CAN/CSA-F379 Series-09
National Standard of Canada
(reaffirmed 2024)

Packaged solar domestic hot water systems (liquid-to-liquid heat transfer)

REVISED DECEMBER 2014

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Revised	**CAN/CSA-F379.1-09:** Clauses 6.5.2 and 8.2.2
New	None
Deleted	None

- Update your copy by inserting these revised pages.
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6.3 Corrosion

6.3.1 Joints and connections between dissimilar metals

Joints and connections between dissimilar metals shall be made with compatible metals and shall not cause detrimental galvanic action.

6.3.2 Compatibility of dissimilar materials

Incompatible dissimilar materials shall be isolated or treated to prevent degradation that could significantly impair their function under in-service conditions during the design life.

Note: *Components and materials such as gaskets, sealants, and coatings can yield degradation products during their service life without impairing their function or aesthetic properties; however, the degradation products could significantly impair the performance of other components in the system. Heat-transfer fluids, including inhibited water, can decompose and produce scale buildup, which can cause deterioration of performance. This is particularly true of water heaters in which supply water is heated directly in the collector, and dissolved solids (calcium salts) precipitate.*

6.4 Collectors

6.4.1

Solar collectors shall meet the requirements of CAN/CSA-F378. The thermal performance test is not required unless this Standard requires the results of that test.

6.4.2

Solar collector connections shall be designed to withstand the test temperature used for testing the collector absorber according to the requirements of CAN/CSA-F378, when tested according to the procedures in Clause 8.3 of this Standard.

6.5 Tanks

6.5.1 Tank drainage

The solar energy storage tank shall be drainable.

6.5.1A Test pressure for pressurized tanks

Pressurized tanks shall be designed for a hydrostatic test pressure of 2000 kPa. The rated working pressure shall not exceed 50% of the hydrostatic test pressure.

Note: *See Clause 8.2 for the pressure test method.*

Δ 6.5.2 Requirements for glass-lined storage tanks

Hot water storage tanks shall conform to applicable standards.

6.6 Pumps

6.6.1 Standards and installation

Where applicable, pumps or pump motors, or both, shall meet the requirements of applicable standards and codes and shall be installed

(a) so that they are easily serviceable;

(b) such that the net positive suction head requirements as defined by the pump manufacturer are met; and

(c) in a location where the electrical components or connections will not come in contact with fluid from a tank overflow or from the outlet of a pressure/temperature-relief valve.

Note: *In Canada, requirements for the installation of electrical components are found in the* Canadian Electrical Code, Part I.

6.6.2 Sizing

Pumps shall be sized to overcome static liquid head and system friction. Pump motors and impellers shall be sized so as to prevent overloading of the motor. Adequate positive suction head shall be provided to prevent cavitation.

6.6.3 Staging

Pumps may be staged in order to meet liquid delivery requirements provided that the failure of one of the pumps in the system does not constitute a hazard.

6.6.4 Materials of construction

Circulating pumps used for handling water or other non-corrosion-inhibited heat-transfer fluids shall be constructed of corrosion-resistant materials.

6.7 Heat exchangers

Heat exchangers used in solar domestic hot water heaters shall conform to the health and safety requirements specified in Clause 7.4.

6.8 — *Deleted*

6.9 Auxiliary heating systems

In a solar-plus-supplemental system, the auxiliary heating system shall meet the applicable safety standards for the auxiliary energy source.

Note: *For possibly applicable standards see, e.g., CAN/CSA-C22.2 No. 110 for electric energy sources, ANSI Z21.10.1/ CSA 4.1 for gas energy sources, and B140.12 for oil energy sources. See also Table A.1.*

6.10 Plumbing

6.10.1 Diaphragms or bellows

Diaphragms or bellows, when used as barriers in control piping that bypasses one or more check valves, shall be installed in such that evidence of their failure will be detectable.

6.10.2 Air ports and vent ports

Ports shall be protected against the collection of debris, which can reduce the flow area and adversely affect the performance of the system. There shall be no provision for making a direct connection to a vent port.

6.10.3 Entrapped air

Systems shall provide suitable means for air or gas removal from high points in the piping systems.

6.10.4 Vacuum relief protection

Closed storage tanks and piping shall be protected against collapsing from vacuum-induced pressure. Such components shall be designed to withstand such pressures or have vacuum relief protection.

6.10.5 Filters

The system shall have filters or other means to prevent contamination by foreign substances, which can impair the flow and quality of the heat-transfer fluid beyond acceptable limits.

Filters in contact with potable water shall meet codes and standards applicable to potable water systems.

6.10.6 Interconnections

Interconnections between an auxiliary energy system and the solar energy system shall be made in a manner that will not result in temperatures or pressures exceeding the allowable design conditions in either system (in operational or non-operational mode). The interconnections shall not compromise or bypass the safety devices.

7.4.3.9

Except where permitted by the system design, liquids that are exposed to maximum and minimum service temperatures and pressures during their design life shall not

(a) freeze;
(b) give rise to excessive precipitation or otherwise lose their homogeneity;
(c) boil;
(d) change absorptivity;
(e) change pH; or
(f) change viscosity beyond the design ranges.

Notes:

(1) *See Clause 9.3.1.2 for marking requirements for heat-transfer fluid.*

(2) *Although boiling can be prevented by pressurization, excessive temperatures can break down constituents of some heat-transfer fluids to form organic acids. Buffers can counter the pH balance, but only until they are exhausted. Changes in pH may occur, but when the allowable range is exceeded, the transfer liquid, or at least the buffers, should be renewed. This can be a maintenance requirement.*

(3) *Thermal cycling can cause precipitation, which can lead to malfunction through a buildup of solids on pump seals and valve seats.*

(4) *If not accommodated in the design, viscosity changes in heat-transfer fluids can cause pumping problems such as excessive pumping power requirements or overheating due to thickened heat-transfer fluid.*

7.4.4 Test requirements

The pressure rating of heat exchangers used in SDHW systems shall be tested in accordance with Clause 8.10 using a representative sample.

Notes:

(1) *The discharge of toxic, corrosive, combustible, or explosive liquids into sewers can create serious health and safety hazards both within the immediate community and at a considerable distance along watercourses into which the sewers discharge. Safe disposal of such liquids involves, at minimum, consideration of composition, concentrations and frequency of discharge, and the nature of the sewage treatment and disposal system available at the site. In some instances, catchment of this discharge and removal to specialized treatment facilities is the only acceptable disposal method. Under such conditions, adequately sized and protected catch basins should be provided. The leakage of toxic liquids into the ground can contaminate groundwater. In addition, leakage of some heat-transfer fluids can damage roofing, sealants, and other building materials. Leakage of combustible liquids can pose a fire hazard when exposed to external ignition or heat loss.*

(2) *Corrosive, toxic, or high-temperature (over 60 °C) heat-transfer fluids (which can destroy or injure a drain, sewer soil, or waste pipe; create noxious or toxic fumes; or interfere with sewage treatment processes) should not be discharged into a plumbing system without being thoroughly diluted, neutralized, or treated by being passed through a properly constructed and acceptable dilution or neutralizing device. The nature of the corrosive or harmful waste and the method of its treatment or distribution should be acceptable to the authorities having jurisdiction.*

8 Testing

8.1 General

The SDHW system shall be assembled according to the manufacturer's instructions and tested as specified in Clauses 8.2 to 8.10. For add-on packaged SDWH systems, the system shall be assembled with an approved thermal storage device, and all reports shall clearly identify the particular approved storage device used during testing.

8.2 Pressure test

8.2.1 Collector loop piping

Closed-loop solar heating system piping using liquid heat-transfer fluids not directly connected to the potable water supply shall be tested at not less than 1.5 times the maximum design operating pressure for a minimum of 15 min using the manufacturer's recommended working liquid.

Δ 8.2.2 Domestic water system plumbing

The portion of the solar heating system connected to the domestic water system shall be isolated and tested as follows:

(a) A water pressure of not less than 2.0 times the maximum design operating pressure or 2000 kPa, whichever is larger, shall be used. The test pressure shall be maintained for a minimum of 30 min without the system leaking.
(b) Systems operating at atmospheric pressure shall be tested by being filled to overflow.
(c) This test shall not be required for any hot water storage tanks that meet the requirements of the applicable hot water storage tank standard.

Notes:

(1) *Clear water is used for most hydrostatic tests. The temperature of the water should not be lower than that of the ambient atmosphere. If it is lower, sweating will result and proper examination will be difficult. In environments where freezing can occur, antifreeze or hydrocarbons may be added to keep the water from freezing. Bleeder valves or petcocks should be provided at the highest point or points in the system to permit venting of all air in the piping during the filling operation. Automatic vents should be protected from freezing.*

(2) *After completion of piping tests and after all equipment has been installed, the liquid system should be flushed to remove sediment, dirt, loose scale, etc. Strainers should be cleaned or replaced. During the flushing of the system, the collectors should be disconnected or bypassed to prevent passage of debris through the collectors.*

8.3 Collector coupling test

External collector coupling hoses shall be subjected to the tests and meet the requirements specified for internal coupling hoses in CAN/CSA-F378.

8.4 Hot water delivery/recovery test (solar-plus supplemental system only)

8.4.1 Purpose

The hot water delivery/recovery test ensures that a solar-plus-supplemental system can deliver an amount of hot water adequate to meet the maximum requirements of the household size for which it is designed, under all conditions. The test also ensures that the solar-plus-supplemental system can recover at a sufficiently fast rate to meet the worst-case hot water scheduling requirements of the household size for which it is designed, under all conditions.

This test shall not be required for any system in which the auxiliary energy is provided by an electric or gas domestic storage-type water heater that

(a) meets the requirements of the appropriate CSA standard;
(b) is plumbed in series downstream from the solar storage tank; and
(c) is independently controlled.

8.4.2 Required information from manufacturers

Manufacturers shall classify the solar-plus-supplemental system as size A, B, or C according to its capacity to fulfill the hot water delivery requirements specified in Table 2. Information shall also be provided on how to set the auxiliary energy sources.

8.4.3 Apparatus

The test apparatus shall consist of

(a) a means of drawing specific quantities of hot water from the system at specified time intervals; and
(b) instruments capable of measuring the quantity and average temperature of the water withdrawn with an accuracy of ± 5% and ± 1 °C, respectively.

8.4.4 Procedure

The test shall be performed as follows:

(a) The solar storage tank water temperature shall be set at 20 °C or lower.
(b) The auxiliary energy sources shall be set according to the manufacturer's recommendations.
(c) The room ambient temperature shall be 20 ± 1 °C.

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8.7.7.3 Solar simulator and collector simulators (slave heaters)

8.7.7.3.1

If slave heaters are used to simulate the heat input of series plumbed extra collectors,

(a) the irradiated collectors shall be set up in the solar simulator;
(b) the temperature rise shall be measured continuously across the irradiated collectors; and
(c) heat shall be added to the slave heaters to provide temperature rises as specified in Table 4. The flow through each slave heater used in place of the extra collectors shall be adjusted to equal the flow through its irradiated master collector.

8.7.7.3.2

If the collectors in an array are intended to be plumbed in parallel, one or more collectors shall be so plumbed in the solar simulator and the temperature rise across, and fluid flow rate through, this unit shall be continuously measured. A slave heater shall be plumbed in parallel with the irradiated unit and the temperature rise across the heater shall be controlled to equal that across the irradiated unit. The flow rate through the slave heater shall be controlled such that the ratio of the flow rate through the slave heater to the flow rate through the irradiated unit is equal to the ratio of the number of collectors that the slave heater is replacing to the number of collectors in the irradiated unit.

8.7.7.4 Non-irradiated collector array

If a non-irradiated solar collector array is used, the test shall be in accordance with ASHRAE 95.

Note: *This test should be treated with caution. Although usually appropriate for flat plate collectors, this test is sometimes not suitable for solar collectors in which the net thermal output cannot be represented by the use of the combination of a heater and non-irradiated solar collector (e.g., collectors that operate as a thermal diode, or integral collector-storage units).*

8.7.7.5 Solar preheat system test

The following shall apply to the solar preheat system test:

(a) The test procedure shall be as specified in ASHRAE 95, using the rating conditions given in Table 3 of this Standard, except that the delivered hot water shall pass through the mixing valve, which tempers the hot water to 55 ± 2 °C with mains water as necessary.
(b) In order to reduce the time needed to obtain a repeatable result, the test may be started with a storage temperature greater than t_{main} and terminated as soon as a repeatable 24 h period has been obtained.
(c) The energy content of the delivered water at any time, as determined by m_j and $t_{w,j}$, shall be for the delivered hot water after the mixing valve has been inserted between the system and the load.
(d) The hot water draw specified in Table 3 shall be for the mixed hot water.
(e) Values of $t_{w,j}$ and m_j shall be measured for each withdrawal.
(f) Cumulative values of Q_{PAR} shall be calculated at least every 30 min during the test when solar energy is being collected.
(g) Each day's test shall be started with the system temperatures as they were at the end of the previous 24 h test.
(h) The test shall be performed until the net daily solar energy delivered is within 5% of the previous day's value. The net daily solar energy delivered shall be calculated as

$$Q_{NET} = \Sigma\, C_{p,w} (t_{w,j} - t_{main,j})\, m_j - Q_{PAR}$$

where

Q_{NET} = net daily solar energy delivered by the system, kJ

$C_{p,w}$ = specific heat of water, kJ/(kg•°C)

$t_{w,j}$ = mixed temperature of the jth withdrawal of water, °C

$t_{main,j}$ = average temperature of the incoming cold water supply to the solar hot water system during the jth withdrawal of water, °C

m_j = mass of the jth withdrawal of water, kg

Q_{PAR} = daily energy consumed for parasitic power by pumps, controls, solenoid valves, etc., in the solar hot water system, kJ

Δ 8.7.7.6 Solar-plus supplemental system test

The following shall apply to solar-plus supplemental system test:

(a) The test procedure shall be as specified in ASHRAE 95, using the rating conditions given in Table 3 of this Standard, except that the auxiliary energy source (delivered temperature) shall be set as for the delivery test (see Clause 8.4) and the delivered hot water shall pass through the mixing valve, which tempers the hot water to 55 ± 2 °C with mains water as necessary.

Note: *The "hot water supply rating — continuous draw" tests described in ASHRAE 95 are not used in this Standard.*

(b) In order to reduce the time needed to obtain a repeatable result, the test may be started with a storage temperature greater than t_{main} and terminated as soon as a repeatable 24 h period has been obtained.

(c) The energy content of the delivered water at any time, as determined by m_j and $t_{w,j}$, shall be for the delivered hot water following the mixing valve.

(d) The hot water draw specified in Table 3 shall be for the mixed hot water.

(e) Values of $t_{w,j}$ and m_j shall be measured for each withdrawal.

(f) Cumulative values of Q_{PAR} shall be calculated at least every 30 min during the test when solar energy is being collected.

(g) Cumulative values of Q_{AUXNET} shall be calculated at least every 30 min throughout the test.

(h) Each day's test shall be started with the system temperatures as they were at the end of the previous 24 h test.

(i) The test shall be performed until the cumulative test value of Q_{AUXNET} is within 5% of the previous day's value.

(j) The net daily solar energy delivered shall be calculated as

$$Q_{NET} = \Sigma\, C_{p,w}\,(t_{w,j} - t_{main,j})\, m_j - Q_{AUXNET} - Q_{PAR}$$

where

Q_{AUXNET} = net auxiliary energy delivered by the auxiliary energy system after combustion losses (if applicable) have been accounted for, kJ

All measurements shall be for the final test day.

8.7.7.7 Solar-only system test

The following shall apply to the solar-only system test:

(a) The test procedure shall be as specified in ASHRAE 95, using the rating conditions given in Table 3 of this Standard, except that

(i) the delivered hot water shall pass through the mixing valve, which tempers the hot water to 40 ± 2 °C with mains water as necessary; and

(ii) no hot water shall be drawn below a temperature of 30 ± 2 °C.

(b) The storage device shall be filled with water at the mains temperature (t_{main}) on the morning of the first day of the test.

(c) The test shall start at 08:00 as indicated in Table 3.

(d) No water shall be drawn from the system until the water temperature at the top of the storage tank reaches 40 ± 2 °C.

(e) Water shall be drawn from the system at the next scheduled times up to the specified volumes or until the temperature of the water being withdrawn drops to 30 ± 2 °C during a particular scheduled draw.

(f) The mass of hot water withdrawn shall be recorded and the average temperature of the draw shall be calculated.

(g) The time, T, between the beginning of the test and the first draw shall be recorded.

(h) The system shall be tested until its performance is the same after two successive 24 h periods.

(i) The test shall be repeated starting each day with water at mains temperature until the total mass of water withdrawn is within 5% of the previous day's value.

(j) Results shall be calculated based on measurements made during the final test, as follows:

Δ

Table 2
Delivery schedules for hot water delivery/recovery test
(See Clause 8.4.2)

Elapsed time, h	Withdrawal, L		
	Size A (1 or 2 persons)	Size B (3 or 4 persons)	Size C (5 or more persons)
0	5	10	25
1	30	35	45
1.5	5	5	10
2	0	5	55
2.5	5	55	55
3	55	55	55
3.5	55	55	10
4	45	55	55
5	0	5	55
5.5	5	10	40
6	0	5	10
9	0	10	10
10	5	25	25
11	10	45	45
12	45	30	35
13	30	30	30
14	5	10	30
15	0	5	10
Total	300	450	600

Note: *The draw schedules specified in this Table are for testing only. Systems shall be rated in accordance with Clause 5.3.3.*

Table 3
Rating conditions for thermal performance test

(See Clauses 8.4.4, 8.7.1, 8.7.4.2, 8.7.7.2.2, 8.7.7.2.3, and 8.7.7.5–8.7.7.7.)

Time of day	Incident radiation*				Incident angles†			Withdrawals‡, L, at 10 L/min		
	Total, MJ/m^2	W/m^2	Beam, W/m^2	Diffuse, W/m^2	Total	Vert.	Horiz.	Size A	Size B	Size C
00:00–07:00	0	0	0	0	—	—	—	0	0	0
07:00–08:00	0	0	0	0	—	—	—	5	10	10
08:00–09:00	1.212	337	172	165	56.9	17.6	56.3	25	25	25
09:00–10:00	1.425	396	231	165	42.3	13.2	41.3	0	5	25
10:00–11:00	1.566	435	270	165	28.0	11.1	26.3	45	45	45
11:00–12:00	1.779	494	329	165	15.0	10.2	11.3	0	5	25
12:00–13:00	2.764	768	603	165	10.7	10.0	3.7	5	10	10
13:00–14:00	1.485	413	248	165	21.1	10.5	18.7	0	5	5
14:00–15:00	1.247	346	181	165	35.0	12.0	33.7	0	0	0
15:00–16:00	1.024	284	119	165	49.5	15.0	48.7	0	0	0
16:00–17:00	0	0	0	0	—	—	—	0	10	15
17:00–18:00	0	0	0	0	—	—	—	5	25	25
18:00–19:00	0	0	0	0	—	—	—	15	45	45
19:00–20:00	0	0	0	0	—	—	—	30	25	25
20:00–21:00	0	0	0	0	—	—	—	20	10	30
21:00–22:00	0	0	0	0	—	—	—	0	5	10
22:00–23:00	0	0	0	0	—	—	—	0	0	5
23:00–24:00	0	0	0	0	—	—	—	0	0	0
Total	12.502							150	225	300

**This represents the radiation in the plane of the collector during the specified period.*

†*This represents the angle as applicable during the specified period. Accuracy shall be* ± 0.5°.

‡*This represents the water withdrawn at the beginning of the specified time period. The rate of draw shall have an accuracy of* ± 1 L/min. *The total amount drawn during each test day shall be within* 5 L *of the total draw specified.*

Notes:

(1) *The ambient air temperature at the storage tank shall be* 20 ± 2 °C.

(2) *The ambient air temperature at the collectors shall be* 15 ± 1 °C *(this requirement may be relaxed during non-irradiated periods if the collector contains no significant [i.e., easily observed or measured] energy storage).*

(3) *The inlet water temperature shall be* 15 ± 1 °C.

(4) *The collector tilt angle shall be* 60°.

(5) *The wind speed at the collectors shall be* 4.5 ± 1 m/s.

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8.8.2.4.3 Method B

The Method B test procedure shall be as follows:
(a) The collector and piping shall be inspected to determine possible locations where water can be retained in the collector after draining. The dimensions (e.g., diameters) of pipes, tubes, and fittings that might have retained water shall be measured and recorded.
(b) The collector(s) and all outdoor exposed piping shall be subjected to a freezing temperature of –10 °C or lower for a period of at least 10 h, either by placing the system in an environmental chamber or by moving the system to the outdoors. If the test is conducted outdoors in the daytime, the collector shall be shaded from sunlight.
(c) The collector and exposed piping shall be warmed to above freezing, and the collector and exposed piping shall be inspected for leaks caused by freezing. Leaks may be detected by visual inspection or by pressure testing using either water at the normal operating pressure of the collector or air at between 2 and 5 psi.
(d) The dimensions recorded in Item (a) shall be measured and recorded. If necessary, the collector may be disassembled and the collector piping diameters measured in locations where water is suspected of being retained. To determine if internal collector tube diameters have increased due to freezing, comparisons may be made between sections of tube suspected of retaining water and sections of tubes unlikely to retain water.
(e) The system shall be considered to have passed the test if no leaks are detected and no parts of the collector or exposed pipes, tubes, or fittings have undergone a permanent expansion.

8.8.3 Minimum static head test (drainback systems only)

8.8.3.1 Purpose

The minimum static head test ensures that when the solar pump is started, water flow in a drainback system is promptly established at an acceptable rate.

8.8.3.2 Apparatus

The test apparatus shall consist of
(a) the solar collector circulating pump supplied by the manufacturer;
(b) a water pipe circuit from the outlet to the inlet of the pump;
(c) a pressure gauge at the pump outlet; and
(d) a gate valve downstream from the pressure gauge.

8.8.3.3 Procedure

The test shall be performed as follows:
(a) The solar collector pump shall be run with the circuit filled with water.
(b) The gate valve shall be closed until the static head pressure reaches the value required by Clause 8.8.3.4.
(c) The static head pressure at the pump outlet shall be recorded when the flow of water is completely blocked.

8.8.3.4 Requirement

The static head pressure at the pump outlet shall exceed the head required to reach the manufacturer's recommended maximum vertical distance to the highest point of the solar loop, plus at least 12.0 kPa.

8.8.4 Power failure/cut-off test (all systems)

8.8.4.1 Purpose

The power failure/cut-off test ensures that the means of freeze protection is fail-safe. For example, if power fails to the system, draindown valves will open, or if power fails to the controller, circulating pumps will stop operating.

8.8.4.2 Procedure
The test shall be performed as follows:
(a) The collector loop circulating pump shall be run at the minimum design flow rate.
(b) Power shall be cut off at all system power connections and component ON/OFF switches one at a time and in all combinations.

8.8.4.3 Requirements
The shutting off of power to the system or selectively to any component or controller shall result in
(a) the draining of water from the collector or exposed piping; or
(b) the switching off of the pump circulating non-freezing liquid.

8.9 Sensor fail-safe test

8.9.1 Purpose
The sensor fail-safe test ensures that the malfunction of any temperature sensor will not interfere with the operation of freeze or overheating protection.

8.9.2 Procedure
Temperature sensors shall be short-circuited and open-circuited one at a time and then simultaneously. The system shall be in operation during these tests.

8.9.3 Requirement
The freeze and overheating protection mechanism shall remain operable after the short-circuiting or open-circuiting of the sensors separately or together.

8.10 Heat exchanger pressure test

∆ 8.10.1 Purpose
The pressure rating of heat exchangers used in SDHW systems shall be investigated by subjecting a representative sample to the test described in Clause 8.10 in a qualified laboratory.

Note: *The Standards Council of Canada is the national authority responsible for the accreditation of laboratories and certification agencies acceptable to the authorities having jurisdiction.*

8.10.2 Requirements
Both sides of the heat exchanger (unless one side of the heat exchanger is designed to be open to atmospheric pressure) shall be subjected to a hydrostatic pressure test without developing any leakage and without producing permanent visible deformation when tested in accordance with Clause 8.10.3.

8.10.3 Procedure
The test shall be performed as follows:
(a) Both sides of the heat exchanger shall be alternately connected to a water supply through a pump system with
   (i) a calibrated Bourdon pressure gauge graduated in increments of not more than 25 kPa;
   (ii) a check valve; and
   (iii) shut-off valves.
(b) The heat exchanger test set-up shall be filled with water at room temperature (± 5 °C) and at atmospheric pressure. Care shall be exercised to avoid any pocketing of air. All openings shall be suitably closed.
(c) Hydrostatic pressure shall be gradually raised by means of the pump until the test pressures specified in Item (e) are reached, within ± 25 kPa.
(d) Test pressure shall be maintained for 0.5 h, at which time the pressure shall be reduced to atmospheric.

9.3.2 Scald warning

9.3.2.1 General

The English label illustrated in Figure 2 shall appear on all water heaters. The label is shown with a vertical arrangement but may have a horizontal arrangement for water heaters with a capacity of 7.57 L (20 gal) or more.

9.3.2.2 Water heaters with adjustable thermostats

Each water heater equipped with an adjustable thermostat shall bear a label of Class IIIA marking material as shown in Figure 2. This label shall be located adjacent to the adjustment means so as to be visible with the control cover, if provided, in place.

9.3.2.3 Water heaters with a capacity of 75.7 L (20 gal) or more

Labels shall comply with the following requirements:

(a) The text of the label shall be located below (for the vertical arrangement) or to the right of (for the horizontal arrangement) the graphic illustration.

(b) The minimum label sizes are as follows:
  (i) for vertical: 82.5 mm × 159 mm (3-1/4 in × 6-1/4 in); and
  (ii) for horizontal: 152 mm × 82.5 mm (6 in × 3-1/4 in).

Δ (c) The text and illustrations on the label shall be boxed by a 6.35 mm (1/4 in) border. A 9.5 mm (3/8 in) red bar shall be at the top of the label, within the border. A red on white international symbol for caution shall be located on the red bar followed by the word "DANGER" in white boldface letters having a minimum height of 6.1 mm (0.240 in).

(d) The graphic illustrations for the faucet, knobs, bathtub outline, spraying water, and hand shall be black on a white background. The water spattered on the hand shall be in red.

(e) The word "HOT" (the equivalent French word is "CHAUDE") shall be in red boldface letters. The letters shall have a minimum height of 4.6 mm (0.180 in).

(f) The word "BURN" (the equivalent French word is "BRÛLURE") shall be in red boldface letters. The letters shall have a minimum height of 3.56 mm (0.140 in).

(g) All text below the illustration shall be either black boldface letters on a white background or white boldface letters on a black background. The letters shall have a minimum upper-case height of 3.05 mm (0.120 in). Lower-case letters shall be compatible with the upper-case size specifications.

See Figure 2.

Annex B (informative)
Techniques for simulation and calibration

Note: *This Annex is not a mandatory part of this Standard.*

B.1 General

This Standard specifies the details of a system test (see Clause 8.7) that is the primary means of determining the net solar energy delivered by packaged SDHW systems. Clause 8.7.4.2(e) also allows for the use of computer simulation to establish the net solar energy delivered by other systems that are nearly identical to one that has been tested.

This Annex describes conditions under which simulations can be used to accurately complement the test results. In all cases, at least one physical system test is completed in order to have physical test data that can be used to validate the model(s) used to estimate the performance of system(s) not tested, as specified in Clause 8.7.4.2.

Systems eligible for rating by simulation will have exactly the same plumbing configuration as the "nearly identical" system tested in accordance with Clause 8.7, with only the size of certain components changed relative to the tested system. For purposes of this Standard, "nearly identical" means systems that are assembled from components that are nearly identical. For example,

(a) the collector array can be made up of either a different number of identical collectors or different evacuated tube collectors having different numbers of identical tubes with the identical thermal connection to the collector header;
(b) the tank can be a different size than the tank used in the physical system test;
(c) the heat exchanger can be a different size or capacity (but of the same type and plumbing connections) than the heat exchanger used in the physical system test; or
(d) the pump can be of a different flow rate and capacity than used in the physical system test.

∆ B.2 Example of a simulation method that has been used with good results

TRNSYS is a detailed transient computer simulation program that has been used to simulate the standard day testing of packaged SDHW systems to the CSA F379 Series. An expert simulator with extensive TRNSYS experience assembled the component subroutines (Types) into a complete system model. A 1s time step and a simulation period of seven standard days in succession were used (typically performance does not change significantly after the first two or three days). Accurate modelling requires system component characteristics to be known in detail and used to define the properties of all system components that affect system thermal performance. Examples of such components include collectors, piping, insulation (inside and outside of the heated space), pumps, the heat exchanger, the storage tank, and controllers. Auxiliary system and control details are also important in the case of auxiliary energy supplied to the solar energy tank. Particularly important are tested values of heat exchanger performance.

The model was first used to simulate the performance of the system as tested, using the installed pipe lengths, measured incident radiation, air temperatures, and load draws during the test in Canada's National Solar Test Facility (NSTF). If any of the inputs to this model were uncertain (e.g., the number of stratified nodes in the storage tank, the natural convection heat transfer coefficients, and the effective heat loss coefficient for the solar tank assembly), they were fine-tuned to achieve the measured tank temperature profiles and energy delivered by the system. The resulting simulation was referred to as the "as tested" simulation.

Note: *Harrison and Cruikshank (2007) also illustrates an approach used to model and calibrate a computer simulation of a CSA F379 Series standard test result in order to estimate annual performance and investigate the effect of changing system characteristics and installation and load conditions. A similar approach could be used to estimate the effect of changing system specifications on CSA F379 Series test results.*

The ratio of the measured (test) net daily solar energy delivered by the system (Q_{NET}) to the corresponding simulated value was used as a correction factor on the simulated results for any models that were not tested as follows.

$$\text{correction factor} = \frac{Q_{NET,\ measured}}{Q'_{NET,\ simulated}}$$

where

$Q_{NET,\ measured}$ = measured daily solar energy delivered by the measured system

$Q'_{NET,\ simulated}$ = simulated daily solar energy delivered by the measured system

Next, the inputs to the TRNSYS model were adjusted to reflect the smaller or larger components of a "nearly identical" SDHW system with standardized-length collector loop piping (35 ft × 2 = 70 ft total) that was not tested, and the seven standard day simulation was repeated. For the system that was only simulated, the calibrated simulation result was the Q_{NET} determined from simulation multiplied by the correction factor, as follows:

$$Q_{NET,\ calibrated} = Q'_{NET,\ simulated} \times \text{calibration factor}$$

B.3 Sample method for validating a computer model of an SDHW system

An example of a process of calibrating a computer model to the results of a system test done at the NSTF is described in Harrison and Cruickshank (2007). Figure B.1, adopted from Harrison and Cruikshank (2007), shows the process that was followed, and may be used as a model for verifying the component models within a computer simulation tool prior to using that simulation tool to model a modified system with "nearly identical" components of different sizes and capacities. The process of fine-tuning the overall computer model would be the same for any type of heat exchanger (or other component), despite the fact that the mathematical model for the heat exchanger (or other component) can be different.

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Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users to judge its suitability for their particular purpose.

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a) *Standard designation (number);*
b) *relevant clause, table, and/or figure number;*
c) *wording of the proposed change; and*
d) *rationale for the change.*

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Preface

This is the first edition of the CSA F379 Series, *Packaged solar domestic hot water systems (liquid-to-liquid heat transfer)*. It replaces the previous editions of CSA F379.1, *Solar Domestic Hot Water Systems (Liquid-to-Liquid Heat Transfer)* and CSA F379.2, *Seasonal Use Packaged Solar Domestic Hot Water Systems,* published as stand-alone documents in 1988 and 1989, respectively.

This Series was developed in response to the need for an updated document that, together with CSA F378, specifies safety and performance criteria for packaged solar domestic hot water systems. Since the last editions of CSA F379.1 and CSA F379.2, significant advances have been made in solar domestic water heater technology.

This Series includes a simple calculation for converting "standard day" results into a prediction of seasonal performance for any location in Canada.

CSA acknowledges that the development of this Series was made possible, in part, by the financial support of Natural Resources Canada (Office of Energy Efficiency and CANMET), the Ontario Ministry of Energy, BC Hydro, and Manitoba Hydro.

These Standards are considered suitable for use for conformity assessment within the stated scopes of the Standards.

This Series was prepared by the Subcommittee on Packaged Solar Hot Water Systems, under the jurisdiction of the Technical Committee on Renewables and the Strategic Steering Committee on Performance, Energy Efficiency, and Renewables, and has been formally approved by the Technical Committee. It will be submitted to the Standards Council of Canada for approval as a National Standard of Canada.

January 2009

Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

(3) *This publication was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this publication.*

(4) *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee.*

(5) *All enquiries regarding this Standard, including requests for interpretation, should be addressed to Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6.*

Requests for interpretation should

(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;

(b) provide an explanation of circumstances surrounding the actual field condition; and

(c) be phrased where possible to permit a specific "yes" or "no" answer.

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