SOLAR/2015-78/50

Solar Project Description

Kalwall Corporation Warehouse
Manchester, New Hampshire

May 31, 1978

Contracts EG-77-C-01-4049
EG-77-C-01-2522

United States Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

NOTICE

SOLAR/2015-78/50
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IBM Corporation
Huntsville, AL 35805

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National Solar Data Program

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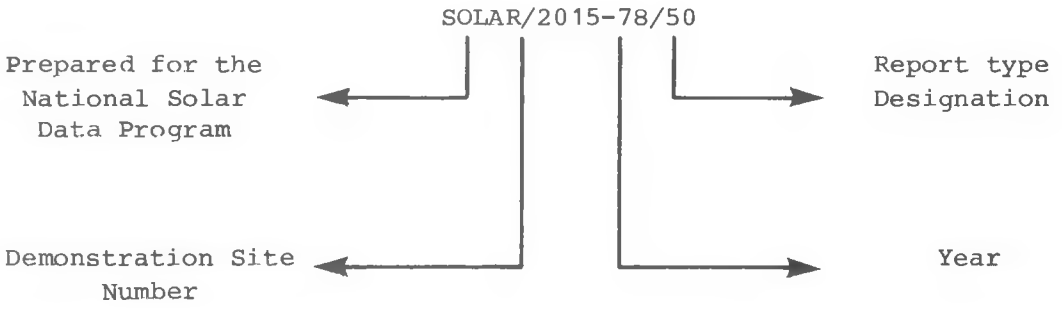
NATIONAL SOLAR DATA PROGRAM REPORTS

Reports prepared for the National Solar Data Program are numbered under a specific format. For example, this report for the Kalwall Corporation project site is designated as SOLAR/2015-78/50. The elements of this designation are explained in the following illustration:



- Demonstration Site Number:

  Each project site has its own discrete number - 1000 through 1999 for residential sites and 2000 through 2999 for commercial sites.

- Report Type Designation:

  This number identifies the type of report, e.g.,

  - Monthly Performance Reports are designated by the numbers 01 (for January) through 12 (for December)
  - Solar Energy System Performance Evaluations are designated by the number 14
  - Solar Project Descriptions are designated by the number 50
  - Solar Project Cost Reports are designated by the number 60

These reports are disseminated through the U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

I. FOREWORD

The National Program for Solar Heating and Cooling is being conducted by the Department of Energy as mandated by the Solar Heating and Cooling Demonstration Act of 1974. The overall goal of the Federal Demonstration Program is to assist in the establishment of a viable solar industry and to achieve a substantial reduction in fossil fuel use through widespread use of solar heating and cooling applications. An analysis and synthesis of the information gathered through this program will be disseminated in site-specific reports and summary documents as products of the National Solar Data Program. These reports will cover topics such as:

- Solar Project Description
- Design/Construction Contractor Final Report
- Project Costs
- Maintenance and Reliability
- Operational Experience
- System Performance Evaluation
- Monthly Performance Reports

The Solar Project Description is prepared for the purpose of documenting the project description in the "as-built" state. Information contained herein has been extracted from data collected during site visits and from reference documents such as the project proposal, designer specifications, contractor submittals, manufacturer literature, photographs, "as-built" drawings and other project documentation as available. The remaining reports in this series will rely on the Solar Project Description for specific site details.

II. EXECUTIVE SUMMARY

The following is a brief summary of the Kalwall Corporation's solar heated warehouse demonstration project. Highlights of this site include:

- COLLECTOR TYPE: Passive wall
- FREEZE PROTECTION: None required
- APPLICATION: Heating
- STORAGE TYPE: Concrete floor and warehouse contents
- NEW OR RETROFIT: Retrofit
- INSTRUMENTED FOR PERFORMANCE EVALUATION: Yes

The direct gain passive solar system was retrofitted to a 10,000 square foot warehouse section in Manchester, New Hampshire. The design used 1750 square feet of Kalwall Corporation's Sunwall Solar Window as the south wall collector aperture. The warehouse's concrete slab floor and inventories provide thermal storage. Five 24-inch, thermostatically controlled fans are used for heat circulation. Auxiliary heat is provided by two space heaters supplied by hot water from an oil-fired boiler.

The solar system has been fully instrumented for data acquisition and is included in the National Solar Data Network.

III. SITE AND BUILDING DESCRIPTION (See Figure III-1)

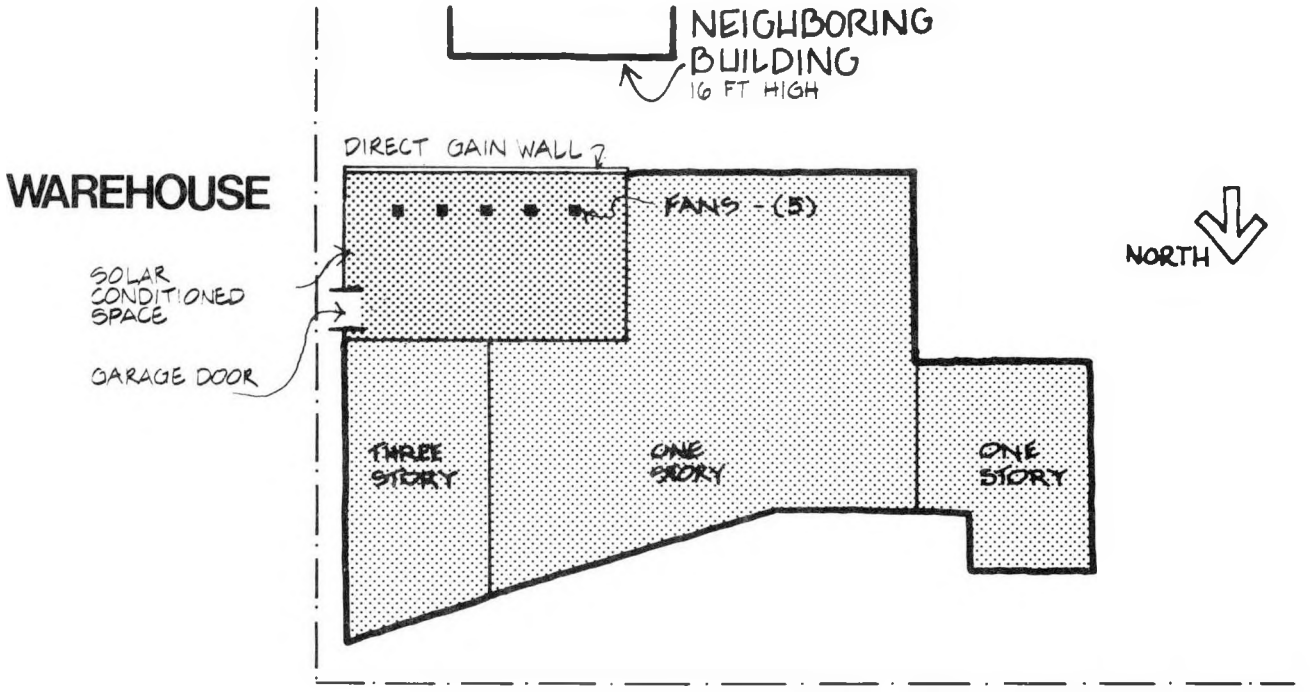


Figure III-1
Site Plan

Site Description

- Special topographic or climatic conditions - None
- Latitude - 43°N
- Annual degree days (65°F base)
  - Heating - 5499
  - Cooling - 895
  - Data location - Boston, Massachusetts
  - Data reference - "Local Climatological Data Annual Summaries for 1976," Department of Commerce, National Oceanic and Atmospheric Administration
- Average horizontal insolation
  - January - 435 BTU/FT^2-DAY
  - June - 1981 BTU/FT^2-DAY

- Data location - Lynn, Massachusetts
- Data reference - Solar Heating Design By The F-Chart Method, Beckman, Klein, Duffie, Wiley-Interscience Publication, 1977.

- Site topographic description - Flat
- Shading - Partial shading, there is a 16 FT high building directly south, approximately 50 FT from the direct gain wall. The wall will be in partial shadow when the sun is lower than 18° from horizon. Roof overhang partially shades the wall during summer midday.

Building Description

- Occupancy - Warehouse
- Total building area - Approximately 40,000 FT^2
- Solar conditioned area - 8,640 FT^2
- Number of stories - One
- Roof slope - Flat
- Special features - Passive solar system with a vertical direct gain wall

Structure

- Walls (Solar conditioned area)
  - Frame - Wood post and beam construction with Kalwall panel connected to aluminum ties with aluminum battens and caulking
  - Exterior finish
    - Type - Fiberglass-reinforced plastic honeycomb panel, assembly provides for lateral bracing
    - Manufacturer - Kalwall
  - Insulation
    - Type - Kalwall panel and 2-1/2 IN air space
    - R-value - R-2.5 for total section
  - Interior finish
    - Type - Integral with exterior
    - Manufacturer - Kalwall

- Windows - 2 exterior walls have Kalwall panels for glazing, 2 interior walls are also Kalwall panels. The Kalwall panels are translucent

- Doors - 1 garage door, approximately 16 FT x 24 FT with R-12.5, 2 IN rigid urethane foam laminated to door, weatherstripped around edges, with plastic sheet taped over door panels

- Roof

  - Structured frame - Wood beams and rafters spanned with 2-3/4 IN Kalwall panels

  - Exterior finish - Sheet plastic over 2 IN sprayed urethane foam glued in place

  - Insulation - R-12.5, 2 IN urethane foam

  - Interior finish - Some panels are covered with fiberglass-reinforced plastic sheets, remainder are covered with asbestos sheets

- Floor material - 8 IN concrete slab on grade, painted black with perimeter insulation R-12.5, 2 IN urethane foam covered with fiberglass sheathing

Mechanical System

- Heating

  - Solar - Passive solar gain walls, heating with concrete floor slab as the storage medium. Circulating fans move warm air.

  - Backup - 2 oil-fired boiler with two hot water space heaters.

  - Distribution - 5 individually thermostatically controlled fans.

- Cooling

  - Description - Natural ventilation provided by opening 16 FT x 24 FT overhead garage door.

  - Distribution - Five 24 IN diameter fans, each rated at 5500 CFM with 1/4 HP motors, located 3 FT from direct gain wall and 4 FT from ceiling

- Domestic hot water - Not included

IV. SOLAR SYSTEM DESCRIPTION

A. General Overview

The Kalwall passive solar heating system is shown in Figure IV-A-1. The major components include 1750 FT^2 of direct solar gain wall, an 817,000 LBS concrete floor slab, circulating fans, controls, and an auxiliary heating system.

Subsequent sections describe the collector, storage, energy-to-load, auxiliary energy, and control subsystems. Appendices A and B respectively present a glossary and a legend of symbols.

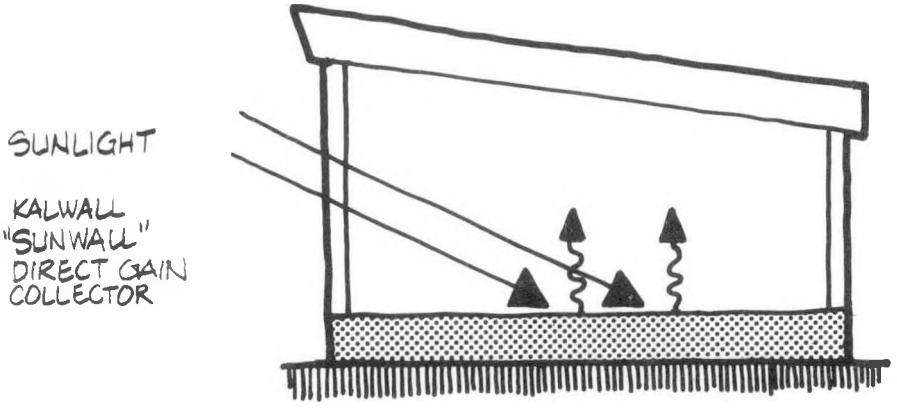


Figure IV-A-1

B. Collector Subsystem

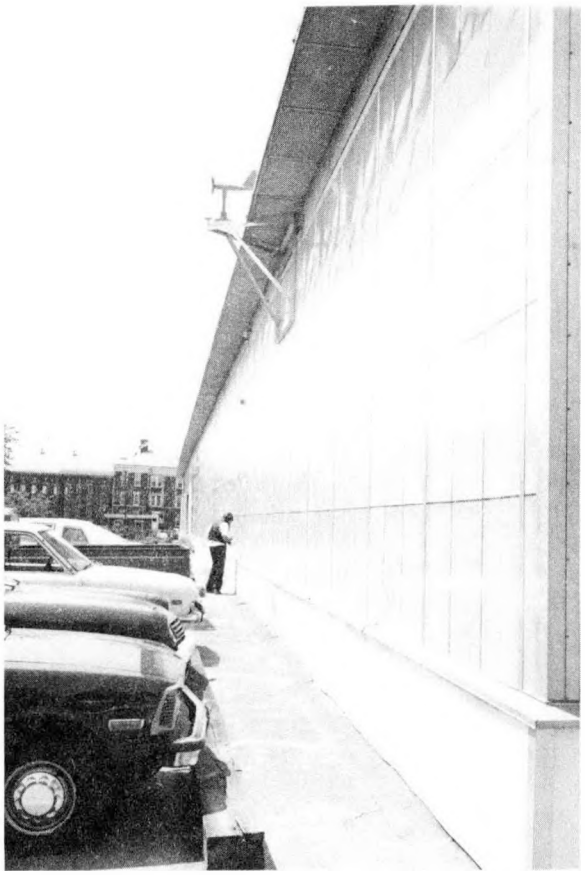


Figure IV-B-1
Passive Solar Wall

General Description

The collector is the southern wall in the warehouse and is constructed from plastic panels. The absorber is the concrete floor slab and the warehouse inventory. (See Figure IV-B-2)

Collector

- Type - Direct solar gain passive system with wall made of plastic panels
- Collector orientation - Due south
- Angle - 90° from horizontal
- Manufacturer/Model No. - Kalwall/Sunwall Solar Window Panel

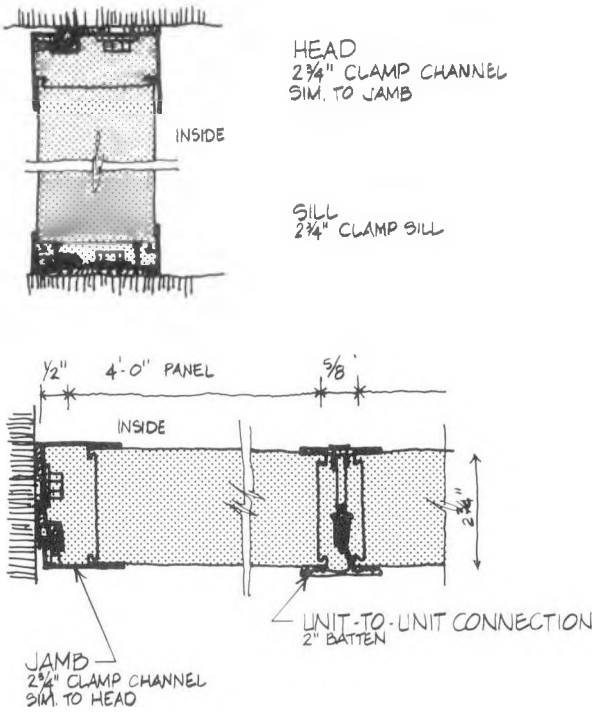


Figure IV-B-2
Collector/Wall Detail

- Collector enclosure
  - Frame material - Aluminum
  - Surface area - 1750 FT^2
  - Overall size - 14 FT high x 125 FT long
  - Total weight - 2100 LBS
- Glazing
  - Number - 2 layers separated by a 2-1/2 IN airspace
  - Material - Fiberglass reinforced plastic sheet, heat and pressure bonded to an aluminum grid core
  - Thickness - 2-3/4 IN total
  - Transmittance
    - Winter - 77%
    - Summer - 30%

- Absorber

  - Description - The absorber consists of a floor slab and the inventory. The 8 IN thick concrete slab is described under the storage system, since the slab absorbs and radiates the solar energy.

  - Floor slab

    - Coating - Flat black paint

    - Absorptance - 95%

    - Emittance - 95%

Collector Support (See Figure IV-B-3)

- Type - Self-supporting direct solar gain wall

- Structural framing material - Aluminum tee's and battens

- Fasteners and collector attachments - Lag screws, clamp sills

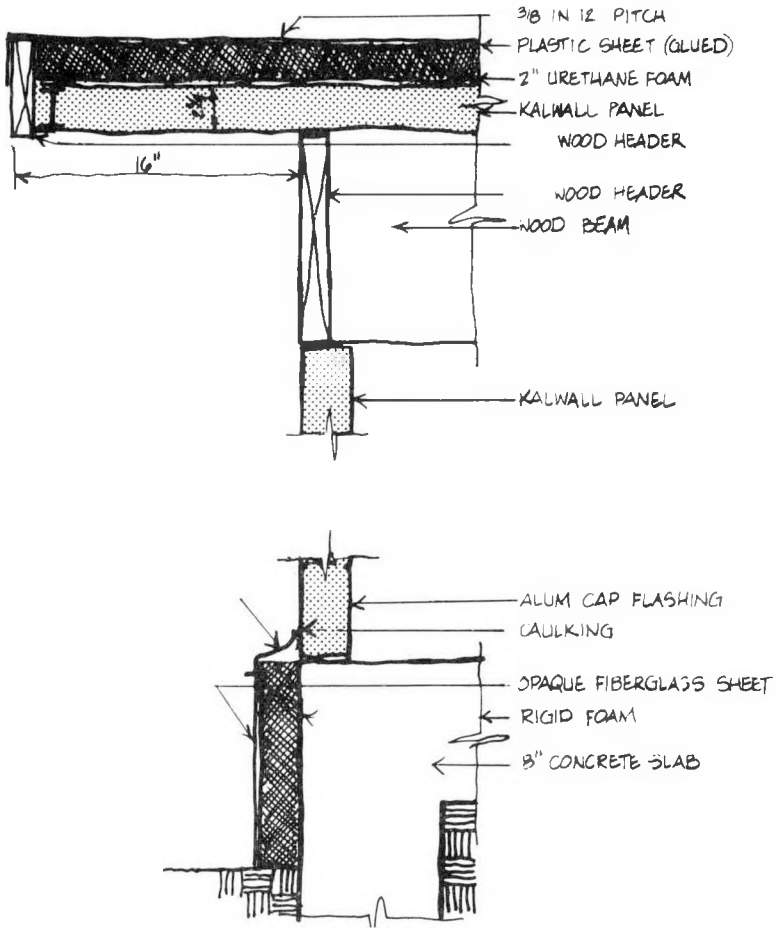


Figure IV-B-3
Collector Support

C. Storage Subsystem

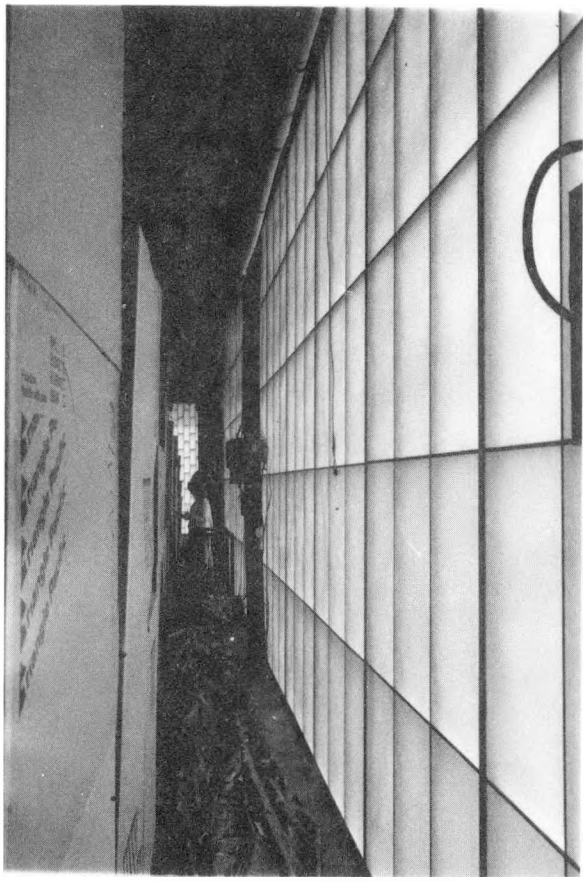


Figure IV-C-1
Floor and Inventory Used for Storage

General Description

The storage subsystem consists of the concrete floor slab and the warehouse inventory. The inventory, which covers approximately 80% of the floor area and is piled 5 to 10 FT high, must be considered as part of the storage subsystem. (See Figure IV-C-2)

Floor Slab

- Size - 125 FT long x 70 FT wide x 8 IN thick
- Material - Concrete
- Total mass - 817,000 LBS
- Insulation - R-12.5, 2 IN urethane foam around perimeter
- Installation - On grade, uninsulated
- Sensor probe - Thermocouples

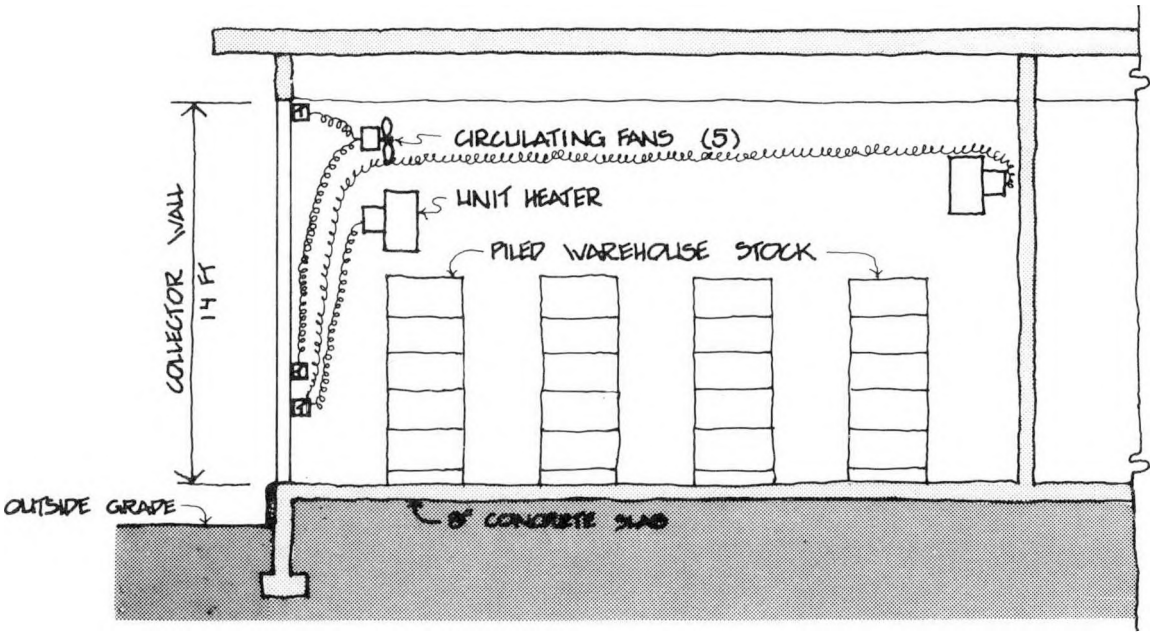


Figure IV-C-2
Building/Storage Section

D. Energy-To-Load Subsystem

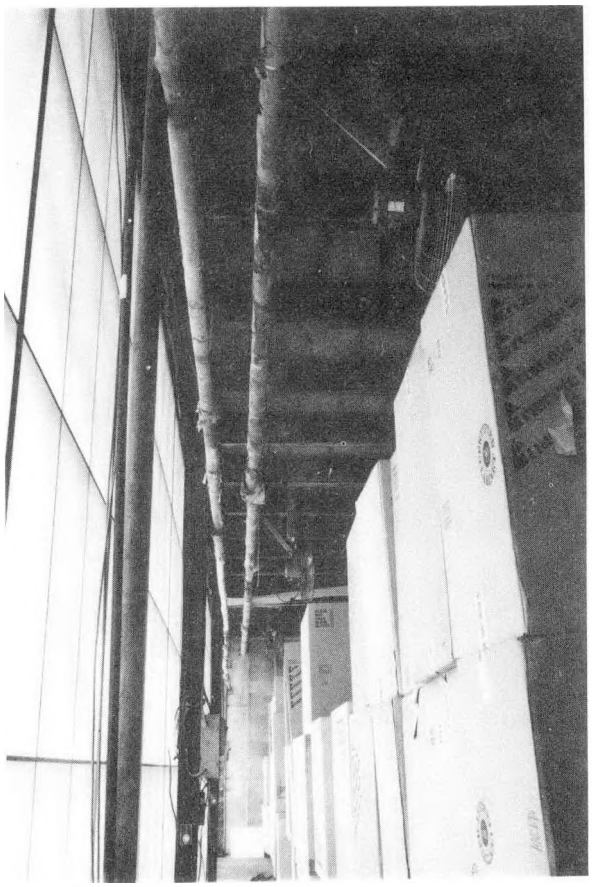


Figure IV-D-1
Circulating Fans Used to Circulate Warm Air

1. Space Heating

- General Description - Solar energy is transmitted through the direct gain wall and is absorbed into the concrete slab and warehouse inventory. The space is heated through thermal radiation given off by both the floor and inventory. Circulating fans move the warm air to heat the other areas in the warehouse when the room temperature drops below 60°F.

2. Space Cooling

- General Description - The circulating fans are activated whenever the room temperature is above 85°F. The overhead door is opened for natural ventilation.

Circulating Fans

- Type - 24 IN diameter with 1/4 HP motor
- Rating - 5500 CFM
- Location - 3 FT from direct gain wall and 4 FT below ceiling

Thermostats

- Description - One set of thermostats individually turns on the 5 circulating fans when the temperature is below 60°F. The sensors for these thermostats are located 5 FT from the floor. A second set of thermostats individually turn on the 5 circulating fans when the temperature is above 85°F. The sensors for these thermostats are near the ceiling.

E. Auxiliary Energy System

General Description

The auxiliary heating system consists of two forced-draft unit heaters that are energized when the room temperature falls below 45°F. Hot water for the unit heaters is supplied from the building's central heating system.

Auxiliary Space Heaters

- Type - Hot water space heater supplied by an oil-fired boiler
- Number - 2
- Rating - One is rated at 196,000 BTU/HR, while the other is rated at 209,000 BTU/HR
- Location - Near the ceiling, on opposite sides of warehouse

F. Control Subsystem

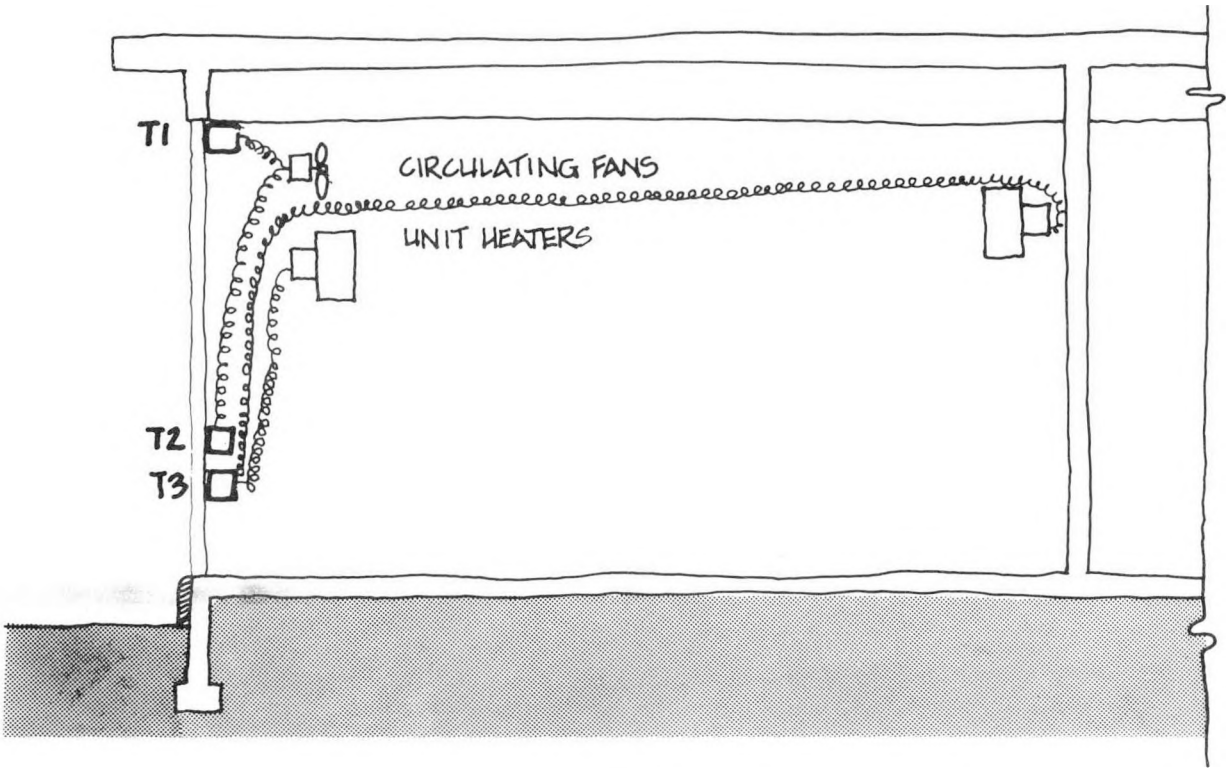


Figure IV-F-1
Controls Diagram

1. Space Heating Mode

- General Description - Space heating is provided to the warehouse in two steps. In the first step, the room temperature, measured by sensor T-2, drops below 60°F. The sensor activates the 5 circulating fans. In the second step, the room temperature, measured by sensor T-3, continues to drop and falls below 45°F. This sensor activates the hydronic unit heaters. The control system operates in reverse when the room temperature rises.

2. Space Cooling Mode

- General Description - Space cooling is provided by activating the circulating fans whenever thermostat T-1 senses a temperature above 85°F. The fans are deactivated when the temperature drops below 82°F.

Thermostats

- Manufacturer/Model No. - Dayton/2E158
- Range - 60° to 90°F
- Deadband differential - 3°F, fixed
- Thermometer - 50° to 90°F, integral

V. PERFORMANCE EVALUATION INSTRUMENTATION

A. The National Solar Data Network

The National Solar Data Network (See Figure V-A-I) has been developed for the Department of Energy to process data collected from specific commercial demonstration sites which were selected for thermal performance evaluation. The data flow in the Network is shown in Figure V-A-2. Products from the Network include monthly and seasonal system performance reports describing the thermal performance of the solar energy system and subsystems.

The performance evaluation instrumentation at each selected demonstration site is part of a comprehensive data collection system that allows for valid analyses of the solar system performance. Collected data are both applicable and practical in calculating thermal performance factors which describe the behavior of the solar system (See NBSIR 76-1137, National Bureau of Standards). Additional instrumentation may also be included as a result of site-specific requirements. Typically, the instrumentation include sensors that monitor the following:

- Total insolation in the plane of the collector array
- Ambient temperature
- Collector subsystem flow rate and temperatures
- Storage inlet flow rate and temperatures
- Storage outlet flow rate and temperatures
- Storage temperature
- Storage-to-load subsystem flow rate and temperatures
- Auxiliary fuel flow rates

Site data are recorded automatically at prescribed intervals by the Site Data Acquisition System (SDAS). The recorded data are transmitted daily to the Communications Processor in the Central Data Processing System (CDPS). The communications link between every SDAS and the CDPS consists of voice-grade telephone lines and telephone data couplers. A reading is transmitted from the SDAS internal timer with every data sample to ensure that the data are time-tagged correctly.

The Communications Processor scans the receiving data to identify any apparent transmission errors and verifies correct site contact by checking the address code transmitted by the SDAS. Data is stored temporarily in the Communications Processor and processed by the Host Computer. The processing includes measurement checking to ensure that the data are reasonable; that is, that they are not beyond the known instrument limits and that they are not erratic. Data which appear questionable are discarded and are not used in the solar system performance analyses.

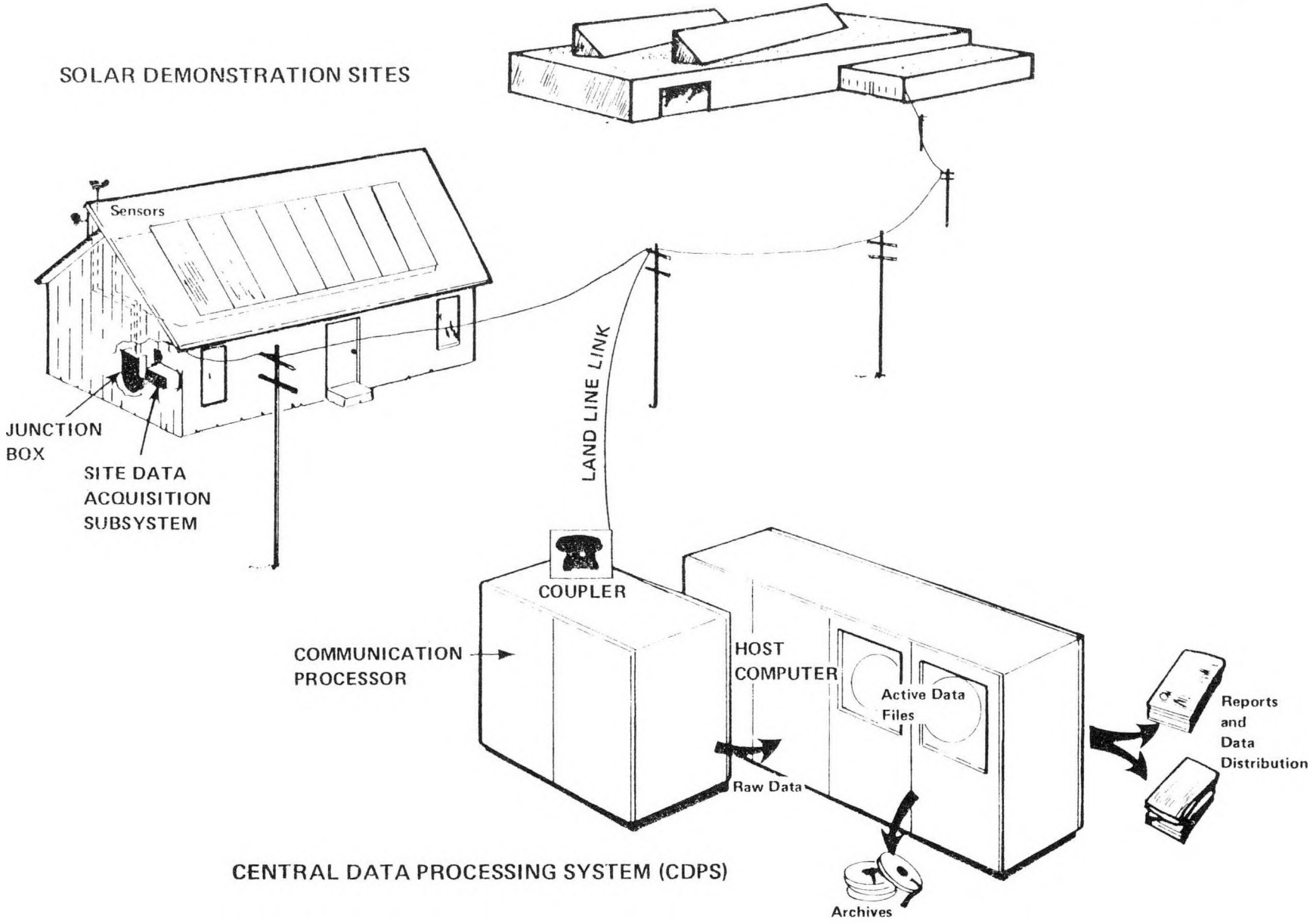


Figure V-A-1. The National Solar Data Network

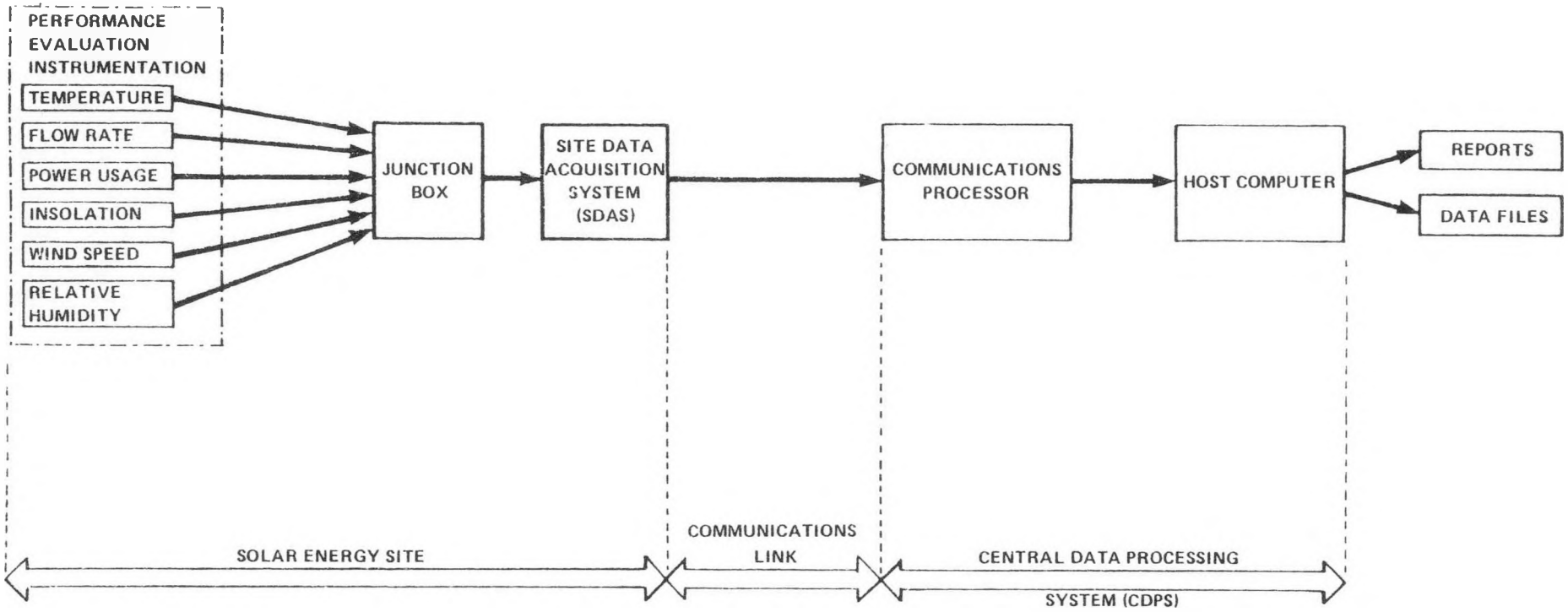


Figure V-A-2. Data Flow Path for the National Solar Data Network

Appropriate equations were formulated and programmed to define desired performance factors for the solar energy systems at each selected demonstration site. A performance factor is a number that describes either the efficiency or the quantity of energy lost, gained, or converted by a solar energy system or by a component. All valid data are processed using these performance factor equations to generate hourly performance factors. Hourly performance factors are integrated into daily and monthly performance factors. These hourly, daily, and monthly performance factors are stored in data files in the CDPS. These data files also include measurement data, expressed in engineering units; numerical and textual site identification; and specific site data used in generating the performance factors.

B. On-Site Instrumentation

The on-site instrumentation include sensors to monitor the various parameters of the solar energy system, a junction box, and a Site Data Acquisition System that stores data and transmits data to the Host Computer (See Figure V-A-1 and V-A-2). Specific information for temperature, flow, power and miscellaneous sensors are presented in Tables V-B-1 thru V-B-4, respectively.

TABLE V-B-1. TEMPERATURE INSTRUMENTATION FOR KALWALL CORPORATION

SENSOR	NAME	RANGE (F)		MFGR	THERMOWELL PART NO
		Min	Max		
T001	External Air Temperature	-20	120	Minco	I54
T100	External Roof Surface Temperature	30	160	Minco	
T101	Southeast Absorber Surface Temperature	30	160	Minco	
T102	South Absorber Surface Temperature	30	160	Minco	
T103	Southwest Absorber Surface Temperature	-20	120	Minco	
T104	South Absorber Temperature (8 inch depth)	-20	120	Minco	F203U55
T105	Northeast Absorber Temperature (8 inch depth)	-20	120	Minco	F203U55
T400	Primary Auxiliary Outlet Temperature	30	230	Minco	F203U15
T401	Secondary Auxiliary Outlet Temperature	30	230	Minco	F203U15
T450	Auxiliary Inlet Temperature	30	230	Minco	F203U15
T600	West Wall Exterior Air Temperature	-20	120	Minco	
T601	North Wall Exterior Air Temperature	-20	120	Minco	
T602	Southeast Floor Surface Temperature	-20	120	Minco	
T603	Southwest Floor Surface Temperature	-20	120	Minco	
T604	Northeast Floor Surface Temperature	-20	120	Minco	
T605	Northwest Floor Surface Temperature	-20	120	Minco	
T606	Southeast Roof Interior Surface Temperature	-20	120	Minco	
T607	Southwest Roof Interior Surface Temperature	-20	120	Minco	
T608	Northeast Roof Interior Surface Temperature	-20	120	Minco	
T609	Northwest Roof Interior Surface Temperature	-20	120	Minco	
T610	East Wall Interior Surface Temperature - South	-20	120	Minco	
T611	East Wall Interior Surface Temperature - North (Door)	-20	120	Minco	
T612	South Wall Interior Surface Temperature - East	-20	120	Minco	
T613	South Wall Interior Surface Temperature - West	-20	120	Minco	
T614	West Wall Interior Surface Temperature - South	-20	120	Minco	

TABLE V-B-1. TEMPERATURE INSTRUMENTATION FOR KALWALL CORPORATION (Continued)

SENSOR	NAME	RANGE (F)		MFGR	THERMOWELL PART NO
		Min	Max		
T615	West Wall Interior Surface Temperature - North	-20	120	Minco	
T616	North Wall Interior Surface Temperature - West	-20	120	Minco	
T617	North Wall Interior Surface Temperature - East	-20	120	Minco	
T618	Southeast Interior Air - Low	-20	120	Minco	
T619	Southeast Interior Air - High	-20	120	Minco	
T620	Southwest Interior Air - Low	-20	120	Minco	
T621	Southwest Interior Air - High	-20	120	Minco	
T622	Northeast Interior Air - Low	-20	120	Minco	
T623	Northeast Interior Air - High	-20	120	Minco	
T624	Northwest Interior Air - Low	-20	120	Minco	
T625	Northwest Interior Air - High	-20	120	Minco	

TABLE V-B-2. FLOW RATE INSTRUMENTATION FOR KALWALL CORPORATION

SENSOR	NAME	RANGE (GPM/CFM)			MFGR.	MODEL NO
		Min.	Design.	Max.		
W400	Primary Auxiliary Flow	4	20	40	Ramapo	MK-V-3/4-J01
W401	Secondary Auxiliary Flow	4	20	40	Ramapo	MK-V-3/4-J01

TABLE V-B-3. POWER INSTRUMENTATION FOR KALWALL CORPORATION

SENSOR	NAME	PHASE	MFGR	FULL SCALE INPUT		MODEL NO
				Volts	Amps	
EP001	Circulation Fans 1 through 5	1	Ohio Semi-tronics	120	45	PC5-28
EP002	Auxiliary Space Heating	1	Ohio Semi-tronics	120	24	PC5-28

TABLE V-B-4. MISCELLANEOUS INSTRUMENTATION FOR KALWALL CORPORATION

SENSOR	NAME	MODEL NO.	MFGR.
I001	Total Insolation	PSP	Eppley Laboratories
V001	Wind Speed	W101-P-DC/540	Weathermeasure
D001	Wind Direction	W101-P-DC/540	Weathermeasure
D002	Door Microswitch	C2-J	

VI. APPENDIX

A. GLOSSARY

ABSORBER PLATE - The surface in a flat plate collector that absorbs incident solar radiation and transfers the absorbed energy to a heat transfer fluid.

ABSORPTANCE - The ratio of absorbed radiation by a surface to the total incident radiation on that surface.

ABSORPTION SUBSYSTEM - The mechanical equipment that conditions indoor air by an absorption process.

ACTIVE SOLAR SYSTEM - An integrated solar energy system, consisting of collector, storage, solar energy-to-load subsystems, that can condition indoor air or preheat domestic hot water in a controlled manner.

AIR-BASED SOLAR COLLECTOR SYSTEM - A solar energy system in which air is the heat transfer fluid.

AIR CONDITIONING - The process of treating indoor air by controlling the temperature, humidity, and distribution to specified comfort settings as set by the occupants in the conditioned space.

AMBIENT AIR - A term for outdoor air, and may be brought into a building to be conditioned or circulated.

ANTIFREEZE FREEZE PROTECTION SYSTEM - A freeze protection system that uses a solution of water and glycol. This solution depresses its freezing point sufficiently to prevent possible water freeze in the solar collectors and the exterior piping.

AUXILIARY ENERGY SUBSYSTEM - The equipment, utilizing conventional energy sources, used to supplement the output provided by a solar energy system and used to provide a full backup system when the solar system is inoperable.

BACKFLOW - The unintentional reversal of flow in a potable water distribution system by foreign or toxic substances that may contaminate the potable water.

BACKFLOW PREVENTER - A device or means to stop backflow.

BEAM RADIATION - Solar radiation which is not scattered and may be concentrated.

BRITISH THERMAL UNIT (Btu) - A unit of energy that is required to heat one pound of water from 59° to 60°F.

BUILDING ENVELOPE - The exterior surface of a building that encloses the conditioned space.

CLIMATE - The prevailing or average weather conditions of a specific geographic region as described by temperature and other meteorological data.

COLLECTOR MANIFOLD - The piping that connects the absorber tubes in a collector plate.

COLLECTOR PLATE - A term used for an absorber plate.

COLLECTOR SUBSYSTEM - The assembly that absorbs incident solar radiation and transfers the absorbed thermal energy to a heat transfer fluid.

COMBINED COLLECTORS - An assembly that both collects incident solar radiation and stores the thermal energy in the same unit.

CONCENTRATING SOLAR COLLECTOR - A solar collector which focuses beam radiation onto an absorber in order to obtain higher energy fluxes than can normally be achieved by flat plate solar collectors.

CONCENTRATOR - A reflective surface or refracting lens used in directing insolation onto an absorber.

CONDITIONED SPACE - The space in a building that has the air conditioned for heating and cooling.

CONTROL SUBSYSTEM - The assembly of electric, pneumatic, and hydraulic actuated sensing devices used in regulating the solar energy system and the auxiliary energy subsystem.

COOLING TOWER - A heat exchanger that transfers waste heat from an absorption cooling system to ambient air.

DIFFUSE RADIATION - Solar radiation which is scattered by air molecules, dust, or water droplets and incapable of being focused.

DRAIN-DOWN FREEZE PROTECTION SYSTEM - A freeze protection system that prevents potential water freeze problems by automatically opening a valve to drain the solar collectors and exterior piping. Air is used for some systems, while others use nitrogen.

DUCT HEATING COIL - A liquid-to-air heat exchanger in the duct distribution system used to heat air by passing a hot fluid into a coil in the air stream.

EQUIVALENT FULL LOAD COOLING HOURS - The seasonal cooling load for a building described as the total number of hours that the air conditioning system will operate under full load conditions to meet the required cooling load.

EMITTANCE - The ratio of energy radiated by a body to the energy radiated by a black body at the same temperature.

EXPANSION TANK - A tank which will permit water to expand whenever it is heated to prevent excessive pressures on the other system components.

FIXED COLLECTOR - A solar collector that is permanently orientated towards the sun and cannot track the sun nor be adjusted for seasonal variations.

FLAT PLATE COLLECTOR - A basic heat collection device used in solar heating systems, which consists of an absorber plate, with insulated bottom and sides, and covered by one or more transparent covers. There are no concentrators or focusing aids in a flat plate collector.

FOCUSING COLLECTOR - A solar collector using a parabolic mirror, fresnel lens, or other type of focusing device to concentrate solar radiation onto an absorber.

FRESNEL COLLECTOR - A concentrating solar collector which uses a fresnel lens to focus beam radiation onto an absorber.

GLAZING - The transparent cover(s) on a solar collector used to reduce the energy losses from the top of the collector.

HEAT TRANSFER FLUID - The fluid that transfers solar energy from the solar collector to the storage subsystem or to the load.

INCIDENCE ANGLE - The angle in which the insolation strikes a surface and the normal for that surface.

INSOLATION - The total amount of solar radiation on a surface in a given unit of time.

LAMINATED GLASS - A glazing consisting of multiple glass sheets bonded together by intervening layer or layers of plastic.

LANGLEY - The standard unit of insolation defined as 1 langley = 1 cal/cm^2 (1 Langley = 3.69 Btu/ft^2).

LIQUID-BASED SOLAR COLLECTOR SYSTEM - A solar energy system in which either water or an antifreeze solution is the heat transfer fluid.

LOAD - The total space conditioning or domestic water heating requirements that are supplied by both the solar energy system and the auxiliary energy subsystem.

NOCTURNAL RADIATION - The loss of thermal energy by the solar collectors to the sky at night.

NO-FLOW CONDITION - The condition obtained when the heat transfer fluid is not flowing through the collector array due to a shutdown or a malfunction.

OPAQUE - A surface that is not transparent, thus solar radiation is either reflected or absorbed.

OUTGASSING - The emission of gases by materials and components, usually during exposure to elevated temperature, or reduced pressure.

PACKAGE AIR-CONDITIONING UNIT - A factory-made assembly consisting of an indoor coil, a compressor, an outdoor coil, and other components needed for space cooling operations. This unit may also include additional components to heat the condition space.

PARABOLIC FOCUSING COLLECTOR - A concentrating collector which focuses beam radiation by a parabolic reflector.

PASSIVE SOLAR SYSTEM - An integrated solar energy system that can provide for space heating needs without the use of any other energy source other than the sun.

PEBBLE BED - A storage tank using uniform-sized pebbles to store solar energy in air-based solar collector systems.

REFLECTANCE - The ratio of radiation reflected by a surface to the total incident radiation on the surface.

REFLECTED RADIATION - Insolation which is reflected from a surface, such as the ground, and is incident on the solar collector.

SELECTIVE SURFACE - A surface which has a high absorptance for solar radiation and a low emittance for thermal radiation.

SOLAR CONDITIONED SPACE - The area in a building that depends on solar energy to provide for a fraction of the heating and cooling needs.

SOLAR HEATING SYSTEM - An integrated assembly of collector, storage, solar energy-to-load, and control subsystems required to convert solar energy into thermal energy for space heating requirements, as well as the addition of an auxiliary backup system.

SOLAR RETROFIT - The addition of a solar energy system to an existing structure.

STORAGE SUBSYSTEM - The components used to store solar energy so that the stored energy can be used for heating, cooling, or heating water during periods of low insolation.

STRATIFICATION - The horizontal layering by a fluid due to temperature differentials, commonly noticed in storage tanks filled with water.

THERMOSTAT - A temperature dependent sensor which controls the heating and cooling systems for space conditioning or the hot water heater.

TON OF REFRIGERATION - A unit of refrigeration which is equivalent to 12,000 BTU/HR.

TRACKING COLLECTOR - A solar energy collector that constantly moves to follow the path of the sun.

VAPOR BARRIER - A material which is used to reduce the transmission of water vapor.

ZONE - A portion of a conditioned space with similar heating and cooling requirements so that a common control is used.

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