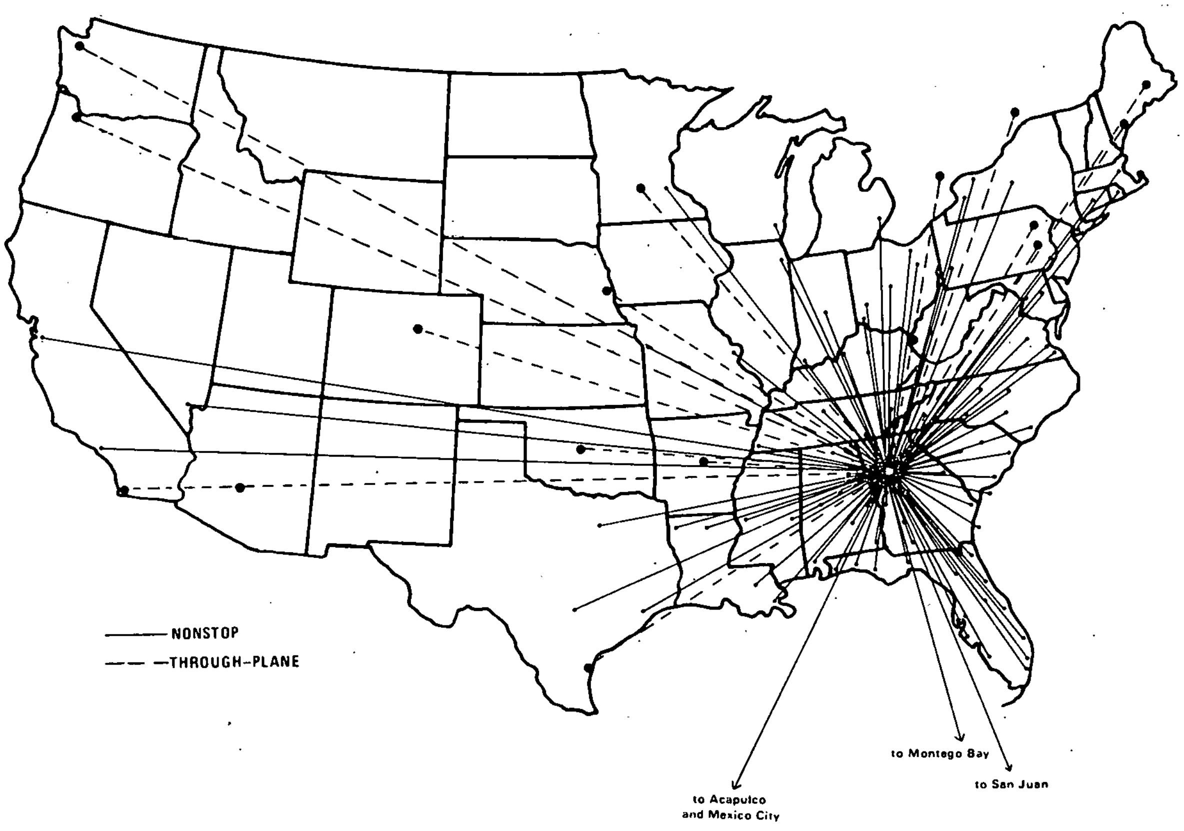

Figure C-18. Nonstop and Through-Plane Service at Atlanta Airport prime connecting points in the nation's air route pattern. Atlanta is served by seven airlines, two railroad systems (composed of seven railroad companies), 350 registered motor carriers, three buslines, a progressive Metropolitan Atlanta Rapid Transit Authority, and numerous allied services. Twenty-two general aviation airports supplement the facilities and operations of Atlanta's Hartsfield International Airport. Offline offices are maintained in Atlanta by 19 airlines, 33 railroads, and 19 steamship companies. In addition, Atlanta is one of only five U. S. cities located at the focal point of six legs of three interstate highways (I-20, I-75, and I-85), making it the southeastern hub of a 41,000 mile interstate highway system.

Atlanta has nonstop air service to 99 cites (Figure C-18) with direct through-plane service to an additional 39 cites, and direct flights to London and Brussels. The table below indicates the flight service that STE-LSE personnel have in Atlanta. For example, between Washington National and Atlanta, there are 30 round-trip flights per day and round-trip fare for the 1.5 hour flight is only $132. Although there is no direct or throughplane service to Albuquerque from Atlanta, there are 19 one-stop flights daily, with the average flight lasting four hours and 25 minutes.

From To / To From	ATLANTA	Albuquerque	Boston	Denver	Knoxville	Miami	Minneapolis	Phoenix	San Francisco	Washington
ATLANTA	–	0	21	4	9	26	7	2	6	33
Albuquerque	0	–	0	9	0	0	0	4	5	2
Boston	20	1	–	5	0	8	7	5	11	26
Denver	4	9	7	–	0	5	11	12	16	9
Knoxville	9	0	0	0	–	0	0	0	2	4
Miami	24	0	8	3	0	–	5	2	5	13
Minneapolis	7	0	8	12	0	7	–	5	5	9
Phoenix	2	5	5	13	1	2	6	–	11	6
San Francisco	6	4	8	14	2	5	5	14	–	8
Washington	32	2	28	8	5	15	12	4	11	–

Atlanta also is a gateway city for international flights, authorized for nonstop service to London in recent proceedings before the Civil Aeronautics Board.

Atlanta is rapidly becoming an international city with its eight career consulates, 22 honorary consulates, and the Georgia World Congress Center, a $34 million international trade, consumer show, and convention facility. Shenandoah has been designated as the Atlanta Foreign Trade Zone.

C.10 NEAR-BY SOLAR PROJECTS

A 25-acre Solar Recreation Area, located approximately one mile southeast of the STES site, shown in Figure C-19, offers ice skating, hockey, a gymnasium, game rooms, an exhibition theatre, and meeting rooms. The gymnasium, served by a small kitchen facility, can also serve as a banquet hall, and was used for the indoor displays of Georgia's first Solar Fair. A near-by swimming pool is heated in the spring and fall by excess solar energy from the Recreation Center, utilizing the waste heat efficiently and prolonging the swimming season. Shenandoah Development, Inc., has financed the nearly $2 million cost of the building and its conventional heating and cooling system. The Department of Energy has awarded Georgia Tech and Shenandoah a $726,000 grant for design and construction of the solar energy system.

The Solar Recreation Center bulding is approximately 54,000 sq. ft. with nearly 11,200 sq. ft. of collectors, and an equal number of reflectors. The flat plate collectors are copper with a selectively coated black chrome finish over the absorber plates. Copper has a high initial cost factor, but the Georgia Institute of Technology, Principal Investigator for the Shenandoah project, reasons that copper's resistance to corrosion and its overall longevity will result in a lower life cycle cost than aluminum or steel collectors. The collectors are covered with two sheets of tempered glass to trap the heat inside, similar to a greenhouse effect.

The collectors are installed facing south at a 45 degree inclination. They are augmented by arrays of reflectors, mounted at a 36 degree slope to the north, so as to catch the high summer sunlight and bounce it onto the collectors. The same saw-toothed array of collectors and reflectors is mounted on the Towns Elementary School in Atlanta, with the following differences in design and concept:

- Towns School uses aluminum collectors while the Shenandoah Recreation Center uses copper.
- Towns School is an old building retrofitted for solar; the Shenandoah Recreation Center was designed to accommodate solar concepts.
- Towns School has the usual insulation common to schools; the Shenandoah Recreation Center was designed so that insulation produces additional energy savings.

The air conditioning unit for the Shenandoah Recreation Center is a water-fired absorption chiller with a nominal rating of 200 tons. The chilled water flows through the heat exchangers to provide cool air for the building. Heated water is stored in three tanks with a combined capacity of 75,000 gallons. The large storage capacity enables the solar system to heat the building during five to seven consecutive days without sunshine (a rare event in Shenandoah) or to cool the building for 36 to 48 hours without sunshine. The system provides as much as 70 percent of the heating and cooling needs of the center.

During the autumn and spring, when the collectors are providing more energy for heat than is needed by the building, the excess heat is used to warm the water in the community swimming pool, east of the center, thus providing an almost year-round use for the solar system. The chlorinated swimming pool water does not pass through the collector or storage system, but is heated through a water-to-water heat exchanger.

Figure C-19. Ice Skating in Shenandoah Solar Recreation Area

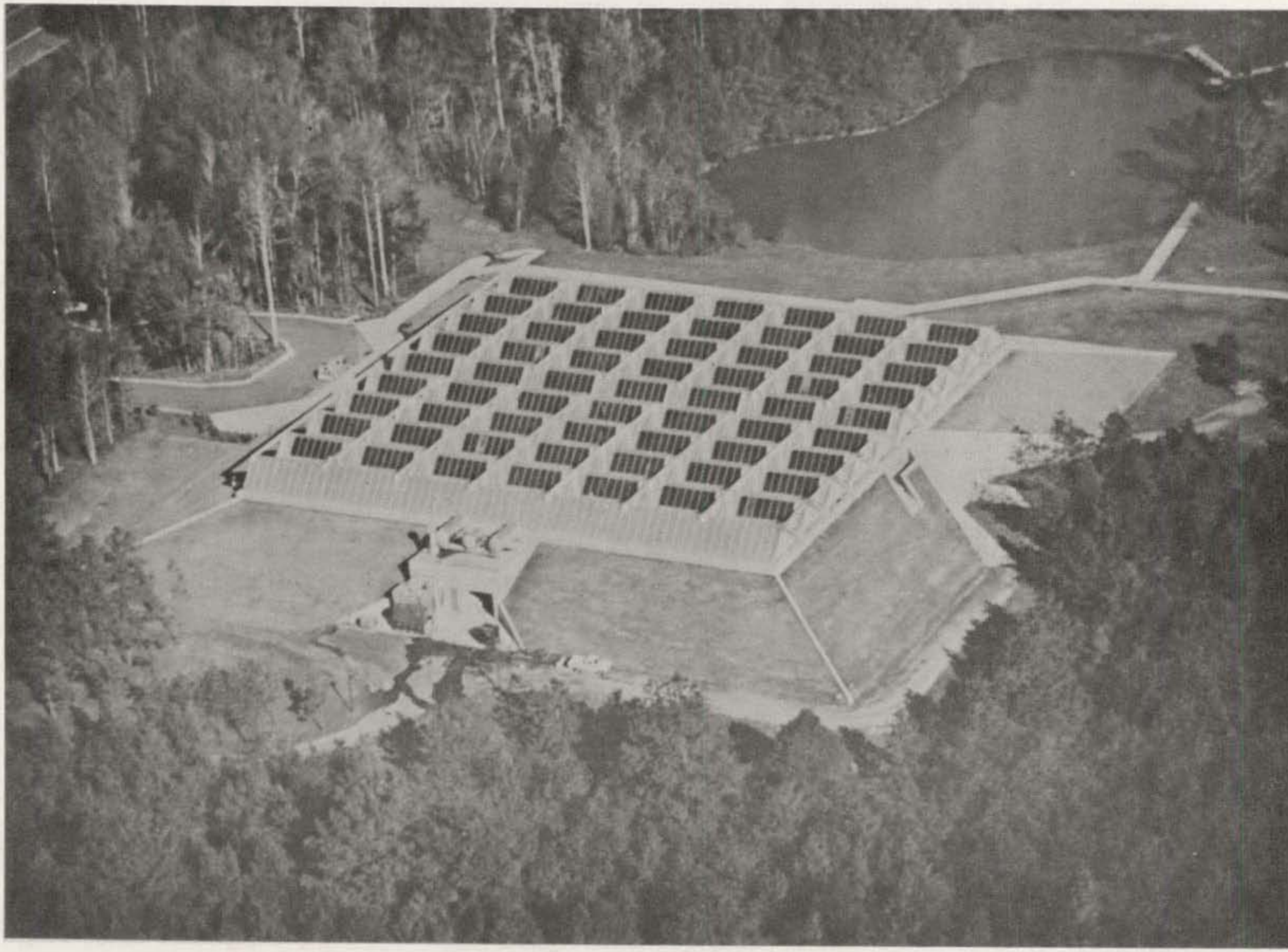

Figure C-20. Roof of Solar Recreation Center with Collectors

Figure C-21. Solar-heated and Cooled Atlanta Office Building Planned by Georgia Power Company

An appropriate building load profile computer program was implemented on the Georgia Tech computer and utilized to predict system performance and to insure that there were enough collectors and storage to do the job, but not so much as to waste money. A 14-year weather tape of the Atlanta region was secured for the simulation run, and the solar system has been instrumented to provide data that will be used by future solar designers. Periodic reports will be issued according to a DOE schedule.

Figure C-20 shows the dramatic array of copper solar collectors and reflectors that also serve as the roof of the community Recreation Center. A unique approach was taken by interlacing the solar panels into the web of the long span truss system, expressing a new technology rather than an architectural style. The design also expresses a concern for the conservation of energy. The building is depressed six feet, and the earth it displaces is packed around it on three sides to form a grassy berm that provides a striking reduction in energy demands. The facade of the building, facing north across a pond and park, is simply a wall of glass opening onto a patio.

The Shenandoah Community Solar Recreation Center has one especially heavy energy demand: refrigeration for a hockey-sized ice skating rink. Since an ice rink of this magnitude normally requires tremendous outlays for utility costs, the solar system reduces the financial burden significantly.

In the lobby behind the reception area, visitors can walk past an exposed portion of the mechanial equipment where colored pipes, polished dials, and monitoring devices form a kind of working sculpture. A visual display explains the workings of the solar system in simple terminology.

The northwest corner of the building has an exhbition theater, where displays and audio-visual equipment are used to educate and inform visitors about the uses of solar energy in Shenandoah, soon to become a Solar City.

The first solar home in Shenandoah, a 1200 sq. ft. unit with flat solar panels on the roof, already is occupied, with several more planned.

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 the electricity they require. Part of this commitment involves furthering research and development in the field of solar energy.

- Co-generation of electricity and thermal energy (process steam) from solar collection
- Generation of electricity through photo-voltaic conversion
- Development of residential solar systems for water and space heating
- Development of methods for storing solar energy

Under terms of the subject Cooperative 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 instrumentation to monitor and record energy usage data within the knitwear manufacturing application. This contribution includes all necessary personnel, materials, services, and facilities.

The Shenandoah STE-LSE is not the only project in which Georgia Power Company is demonstrating its commitment to the commercialization of solar energy. In a related endeavor, Georgia Power Company will construct the 24-story GPC office tower shown in Figure C-21. Designed to accommodate 2,400 Atlanta area employes, it will contain what is believed to be the world's largest application of concentrated solar collectors for heating, cooling, and water heating in a commercial structure. Adjacent to the 24-story office tower will be a three-story low-rise section containing 24,000 square feet of medium-temperature parabolic trough concentrating solar collectors mounted on its 67,000 square-foot roof. Energy collected in this system will be used in conjunction with, or in place of, the conventional heating, cooling, and hot water systems. Chilled water produced at night during off-peak hours will be held in a 300,000 gallon storage tank for use the next day in meeting the cooling needs of the building. A 1,500 gallon domestic water heater with solar heat exchanger and electric backup have been incorporated into the design. An absorption chiller will utilize solar heat for cooling. The solar energy system is expected to displace approximately 15 percent of the total energy requirements for the Atlanta Office Building. Up to 30 percent of the energy required for building cooling will be met by the system, significantly reducing the electrical needs of the building during peak demand hours.

The building is designed and oriented to reduce significantly heat loss and heat gain. Double-pane insulating, reflective glass will be used on the exterior, reflecting 80 percent of the solar heat away from the building while admitting natural daylight. The combination of energy efficient features developed by Georgia Power Company and Heery & Heery Architects and Engineers is expected to reduce requirements for purchased energy by as much as 50 percent over similar office buildings. Estimated completion date is late 1980.

GPC also will supply the site for, own, and operate a new South Fulton Operating Headquarters. The U.S. Department of Energy and Westinghouse Electric Corporation will assist in developing a photo-voltaic solar conversion system to serve the facility. Up to 15 percent of the total energy requirements for the facility will be provided by this solar energy system. This building will provide offices for approximately 60 Georgia Power employes, including customer accounting personnel, meter readers, distribution engineers and line crews. The scheduled completion date is June 1980.

Georgia Power began an "Answer House" project in 1976. The first phase of the experiment involved construction of houses in four Georgia cities: Macon, Atlanta, Augusta, and Columbus. Each house contains a solar water heating system expected to provide up to 75 percent of the energy required to heat water for the residents. The Atlanta "Answer House" is providing research information on solar home heating as well as water heating. The solar panels on the roof collect heat, which is transferred to a liquid flowing through pipes into a 3,000 gallon storage tank.

The Georgia Power Company Plant Yates Thermal Storage System near Newnan is a project that will relate to future construction of large solar energy generating plants. As part of a major national effort to construct a 10 MW electric solar pilot plant at Barstow, California, GPC Plant Yates tests the transfer of high temperature heat through two separate storage media--a salt mixture and oil. Information from the tests will help determine which media can store heat the longest time at the highest temperature.

C-11 TOPOGRAPHY

The Shenandoah STE-LSE site, particularly the portion to be used for the STES collector field, is reasonably level, sloping gently from a high point of 956 feet above sea level at the southwest corner, to 920 ft. at the northeast corner. Some grading is required, and this activity is scheduled to be accomplished during July, 1978. The site area is unoccupied and is not heavily wooded, so grading can proceed rapidly.

The surrounding area is also nearly level and shading will not be a problem. The most prominent structure is a watertower just south of the site, for which a shading study was carried out. The line of northernmost progression of the tower shadow is shown in Figure C-22. The only encroachment is between 3:00 p.m. and 3:15 p.m. near winter solstice, which does not present a problem since less than the full collector area will be required to run the plant. All future structures to the south will be under the control of Shenandoah as the industrial park is developed, and Shenandoah, Inc., is finalizing pertinent solar easements.

The Bleyle Knitwear Manufacturing facility is located west of the STES site and is a low structure, approximately 14 feet in height. No shading from the building will affect the collector field. The area north of the site is privately owned farm property, not under Shenandoah control, but structures added in this area will not shade the site.

Georgia and Coweta County zoning and environmental control ensures that the air cleanliness levels will be continued, and future use of the surrounding area will not adversely impact the STE-LSE. Both the State of Georgia and Coweta County have expressed firm support of solar energy projects.

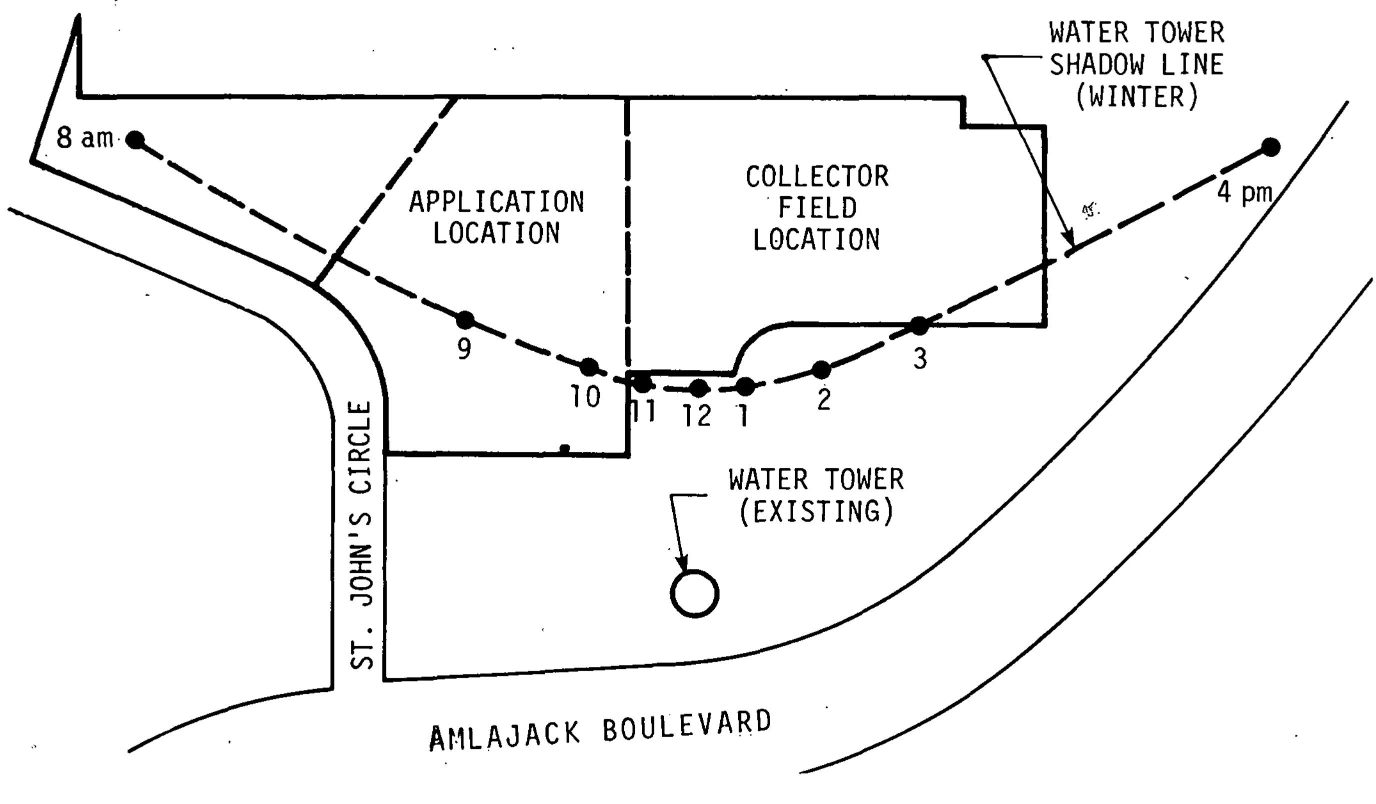

Figure C-22 Northernmost Progression of Water Tower Shadow in Relation to Collector Field

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