SOLAR/0001-80-15
Distribution Category UC-59
(Modified)

Instrumentation Installation Guidelines

Part 1

July 1, 1980

PROGRAM OUTLINE

Contract DE-AC01-79CS30027

United States Department of Energy

National Solar Data Network

National Solar Data Program

VITRO ENGINEERING CORPORATION
14000 GEORGIA AVE. SILVER SPRING, MD 20910
TELEPHONE 301/871-4829

January 13, 1981

Mr. R. L. Alvis
Organization 4725
P.O. Box 5800
Sandia National Laboratory
Albuquerque, NM 87185

Dear Mr. Alvis:

I am enclosing several brochures which briefly describe the National Solar Data Network and data acquisition system. I would also like to express my thanks for your time in explaining Sandia's Modular Solar Industrial Retrofit Project and the on-site monitoring requirements and allowing us to present Vitro's interest in that program.

The National Solar Data Network, sponsored by the Department of Energy, has been in existence for six years. Each solar site contains a weather station and selected sensors to monitor the energy flows in the solar installation. As a result of this program, Vitro maintains what is probably the world's largest data base on solar systems design and performance characteristics. In addition, this program has resulted in personnel experience and knowledge on virtually all solar system design concepts, systems analysis, and system instrumentation designs. Such diverse, "hands-on" experience is probably not available elsewhere; Vitro would certainly like to make this capability available to the MISR program.

The evaluation of various design criteria and options for solar systems instrumentation is a continuing part of this program. On-site data reduction and analysis, with subsequent manual tape retrieval, is a viable option in certain applications. A serious drawback is the possibility of failure early in the retrieval cycle; as a result, the data for that period is lost. The availability of a central computer facility provides daily monitoring of both site performance and operation of the instrumentation system. Vitro believes that a combination of these two concepts would provide both instrumentation system flexibility at the site and increased reliability. At Vitro, a central processing facility is available at operational costs only; avoiding the large, "up-front" cost would represent a significant savings to your program.

As I mentioned in our conversation, we will be in the Albuquerque area in early February. If possible, we would like to schedule a meeting with both you and Tom Evans at that time. In the meantime, if we can provide any additional information do not hesitate to give me a call.

Sincerely,

VITRO ENGINEERING CORPORATION

Nelson A. Bradley
Group Manager
Solar Systems Engineering Group

NAB:ps

Enclosure

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Instrumentation Installation Guidelines

Part 1

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PROGRAM OUTLINE

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AUTOMATION INDUSTRIES, INC.
VITRO LABORATORIES DIVISION
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United States Department of Energy

National Solar Data Network

National Solar Data Program

FOREWORD

The National Solar Data Network (NSDN) establishes the performance of selected residential and commercial solar demonstration projects. This is done by installing an instrumentation system in a solar system that monitors its operating characteristics (temperatures, flow rates, power usage, etc.). This data is collected, analyzed, and the results are published and made available for public use as aids for further solar development.

A systematic approach is used to develop data requirements, instrumentation techniques, and analysis methods. This ensures uniform data collection from each site. Instrumentation and technical evaluation of each solar system, building, and climate combination is not practical on all government sponsored demonstration sites. Only selected installations meeting DOE guidelines in various U. S. geographic locations will be instrumented.

This document identifies the various activities which must be performed in instrumenting solar systems. The Instrumentation Installation Guidelines (IIG) also defines the required responsibilities of DOE, the NSDN Contractor, and the site contractor. Active communications between each NSDN participant can ensure that a good instrumentation system will be installed. This will render useful data to engineers, designers, contractors, manufacturers, and others to further promote solar energy applications.

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TABLES AND FIGURES

1.0 INTRODUCTION

In order to meet the data collection, performance evaluation, and data distribution goals of the National Solar Data Network, (NSDN) selected demonstration site contractors must participate in the installation of a comprehensive instrumentation system on his project. This document provides the definition of the responsibilities of the site contractor, DOE, and the NSDN contractor in accomplishing the required instrumentation installation.

1.1 NSDN PARTICIPANTS

The NSDN encompasses commercial and residential solar sites. The commercial demonstration program is directly managed by DOE. Residential demonstration sites are managed by HUD under guidelines and funding provided by DOE. In this context, the participants for commercial solar applications are:

- DOE
  - the United States Department of Energy
- Site Contractor
  - the original person, contractor, designer, or organization with whom a solar demonstration project agreement was negotiated
- NSDN Contractor (Vitro)
  - performs contract work for DOE to collect and analyze data and publishes reports on the performance of instrumented solar sites

and for residential applications, the participants are:

- HUD
  - the United States Department of Housing and Urban Development
- Grantee
  - the original person, contractor, designer, or organization with whom a solar demonstration project agreement was negotiated

- o HUD Management Support Contractor (Boeing)
  - performs contract work for HUD to fulfill the policies of the Residential Solar Heating and Cooling Demonstration Program
- o NSDN Contractor (Vitro)
  - performs contract work for DOE to collect and analyze data and publish reports on the performance of instrumented residential solar applications

The HUD residential demonstration program follows a different procedural path for instrumenting sites than the DOE managed commercial program. The HUD Management Suppport Contractor (Boeing) is effectively the site contractor for all residential sites slated for inclusion in the NSDN. A counterpart to this document, HUD Instrumentation Installation Guidelines, establishes the responsibilities and procedures residential site grantees must follow in becoming an instrumented site. The requirements imposed on the site contractor by the HUD IIG are assumed by the HUD Management Support Contractor.

This generalized document, IIG Part 1, is introductory and is the first document provided to a site contractor/grantee of a site selected for inclusion in the NSDN. For HUD managed sites, the HUD IIG is also transmitted to the grantee.

The following sections provide general information about the NSDN and the procedural steps and responsibilities of participants in becoming a NSDN site. The specific policies and steps that follow apply to commercial sites. The HUD IIG defines the process followed for residential sites.

2.0 DATA COLLECTION

The goal of DOE's data collection activity is to provide the information necessary for evaluation of the performance and operation of solar systems and subsystems under a broad range of geographic and climatic conditions

The information generated as a result of this data collection activity will be used to:

1) stimulate industrial and commercial capability to produce and distribute solar heating and cooling systems

2) improve the general knowledge and understanding of solar energy

3) provide the data base for design of new applications by the private sector

4) develop definitive solar energy system performance criteria

5) provide a basis for component system improvements

6) develop cost comparisons for solar energy applications

Results will be available for use by property owners, the building industry, and related sections of the economy to compare costs and benefits of solar heating and cooling systems. The end result will be a reduction in conventional fuel consumption. DOE's Technical Information Center at Oak Ridge, Tennessee, is the NSDN documentation center and focal point for distribution of reports.

2.1 DATA SYSTEM OVERVIEW

The Data System depicted in Figure 2-1 provides for the automatic gathering, conversion, transfer, reduction, and analysis of demonstration site data. This system is made up of three basic elements: installed sensors, a Site Data Acquisition Subsystem (SDAS), and a Central Data Processing System (CDPS). The process of collecting uniform and comparable data requires a thorough understanding of responsibilities and a close working relationship between DOE, the NSDN contractor, and the site contractor. In order to evaluate performance, the NSDN contractor will specify type, number, and location of measurements based on required evaluation factors for a particular system. After approval by the NSDN contractor of final installa-

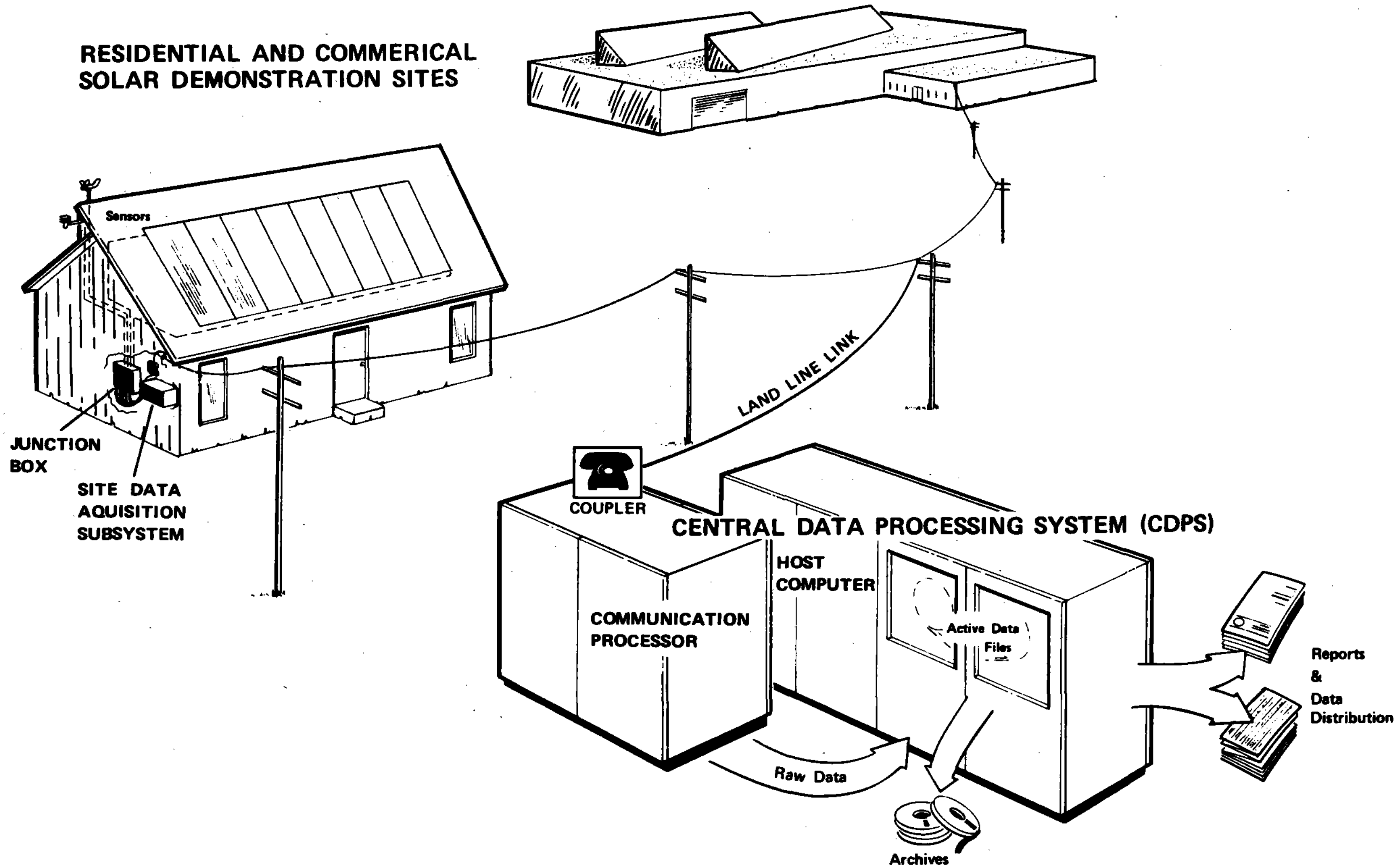

Figure 2-1. *National Solar Data Network*

tion drawings incorporating the sensors, the NSDN contractor will furnish the sensors to the site contractor. The NSDN contractor also furnishes to the site contractor a junction box which is the interface between installed sensors and the Site Data Acquisition System (SDAS). The junction box will contain an Installation Kit which gives specific wiring instructions and identifies the terminals in the junction box to which each sensor is connected. The NSDN contractor furnishes the SDAS and its mounting base to the site contractor and mutually arranges for installation of the SDAS base. Only the NSDN contractor will install the SDAS, special interface cables between the junction box and SDAS, and arrange for telephone coupler installation. The data will be gathered at each operational site at predetermined intervals of time and stored for transfer to the Central Data Processor. The collected data will be transferred via telephone communications upon request from the Central Data Processing Facility. At the Central Data Processing Facility, the collected data will be processed, analyzed, evaluated, and documented as Performance Evaluation Reports. Each site contractor will receive these reports for his site on a monthly or seasonal basis.

3.0 INSTRUMENTATION PROCEDURE

DOE, the NSDN contractor, and the site contractor have well-defined responsibilities in accomplishing the required data collection activities. For cost effectiveness, a standard procedure will be followed in establishing the required instrumentation at each demonstration site. The procedure to be followed is listed in Table 3-1. A flow chart of the major activities listed in Table 3-1 is provided in Figure 3-1.

3.1 TYPICAL DOE/SITE CONTRACTOR AGREEMENT

DOE will supply to the site contractor the sensors required to implement the Approved Instrumentation Plan (AIP) plus the Site Data Acquisition Subsystem required to interface the sensors to the Central Data Processing System after the site is operational. The NSDN contractor also will provide the site contractor with performance reports for his site approximately 45 days after the end of each monthly or seasonal performance evaluation period. The site contractor, from the guidelines set forth in this document, will complete an Instrumentation System Planning Information (ISPI) Package furnished as Appendix A to this part of the IIG. Once the AIP is established, the site contractor agrees to install the sensors supplied by DOE and verify correct wiring before the Site Data Acquisition Subsystem is installed. At the end of the test the site contractor will remove, upon DOE's direction, all instrumentation which can be cost effectively removed and reused at another site.

TABLE 3-1. PROCEDURAL RESPONSIBILITIES FOR INSTRUMENTING SOLAR HEATING AND COOLING DEMONSTRATION PROJECTS

STEP NUMBER	ACTION BY	ACTION
1.	DOE/NSDN Contractor	Supplies to the site contractor copies of the "Instrumentation Installation Guidelines" Part One and Instrumentation System Planning Information (forms) (ISPI as shown in Appendix A
2.	Site Contractor	Prepares and submits completed Instrumentation System Planning Information (ISPI) as shown in Appendix A
3.	NSDN Contractor	Uses the ISPI to develop an instrumentation system that complies with performance evaluation requirements
4.	NSDN Contractor	Supplies the site contractor with IIG Part Two. This is the Approved Instrumentation Plan (AIP) for the site. It provides detailed site specific instrumentation installation instructions
5.	Site Contractor	Incorporates the information from the AIP onto project drawings and estimates the installation costs
6.	Site Contractor	Submits the final drawings to DOE along with the installation cost estimate (Contract Pricing Proposal, Optional Form 60, App. A, IIG Part Two) and forwards a final drawing package to the NSDN contractor
7.	NSDN Contractor	Reviews the final project drawings for adequacy to meet NSDN requirements. When approved the site contractor must install the instrumentation as shown on approved final drawings
8.	NSDN Contractor	Negotiates funding arrangements with the site contractor to implement the approved installation drawings and AIP and defines installation schedule
9.	NSDN Contractor	Develops site specific wiring instructions for the instrumentation system and forwards to the site contractor
10.	DOE/NSDN Contractor	Provides and ships all necessary instrumentation as Government Furnished Equipment (GFE) to the demonstration site for site contractor installation

TABLE 3-1. PROCEDURAL RESPONSIBILITIES FOR INSTRUMENTING SOLAR HEATING AND COOLING DEMONSTRATION PROJECTS (Continued)

STEP NUMBER	ACTION BY	ACTION
11.	Site Contractor	Informs DOE that the instrumentation has been implemented, that all wiring from J-Box to each sensor has satisfactorily undergone continuity and ground tests, and the SDAS is properly mounted.
12.	DOE/NSDN Contractor	Arranges for the installation of the necessary telephone transmission equipment to accommodate the Site Data Acquisition Subsystem
13.	DOE	Sends an Instrumentation Verification Team to the site to ensure installation meets DOE/NSDN policies and workmanship requirements
14.	DOE/NSDN Contractor	Energizes the SDAS and the instrumentation system and calibrates all sensors
15.	DOE/NSDN Contractor	Receives and evaluates incoming performance data and prepares monthly performance reports using standardized data reduction techniques
16.	DOE/NSDN Contractor	Mails performance reports for each site to the respective site contractor within thirty days after the end of each performance period after the site is determined operational
17.	Site Contractor	Replaces failed or inoperable sensors when directed to by the NSDN contractor
18.	DOE/NSDN	Provides and ships all necessary replacement instrumentation as GFE to the site for grantee installation.
19.	DOE	Negotiates funding and directs removal of SDAS and GFE from the site at the end of the test period.
20.	Site Contractor	Upon DOE's direction, removes all instrumentation defined by DOE which can be cost effectively removed and returned to DOE or the NSDN contractor at the end of the test period.

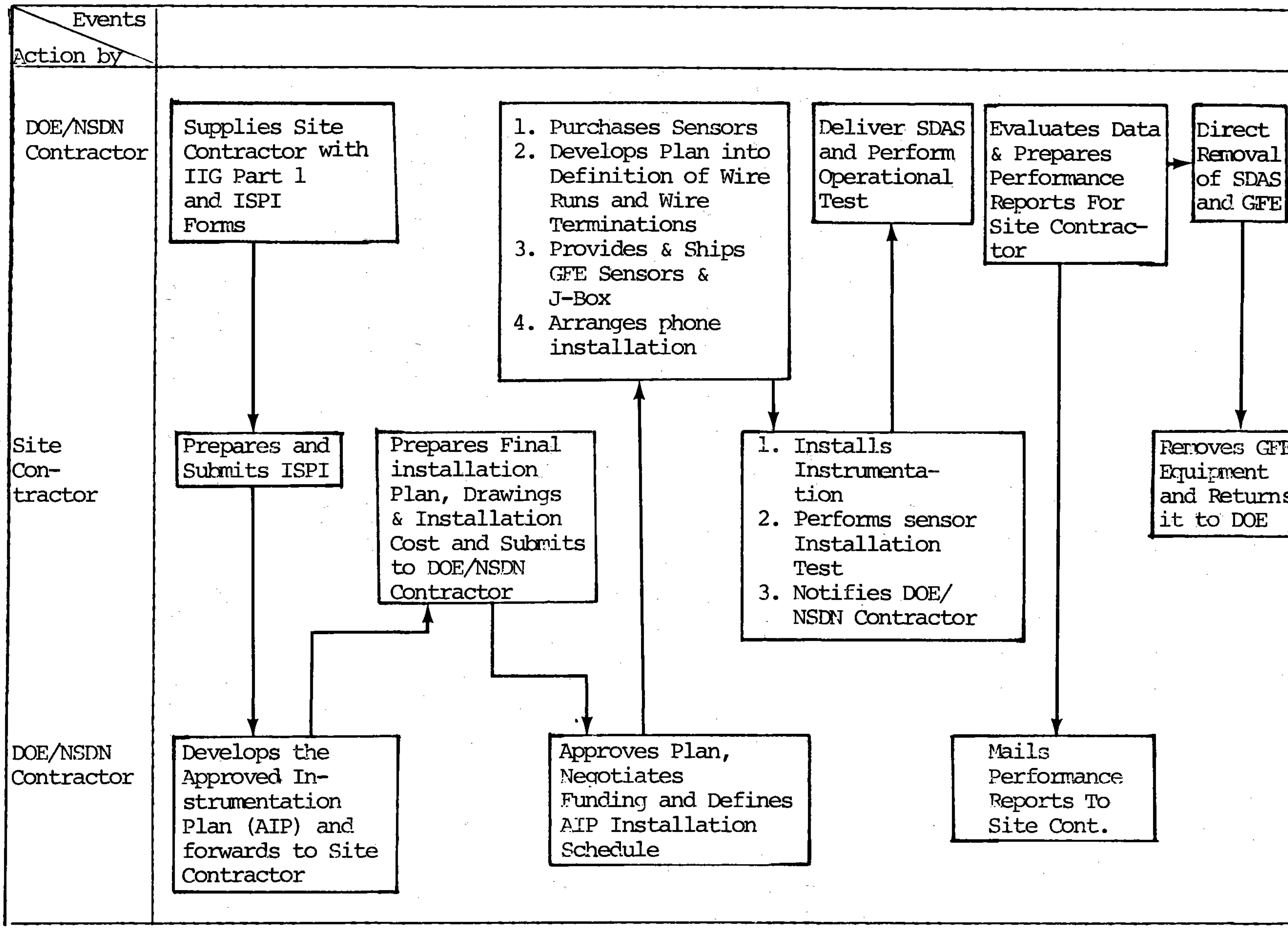

FIGURE 3-1. INSTRUMENTATION PROCEDURE MAJOR ACTIVITY FLOW

3.2 NSDN SITE CONTRACTOR DELIVERABLE ITEMS

After a thorough review and understanding of the guidelines presented in this document, the site contractor is responsible for delivering an Instrumentation System Planning Information (ISPI) package to DOE so that instrumentation can be accomplished in a timely and cost-effective manner.

3.3 INSTRUMENTATION SYSTEM PLANNING INFORMATION (ISPI)

The ISPI as shown in Appendix A is the vehicle used by the site contractor to communicate to DOE and the NSDN contractor all necessary information concerning his site that will be used in defining the location and type of instruments to monitor performance. All site contractors are to follow the format and include additional information that would be considered beneficial. At the site contractor's option, he can define the recommended sensor selection and placement in accordance with the guidelines of this document. However, the site contractor must inform the NSDN contractor of this option so he can be furnished additional instrumentation design information.

4.0 ANALYSIS AND INSTRUMENTATION TECHNIQUES

Section four is to familiarize the site contractor with the analysis and instrumentation techniques employed by DOE and the NSDN contractor. The performance evaluation of a solar energy system requires that selected parameters be computed from data collected during actual system operation. These parameters, or performance evaluation factors, are based on system and critical subsystem energy balance concept. The determination of these performance evaluation factors requires that each system be properly instrumented and the required operational system measurements are made.

4.1 PERFORMANCE EVALUATION FACTORS

The technical performance evaluation of each solar energy system/building/climatic region demonstration will be made by:

1. Determining the savings in fossil fuel and electrical energy resulting from the use of solar energy for space heating, space cooling, and/or hot water.
2. Determining the total heating, cooling and/or hot water thermal energy loads, and the fraction of each load supplied by solar energy for monthly, seasonal, and/or annual periods.
3. Measuring the solar energy system efficiency for converting solar radiation into useful thermal energy for monthly and seasonal or annual periods.
4. Measuring the thermal performance of major subsystems or components and the thermal interactions between collector array, storage, and energy conversion equipment
5. Measuring the occupants use of the system by means such as the temperature level maintained in occupied space and hot water demand.
6. Determining the major system operational characteristics and degradation over the life of the demonstration.
7. Obtaining records of the incident solar radiation and other pertinent site environmental factors that could affect the performance of the system over the life of the demonstration.

To develop these results, the appropriate performance factors from among those listed in Table 4-1 are computed for each installation. Table 4-1 is a representative list and is for information only.

4.2 SPECIFIC SENSOR LIST

An approved parts list of sensors which meets the requirements for the NSDN is shown in Table 4-2. These sensors are used for all Demonstration Program systems.

TABLE 4-1. PRIMARY PERFORMANCE FACTORS (TYPICAL)

- Total Solar Energy Incident
- Average Ambient Dry Bulb Temperature
- Average Building Dry Bulb Air Temperature
- Solar Energy Collected
- Hot Water Load
- Space Heating Load
- Space Cooling Load
- Hot Water Electric Energy Savings
- Hot Water Fossil Fuel Energy Savings
- Space Heating Electric Energy Savings
- Space Heating Fossil Fuel Energy Savings
- Space Cooling Electric Energy Savings
- Space Cooling Fossil Fuel Energy Savings
- Solar Fraction of Hot Water Load
- Solar Fraction of Space Heating Load
- Solar Fraction of Space Cooling Load
- Total Energy Delivered to Building Load
- Total Solar Energy Utilized
- Total Electric Energy Saved
- Total Fossil Fuel Energy Saved
- Total Auxiliary Energy Used
- Total Operating Energy Used
- Solar Energy Fraction of Total Load
- System Performance Factor
- Energy Collection and Storage Subsystem Conversion Efficiency
- Total Energy Consumed

TABLE 4-2. APPROVED MASTER SENSOR LIST

DATA REQUIREMENT	NAME	MANUFACTURER	MODEL
Total radiation	Pyranometer	Eppley	PSP
Diffuse radiation	Pyranometer w/shadow band	Eppley	PSP w/ shadow band
Ambient outside air temperature	Resistance temperature detector	Minco	S53P S57P
Ambient Sensor enclosure	(Radiation Shield)	(Weather Measure)	IS4, IS2
Temperature (air)	Resistance temperature detectors	Minco	S53P S57P S7850
Temperature (liquid)	Single element resistance temperature detectors	Minco	S53P S54P
	Dual element resistance temperature detectors	Minco	S57P S59P
Surface temperature	Resistance temperature detectors	Minco	S34A S32B S7301
Inside ambient	Resistance temperature detectors	Minco	S7850
Flow rate (air)	Flowmeter	Dietrich Std. 1 Robinson-Halpern	Type 74 157A
	Air velocity meter	Kurz Instrument Anemometer	430-X-XX 430-DC
Gas	Gas Meter	American Meter	Diaphram Meter

TABLE 4.2. APPROVED MASTER SENSOR LIST (Continued)

DATA REQUIREMENT	NAME	MANUFACTURER	MODEL
Flow rate (liquid)	Flowmeter	Ramapo	MK-V
	Flowmeter	Floscan	300-3
	Totalizer	Hersey-Niagara	10,20,21,22, etc.
		Hersey-American	430,530,540, etc.
		American Meter	432,532,542, etc.
Fuel oil	Flowmeter	Hersey	10,20,21,etc.
	Fuel Oil Meter	Kent	4 Mini Major/ Metron
Electrical power	Watt transducer	Ohio Semitronics	PC5-YYF
Differential pressure (air)	Low pressure	Robinson-Halpern	157A
(liquid)	Pressure	Robinson-Halpern	150D/155D
Relative humidity	RH probe	Weather-Measure	HM111-P HM14-U
Wind velocity and direction	Skyvane I	Weather-Measure	W101-P-DC/540, W102-P-DC/360
Angular displacement	Precision potentiometer	New England Instruments	78EB0502
Position indicator	Linear position	Potentiometer Research, Inc.	R14040-10
Heat Flux	Heat Flow Meter	Hy-CAL	BIX-7X
Discrete Switch	Contact switch	Radio Shack/Archer	P/N 275-495
	Electrical relay switch	Magnecraft	P/N W88ACPX-3, 4
	Temperature switch	Fenwall	30002-0
	Microswitch	Denison	C2T-J

4.3 SENSOR LOCATION

The general requirement for determination of performance evaluation factors dictates sensor selection and placement. The method used for evaluation is the energy balance concept. Simply stated, the energy entering a system (or subsystem) is equal to the sum of the energy leaving, plus the energy accumulated, plus the energy lost through thermal leakage and/or conversion inefficiency. The sensors selected are those necessary to accurately and economically determine this energy flow either directly or by computation. Specific installation requirements are dependent upon the design characteristics of each system. The following methodology is used for determining the measurements required and locating the acceptable sensors used for performance evaluation of space heating, space cooling, and/or hot water systems. This technique is used for designing the instrumentation installed for each demonstration project utilizing the sensors defined in Table 4-2.

a. Meteorological Data

   Provide indication of outdoor ambient temperature and total radiation. Diffuse radiation shall be measured only for installations utilizing concentrating solar energy collectors. Outdoor relative humidity, wind speed, and wind direction shall be measured only for selected systems.

b. Collector Array

   Sensors provide indication of actual temperature at the last singular point entering and exiting the collector array. Sensors provide flow rate of the heat transport medium in the collector loop.

c. Storage

Sensors provide indication of actual temperature and flow rate at each functional energy entrance and exit to the storage subsystem. Internal energy shall be indicated by average temperature in liquid storage tanks. Depending on the tank design, three temperature measurements may be required to detect stratification and establish a good average temperature. For most rock storage systems three temperature measurements will be required. Additionally, measurements shall be made of all auxiliary energy supplied to the storage subsystem.

d. Space Heating, Space Cooling, and Hot Water Subsystem

Sensors provide indication of actual temperature as well as flow rate or total flow to the space heating, space cooling, and hot water subsystems. Measurements shall be made of auxiliary energy supplied to each subsystem.

e. Building Occupancy Related Factors

Sensors provide measurement of representative building internal ambient temperature and the domestic hot water temperature and flow rate. Relative humidity will be measured only for selected systems. Internal ambient temperature is not required for a domestic hot water <u>only</u> installation.

f. Other Subsystem

Sensors provide sufficient flow and temperature measurements to evaluate the interconnecting solar energy transport subsystems. Sufficient temperature and flow measurements are made to utilize the energy balance technique on all subsystems (including the energy transport systems) contained in the solar energy system which have not been discussed previously.

4.4 MEASUREMENTS DESIGNATIONS

To standardize the performance calculations and identify sensors according to type and location, an alpha-numeric designation is used for each performance factor or sensor. In accordance with the concept adapted in the document, "Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program", NBSIR 76-1137, a four or five character designation will be used. This consists of a letter or letters which define either the sensor type or the measured or calculated quantity and a three digit number which identifies the subsystem or data group.

Letter Designation

- C = Specific Heat
- D = Direction or Position
- EE = Electrical Energy
- EP = Electrical Power
- F = Fuel Flow Rate
- HF = Heat Flow Meter
- I = Incident Solar Flux (Insolation)
- N = Performance Efficiency or Effectiveness
- P = Pressure
- PD = Pressure Differential
- Q = Thermal Energy
- RH = Relative Humidity
- SM = Special Measurement
- T = Temperature
- TD = Differential Temperature
- V = Velocity
- W = Heat Transport Medium Flow Rate
- TI = Time

Subsystem Designation

Number Sequence	Subsystem/Data Group
001 to 099	Climatological
100 to 199	Collector
200 to 299	Thermal Storage
300 to 399	Domestic Hot Water
400 to 499	Space Heating
500 to 599	Space Cooling
600 to 699	Building/Load

Thus sensor designation T100 defines an actual temperature measurement in the collector subsystem.

The designation W100 defines a flow measurement in the collector subsystem associated with temperature measurement T100. Variable Q100 would define the solar energy collected by a collector array utilizing the instrumented parameters and the collector performance factors. This convention is uniformly applied to each defined subsystem/data group.

4.5 SENSOR DELIVERY

Sensors will be delivered to the test site or site contractor by the most expeditious common carrier. Date of delivery will be mutually established between DOE and the site contractor. Sensors will be:

a. adequately packed to minimize shipping and handling damage

b. properly identified by part number and letter/number designation

c. packed with any special instructions required for handling, installation, or checkout

Proper installation of sensors will be the responsibility of the site contractor.

4.6 SYSTEM INSTRUMENTATION (EXAMPLE)

Figure 4-1 shows sensor types and locations which result from the application of the instrumentation selection ground rules to a domestic hot water, space heating and cooling system. The measurements required for this example are listed in Table 4.3. An instrumented site isometric is shown in Figure 4-2.

TABLE 4.3 TYPICAL INSTRUMENTATION EXAMPLE OF A SITE SENSOR LIST

MEASUREMENT	NOMENCLATURE
I001	Total radiation
T001	Outdoor ambient temperature
T100	Collector Inlet temperature
T102	Storage Inlet temperature
T150	Collector outlet temperature
T152	Storage outlet to collector temperature
T200	Storage media temperature top
T201	Storage media temperature middle
T202	Storage media temperature bottom
T203	Storage inlet from load temperature
T253	Storage outlet to load temperature
T301	DHW HX inlet temperature
T302	Cold water supply temperature
T351	DHW HX outlet temperature
T352	DHW supply to load temperature
T400	Space heating HX load inlet temperature
T401	Space heating auxiliary inlet temperature
T402	Space heating auxiliary electric duct heater temperature

TABLE 4.3 TYPICAL INSTRUMENTATION EXAMPLE OF A SITE SENSOR LIST (Continued)

MEASUREMENT	NOMENCLATURE
T450	Space heating HX load outlet temperature
T451	Space heating auxiliary outlet temperature
T452	Space heat supply duct temperature
T500	Space cooling load HX inlet
T501	Absorption chiller from storage inlet temperature
T502	Cooling tower inlet temperature
T550	Cooling load HX outlet temperature
T551	Absorption chiller outlet to storage temperature
T552	Cooling tower outlet temperature
T600	Return air duct temperature
W100	Collect flow rate
W301	DHW HX circulation flow
W302	Cold water supply flow
W401	Space heating loop flow
W402	Space heating (cooling) supply flow rate
W500	Space cooling HX flow rate
W502	Cooling tower flow rate
EP100	Solar loop circulation pump power
EP301	DHW circulation pump power
EP302	DHW auxiliary (electric) power

TABLE 4.3 TYPICAL INSTRUMENTATION EXAMPLE OF A SITE SENSOR LIST (Continued)

MEASUREMENT	NOMENCLATURE
EP401	Space HTG circulation pump power
EP402	Space HTG auxiliary (electric) power
EP500	Chilled water pump power
EP501	Absorption chiller power
EP502	Cooling tower pump and fan power
EP600	Space heating/cooling fan power
RH600	Space heating/cooling return air relative humidity

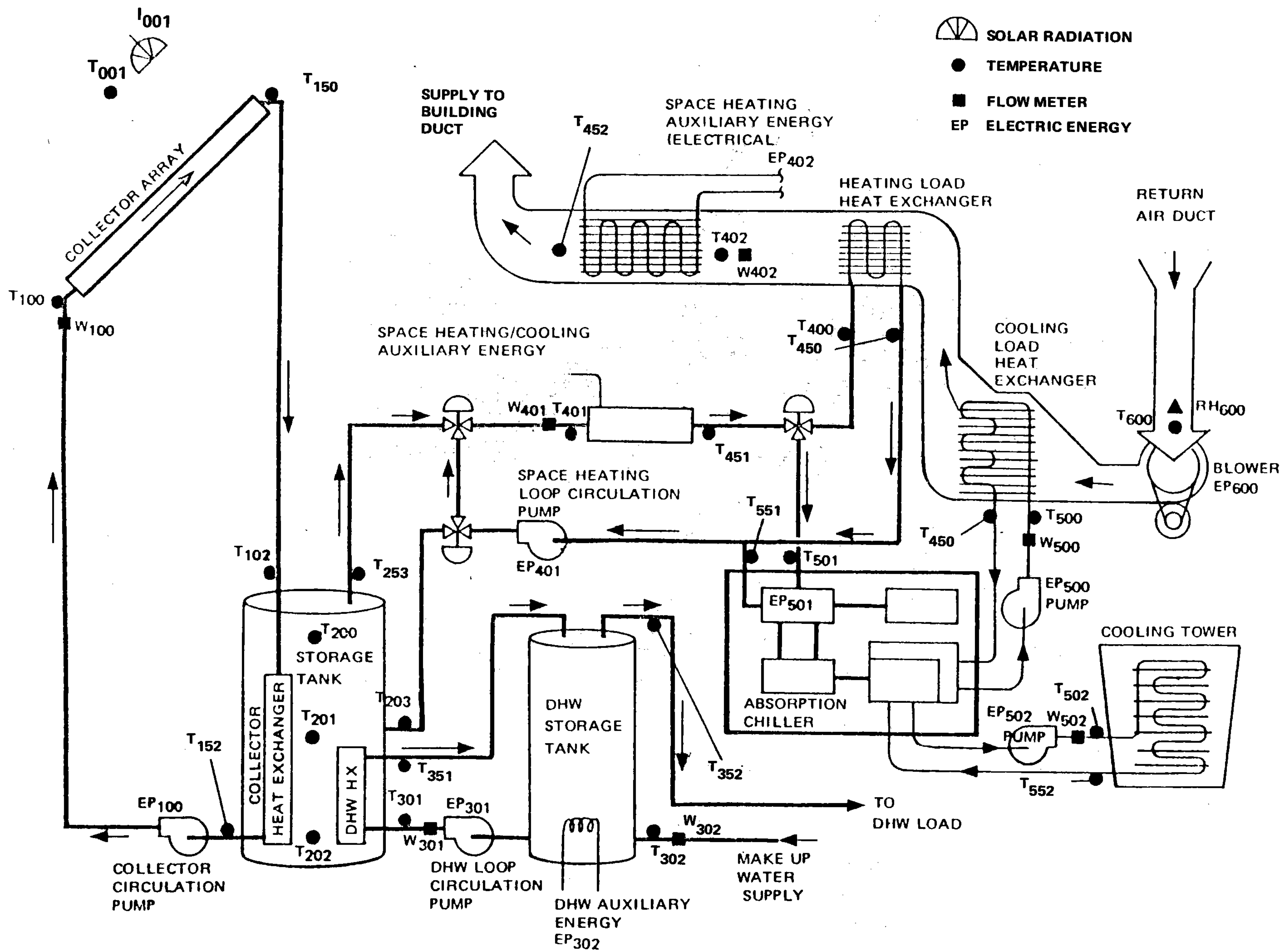

FIGURE 4-1. INSTRUMENTED SITE SENSOR LAYOUT

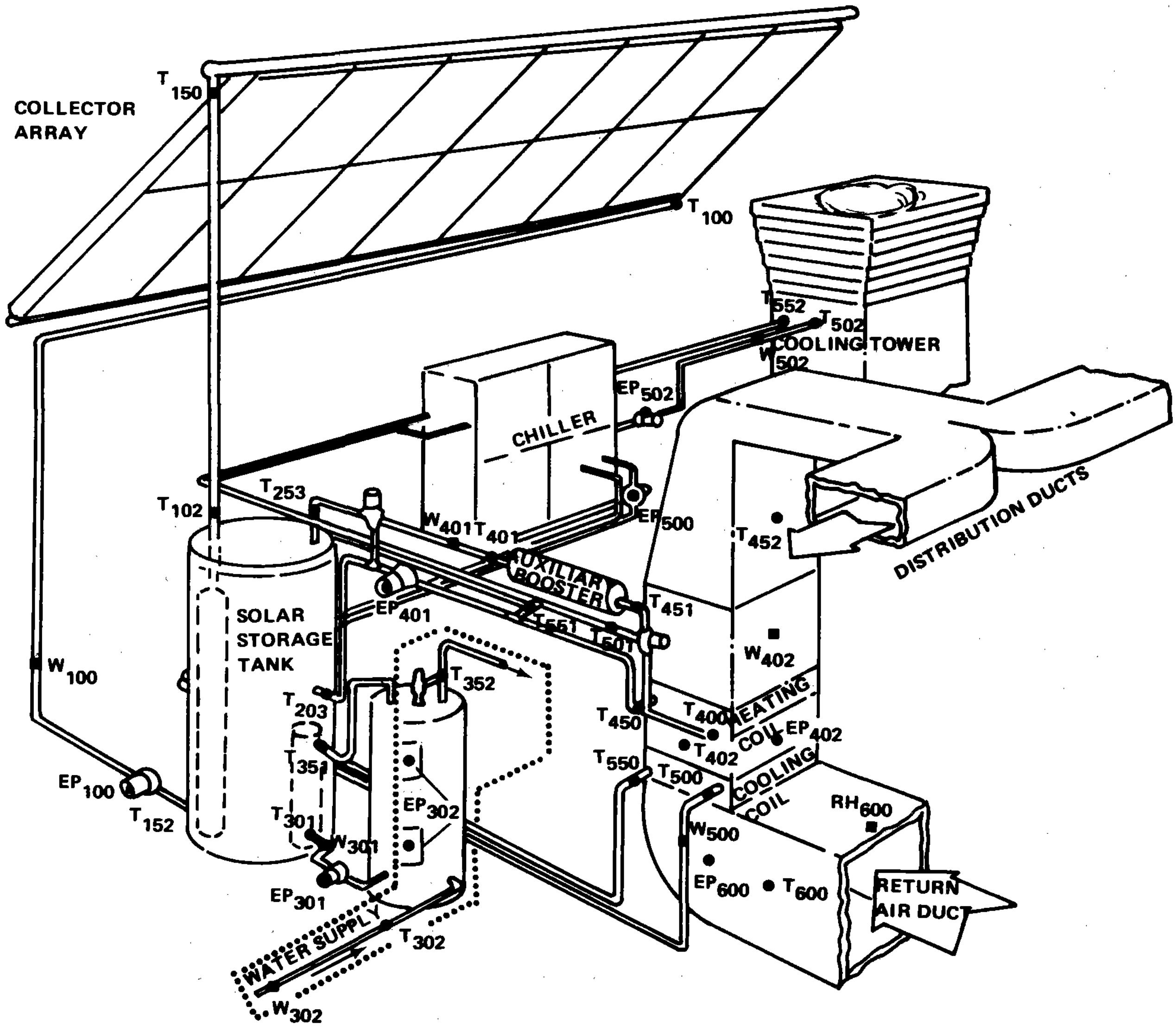

FIGURE 4-2. INSTRUMENTED SITE ISOMETRIC

Instrumentation System Planning Information (forms)

Appendix A, IIG Part 1

Contract DE-AC01-79CS30027

United States Department of Energy

National Solar Data Network

National Solar Data Program

APPENDIX A

ISPI (Forms)

INSTRUMENTATION SYSTEM PLANNING INFORMATION (ISPI)

This appendix is filled out by the site contractor as the first step for instrumenting a site as part of the NSDN.

There are three parts to the ISPI.

1) Key Personnel

2) Project Description Summary

   Site description

   Building description

   Mechanical description

   Solar System description

3) Technical proposal document and project drawing package

Parts one and two are filled out on the attached sheets. Part three is a copy of the site contractor's solar project proposal submitted to DOE to obtain demonstration project grants. These proposals often contain full technical descriptions of the project. Common contents of a technical proposal and the type of technical information required to properly instrument a site is listed in Table A-1.

If no in-depth technical proposal exists, the site contractor must thoroughly describe the system as best as possible. Use the information in Table A-1 as a guideline for required information. Many times the scope of the project (smaller commercial projects) will not include some of the subjects in Table A-1. The site contractor can submit data by manufacturers or suppliers as substitute for developing equipment lists.

Part three must also include all project drawings relating to the solar system HVAC system or hot water system. This includes all mechanical, electrical, instrumentation, or other drawings. Site and architectural drawings must be included if the building is designed to take advantage of passive solar contributions.

TABLE A-1

REQUIRED TECHNICAL INFORMATION

Summary Description
- Solar Energy System
- Building
- Building Site

Completed Forms of Appendix B

Energy Conservation Consideration
- ASHRAE Standards 90-75
- Central Environmental Control and Monitoring System
- Site Orientation
- Landscaping
- Building Configuration & Interior Space Planning
- Fenestration, Glazing and Shading Devices
- Design Transmission Coefficients & Mass Consideration
- Mechanical Systems
- Electrical and Lighting Systems
- Heat Recovery Design
- Target for Building Annual Energy Consumption/BEPS
- Methodology of Energy Analysis

Interim Performance Criteria

Control of System Design Changes

Description of Solar Collectors

Acceptance Test Plan

Installation, Operation, and Maintenance Manual

Design, Construction, and Completion Schedule

System Description
- Heating and Air Conditioning
- Service Water
- Solar Collection and Storage
- Back-Up System
- Schedmatic Drawing

Control System
- Description
- Schematic Drawing

Drawings/Full Project Set
- Site Plan
- Schematics
- Floor Plan
- Mechanical Layout
- Electrical Layout
- Elevations
- Rendering - Solar Collector Location

Technical Data

Collection Manufacturer

Mechnical Equipment Lists
- Manufacturers' Data/Chillers, Turbines, Heat Pumps, Compressors, etc.
- Pump Curves, Motor Requirements
- Blower/Fan Curves
- Valve Data, Operators
- Piping materials, schedules, insulation schedules
- Ductwork materials, schedules, insulation, schedules

ISPI
KEY PERSONNEL

PROJECT INDENTIFICATION NO: DATE:

PROJECT TITLE: PREPARED BY:

1. DEMONSTRATION PROJECT LOCATION

NAME ____________________

STREET ____________________

CITY __________ STATE __________ ZIP ______

2. OWNER:

NAME ____________________

STREET ____________________

CITY __________ STATE __________ ZIP ______

CONTACT __________ PHONE ______

3. PROJECT MANAGER:

NAME __________ PHONE ______

ORGANIZATION ____________________

STREET ____________________

CITY __________ STATE __________ ZIP ______

4. CONTRACT OFFICER REPRESENTATIVE:

ORGANIZATION ____________________

PROGRAM ____________________

LOCATION ____________________

CITY __________ STATE __________ ZIP ______

COR __________ PHONE ______

5. ARCHITECT

NAME ____________________

STREET ____________________

CITY __________ STATE __________ ZIP ______

CONTACT __________ PHONE ______

ISPI
KEY PERSONNEL (CONT'D)

6. SOLAR DESIGNER:

NAME ____________________

STREET ____________________

CITY ____________ STATE ____________ ZIP ______

CONTACT ____________ PHONE ______

7. MECHANICAL ENGINEER:

NAME ____________________

STREET ____________________

CITY ____________ STATE ____________ ZIP ______

CONTACT ____________ PHONE ______

8. ELECTRICAL ENGINEER:

NAME ____________________

STREET ____________________

CITY ____________ STATE ____________ ZIP ______

CONTACT ____________ PHONE ______

9. GENERAL CONTRACTOR

NAME ____________________

STREET ____________________

CITY ____________ STATE ____________ ZIP ______

CONTACT ____________ PHONE ______

10. MECHANICAL CONTRACTOR:

NAME ____________________

STREET ____________________

CITY ____________ STATE ____________ ZIP ______

CONTACT ____________ PHONE ______

11. ELECTRICAL CONTRACTOR:

NAME ______________________________

STREET ______________________________

CITY ______________ STATE ______________ ZIP ________

CONTACT ______________________ PHONE ______________

12. SUBCONTRACTORS:

ORGANIZATION ______________________________

PROGRAM ______________________________

LOCATION ______________________________

CITY ______________ STATE ______________ ZIP ________

COR ______________________ PHONE ______________

OTHER CONTRACTORS (LIST) ______________________________

____

____

____

ISPI
SITE DESCRIPTION

PROJECT IDENTIFICATION NO: DATE:

PROJECT TITLE: PREPARED BY:

1. LATITUDE: ________ °N LONGITUDE: ________ °
2. ALTITUDE: ________ FT TIME ZONE: ________
3. AREA CLIMATE DESCRIPTION:
   - A • YEARLY HEATING DEGREE DAYS ________
     REFERENCE ________ LOCATION ________
   - B • YEARLY COOLING DEGREE DAYS ________
     REFERENCE ________ LOCATION ________
   - C • AVERAGE HORIZONTAL INSOLATION FOR JANUARY ________
     REFERENCE ________ LOCATION ________
   - D • AVERAGE HORIZONTAL INSOLATION FOR JULY ________
     REFERENCE ________ LOCATION ________
4. SITE TOPOGRAPHIC DESCRIPTION ________
5. SPECIAL TOPOGRAPHIC OR CLIMATIC CONDITIONS ________
6. COLLECTOR SHADING
   - A • CAUSE ________
   - B • EXTENT ________ %
7. REGULATORY CODES

STATE ________ LOCAL ________

			EDITION (YEAR)
A •	______ UNIFORM	ICBO	______
B •	______ BASIC BUILDING CODE	BOCA	______
C •	______ SOUTHERN BUILDING CODE	SBCC	______
D •	______ NATIONAL BUILDING CODE	AIA	______
E •	______ MINIMUM PROPERTY STANDARDS	HUD	______
F •	______ OTHER (SPECIFY) ______		______
G •	NONE		

ISPI
BUILDING DESCRIPTION

PROJECT IDENTIFICATION NO: DATE:

PROJECT TITLE: PREPARED BY:

1. TYPE
2. OCCUPANCY ______________________
3. TOTAL AREA __________ FT^2
4. SOLAR CONDITIONED AREA __________ FT^2
5. HEATING DESIGN TEMPERATURES
   - A. OUTDOOR __________ °F
   - B. INDOOR __________ °F
6. COOLING DESIGN TEMPERATURES
   - A. OUTDOOR __________ °F DEW POINT __________ °F
   - B. INDOOR __________ °F
7. TOTAL HEIGHT ABOVE GROUND __________ FT
8. ROOF SLOPE __________ °
9. STRUCTURE

A • WALLS – EXPOSED SURFACE AREA

- FRAME ______________________
- EXTERIOR FINISH ______________________
- INSULATION TYPE ______________________
  - ----THICKNESS ______________________
  - ----R - VALUE ______________________
- INTERIOR FINISH ______________________
- WINDOWS ______________________
- DOORS ______________________

B • ROOF–EXPOSED SURFACE AREA

- FRAME ______________________
- EXTERIOR FINISH ______________________
- INSULATION TYPE ______________________
  - ----THICKNESS ______________________
  - ----R - VALUE ______________________
- INTERIOR FINISH ______________________

ISPI

MECHANICAL SYSTEM DESCRIPTION

A • HEATING

- SOLAR ______________________________
- AUXILIARY ______________________________
- DISTRIBUTION ______________________________

B • COOLING

- SOLAR ______________________________
- AUXILIARY ______________________________
- DISTRIBUTION ______________________________

C • DOMESTIC HOT WATER

- SOLAR ______________________________
- BACKUP ______________________________
- DAILY HOT WATER DEMAND ______________________________

D • ENERGY CONSERVATION AND RECOVERY DEVICES

_____ CONDENSER WATER USED FOR HEATING

_____ DEMAND LIMITERS

_____ ENERGY STORAGE

_____ HEAT RECOVERY WHEELS

_____ RECUPERATORS

_____ OTHER

_____ NONE

EXPLANATION: ______________________________

ISPI
SOLAR SYSTEM DESCRIPTION

PROJECT IDENTIFICATION NO: DATE:

PROJECT TITLE: PREPARED BY:

1. FUNCTION

______ DOMESTIC HOT WATER ______ OTHER ______________
______ SERVICE HOT WATER
______ SPACE HEATING
______ SPACE COOLING

2. SYSTEM TYPE

______ AIR _____ OTHER ____________________
______ LIQUID
______ ACTIVE
______ PASSIVE

3. COLLECTORS

A • NUMBER OF COLLECTORS ________

B • COLLECTOR TYPE(S) ______________________________
MANUFACTURER ______________ MODEL ____________
ADDRESS ____________________ CONTACT ____________

C • ORIENTATION ______ DUE SOUTH; _____° E OF S; _____° W OF S. ________

D • TILT _____° FROM HORIZONTAL, ADJUSTABLE? ______

E • LOCATION ______________________________

F • TOTAL AREA ________ GROSS AREA ________ NET APERTURE AREA ________

G • FREEZE PROTECTION ______________________________

H • OVERHEAT PROTECTION ______________________________

I • REFLECTOR TYPE ______________________________

4. STORAGE

A • TYPE ____________ NO. OF TANKS ____________ LOCATION ____________

B • CAPACITY ____________ MEDIUM ____________ SPECIFIC HEAT ____________

C • SIZE ______________________________

D • MATERIALS ______________________________

E • MANUFACTURER MODEL ______________________________

F • INSULATION ______________________________

G • IMMERSION HEATER CAPACITY ______________________________

5. ENERGY TRANSPORT

_____ AIR

_____ LIQUID; TYPE ____________________

ADDITIVES: ____________________

6. HOT WATER HEATER

A • MANUFACTURER ____________ ADDRESS ____________

CONTACT ____________________

B • MODEL NAME ____________________

C • MODEL NO. ____________________

D • CAPACITY _____ GAL

E • FUEL (POWER SOURCE): ____________________

F • ENERGY INPUT (RATED) ____________________ BTU/HR

G • ENERGY OUTPUT (RATED) ____________________ BTU/HR

7. SPACE HEATING AUXILIARY EQUIPMENT

A • MANUFACTURER ____________ ADDRESS ____________

CONTACT ____________________

B • MODEL NAME ____________________

C • MODEL NUMBER ____________________

D • TYPE OF EQUIPMENT ____________________

E • FUEL ____________________

F • ENERGY INPUT (RATED) ____________________ BTU/HR

G • ENERGY OUTPUT (RATED) ____________________ BTU/HR

8. SPACE COOLING AUXILIARY EQUIPMENT

A • MANUFACTURER ____________ ADDRESS ____________

CONTACT ____________________

B • MODEL NAME ____________________

C • MODEL NUMBER ____________________

D • TYPE OF EQUIPMENT ____________________

E • POWER SOURCE ____________________

F• ENERGY INPUT (RATED) ______________________ BTU/HR

G• ENERGY OUTPUT (RATED) ______________________ BTU/HR

H• COP ______________________

OTHER HEATING AND COOLING AUXILIARY EQUIPMENT (INCLUDE MANUFACTURER MODEL, SIZE, FUEL, CAPACITIES, CONTACT)

A• MANUFACTURER ______________________

B• MODEL NAME ______________________

OTHER AUXILIARY EQUIPMENT (INCLUDE MANUFACTURER, MODEL, FUEL, CONTACT, CAPACITY)

CONTROLS

LOGIC UNITS

MANUFACTURER ______________________ MODEL ______________

ADDRESS ______________________ CONTACT ______________

OPERATING MODE DESCRIPTION

(Please describe the operating mode using set point temperatures, valve logic, or other criteria based on the system schematic)

AUTOMATION INDUSTRIES, INC.
VITRO LABORATORIES DIVISION