ICC 900/SRCC 300-20xx

Minimum Standards for Solar Thermal Systems
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CHAPTER 1
APPLICATION AND ADMINISTRATION

SECTION 101
GENERAL

101.1 Purpose. This standard sets forth the minimum criteria for the design and installation of solar thermal systems. Furthermore, this standard describes the requirements and methodology for standardized solar thermal system design evaluation, including the analytical evaluation of its components. Resulting data serves as the basis for comparing solar systems.

SECTION 102
SCOPE

102.1 Scope.

This standard applies to Solar Energy Systems used in applications for heating, cooling and cogeneration; generally referred to as Solar Thermal Systems. It is not intended for utility-scale power generation. The standard does not address the equipment associated with the load that is provided with heated fluid.

104 REFERENCED DOCUMENTS

104.1 Reference documents. The codes and standards referenced in this standard shall be considered part of the requirements of this standard to the prescribed extent of each such reference. Chapter 4 contains a complete list of all referenced standards.
CHAPTER 2 DEFINITIONS

201 GENERAL

201.1 General. For the purpose of this standard, the terms listed in Section 202 have the indicated meaning.

201.2 Undefined terms. The meaning of terms not specifically defined in this document or in referenced standards shall have ordinarily accepted meanings such as the context implies.

201.3 Interchangeability. Words, terms and phrases used in the singular include the plural and the plural the singular.

202 DEFINED TERMS

ACIDIC/CAUSTIC FLUIDS. A fluid is considered to be acidic if its pH is less than 6.7 and caustic if its pH is greater than 7.3.

ACCESS (TO). That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel, door or similar obstruction [see also “Ready access (to)”].

ACTIVE SYSTEM. A solar thermal system utilizing a pump to circulate fluid through any part of the system.

APPROVED. Acceptable to the code official or other authority having jurisdiction.

AUXILIARY HEATING EQUIPMENT. Equipment utilizing energy other than solar to supplement the output provided by the solar energy system.

BACKFLOW. The flow of water or other liquids, mixtures or substances into the distribution pipes of a potable water supply from any source except the intended source.

CONTROLLER. Any device or part thereof which regulates the operation of the solar water heating system.

DESIGN LIFE. The intended useful operation life of the system as defined by the Supplier.

DESIGN MAXIMUM NO-FLOW TEMPERATURE.

DOUBLE WALL HEAT EXCHANGER. A heat exchanger design in which a single failure of any fluid barrier will not cause a cross connection or permit backflow of heat transfer fluid between two separate fluid systems.
DRAIN-BACK. Refers to systems in which the fluid in the solar collector loop is drained from the collector into a holding tank under prescribed circumstances.

DRAIN-DOWN. Refers to systems in which the fluid in the solar collector is drained from the system under prescribed circumstances.

DRAINAGE SLOPE. The designed continuous downward slope of installed piping or other components toward drain points.

FOOD GRADE. A fluid that contains only non-toxic components listed in Code of Federal Regulations, Title 21, Food and Drugs; Chapter 1, Food and Drug Administration; Part 182, Substances Generally Recognized as Safe; Part 184, Direct Food Substances Affirmed as Generally Recognized As Safe (GRAS).

HEAT EXCHANGER. A device that transfers heat from one medium to another.

INDIRECT. Refers to systems in which the fluid in the solar collector loop circulates between the solar collector(s) and a heat exchanger and is not drained from the system, nor is it supplied to the load, during normal operation.

INDOOR TANK. A tank which is not directly exposed to weather conditions.

IN-SERVICE CONDITIONS. The conditions to which a solar thermal system and its components will be exposed.

LABELED. Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

LISTED. Equipment, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

MANUAL. The total documentation package provided by the supplier to the purchaser which describes the general operation and maintenance procedures of the system.

NO-FLOW CONDITION. Condition where thermal energy is not transferred from the collector by means of fluid flow heat transfer.

NON-FOOD GRADE. A fluid that contains components that are not listed in the Code of Federal Regulations, Title 21, Food and Drugs; Chapter 1, Food and Drug Administration; Part 182, Substances Generally Recognized as Safe; Part 184, Direct Food Substances Affirmed as Generally Recognized As Safe (GRAS).
NONPOTABLE WATER. Water not safe for drinking, personal or culinary utilization.

NON-TOXIC FLUIDS. Fluids, and additives to the heat transfer fluid, which are listed in the Code of Federal Regulations, Title 21, Food and Drugs; Chapter 1, Food and Drug Administration; Part 182, Substances Generally Recognized as Safe; Part 184, Direct Food Substances Affirmed as Generally Recognized As Safe (GRAS).

POTABLE WATER. Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming to the bacteriological and chemical quality requirements of the Public Health Service Drinking Water Standards or the regulations of the public health authority having jurisdiction.

READY ACCESS (TO). That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction [see “Access (to)”].

SOLAR COLLECTOR LOOP. The portion of the solar system which transports the heat transfer fluid in form of heated gas or liquid through the collector.

SOLAR THERMAL SYSTEM. A system that converts solar radiation to thermal energy for use in heating or cooling.

SOLAR WATER HEATING SYSTEM (SWH). A solar thermal system that provides residential water heating, process heating for commercial/industrial processes, or cooling for residential and commercial buildings.

SUBSYSTEM. A separable, functional assembly of components.

SUPPLEMENTAL HEATING EQUIPMENT. Equipment utilizing energy other than solar to supplement the output provided by the solar energy system.

THIRD-PARTY TESTED. Procedure by which an approved testing laboratory provides documentation that a product, material or system conforms to specified requirements.

TOXIC FLUIDS. Fluids which are poisonous or irritating in nature or composition.

WATER HAMMER. Pressure surge that occurs when water flow is suddenly stopped in a water supply system.
CHAPTER 3 SYSTEM REQUIREMENTS

301 OVERALL SYSTEM DESIGN CRITERIA

301.1 Overall system design. The overall system design criteria of the SWH system shall comply with Sections 301.1.1 through 301.1.11.

301.1.1 Operating limits. Means shall be provided to protect the SWH system within the design limits of temperature and pressure as specified by the manufacturer.

301.1.2 Solar system isolation. Isolation valves shall be provided with ready access and installed to allow the solar storage tank to be bypassed in the case of a two-tank system, or to shut off the cold water supply to the solar tank in a one-tank system. The normal operating position shall be marked on a label affixed to the isolation valve.

301.1.3 Thermal expansion. The system design, components and subassemblies shall include adequate provisions for the thermal contraction and expansion of heat transfer fluids, thermal storage fluids and system components that will occur over the manufacturer(s) specified design temperature range.

301.1.4 Auxiliary water heating equipment. A backup system shall be provided such that the combined system will provide the same degree of reliability and performance as a conventional system. Auxiliary (non-solar) water heating equipment shall be compatible with the solar system heat output, temperatures, flow rates and fluid types. Auxiliary equipment shall be listed and labeled by a recognized third party listing agency.

301.1.5 Thermosiphon prevention. Means shall be provided to prevent undesired escape of thermal energy from storage through thermosyphoning action.

301.1.6 Fluid system sizing. Pumps, piping, fans, ducts and other components shall be sized to carry the heat transfer fluid at design flow rates without significant operational impairment, erosion or corrosion.

This standard shall be applied for residential ratings using a 4.9 meter (16 ft.) head and 7.6 meter (25 ft) pipe runs to and from the collector array.

301.1.7 Pressure drop and vibration. The maximum pressure drop and vibrations of solar thermal systems shall be limited to levels not to exceed the manufacturer’s design specifications or adversely impact system performance and longevity.

301.1.8 Vacuum-induced pressure protection. All components of the solar energy system shall be protected against the maximum vacuum which could occur within the system.

301.1.9 Thermal shock protection. The system shall be able to withstand any thermal shock caused by a loss of sufficient heat transfer.
301.1.10 **Protection from ultraviolet radiation.** Ultraviolet radiation shall not significantly alter the performance of any component or subcomponent of the system.

301.1.11 **Airborne pollutants.** Solar components and materials that are exposed to airborne pollutants such as ozone, salt spray, \( \text{SO}_2 \) or \( \text{NO}_x \) shall not be adversely affected by these factors to the extent that their function will be significantly impaired during their design life.

301.2 **Collector design criteria.** Collectors shall comply with Sections 301.2.1 through 301.2.2.

301.2.1 **Collectors.** The collector component(s) shall be listed and labeled with relevant sections of ICC 901/SRCC 100.

301.2.2 **Collector circulation control.** The collector subsystem control shall be designed to be compatible with control requirements of the system.

301.3 **Water heating equipment and hot water storage tanks.** Water heating equipment and storage tanks shall comply with Sections 301.3.1 through 301.3.3.

301.3.1 **General.** All hot water storage tanks and water heating equipment shall comply with the requirements of this section. Tanks that are not separable from the collector shall also comply with ICC 901/SRCC 100.

301.3.1.1 **Insulation.** Hot water storage tanks shall be insulated to a minimum of \( R-12.5 \ (h \cdot \text{ft}^2 \cdot ^\circ \text{F})/\text{Btu} \ (R-2.2\text{m}^2 \cdot \text{K}/\text{W}) \).

301.3.1.2 **Protection from damage.** Hot water storage tanks and water heating equipment shall not be installed in a location where subject to mechanical damage unless protected by approved barriers.

301.3.1.3 **Non-pressurized tank venting.** Non-pressurized tanks shall be vented to atmospheric pressure.

301.3.1.4 **Outdoor installation.** Tanks and outdoor heating equipment installed in other than indoor locations shall be designed for outdoor installation. Separable tanks shall comply with 301.3.1.4.1.

301.3.1.4.1 **Exposure test procedure.** During these tests, if solar collectors are intended to be connected to the tank (e.g., as in a thermosiphon system), the solar collector(s) shall be installed in accordance with the system manufacturer’s normal installation procedures. Following the tests specified above, if solar collectors are intended to be connected to the tank, the tank and the collectors shall be filled with the heat transfer fluid(s) specified in the installation manual and allowed to operate as they would in a typical installation while being exposed to one of these conditions:

- Outdoors: one day with the daily clearness index \( (K_t) \) is equal to or greater than 0.7, where:
- Under a solar simulator: eight hours with the irradiance greater than 800 W/m$^2$ and the ambient air temperature greater than 25°C.

After all of these tests have been completed, there shall be no severe deformation of any of the tank components or excessive retention of water anywhere inside the tank jacket.

### 301.3.1.5 Pressurized hot water tanks.**

Pressurized hot water tanks shall comply with ASME Boiler and Pressure Vessel Code, Division 1, Section VIII, “Rules for Construction of Pressure Vessels”

Exceptions:

2. Fiber-reinforced plastic pressure vessels shall comply with ASME Boiler and Pressure Vessel Code, Section X, unless they fall into one of the classes of vessels exempted in Part RG-121.

### 301.3.2 Water heating equipment.

Electric water heaters shall be listed and labeled to UL 174 or UL 1453. Oil-fired water heaters shall be listed and labeled to UL 732. Solid-fuel-fired water heaters shall be listed and labeled to UL 2523. Gas water heaters shall comply with ANSI Z21.10.1/CSA 4.1 or ANSI Z21.10.3/CSA 4.3.

### 301.3.3 Waterproofing.

Underground and above ground unsheltered storage tanks shall be waterproofed to prevent water seepage.

### 301.3 Expansion tank(s) design criteria.

The expansion tank in a collector loop shall be sized to allow for adequate compensation of pressure and volume increase due to accumulation of thermal energy in the form of heat during operating conditions in accordance with Section 301.3.1. Operating conditions include stagnation under no flow conditions at the solar collector.

#### 301.3.1 Expansion tank sizing.

The required expansion tank volume shall be established using the following conditions:

a) Total system volume shall be calculated for as-built conditions.
b) Calculation of total collector volume that can evaporate and turn to steam, including associated piping experiencing similar conditions for the heat transfer fluid contained therein.

c) Static pressure height calculated from the highest point in the collector loop to the location of the pressure relief device. Typically the highest point will experience the hottest temperature in a collector loop.

d) An additional 10% safety factor shall be used.

e) If the calculated size is greater than a readily available expansion tank the next greater size shall be specified.

301.3.2 Tank components. The tank components shall be compatible with the heat transfer fluid, rated for the fluid temperature and pressure at design conditions, and sized for all conditions the system could experience.

301.4 Heat exchanger design criteria. Heat exchangers shall comply with Sections 301.4.1 through 301.4.2.

301.4.1 Double-wall heat exchangers. Double wall heat exchangers shall be required. Double wall heat exchanger design shall be such that any failure of a barrier material shall allow the discharge of exchanger fluid and/or potable water to the atmosphere. The discharge shall be readily observable and in accordance with Section 304.1.3.

Exception. Single wall heat exchangers shall be permitted when in compliance with both of the following:

1. The heat transfer fluid is taken from a potable water source or is distilled water suitable for domestic use. Any additives used within heat transfer fluid shall be third-party tested in accordance with the Code of Federal Regulations, Title 21, Food and Drugs, Chapter 1, Food and Drug Administration, Part 182, “Substances Generally Recognized as Safe,” Part 184, “Direct Food Substances Affirmed as Generally Recognized as Safe.”

2. The maximum operating pressure of the non-potable heat transfer fluid within the heat exchanger shall be less than the normal minimum operating pressure of the potable water system.

301.4.2 Shutoff valves. Shutoff valves shall be installed on the supply and return side of a heat exchanger.

Exception: Shutoff valves shall not be required when heat exchangers are integral with water heating equipment; or are a component of a manufacturer’s water heating equipment and heat exchanger packaged unit and are capable of being isolated from the solar thermal system by the supply and return valves required by Section 301.5.2.
301.5 Control system design criteria. Control systems shall comply with Sections 301.5.1 through 301.5.5.

301.5.1 General. The control subsystem shall facilitate installation, startup, operation, shutdown and maintenance of the system. Sensors, if used, shall be installed in accordance with the control subsystem design. The control subsystem shall include provisions for bypass, adjustment or override controls as established in a design evaluation in accordance with the requirements set forth in this standard. Safety controls shall not have provision for bypass or override. All switches and their function shall be labeled and easily accessible.

301.5.2 Wiring identification and temperature rating. Control circuit wiring, terminals, and temperature ratings shall be identified in accordance with the NFPA 70.

301.5.3 Degradation. All wires and connections, sensors, pneumatic lines, hydraulic lines or other means for transmitting sensor outputs to control devices shall be sufficiently protected from degradation or from introducing false signals as a result of environmental or system operating conditions.

301.5.4 Temperature control. Where hot water is supplied to the potable hot water distribution system a master thermostatic mixing valve complying with ASSE 1017. shall be provided as equipped with a means for automatically limiting the temperature of the hot water at the outlet of the water heating system to a selectable temperature. The range of selectability shall be at least 10°C (18°F) and the valve shall achieve a set point of 48.9°C (120°F).

   Exception: The control shall be placed downstream of the solar storage tank for auxiliary systems not fully compatible with solar storage temperatures.

301.6 Plumbing and piping design criteria. Plumbing and piping shall comply with Sections 301.6.1 through 301.6.7.

301.6.1 Protection from ultraviolet radiation. Ultraviolet radiation shall not significantly alter the performance of any component or subcomponent of the system. All exterior piping insulation shall be protected from ultraviolet radiation and moisture damage.

301.6.2 Potable piping materials and standards. Water distribution pipe shall conform to NSF 61 and shall conform to one of the standards listed in Table 301.5.2. Hot water distribution pipe and tubing shall have a pressure rating of not less than 100 psi (690 kPa) at 180°F (82°C).

301.6.3 Non-potable piping materials standards. Non-potable pipe shall conform to the standards listed in Table 301.5.3. The exterior of the pipe shall be protected from corrosion and degradation.
### TABLE 301.6.2
POTABLE WATER PIPE

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass pipe</td>
<td>ASTM B 43</td>
</tr>
<tr>
<td>Chlorinated polyvinyl chloride (CPVC) plastic</td>
<td>ASTM D 2846; ASTM F 441; ASTM F 442; CSA C115/A21.15</td>
</tr>
<tr>
<td>Copper or copper-alloy pipe</td>
<td>ASTM B 42; ASTM B 302</td>
</tr>
<tr>
<td>Copper or copper-alloy tubing (Type K, WK, or M)</td>
<td>ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 302</td>
</tr>
<tr>
<td>Cross-linked polyethylene (PEX) plastic</td>
<td>ASTM F 876; ASTM F 877; CSA B137.5</td>
</tr>
<tr>
<td>Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pipe</td>
<td>ASTM F 1281; ASTM F 2262; CSA B137.10M</td>
</tr>
<tr>
<td>Cross-linked polyethylene/aluminum/high-density polyethylene</td>
<td>ASTM F 1986</td>
</tr>
<tr>
<td>Ductile iron pipe</td>
<td>AWWA C151/A21.51; AWWA C115/A21.15</td>
</tr>
<tr>
<td>Galvanized steel pipe</td>
<td>ASTM A 53</td>
</tr>
<tr>
<td>Polyethylene/aluminum/polyethylene (PE-AL-PE)</td>
<td>ASTM F 1282</td>
</tr>
<tr>
<td>Polyethylene of raised temperature (PE-RT)</td>
<td>ASTM F 2769</td>
</tr>
<tr>
<td>Polypropylene (PP) plastic pipe or tubing</td>
<td>ASTM F 2389; CSA B137.11</td>
</tr>
<tr>
<td>Stainless steel pipe (Type 304/304L)</td>
<td>ASTM A 312; ASTM A 778</td>
</tr>
<tr>
<td>Stainless steel pipe (Type 316/316L)</td>
<td>ASTM A 312; ASTM A 778</td>
</tr>
</tbody>
</table>

### TABLE 301.6.3
NON-POTABLE WATER PIPE

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile butadiene styrene (ABS) plastic</td>
<td>ASTM D 1527; ASTM D 2282</td>
</tr>
<tr>
<td>Brass pipe</td>
<td>ASTM B 43</td>
</tr>
<tr>
<td>Brass tubing</td>
<td>ASTM B 135</td>
</tr>
<tr>
<td>Copper or copper-alloy pipe</td>
<td>ASTM B 42; ASTM B 302</td>
</tr>
<tr>
<td>Copper or copper-alloy tubing (Type K, L or M)</td>
<td>ASTM B 75; ASTM B 88; ASTM B 251</td>
</tr>
<tr>
<td>Chlorinated polyvinyl chloride (CPVC) plastic</td>
<td>ASTM D 2846; ASTM F 441; ASTM F 442</td>
</tr>
<tr>
<td>Cross-linked polyethylene/aluminum/cross-linked polyethylene (PE-AL-PEX) pipe</td>
<td>ASTM F 1281; CSA CAN/CSA-B-137.10</td>
</tr>
<tr>
<td>Cross-linked polyethylene (PEX) tubing</td>
<td>ASTM F 876; ASTM F 877</td>
</tr>
<tr>
<td>Ductile iron pipe</td>
<td>AWWA C151/A21.51; AWWA C115/A21.15</td>
</tr>
<tr>
<td>Lead pipe</td>
<td>FS WW-P-325B</td>
</tr>
<tr>
<td>Polybutylene (PB) plastic pipe and tubing</td>
<td>ASTM D 3309</td>
</tr>
<tr>
<td>Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe</td>
<td>ASTM F 1282; CSA B137.9</td>
</tr>
</tbody>
</table>
301.6.4 Potable pipe fittings. Pipe fittings shall be approved for installation with the piping materials to be installed, and shall conform to the respective pipe standards or to the standards listed in Table 301.6.4.

301.6.5 Non-potable pipe fittings. Pipe fittings shall be approved for installation with the piping materials to be installed, and shall conform to the respective pipe standards or to the standards listed in Table 301.6.5.

### TABLE 301.6.4
POTABLE PIPE FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile butadiene styrene (ABS) plastic</td>
<td>ASTM D 2468</td>
</tr>
<tr>
<td>Cast-iron</td>
<td>ASME B16.4; ASME B16.12</td>
</tr>
<tr>
<td>Chlorinated polyvinyl chloride (CPVC) plastic</td>
<td>ASSE 1061; ASTM D 2846; ASTM F 437; ASTM F 438; ASTM F 1986</td>
</tr>
<tr>
<td>Copper or copper alloy</td>
<td>ASSE 1061; ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASTM F 1986</td>
</tr>
<tr>
<td>Cross-linked polyethylene/aluminum/high-density polyethylene</td>
<td></td>
</tr>
<tr>
<td>Fittings for cross-linked polyethylene (PEX) plastic tubing</td>
<td>ASSE 1061, ASTM F 877; ASTM F 1807; ASTM F 1960; ASTM F 2080; ASTM F 2098; ASTM F 2159; ASTM F 2434; ASTM F 2735; CSA B137.5</td>
</tr>
<tr>
<td>Fittings for polyethylene of raised temperature (PE-RT) plastic tubing</td>
<td>ASTM F 1807; ASTM F 2098; ASTM F 2159; ASTM F 2735</td>
</tr>
<tr>
<td>Gray iron and ductile iron</td>
<td>AWWA C110/A21.10; AWWA C153/A21.53</td>
</tr>
<tr>
<td>Insert fittings for polyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PE)</td>
<td>ASTM F 1974; ASTM F 1281; ASTM F 1282; CSA B137.9; CSA B137.10M</td>
</tr>
<tr>
<td>Malleable iron</td>
<td>ASME B16.3</td>
</tr>
</tbody>
</table>
Metal (brass) insert fittings for polyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PE) | ASTM F 1974

<table>
<thead>
<tr>
<th>Material</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (PE) plastic pipe</td>
<td>ASTM D 2609; ASTM D 2683; ASTM D 3261; ASTM F 1055; CSA B137.1</td>
</tr>
<tr>
<td>Polypropylene (PP) plastic pipe or tubing</td>
<td>ASTM F 2389; CSA B137.11</td>
</tr>
<tr>
<td>Polyvinyl chloride (PVC) plastic</td>
<td>ASTM D 2464; ASTM D 2466; ASTM D 2467; CSA B137.2; CSA B137.3</td>
</tr>
<tr>
<td>Stainless steel (Type 304/304L)</td>
<td>ASTM A 312; ASTM A 778</td>
</tr>
<tr>
<td>Stainless steel (Type 316/316L)</td>
<td>ASTM A 312; ASTM A 778</td>
</tr>
<tr>
<td>Steel</td>
<td>ASME B16.9; ASME B16.11; ASME B16.28</td>
</tr>
</tbody>
</table>

**TABLE 301.6.5**

**NON-POTABLE PIPE FITTINGS**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass</td>
<td>ASTM F 1974</td>
</tr>
<tr>
<td>Bronze</td>
<td>ASME B16.24</td>
</tr>
<tr>
<td>Copper and copper alloys</td>
<td>ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASME B16.29</td>
</tr>
<tr>
<td>Ductile iron and gray iron</td>
<td>ANSI/AWWA C110/A21.10</td>
</tr>
<tr>
<td>Ductile iron</td>
<td>ANSI/AWWA C153/A21.53</td>
</tr>
<tr>
<td>Gray iron</td>
<td>ASTM A 126</td>
</tr>
<tr>
<td>Malleable iron</td>
<td>ASME B16.3</td>
</tr>
<tr>
<td>PEX fittings</td>
<td>ASTM F 877; ASTM F 1807; ASTM F 2159</td>
</tr>
<tr>
<td>Plastic</td>
<td>ASTM D 2466; ASTM D 2467; ASTM D 2468; ASTM F 438; ASTM F 439; ASTM F 877; ASTM F 2389; ASTM F 2735</td>
</tr>
<tr>
<td>Steel</td>
<td>ASME B16.5; ASME B16.9; ASME B16.11; ASME B16.28; ASTM A 420</td>
</tr>
</tbody>
</table>

**301.7.7 Joints and Connections**

**Approval.** Joints and connections shall be of an approved type. Joints and connections shall be tight for the pressure of the hydronic system.

**Joints.** Joints between different materials. Joints between different piping materials shall be made with approved adapter fittings.
301.6.7 Protection from foreign substances. The solar collector loop shall be protected to prevent contamination by foreign substances that could impair the flow and quality of the heat transfer fluid beyond acceptable limits.

301.6.8 Insulation. All interconnecting hot water piping and the final 1.5 meters (5.0 feet) of metallic cold water supply pipe leading to the system, or the length of piping which is accessible if less than 1.5 meters, shall be insulated with R-0.46 °K m²/W (R-2.6 °F·ft²·hr/ Btu) or greater insulation.

All exterior piping insulation shall be protected from ultraviolet radiation and moisture damage.

301.6.9 Water shut-off. The solar thermal system shall have valves to provide for shut-off from the service water supply without interrupting normal cold water service to the remaining portion of the water distribution system.

301.6.10 Service connections. Suitable connections shall be provided with access for filling, draining and flushing liquid systems. Such connections shall be provided

301.6.11 Filters. When filters are used in the solar water heating system, they shall be designed with access so that they can be cleaned or replaced with minimum disruption to the system and adjacent equipment. The maintenance instructions shall be provided in the applicable installation, operation or maintenance section of the system manual provided by the manufacturer.

301.6.12 Coupling hoses. Coupling hoses containing rubber shall be listed and labeled to ASTM D750, ASTM D471, and ASTM D1149.

301.6.13 Piping systems. The piping system shall be provided with isolation valves which can be closed for the purpose of bypassing the solar hot water supply system thereby permitting operation of the auxiliary water heater when the solar hot water system is inoperative or being serviced.

302

RELIABILITY AND DURABILITY

302.1 General. SWH systems shall comply with Sections 302.1.1 through 302.1.13.

302.1.1 Stagnation. The system shall be able to withstand prolonged periods of stagnation (high solar flux, no hot water demand) without degradation of performance and with no maintenance. This includes conditions during loss of electric power to the system.

302.1.2 Solar degradation. Components or materials exposed to sunlight shall not be affected by exposure to sunlight to an extent that will significantly deteriorate their function during their design life.
302.1.3 Operation conditions. Collectors, tanks, pumps, valves, regulating orifices, pressure regulators, heat exchangers, piping, hoses and other components shall be capable of operating within manufacturer(s) specified design pressure and temperature ranges and withstanding environmental extremes anticipated in actual service without significantly reducing system design life.

302.1.4 Incompatible materials. Incompatible materials shall be isolated or treated to prevent degradation to the extent that their function could be significantly impaired under in-service conditions.

302.1.5 Freeze protection. Protection from freeze damage under the most severe environmental conditions that can be expected in actual use shall be provided for all system components containing heat transfer liquids. The Supplier of each system shall specify the limit ("Freeze Tolerance Limit") to the system’s tolerance of freezing weather conditions. Systems installed in a location which has no record of an ambient air temperature below 5°C (41°F) shall be exempted from the requirements of this paragraph except the specification of a freeze tolerance limit.

For systems that rely on manual intervention for freeze protection, the Supplier shall specify the system’s freeze tolerance limit based on exposure for 18 hours to a constant atmospheric temperature. The Certification Body will evaluate the system design to determine the reasonableness of the specified limit.

For solar systems where the collector fluid is water, a minimum of two freeze protection mechanisms shall be provided on each system. Manual intervention (draining, changing valve positions, etc.) is suitable as one mechanism. At least one freeze protection mechanism, in addition to manual intervention, shall be designed to protect components from freeze damage, even in the event of power failure. The thermal mass of a system can be considered to be a limited form of freeze protection.

A system in which components and/or piping are subject to damage by freezing shall have the proper fittings, pipe slope and collector design to allow for manual gravity draining and air filling of the affected components and piping. Pipe slope for gravity draining shall have a minimum 2 cm vertical drop for each meter of horizontal length (1/4 inch per foot). This also applies to any header pipes or absorber plate riser tubes internal to the collector.

At the time of installation, a conspicuously placed label shall be attached to the system explaining how the system is protected from freezing and what actions are required by the homeowner to prevent freeze damage, and further leakage if rupture occurs. For systems which rely on manual intervention for freeze protection, this label shall indicate the minimum ambient temperature conditions (Freeze Tolerance Limit) below which owner actions are required and the procedure to be followed.

302.1.6 Protection from leaks. All piping in a solar water heating system shall pass a leak test in accordance with code requirements and local authorities having jurisdiction.

302.1.7 Fluid compatibility. Fluids in contact with SWH system materials shall not corrode or otherwise adversely affect system materials to the extent that their function will be significantly impaired during the design life.
302.1.8 Deterioration of fluids. Except when allowed by the system design, fluids shall not freeze, give rise to excessive precipitation or otherwise lose their homogeneity, boil or develop excessive vapor pressure, change absorptivity, or change pH, viscosity or thermal properties beyond design ranges when exposed to their maximum and minimum service temperatures and pressures during their design life.

302.1.9 Thermal storage system. Materials comprising the thermal storage system shall not cause corrosive wear which would result in premature failure or degradation in performance greater than that specified within the system.

302.1.10 Buried components. Solar components and materials that are intended to be buried in soils shall be protected from degradation under in-service conditions to insure that their function shall not be impaired.

302.1.11 Deterioration protection. Gaskets, sealants, and coupling hoses shall not be adversely affected by contact with fluids or the environment to an extent that will significantly impair their ability to function. See Section 301.5.6.

302.1.12 Water hammer. When a liquid is used as the transfer fluid and quick-closing valves are employed in the design, the piping system shall be able to control or withstand the effects of water hammer.

302.1.13 Sound and vibration control. Piping and associated fittings shall be designed to carry the heat transfer fluid at design flow rates without vibrations which could induce mechanical stress levels high enough to cause damage.

Pumps and compressors, or other components involving moving parts, shall be balanced or mounted in such a manner that they do not induce vibration that could cause damage.

303
SAFETY CRITERIA

303.1 General. SWH systems shall comply with Sections 303.1.1 through 303.1.13.

303.1.1 Protection of electrical components. Overload and overcurrent protection of electrically operated components shall be consistent with the maximum current rating of the device and NFPA 70.

303.1.2 System failure prevention. The system shall be so designed that, in the event of a power failure or a failure of any of the system components, the temperatures or pressures developed in the SWH system shall not damage the system, or the building, or endanger its occupants.

303.1.3 High temperature control. Means shall be provided to limit temperatures to a value not to exceed all component suppliers’ specified high temperature limits. The pressure/temperature relief valve shall not be used for this purpose under normal operating conditions.
303.1.4 **Protection against auto-ignition of combustibles.** Combustible materials used in solar equipment shall not be exposed to elevated temperatures which could cause ignition.

303.1.5 **Fluid safety labeling.** Labels shall mark all drain and fill valves in the SWH system. Each label shall identify the fluid in that loop. The location of fluid handling instructions shall be referenced. The label shall list the heat exchanger type as defined here:

- Single wall with no leak protection (SW): A heat exchanger that provides single-wall separation between the potable water and the heat transfer fluid.
- Double wall with no leak protection (DW): A heat exchanger that has two separate, distinct walls separating the potable water and the heat transfer fluid.
- Double wall with leak protection (DWP): A heat exchanger that has two separate, distinct walls separating the potable water and the heat transfer fluid, plus a pathway to the outside of the heat exchanger such that fluid leaking through either wall will be visible.

and the heat transfer fluid class as defined in section 202:

- Potable water (PW).
- Food grade (FG)
- Non-food grade (NFG)
- Toxic (T)

The label shall include the following warning:

“Fluid could be discharged at high temperature and/or pressure. No other fluid shall be used that would change the original classification of this system. Unauthorized alterations to this system could result in a hazardous health condition.”

303.1.6 **Containment of potable water.** Materials which come in direct contact with potable water shall not adversely affect the taste, odor or physical quality and appearance of the water and shall conform to NSF 61 and NSF 372.

303.1.7 **Entrapped air.** Suitable means for air or gas removal from all high points in the piping system and any other location where air is most likely to accumulate shall be provided. The method of removal shall be appropriate for the system type as follows:

Automatic for open loop (direct) circulating systems using potable water as the heat transfer fluid,
Manual or automatic for closed loop (indirect) systems,
Not required for integral collector storage (ICS) and direct thermosiphon systems.
303.1.8 Backflow. Means shall be provided to prevent backflow of non-potable fluids, solids or gases into the potable water system.

303.1.9 Toxicity. The use of toxic fluids shall comply with the Federal Hazardous Substances Act, Title 15, or its equivalent, and the requirements of the health authority having jurisdiction.

303.1.10 Combustible liquids. The storage, piping and handling of combustible liquids shall conform to the requirements of the NFPA 30.

303.1.11 Liquid flash point. The flash point of a heat transfer fluid shall exceed by 28°C (50°F), or more, the design maximum no-flow temperature to be reached by the fluid in the collector. The flash point shall be determined by the methods described in NFPA 30. In systems using a gaseous heat transfer fluid; a flammable gas shall not be used.

303.1.12 Pressure relief. Each portion of the system where excessive pressures can develop shall be protected by a pressure relief device. No means of rendering a pressure relief device ineffective shall be allowed under this standard, specifically to ensure that no section can be valved off or otherwise isolated from a pressure relief device. Automatic pressure relief devices shall be designed to open at not more than maximum design pressure of the system device having the lowest pressure rating.

303.1.13 Heated components. System subassemblies which are exposed to public traffic and are maintained at elevated temperatures shall either be insulated sufficiently to keep exposed surface temperatures below 60°C (140°F) during operation, or they shall be suitably isolated. Any other exposed areas that are maintained at hazardous temperatures shall be identified with appropriate warnings.

304
OPERATION AND SERVICING CRITERIA

304.1 General. SWH systems shall comply with Sections 304.1.1 through 304.1.6.

304.1.1 Operating indicators. The solar thermal systems shall include means for an observer to determine readily that the system is operating properly and providing solar heated water.

304.1.2 Tanks. Tanks shall be used within the temperature limitations established by the tank supplier. Tanks shall be labeled to show the maximum operating pressure and temperature.

304.1.3 Waste disposal. Systems utilizing a toxic heat transfer fluid or thermal storage fluid shall provide for the catchments and harmless removal of these fluids from vents where fluid is automatically discharged.

304.1.4 Dirt retention and staining. Solar systems and collectors shall be accessible for periodic cleaning if conditions are such that self-cleaning by rain is not sufficient to keep the collectors operating efficiently.
304.1.5 Maintenance and servicing. All individual components of the system which require periodic examination, adjustment, service and/or maintenance shall be easily and safely accessible by the owner and in accordance with the codes in force at the installation site.

304.1.6 Permanent maintenance accessories. Permanent maintenance accessories such as hose bibs and drains necessary for maintenance of the system shall be provided.

305
INSTALLATION CRITERIA

305.1 General. Solar thermal systems shall comply with Sections 305.1.1 through 305.1.19.

305.1.1 Firestopping. The solar thermal system components shall be assembled such that firestopping shall be possible at time of installation, if required by local codes and ordinances.

305.1.2 Auxiliary system. Interconnection of the auxiliary system to the solar energy system shall be made in a manner which will not result in excessive temperature or pressure in the auxiliary system or bypassing of safety devices of the auxiliary system.

305.1.3 Space use. The location of components used in the solar water heating system design shall allow for the fulfillment of the requirements stated in 6.1.5.2 in regards to facilitating installation, startup, operation, shutdown and maintenance of the system.

Components of a solar water heating system that during operating conditions will cause effects to increase or reduce humidity, temperature or thermal radiation beyond acceptable levels to building materials shall be identified in the installation, operation and maintenance manuals with proper specifications as to clearance requirements to prevent of such effects.

305.1.4 Access. The location of the solar components shall not impair accessibility needed to maintain the building or site.

305.1.5 Building penetrations. Penetrations of the building through which piping or wiring is passed shall not reduce or impair the function of the enclosure. Penetrations through walls or other surfaces shall not allow intrusion by insects and/or vermin. Required roof penetrations shall be made in accordance with applicable codes and also by practices recommended by the National Roofing Contractors Association.
305.1.6 Water damage. Collectors and support shall be installed in such a manner that water flowing off the collector surface will not damage the building or cause premature erosion of the roof. Water tanks located in or above the living space shall be installed on a drip pan with a drain line to a waste line or outside or have other means to safely remove any excess liquid. 305.1.6.1 Required pan. Where a storage tank-type water heater or a hot water storage tank is installed in a location where water leakage from the tank will cause damage, the tank shall be installed in a galvanized steel pan having a material thickness of not less than 0.0236 inch (0.6010mm) (No. 24 gage), or other pans approved for such use.

305.1.6.2 Pan size and drain. The pan shall be not less than 11/2 inches (38 mm) in depth and shall be of sufficient size and shape to receive all dripping or condensate from the tank or water heater. The pan shall be drained by an indirect waste pipe having a diameter of not less than 3/4 inch (19 mm). Piping for safety pan drains shall be of those materials listed in Table 605.4.

305.1.6.3 Pan drain termination. The pan drain shall extend full-size and terminate over a suitably located indirect waste receptor or floor drain or extend to the exterior of the building and terminate not less than 6 inches (152 mm) and not more than 24 inches (610 mm) above the adjacent ground surface.

1. 305.1.7 Relief valve discharge. The discharge piping serving a pressure relief valve, temperature relief valve or combination thereof shall: Not be directly connected to the drainage system.
2. Discharge through an air gap located in the same room as the water heater.
3. Not be smaller than the diameter of the outlet of the valve served and shall discharge full size to the air gap.
4. Serve a single relief device and shall not connect to piping serving any other relief device or equipment.
5. Discharge to the floor, to the pan serving the water heater or storage tank, to a waste receptor or to the outdoors.
6. Discharge in a manner that does not cause personal injury or structural damage. Safety and relief valves shall not discharge so as to be a hazard, a potential cause of damage or otherwise a nuisance.
7. Discharge to a termination point that is readily observable by the building occupants.
8. Not be trapped.
9. Be installed so as to flow by gravity.
10. Terminate not more than 6 inches (152 mm) above and not less than two times the discharge pipe diameter above the floor or flood level rim of the waste receptor.
11. Not have a threaded connection at the end of such piping.
12. Not have valves or tee fittings.
13. Be constructed of rigid pipe listed in Section 301.6.2 or 301.6.3 or materials tested, rated and approved for such use, the temperature of the system and in accordance with ASME A112.4.1
305.1.8 **Structural supports.** Neither wind loading (including uplift) nor the additional weight of filled collectors and/or tanks shall exceed the live or dead load ratings of the building, roof, roof anchorage, foundation or soil. Collector supports shall not impose undue stresses on the collectors. The design load shall be as specified by the codes in force at the installation site and shall include an additional load due to snow accumulation for applicable locations.

305.1.9 **Expansion and contraction of supports.** Structural supports shall be selected and installed in such a manner that thermal expansion of the collector and piping will not cause damage to the collector structural frame or the building.

305.1.10 **Penetration of structural members.** When penetrations are required in structural members to accompany passage of solar components, those modified structural members shall comply with local building codes.

305.1.11 **Protection from thermal deterioration.** Building materials adjacent to solar equipment shall not be exposed to elevated temperatures which could accelerate their deterioration. Many non-metal roofing materials will soften in the temperature range of 60 - 80°C (140-180°F) and begin to degrade above this temperature.

305.1.12 **Tilt and azimuth.** The collector shall be installed on a mount capable of maintaining tilt and azimuth to design conditions.

305.1.13 **Shading of collector.** The location and orientation of the collector shall be such that it is not shaded by external obstructions or mutual shadowing more than the specified period allowed in the design.

305.1.14 **Pipe and component supports.** Hangers shall provide adequate support and correct pitch of pipes. Hangers or supports for insulated pipes or components shall be designed to avoid compressing or damaging the insulation material. Hangers shall not cause galvanic corrosion between the hanger and the pipe.

305.1.15 **Pitch or angle of piping installation.** When draining is used for freeze protection, solar water heating systems containing liquids shall be drainable. Piping shall be sloped to drain with a drainage slope of no less than 2 cm vertical drop for each meter of horizontal length (1/4 inch per foot).

305.1.16 **Underground piping.** Underground piping material shall conform to sections 301.7.2 or 301.7.3. Underground piping subject to vehicular traffic shall be installed to withstand the additional loading applied by this traffic. The trenches and backfill shall be free of sharp objects in contact with the pipe.

305.1.17 **Control sensor installation.** Control sensors and the means for transmitting sensor outputs to control devices shall be protected from environmental influence such as wind, moisture, temperature, ultraviolet radiation, or other factors which may alter their actual reading.

305.1.18 **Penetrations through fire-resistance-rated assemblies.** Penetrations through fire-rated assemblies etc. shall not reduce the building's fire resistance required by local codes, ordinances and applicable standards.
305.1.19 Emergency egress and access. The design and installation of systems shall not impair emergency movement of the building occupants.

305.1.20 Rain and snow on collector. The location, orientation, and position of the collector relative to nearby objects and surfaces shall be such that water run-off from the collector surface is not impeded nor is excessive build-up of snow on lower portions of the collector glazing permitted to occur.

306
MANUAL CRITERIA

306.1 General. Solar thermal systems shall comply with Sections 306.1.1 through 306.1.8.

306.1.1 Provision for manuals. A manual or manuals shall be provided with each solar thermal system. The manual shall contain the name and address of the system supplier, the system model name or number and shall describe the operation of the system and its components and the procedures for installation, operation and maintenance.

306.1.2 Installation instructions. The manual(s) shall include an explanation of physical and functional requirements of the system and its components and the general procedures for their proper installation. The instructions shall describe the interconnection requirement of the various subsystems and components and their interface requirements with the building and the site. The instructions shall be available at the installation site or from normally accessible sources.

306.1.3 Operation instructions. The manual shall:
- clearly describe the operation of the solar thermal system, explaining the function of each subsystem and component.
- include a system diagram showing the components and their relationships in the typical installed system.
- describe major components in a separate section or by enclosing descriptive material furnished by the supplier of the components.
- describe procedures for system start-up, routine maintenance and special conditional operations such as drain-down.
- specify fill weights, pressure ratings and temperature ratings for servicing and routine maintenance of the system.
- specify temperature, pressure and flow conditions expected at various access points to allow simple operational checks and troubleshooting.
- include instructions for valving off different sections of the system in emergency situations and shall include instructions for leaving the system unattended and unused for long periods of time.
- indicate the minimum ambient temperature above which the system is designed not to be damaged due to freezing (Freeze Tolerance Limit).

- include the statement:

  “Freeze tolerance limits are based upon an assumed set of environmental conditions.”

If the freezing point of the fluid in an exposed part of the system is above the freeze tolerance limit specified for the system, the following statement shall be added to the one above:

  “Extended periods of cold weather, including ambient air temperatures above the specified limit, may cause freezing in exposed parts of the system. It is the owner’s responsibility to protect the system in accordance with the Supplier’s instructions if the air temperature is anticipated to approach the specified freeze tolerance limit.”

306.1.4 Maintenance plan. The manual shall include a comprehensive plan for maintaining the specified performance of the solar thermal system.

The plan shall include a schedule and description of procedures for ordinary and preventive maintenance including cleaning of collector exterior surfaces. The manual shall describe minor repairs and give the projections for equipment replacement.

306.1.5 Fluid quality. The manual shall identify the fluid(s) used in the solar thermal system and state whether or not the fluid(s) are toxic or hazardous. Proper procedures for handling, safe disposal, and first aid shall be provided for each non-water fluid. A technical data sheet shall be provided for each non-water fluid used in the system.

Procedures shall be described for maintaining the heat transfer fluid's chemical composition at levels adequate to prevent unacceptable deposits on the heat transfer surfaces, corrosion of the heat transfer surfaces or loss of freeze resistance. Recommended inspection and test intervals for the heat transfer fluid shall be provided.

306.1.6 Service and replacement parts. The manual shall include a parts list giving a sufficient description of each part for ordering a replacement. Parts, components and equipment required for service, repair or replacement shall be commercially available or available from the system or subsystem supplier.

The manual shall list on the same page of both the installation and operation manuals all options (make and model) for the following components: solar collector, solar storage tank, pump, piping material, controller, heat exchanger, and heat transfer fluid. This page shall also include temperature, pressure, and/or flow conditions expected at system access points to allow simple operational checks.

The manual shall include the name and address of at least one company in close geographic proximity to the purchaser that offers service on the system. An 800 telephone number maintained by the supplier that a consumer can call to get in contact with a local service agent will satisfy this requirement.
306.1.7 Hazards. The manual shall provide warning against health and safety hazards that could arise in the operation and maintenance of the system and shall fully describe the precautions that shall be taken to avoid these hazards. For collector(s) that are not grounded via the plumbing components, a warning label shall be affixed to the system and the manual shall reference NFPA 70 in regards to lightning protection.

306.1.8 Warranty coverage. The manual shall provide a full description of the warranty coverage on the system. In addition, the manual shall describe what actions the purchaser shall undertake to obtain warranty coverage.
CHAPTER 4
REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 104.1.

ANSI Z21.10.1-2004/CSA 4.1-2004 Gas Water Heaters Volume 1, Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less

ANSI Z21.10.3-2004/CSA 4.3-2004 Gas Water Heaters - Volume III, Storage Water Heaters With Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous.

SRCC Standard 100, “Test Methods and Minimum Standards for Certifying Solar Collectors”

HUD Minimum Property Standard 4930.2

ASME Boiler and Pressure Vessel Code, Division 1, Section VIII, “Rules for Construction of Pressure Vessels”

ASME Boiler and Pressure Vessel Code, Section X, “Fiber-Reinforced Plastic Pressure Vessels”

Code of Federal Regulations, Title 21, Food and Drugs, Chapter 1, Food and Drug Administration, Part 182, “Substances Generally Recognized as Safe;” Part 184, “Direct Food Substances Affirmed as Generally Recognized as Safe”

NSF International NSF 61 “Drinking Water System Components – Health Effects”

NSF International NSF 372 “Drinking Water System Components – Lead Content”

Federal Hazardous Substances Act, Title 15


National Roofing Contractors Association

U.S. Department of Energy test for water heaters (Federal Register volume 55 number 201 page 42161 – 42177, October 17, 1990)
GAMA Consumers’ Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment, April 1994 (page 134)

TRNSYS: A Transient System Simulation Program, Solar Energy Laboratory, University of Wisconsin – Madison, Madison, WI, July 1994
Appendix A
METHOD FOR EVALUATING PUMP STATIONS IN SOLAR WATER HEATING SYSTEMS

A101 GENERAL

A101.1 General. The performance of a pump station which is comprised of multiple components can be evaluated separately if the performance of the individual components working together as one is known. The pump station may include but is not limited to the following components: pump, piping and fittings, controller, valves, tank and heat exchanger.

A102 PUMP AND CONTROL DESIGN CRITERIA

A102.1 General. Pumps and controls used with solar thermal systems shall comply with Sections A102.1.1 through A102.1.5.

A102.1.1 Control system override. The pump station control shall include such provision for bypass, adjustment or override controls as are required to facilitate installation, startup, operation, shutdown and maintenance. Safety controls shall not have provision for bypass or override. All switches and their function shall be labeled and easily accessible. The pump station control shall be designed to be compatible with control requirements of the solar thermal system.

A102.1.2 Wiring identification, pumps and electrical components. Control circuit wiring and terminals shall be identified in accordance with Chapter 2 of the National Electrical Code. Pumps and electrical components shall have appropriate approvals from recognized third party listing agencies.

A102.1.3 Control lines and sensors. All wires and connections, sensors, pneumatic lines, hydraulic lines or other means for transmitting sensor outputs to control devices shall be sufficiently protected from degradation or from introducing false signals as a result of environmental or system operating conditions.

A102.1.4 Protection of electrical components. Overload and overcurrent protection of electrically operated components shall be consistent with the maximum current rating of the pump station and with the provisions of Article 240, Chapter 2 of the National Electrical Code.
A102.1.5 Pump station failure prevention. The pump station control shall be so designed that, in the event of a power failure or a failure of any of the station components, the temperatures or pressures developed in the solar thermal system shall not damage the solar thermal system, or the building, or endanger its occupants. Pumps shall be tested in accordance with Sections A102.1.5.1 through A102.1.5.3. The result of this test is “pass” if short circuiting the system or open circuiting of the sensors separately or simultaneously together leaves the system frozen and the overheating protection mechanism operable.

A102.1.5.1 Operating conditions. All pumps, etc. shall be tested under operating conditions for the duration of the test.

A102.1.5.2 Failure mode. Fail the temperature sensors by short circuiting the system and opening the circuit one sensor at a time and then simultaneously together.

A102.1.5.3 Operation verification. Verify the operation state or mode of the station.

A103 PLUMBED COMPONENT DESIGN CRITERIA

A103.1 General. Plumbed components of pump stations used with solar thermal systems shall comply with Sections A103.1.1 through A103.1.6.

A103.1.1 Pipe and fittings. Pipe and fittings shall have appropriate approvals from recognized third party listing agencies.

A103.1.2 Valves. Suitable connections shall be provided at readily accessible locations for filling, draining and flushing liquid systems. Valves which can be closed for the purpose of isolating the solar thermal system shall have appropriate approvals from recognized third party listing agencies.

A103.1.3 Fluid system sizing. Plumbed components shall be sized to carry the heat transfer fluid at design flow rates without significant operational impairment, erosion or corrosion.

In the design of plumbed components pressure drop and vibrations shall be limited to levels not to exceed the manufacturer's design specifications or adversely impact system performance and longevity.

The instantaneous flow rate within the pump station shall not exceed 10% of average flow to maintain the proper design flow rate of the heat transfer fluid through the solar thermal system. Exception is allowed for the higher startup flow rate needed in a drainback system to establish a siphon.
A103.1.4 Contamination of potable water. Components which come in direct contact with potable water shall not adversely affect the taste, odor or physical quality and appearance of the water and shall comply with NSF 61 and NSF 372.

A103.1.5 Compatibility with heat transfer fluids. Components which come in direct contact with the heat transfer fluid shall not be adversely affected by the heat transfer fluid within the operating pressure and temperature ranges.

A103.1.6 Pressure Integrity Test. The pressure integrity test shall comply with Sections A103.1.6.1 through A103.1.6.6. The result of this test is “pass” if no observable pressure change has occurred.

A103.1.6.1 Pressure gauge. A pressure gauge is attached to the exit port of the pump station and the outlet is sealed.

A103.1.6.2 Water fill. The supply side is filled with unheated water.

A103.1.6.3 Test pressure. The test pressure shall be 1110 kPa Gauge (160 PSIG).

A103.1.6.4 Hydraulic pressure. Hydraulic pressure is applied to the inlet port until the gauge indicates the test pressure has been reached.

A103.1.6.5 Pressure monitoring. The inlet pressure port is then closed and the pressure is monitored for 15 minutes.

A103.1.6.6 Final pressure reading. The final pressure is recorded.

A104 TEMPERATURE AND PRESSURE CRITERIA

A104.1 General. Temperature and pressure of pump stations used with solar thermal systems shall comply with Sections A104.1.1 through A104.1.3.

A104.1.1 Temperature control. Where hot water is supplied to the potable hot water distribution system a master thermostatic mixing valve complying with ASSE 1017. shall be provided as equipped with a means for automatically limiting the temperature of the hot water at the outlet of the water heating system to a selectable temperature. The range of selectability shall be at least 10°C (18°F) and the valve shall achieve a set point of 48.9°C (120°F).

Exception: The control shall be placed downstream of the solar storage tank for auxiliary systems not fully compatible with solar storage temperatures.
A104.1.2 Components. Temperature and pressure control valves or devices shall have appropriate approvals from recognized third party listing agencies. Means shall be provided to limit temperatures and pressures to a value not to exceed all component suppliers’ specified high temperature and pressure limits. The pressure/temperature relief valve shall not be used for this purpose under normal operating conditions.

A104.1.3 Temperature limiting system test. Temperature limiting system testing shall comply with Sections A104.1.3.1 through A104.1.3.4. The result of this test is “pass” if the pump station disables any heat input device when the maximum temperature limit is exceeded.

A104.1.3.1 Operating conditions. All pumps, etc. shall be tested under operating conditions for the duration of the test.

A104.1.3.2 Heating source. The pump station shall be connected to a suitable heating source which can supply the target temperature.

A104.1.3.3 Temperature. The heating source output temperature shall be set no less than 5°C (10°F) above the maximum temperature limit specified by Supplier.

A104.1.3.4 Observation. Observe the pump station.

A105 EXPANSION TANK AND HEAT EXCHANGER DESIGN CRITERIA (AS APPLICABLE)

A105.1 General. Expansion tanks and heat exchangers shall be evaluated in accordance with Sections 301.4 and 301.5 of this standard.

These requirements are only required if the expansion tank or heat exchanger have not undergone similar testing by an evaluation authority.

A106 RELIABILITY AND DURABILITY CRITERIA

A106.1 General. The pump station shall be evaluated in accordance with Section 6.2 of this standard as applicable.

Combustible materials used in the pump station shall not be exposed to elevated temperatures which could cause ignition. Such materials not used exterior to a building shall have a flame spread of not more than 25 and a smoke developed rating of not more than 50.
A107 LABELING AND MANUALS (AS APPLICABLE)

A107.1 General. Pump station shall be labeled with the Supplier’s name or trademark, model name and/or number, recommended working fluids, maximum working temperature and pressure and recommended flow rate(s).

All warning lights, switches and controls shall be clearly identified. Where the pump station includes electrical components, the station shall be labeled with the electrical rating in volts, amperes and motor phase.

Any operation, maintenance, and installation instructions manuals from the manufacturer shall be supplied or made available to the public with the pump station. Supplier’s contact information shall be included within these documents.

Potential Topics:
   1. Bonding and grounding
   2. Electrolysis
   3. Wind loading.