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Standard Practice for Installation and Service of Solar Space Heating Systems for One- and Two-Family Dwellings[1]

This standard is issued under the fixed designation E 683; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Keywords were added editorially in October 1995.

1. Scope

1.1 This practice covers solar space heating systems for one- and two-family dwellings. It sets forth acceptable installation and service practices to help ensure adequate performance, safety, and consumer satisfaction.

1.2 This practice is intended to describe acceptable practices for space heating systems in new and existing dwellings and shall not be construed as the optimization of good practices.

1.3 This practice does not apply to Rankine cycle, heat pump, or high pressure vapor systems.

1.4 This practice is not intended to abridge safety or health requirements. All systems shall be installed in accordance with local codes and ordinances.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (For specific safety precautions, see Section 6).

2. Referenced Documents

2.1 *ASTM Standards:*

E 772 Terminology Relating to Solar Energy Conversion[2]

2.2 *ANSI Standards:*[3]

A58.1 Building Code Requirements for Minimum Design Loads in Buildings and Other Structures.

C1 National Electrical Code

Z97.1 Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

2.3 *Other Standards:*

Installation Standards for One- and Two-Family Dwellings and Multi-Family Housing, Including Solar[4]

HUD Intermediate Minimum Property Standards Supplement—Solar Heating and Domestic Hot Water Systems[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *air handling unit*, *n*—a device used for distributing conditioned air supply to a room, space, or area.

3.1.2 *building*, *n*—a structure erected and framed of component structural members designed for the housing, shelter, or support of persons, animals, or property.

3.1.3 *code*, *n*—a set of applicable regulations which a jurisdiction has lawfully adopted.

3.1.4 *collector, solar thermal*, *n*—a device designed to absorb solar irradiance and to transfer the energy to a fluid passing through it. **(E 772)**

3.1.5 *collector subsystem*, *n*—that portion of the solar system which includes the solar collectors and related piping or ducts. **(E 772)**

3.1.6 *distribution subsystem*, *n*—that portion of the solar system from the storage device to the point of ultimate use. **(E 772)**

3.1.7 *energy (heat) transfer fluid*, *n*—the medium used to transfer energy from the solar collectors to the storage medium.

3.1.8 *potable water*, *n*—water that is satisfactory for drinking and culinary purposes, meeting the requirements of the health department having jurisdiction. **(E 772)**

3.1.9 *pressure relief device*, *n*—a pressure-activated valve designed to automatically relieve excessive pressure.

3.1.10 *shall*, *vi—as used in this practice*, a term used to denote a mandatory requirement.

3.1.11 *should*, *vi—as used in this practice*, a term used to denote a recommendation.

3.2 *solar system*, *n*—a configuration of equipment and components used to absorb, convey, store, convert, and distribute the energy from the sun.

4. Collector Subsystems

4.1 Collectors shall be installed in accordance with the instructions provided by the collector manufacturer and designer, in compliance with local codes and ordinances.

[1] This practice is under the jurisdiction of ASTM Committee E-44 on Solar, Geothermal, and Other Alternative Energy Sources, and is the direct responsibility of Subcommittee E44.05 on Solar Heating and Cooling Subsystems and Systems.
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[2] *Annual Book of ASTM Standards*, Vol 12.02.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from Sheet Metal and Air-Conditioning Contractors National Assn., 8224 Old Courthouse Rd., Vienna, VA 22180.

[5] Available from HUD USER, P.O. Box 6091, Rockville, MD 20850.

4.2 Structural supports shall be constructed to support the collector under all anticipated extremes of environmental conditions and to withstand local conditions and anticipated loads, such as wind, earthquake, rain, snow, ice, and freezing temperatures, so that the solar system does not impair the resistivity to damage of the building. Additional weight of collectors shall not exceed dead weight limitations of the building structure, foundation, or soil. Conversely, collector supports shall not impose undue stresses on the collectors.

4.3 Structural supports shall be constructed to maintain collector tilt and orientation within design conditions throughout the life of the solar system.

4.4 Structural supports shall be installed in a manner such that the integrity, weather resistance, and fire resistance of the building are not adversely affected. Joints between support structures and building shall be caulked or flashed, or both, to prevent water leakage. Access shall be provided to permit minor repairs to flashing and caulking without disturbing roof, collector supports, or collector panels.

4.5 Collectors shall be installed so as not to contribute to moisture buildup, rotting, or other accelerated deterioration of roofing materials.

4.6 Collectors and supports shall be installed in a manner such that water flowing off the collector surface will not accumulate on the roof surfaces, so as to form ice dams or cause water damage to the building, or both. Provisions shall be taken to minimize buildup of snow upon collectors, which may reduce their effectiveness.

4.7 Structural supports shall be selected and installed in a manner, such that thermal expansion of collector will not cause damage to the collector, structural frame, or building.

4.8 Pipe hangers, supports, expansion devices, and insulation shall be provided to compensate for thermal expansion effects and to minimize thermal losses. Care shall be exercised during their installation to prevent damage to connections on the collector or collector casing.

4.9 Interconnecting piping or ducting shall be installed to minimize flow restrictions and to provide balanced flow. Piping shall be installed to allow for filling and draining.

4.10 Safe access to components subject to deterioration or failure, such as rubber hoses, joint sealants, and cover plates shall be provided to allow for maintenance or repair. For roof-mounted collectors, the work space adjacent to collectors and provisions for safe placement of ladders shall be considered.

4.11 Safety protection shall be provided to prevent injury to personnel from contact with readily accessible hot surfaces.

4.12 Collectors mounted at ground level shall be provided with protective fencing, guard rails, and warning signs in compliance with local codes and ordinances.

4.13 Protection of collectors and components shall be provided during handling and installation to prevent damage from environmental exposure.

4.14 Glazings of collectors mounted at ground level shall meet the requirements specified in ANSI Z97.1.

4.15 Frames and braces used in collector construction shall be made of materials suitable for exterior location.

4.16 Collectors made of combustible materials shall not be located on or adjacent to construction required to be of noncombustible materials or in special fire zones.

4.17 Collectors should be mounted in a manner so as to take the best advantage of the sun's energy.

5. Thermal Storage Devices

5.1 Thermal storage devices shall be installed in accordance with the instructions provided by the manufacturer, in compliance with local codes and ordinances. Consideration shall be given to the type of service, temperature, storage media, design pressures, connections, flow, thermal storage capacity, mixing, and stratification, etc.

5.2 Liquid storage devices shall be leak-tested in accordance with recognized national standards.

5.3 Nonliquid storage devices need not be leak-tested unless a safety hazard or contamination could result from a storage device failure or if leakage could result in deterioration of the storage capacity.

5.4 Above ground storage devices shall be selected and installed to withstand all anticipated loads resulting from wind, hail, snow, and seismic conditions (where applicable). Protective coatings, casing materials, or enclosures shall be provided to prevent damage from continuous exposure to weather. Wood structural members shall be protected against deterioration from weathering, dry rot, ants, termites, and other adverse conditions. Footings and foundations shall support the storage device under all anticipated extremes of soil conditions.

5.5 Underground storage devices shall be selected and installed to withstand all anticipated loads resulting from soil, hydrostatic, and foundation. Such devices shall be anchored to prevent flotation resulting from flooding or high ground water levels (where applicable). Protective coatings, casing material, enclosures, or cathodic protection shall be provided to prevent damage from exposure to soil conditions and electrolytic action.

5.6 Underground storage devices subject to overhead vehicular traffic shall be designed and installed to withstand the additional load applied by this traffic.

5.7 Insulation shall be provided to minimize thermal losses from storage devices, related piping, and duct work. Insulation shall be suitable for the application, site, and occupancy conditions. Underground storage devices shall be given special consideration to prevent deterioration of insulating properties by compression, water penetration, or bacterial action.

5.8 Care shall be exercised during the installation of the storage device to prevent damage to such device and insulation material during handling, mounting, backfilling, packing, or other installation procedures.

5.9 Liquid storage devices shall be provided with means for draining its contents. All above-ground liquid storage devices shall have a valved pipe or bibb at the lowest point for drainage. Underground liquid storage devices shall have provisions for utilizing a pump, siphon, or other device for draining.

5.10 When required by design, liquid storage devices shall have a level gage or other device to indicate when the tank is full of liquid. If liquid storage devices are provided with overflows, the outlets shall be located so that spillage will not run into the building structure or damage the premises. Fill

devices shall be installed with approved backflow prevention devices as required by local codes or ordinances, to prevent contamination of potable water supplies.

5.11 Manholes or access openings shall be provided to permit access to components inside of the storage device.

5.12 Storage devices installed on a roof or in an attic shall be provided with a drip pan whose outlet is piped to an adequate drain.

6. Controls and Safety Devices

6.1 Controls and safety devices shall be selected so that, in the event of a power failure or a failure of any component, temperatures or pressures in the system, or both, will not damage other components or the building, nor present a danger to people. Such devices shall be installed in accordance with the manufacturer's instructions and in compliance with local codes and ordinances. Solar systems shall be selected and installed to fail safe.

6.2 Controls shall be selected and installed so that the solar components and auxiliary components will operate in concert and independently. Controls shall be designed to revert to the most economical mode.

6.3 Adequately sized pressure or temperature relief devices, or both, shall be provided in those isolated parts of the solar system containing pressurized fluids. Relief valves shall drain to locations acceptable to local codes and ordinances. Precaution shall be taken to assure that heat transfer fluids, which may be hazardous, do not discharge onto the roof or other parts of the structure, causing structural damage, building finish discoloration, damage to shrubs and lawns, or danger to people.

6.4 Expansion tanks shall be provided where required, as part of the solar heating system to provide for thermal expansion of heat-transfer liquids. Expansion tanks shall be sized for the operating temperature ranges.

6.5 Controls shall activate the collector loop whenever beneficial results can be obtained.

6.6 Controls, dampers, and valves shall be marked to identify their function. Any control that serves as an emergency shutdown device shall be so indicated by conspicuous and permanent labels.

6.7 Space and control thermostats shall be installed in accordance with the manufacturer's instructions and in compliance with local codes and ordinances. Space thermostats shall be located away from drafts, heat sources, and outdoor walls. Mercury bulb thermostats require leveling to assure satisfactory operation. Thermostats shall be mounted so that they are protected from accidental bumping or jarring. Thermostats mounted outdoors shall be suitable for outdoor environment and shall be protected from the elements.

6.8 Complete operating instructions, including sequence of operation, wiring diagrams, and flow diagrams, shall be provided with the solar heating system. Installers shall instruct the building owner and occupant of the proper operation, safety, and emergency shutdown procedures of the devices. Permanent labels, with shutdown and startup procedures, shall be provided in a conspicuous location.

7. Piping, Ducting and Ancillary Equipment

7.1 Piping, ducting and equipment shall be located so as to not interfere with the normal operation of windows, doors, or other exit openings. Piping, ducting, and equipment shall be installed in a manner so as to prevent damage to such piping, ducting, and equipment; prevent injury to persons; and in accordance with the manufacturer's instructions and in compliance with local codes and ordinances.

7.2 Underground piping subject to overhead vehicular traffic shall be installed to withstand the additional load applied by this traffic.

7.3 Piping shall be installed to facilitate drainage of liquid systems. Isolation valves shall be provided so that major components of solar heating systems can be maintained or serviced.

7.4 Insulation shall be provided to minimize thermal losses from piping and ducting. Insulation shall be suitable for the application and location. Underground installations shall be given special consideration to prevent deterioration of insulating properties by compression, water penetration, or bacterial action.

7.5 Air-bleed provisions shall be required at the high points of liquid systems so that air can be purged from the liquid circuit during filling and normal operations.

7.6 Suitable connections shall be provided for filling, draining, and flushing liquid systems.

7.7 Air-type systems shall be provided with adequate, removable filtering devices to allow initial cleaning and continued filtering to minimize excessive contamination during operation.

7.8 Piping shall be leak-tested before enclosing, backfilling, or insulating. Caution shall be exercised so that excess pressure is not applied to the system. The manufacturer of the system or components shall be consulted for recommended test pressure and procedures.

7.9 Ducts shall be constructed and installed in accordance with recognized national standards. Leak tests shall be conducted in accordance with recognized national standards, when available. Brackets or hangers shall be used to securely support, suspend, or hang ducts.

7.10 Contacts between dissimilar metals, which enhance corrosion of the more active metal to the extent that design function is impaired during the design life, shall be avoided. This shall include not only contacts between pipes, valves, storage devices, heat exchangers, and other components, but also filings, shavings, and other small items of loose metal within the system.

7.11 When dissimilar metals are used in a system and contact of these dissimilar metals would lead to enhanced corrosion of the more active metal to the extent that design function is impaired during design life, the dissimilar metals shall be isolated by electrically insulating members. Care shall be taken not to short-out the insulating members by pipe hangers, control elements, and similar components.

7.12 When necessary to prevent corrosion to the extent that design function is impaired during the design life, suitable inhibitors shall be used and maintained to control any corrosion tendency which might exist. Corrodible portions of the system shall be so designed that fresh inhibitor is available to all surfaces exposed to air or aerated solutions.

7.13 Heat transfer fluids shall be selected for extremes of operating temperatures which will be experienced by the fluid in the collector.

7.14 Piping and ducting installed outside a building or in an exterior wall shall be insulated or otherwise protected from freezing and to minimize loss of energy.

7.15 When a liquid is used in solar heating systems and quick-closing, power-actuated valves are installed, piping and components may be subjected to water hammer. Water hammer arresters, in compliance with local codes and ordinances, shall be installed to prevent damage to the system.

7.16 Heat exchangers shall be installed in accordance with the manufacturer's instructions and good engineering practices.

7.17 Direct connection between the potable water and nonpotable piping systems shall not exist under any conditions.

8. Electric Wiring

8.1 Field electric wiring shall be installed in accordance with the manufacturer's instructions and in compliance with local codes and ordinances.

8.2 Electric utility shall be consulted, if necessary, to ensure adequacy of service conductors, transformers, and electrical meters.

8.3 Control circuit wiring shall be color-coded or otherwise marked so that wires are readily traceable.

9. Auxiliary (Nonsolar) Space-Heating Equipment

9.1 Auxiliary (nonsolar) space-heating equipment shall be installed and serviced in accordance with the manufacturer's instructions and in compliance with local codes and ordinances.

9.2 Auxiliary equipment shall be compatible with the solar system output, such as temperatures, quantities, and fluid types.

10. System Start-Up and Check-Out Procedures

10.1 After the system has been installed, a qualified person familiar with the operation of both the solar heating system and the auxiliary heating system, shall follow the system start-up and operating procedures and shall place the system under all modes of operation to ensure that it is functioning properly.

10.2 The owner and occupant shall be instructed on proper start-up and operation of the system. The owner and occupant shall be shown the location of emergency shutdown devices and be instructed on their operation.

10.3 System operating instructions and parts lists shall be given to the owner for retention.

10.4 The owner shall be properly instructed on the importance of routine maintenance, including filter replacement, collector glazing cleaning, draining and refilling system, air venting of liquid systems, cleaning of components, corrosion control, and other maintenance procedures incorporated in system operating instructions. If hazardous fluids are used in the system, suitable warning labels shall be permanently mounted in a conspicuous place and the owner instructed on safe handling procedures.

10.5 A warranty document(s) shall be given to the owner by the seller, detailing the warranty responsibility assumed by each component manufacturer (including availability of service parts) and by the installer of the system. In addition, document(s) shall detail the responsibility of the owner in such areas as maintenance, service, and operation.

11. Service Practices

11.1 Solar heating systems shall be serviced by a qualified individual to provide continued customer satisfaction, longer equipment life, and reduction of emergency service.

11.2 Service check lists provided with system operating instructions shall be used to develop an efficient routine to assure that all service and maintenance procedures are followed.

11.3 Service logs shall be established for each system so that a historical record is available to indicate trends which may allow routine preventive maintenance.

11.4 Periodic cleaning of cover glazing, when used on collectors, may be needed to maintain optimum efficiency. Operating instructions should recommend proper cleaning agents and methods of cleaning that are compatible with collectors.

12. Keywords

12.1 residential solar space heating; solar energy; solar energy collectors; solar heating systems; solar space heating systems; space heating