

The following specification covers the requirements for a Solar Water Heating System to be installed under this contract.

## PART 1 GENERAL

The objective of this project is to provide a system to use solar energy to preheat service hot water at \_\_\_\_\_ . One qualified contractor will be selected to provide all labor, supervision, equipment, tools, materials and incidentals necessary to design, install test and commission the complete solar water heating system. The system shall operate in conjunction with the building's plumbing systems.

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE)

ASHRAE 93      Methods of Testing to Determine the Thermal Performance of Solar Collectors

NFPA 70          National Electrical Code

ISO 9001          ISO 9001 Certified Manufacturer

ISO 9002          ISO 9002 Certified Manufacturer

SOLAR RATING AND CERTIFICATION CORPORATION (SRCC)

SRCC OG-100    Operating Guidelines and Minimum Standards For Certifying Solar Thermal Collectors

### 1.2 DEFINITIONS

The term "solar" for the purposes of this specification, describes systems that intercept solar radiation and convert it to thermal energy. Thermal energy is imparted to service hot water in the building.

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 Design Requirements

Design new solar water heating systems for the heating of domestic water using roof-mounted, heat-pipe solar collectors. Systems may be of Evacuated Heat-Pipe type suitable to the climate of the site. The system control is by a simple differential temperature controller with optional recording capabilities. The following design requirements apply:

- 1) System tilt angle of --- degrees
- 2) Provide for freezing ambient conditions
- 3) Collector active part shall be interchangeable without discharging heat transfer fluid
- 4) Provide for stagnation conditions when there is no hot water use during vacations
- 5) Provide wind load calculation
- 6) Solar collectors and controllers shall be tested at the manufacturer's plan as required by ISO 9001 and 9002

certifications

- 7) Simple and easy to maintain by design
- 8) Automatic operation not requiring operator intervention
- 9) Include a monitoring system to measure system performance.

Design shall include in the system, components that consist of a solar collector tube, manifold array, expansion tank, storage tank, interconnecting piping and fittings, tempering mixing valve, and as required by the system type, any necessary pumps, controls or heat exchangers, sensors and controls as well as all other accessories and equipment required for completion and proper operation of the solar water heating system.

#### 1.3.2 Performance Requirements

Solar water heating systems must be safe, reliable, require no operator intervention for normal operation, be visually unobtrusive, and be designed and installed in accordance with all applicable codes. Design and size the system so that solar energy supplies the amount of heat that minimizes life cycle cost, but not less than 70 percent of the annualized hot water demand.

- 1) Estimated incoming cold water temperature --- F
- 2) Hot water delivery temperature --- F

Include with the system all labor, supervision, equipment inside and outside the building, tools, materials and incidentals necessary to design, procure, install, checkout and place into operation a complete solar water heating system ready for use in the building.

#### 1.4 SUBMITTALS

Submit the following.

##### 1.4.1 Approval drawings and Data

###### 1.4.1.1 Commercial Products Data with Performance Charts and Curves

Annotate descriptive data to show the specific model, type, and size of the item.

###### 1.4.1.2 Solar System Design

Submit a complete description of the design of the system, including drawings, specifications, wind and flow calculations and written narrative. Submit calculations of solar system performance leading to the proposed design. Submit drawings in both hardcopy and electronic CAD format compatible with the format of existing building plans. Include mechanical, electrical and structural drawings and specifications in sufficient detail for construction bidding and construction of the system.

###### 1.4.1.3 Statements

Prior to installation, submit data showing that the Contractor has successfully designed and installed systems of the same type and design as specified herein and proposed by the contractor or original collector manufacturer supports him during all phases of the project.

###### 1.4.1.4 Drawings

Provide drawings for the system type and size containing a system schematic; a collector layout and roof plan noting reverse-return piping for the collector array; a system elevation; a schedule of operation and installation instructions; and a schedule of design information including collector height and width, recommended collector

flow rate and pressure drop at that flow rate, number of collectors tubes, number of manifolds to be grouped per bank, gross area and net aperture area of collectors, collector fluid volume, collector filled weight, weight of support structure, and tilt angle of collectors from horizontal. Include in the drawings, complete wiring and schematic diagrams, proposed pipe pitch and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work, including clearances for maintenance and operation. Provide a detail of the joint connection between the solar collector mounting brackets and the roof membrane.

#### 1.4.2 Final Drawings and Data

##### 1.4.2.1 Instructions

Submit proposed diagrams, instructions, and other sheets, including a system schematic, wiring and control diagrams, and a complete layout of the entire system for the system type to be installed. Include with the instructions, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system, methods of balancing and testing flow in the system, and methods of testing for control failure and proper system operation.

##### 1.4.2.2 Operating and Maintenance Manuals

Submit manuals that detail the step-by-step procedures required for system filling, startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and brief descriptions of all equipment and their basic operating features. List routine maintenance procedures, possible breakdowns and repairs, recommended spare parts, troubleshooting guides, piping and equipment layout, balanced fluid flow rates, and simplified wiring and control diagrams of the system as installed.

##### 1.4.2.3 Field Test Reports

Submit reports of piping hydraulic pressure test and commissioning.

Submit results of system performance testing.

## PART 2 PRODUCTS

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard or Pre-approved Products

Furnish materials and equipment that are the standard products of a manufacturer regularly engaged in the manufacture of such products and which essentially duplicate items that have been in satisfactory use for at least 10 years prior to proposal due date.

#### 2.1.2 Nameplates

Secure to the major item of equipment the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate.

### 2.2 PIPING SYSTEM

Provide a piping system complete with pipe, pipe fittings, valves, strainers, expansion loops hangers, inserts, supports, anchors, guides, sleeves, and accessories with this specification and the drawings.

Provide, install and test the piping. Provide piping flow rates below 5 feet per second. Piping shall be Type L or

Type M copper tubing, ASTM B-88, with 95-5 tin-antimony soldered joints.

#### 2.2.1 Pipe Insulation

Furnish interior pipe insulation and coverings such as Armaflex, Insul-Tube, Rubatex, or approved equivalent. Provide outside array piping insulation with a capability of withstanding 250 degrees F, except that piping insulation within 1.5 feet of collector connections shall be capable of withstanding 400 degrees F. Protect outside piping insulation from water damage and ultraviolet degradation with a suitable outer coating.

#### 2.2.2 Balancing Valves (for multiple collector banks)

If systems are proposed with multiple collector banks, provide balancing valves suitable for 125 psig and 250 degrees F service. Furnish balancing valves with bronze body/brass ball construction with seat rings compatible with system fluid and differential readout ports across valve seat area. Provide readout ports fitted with internal insert of compatible material and check valve. Provide calibrated balancing valves with a memory stop feature to allow valve to be closed for service and reopened to set point without disturbing balance position, and with a calibrated nameplate to assure specific valve settings. Provide calibrated balancing valves and ball valves at the outlet of the collector bank. The balancing valves are specified to allow the array to be flow balanced. The ball valves are required to enable the array to be disconnected for maintenance or repair. This section is not applicable to systems of only one collector bank, where balance of flow is not an issue.

#### 2.2.3 Pressure Gauges

Provide pressure gauges with throttling type needle valve or a pulsation dampener and shutoff valve. Furnish a 3-1/2 inch minimum dial size.

#### 2.2.4 Thermometers

Supply thermometers with wells and separable bronze sockets.

#### 2.2.5 Pipe Hangers and Supports

Support and hang piping so that the weight of the piping is not supported by drywall, siding, or other building members not designed to bear load. Support piping so that thermal expansion and contraction of pipe lengths is accommodated.

#### 2.2.6 Valves

Provide valves compatible with the piping. Ball valves shall be used for shutoff, with full port, bronze body, bronze ball and Teflon seat. Bronze hose-end gate valves shall be used for draining low points of piping.

### 2.3 COLLECTOR SUBSYSTEM

#### 2.3.1 Solar Collector Construction

The type of solar collector proposed shall be compatible with the proposed system type:

1. Absorber plate shall be in vacuum and coated with high efficient selective coating which ensures maximum radiation absorption and minimize thermal radiation losses
2. Heat pipe's heat transfer fluid shall be water based
3. Heat pipe condenser shall have integral temperature limiting feature
4. Absorber plate and heat pipe shall be enclosed in an evacuated glass tube
5. Condenser heat exchanger and clamp assembly that transfers heat to solar loop shall be enclosed in a

corrosion resistance insulated header box

6. All supporting structures including bolts and nuts shall be stainless steel

Collectors should be evacuated heat-pipe type, with selective absorber surfaces such as Thermomax, or equivalent. Furnish collectors of weather-tight construction and with stainless steel mounting brackets and hinges. Furnish stainless steel assembly hardware including all bolts, washers, and nuts. Install tubes on the absorber plate so that they drain by gravity.

### 2.3.2 Collector Warranty

Provide a minimum 2-year warranty against the following: failure of manifold or riser tubing, joints or fittings; degradation of absorber plate selective surface; rusting or discoloration of collector hardware; and embitterment of header manifold seals. Include with the warranty full repair or replacement of defective materials or equipment.

### 2.3.3 Solar Collector Performance

Plot thermal performance on the thermal efficiency curve in accordance with ASHRAE 93. Show manufacturer's recommended volumetric flow rate and the design pressure drop at the recommended flow rate. Indicate the manufacturer's recommendations for the number of collectors to be joined per bank while providing for balanced flow and for thermal expansion considerations.

## 2.4 SOLAR COLLECTOR ARRAY

### 2.4.1 Net Absorber Area and Array Layout

Collector array shall be oriented so that all collectors face the same direction. Space collectors arranged in multiple rows so that no shading from other collectors is evident between 1000 hours and 1400 hours solar time on December 21. Indicate minimum spacing between rows.

### 2.4.2 Piping

Connect interconnecting array piping between solar collectors, in a reverse-return configuration with approximately equal pipe length for any possible flow path. Indicate flow rate through the collector array. Provide the collector bank isolated by valves, with a pressure relief valve and with the capability of being drained. Locate manually operated air vents at system high points, and pitch array piping a minimum of 0.25 inch per foot so that piping can be drained by gravity. Install balancing valves at the outlet of the collector bank as indicated.

### 2.4.3 Supports for Solar Collector Array

Provide support structure for the collector array of stainless steel. Furnish a support structure, which secures the collector array at the proper tilt angle with respect to horizontal and orientation with respect to true south. The collector tilt angle shall vary by not more than +/- 25 degrees from the angle of the local latitude, and the azimuthal angle may vary by not more than +/-45% from due true south. Provide a support structure that will withstand the static weight of filled collectors and piping, snow loads, wind, seismic, and other anticipated loads without damage. Provide structural reinforcement for the roof as necessary to accommodate the additional loads imposed by the solar water heating system. Provide a support structure, which allows access to all equipment for maintenance, repair, and replacement. Neoprene or EPDM washers shall separate all dissimilar metals.

## 2.5 SOLAR PREHEAT STORAGE TANK

Provide a thermal energy storage solar tank with a storage capacity specified in design drawings. Provide the interior of the tank with glass lining for potable service.

## 2.6 HEAT TRANSPORT SUBSYSTEM

### 2.6.1 Heat Exchanger

Use solar tanks with double wall heat exchanger such as Rheem SolarAide or alike.

### 2.6.2 Pumps

Provide electrically driven circulating pump such as those manufactured by Grundfos, Hartel, March, Taco or approved equivalent. Support pumps on a concrete foundation or by the piping on which installed. Construct the pump shaft of corrosion resistant alloy steel with a mechanical seal. Provide stainless steel impellers and casings of bronze. Control motors with switches that can be activated by the differential temperature controller manual override (Hand-Off-Automatic).

### 2.6.3 Heat Transfer Fluid

Heat transfer fluid shall be compatible with all materials in the system. The nature and amount of heat transfer fluid will depend on the type of system proposed. Any conditioners or corrosion inhibitors added to the heat transfer fluid must be non-toxic.

## 2.7 CONTROL AND INSTRUMENTATION SUBSYSTEM

### 2.7.1 Differential Temperature Control Equipment

As required by the approved system design, furnish the control equipment as a system from a single manufacturer. Furnish a solid-state electronic type controller complete with an integral transformer to supply low voltage. Controller accuracy shall be plus or minus 0.5 degree C. Supply controllers that are compatible with the PT 100 or PT 1000 temperature sensors. Provide differential controls with direct digital temperature readings of all temperatures sensed. Supply controls with a visual indicator when pumps are energized and recording capabilities. Provide a controller that will identify open and short circuits on both the solar collector temperature sensor circuit and the storage tank sensor circuit. An optional BTU reading is preferred.

### 2.7.2 Thermistor Temperature Sensors

Provide temperature sensors that are compatible with the differential temperature controller, with an accuracy of plus or minus 1 percent at 20 degrees c. Supply sensors that have passed an accelerated life test conducted by subjecting thermistor assemblies to a constant temperature of 130 degrees C or greater for a period of 1000 hours minimum with an accuracy of within plus or minus 1 percent as stated above. Provide immersion wells or watertight threaded fittings for temperature sensors.

### 2.7.3 Tempering Valve

Systems must have a tempering or mixing valve to limit the temperature of the hot water supplied to the plumbing fixtures.

## 2.8 ELECTRICAL WORK

Provide electric motor-driven equipment complete with motor, motor starters, and controls. Provide electrical equipment and wiring in accordance with local codes. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Provide the motor of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor.

## 2.9 PAINTING AND FINISHING

Furnish equipment and component items, with the factory applied manufacturer's standard finish.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from sheet rocks or suspended ceilings. Keep interior and ends of new piping thoroughly cleaned of foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. Discharge storage tank pressure and temperature relief valves into floor drains. Provide air vents with threaded plugs or caps. Install control and sensor wiring in conduit.

#### 3.1.1 System Flushing and Disinfection

Flush and disinfect the piping system.

#### 3.1.2 Collector Subsystem

##### 3.1.2.1 Collector Array

Install solar collector array at the proper tilt angle, orientation, and elevation above roof. Install the solar collectors with the ability to be removed for maintenance, repair, or replacement.

##### 3.1.2.2 Array Piping

Install collector array piping in a reverse-return configuration so that path lengths of collector supply and return are of approximately equal length. Install air vents in the high points of the collector array piping. Provide proper pitch for draining of collector array.

##### 3.1.2.3 Array Support

Install array support in accordance with the recommendations of the collector manufacturer.

##### 3.1.2.4 Pipe Expansion

Provide for the expansion and contraction of supply and return piping with changes in the direction of the run of pipe or by expansion loops. Do not use expansion joints in the system piping.

##### 3.1.2.5 Valves

Install ball valves at the inlet and outlet of the bank of manifolded collectors. Install balancing valves at the outlet of the collector bank, and mark final settings on the valve. Install a union adjacent to the ball valve. Balance flow through the collector piping with at least one balancing valve left in the open position. Locate tempering mixing valve downstream of auxiliary water heater to control hot water delivery temperature.

##### 3.1.2.6 Roof Penetrations

All roof penetrations shall be made permanently waterproof. Contractor shall coordinate work with the current warranty of the existing new roof.

### 3.2 INSPECTION AND TESTING

#### 3.2.1 Instructions

Provide instructions for the system type. Include in these instructions a system schematic, and wiring and control diagrams showing the complete layout of the solar system. Prepare condensed operating instructions explaining preventative maintenance procedures, balanced flow rates, methods of checking the system for

normal safe operation, and procedures for safely starting and stopping the system, in typed form, framed as specified above, and posted beside the diagrams. Post the framed instructions before acceptance testing of the system.

### 3.2.2 Acceptance Testing and Final Inspection

Maintain a written record of the results of all acceptance tests, to be submitted in booklet form. Provide the following tests:

### 3.2.3 Hydrostatic Test

Hydrostatically test the system. Isolate valving and instrumentation not suitable for the intended test pressure.

### 3.2.4 Operational Test

Operationally test the system over a period of 48 consecutive hours with sufficient solar insolation to cause activation of the solar energy system during daylight hours.

### 3.2.5 Overall System Operations

Demonstrate the solar energy system will operate properly while unattended for a period of at least 72 hours. As required by system design, demonstrate the system controller will start the pumps after being warmed by the sun, and that it will properly shut down during cloudy weather or in the evening over a minimum of three complete cycles. It is permissible to manipulate the temperature of the storage tank by the introduction of cold water.

### 3.2.6 Temperature Sensor Diagnostics

As required by system design, demonstrate the controller will correctly identify open and short circuits on both the solar collector temperature sensor circuit and the storage tank sensor circuit.

## 3.3 FIELD TRAINING

Provide a field-training course for operating and maintenance staff members after the system is functionally complete. Include in the training a discussion of the system design and layout and demonstrate routine operation, maintenance and troubleshooting procedures.

■ End of Section –