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## **ASSE International**

Performance Requirements for  
Water Heaters with Temperature Limiting Capacity

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### **General Information**

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## **Foreword**

This foreword shall not be considered a part of the standard; however, it is offered to provide background information.

ASSE standards are developed in the interest of consumer safety.

ASSE International considers product performance standards to be of great value in the development of improved plumbing systems.

The working group that developed this standard was set up within the framework of the Product Standards Committee of ASSE International.

This standard is intended to provide a consistent level of scald protection with the current ASSE 1070 / ASME A112.1070 / CSA B125.70 requirements for temperature limiting devices. The technology of heater controls has come a long way over the past several years regarding precise modulation of heat output that directly resembles, improves, or outperforms other devices due to transient temperature drops. A downstream mixing valve would no longer be necessary.

Recognition is made of the time volunteered by members of this working group and of the support of manufacturers who also participated in meetings for this standard.

This standard does not imply ASSE International's endorsement of a product which complies with these requirements.

Compliance with this standard does not imply acceptance by any code body.

It is recommended that these water heaters be installed in accordance with the manufacturer's installation instructions and consistent with local codes. Where there is a conflict with codes and installation instructions, the more stringent requirements should be followed. These water heaters should be installed by properly licensed, qualified and properly trained professionals.

This standard was promulgated in accordance with procedures developed by the American National Standards Institute (ANSI).

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# Performance Requirements for Water Heaters with Temperature Limiting Capacity

## 1. General

### 1.1 Application

Water heaters with precise output temperature control under varying flow conditions are used to provide tempered water to the user. As such, they need to limit the maximum temperature of the water in order to minimize the risk of scalding.

### 1.2 Scope

#### 1.2.1 Description

Water heaters covered by this standard have a cold water inlet connection, a means of heating the water, a means of controlling the water temperature, a means of limiting the temperature to a maximum of 120 °F (48.9 °C), and have an outlet connection to connect to downstream fixture fittings.

This water heater is intended to supply tempered water at point of use in order to reduce and control the risks of scalding. This water heater is not intended to limit thermal shock. This water heater is not a substitute for an automatic compensative valve complying with ASSE 1016 / ASME A112.1016 / CSA B125.16.

#### 1.2.2 Connections

Pipe threads and other connections shall comply with the local plumbing codes.

#### 1.2.3 Maximum working pressure

The maximum working pressure of the water heater shall be at least at least 150 psi (1034 kPa) for water heaters in compliance with standards such as UL 174, UL 499, UL 1453, ANSI Z21.10.1 / CSA 4.1, or ANSI Z21.10.3 / CSA 4.3.

#### 1.2.4 Minimum flow rate

The manufacturer shall designate the minimum rated flow rate of water heaters other than those integral to plumbing supply fittings that have a maximum flow rate. The flow rates for water heaters designed into fixture fittings shall be in accordance with ASME A112.18.1 / CSA B125.1.

#### 1.2.5 Maximum flow rate

The maximum flow rates of the water heater at given temperature rises shall be included in the manufacturer's literature.

#### 1.2.6 Water Heater Standards

Electrical controls shall be Class B or Class C control functions as defined per UL 60730-1 or comply with the applicable requirements of UL 353, UL 795, or UL 873. An informative list of water heater standards is given in Appendix B (informative).

### 1.2.7 Outlet temperature range

The water heater shall:

1. be capable of supplying water with a minimum adjustable hot water setpoint range of 100°F to 110°F (37.7°C to 43.3°C)
2. be set to deliver a maximum water temperature of 120°F (48.9 °C) or less.

For non-adjustable water heaters, the outlet temperature shall be set no greater than 110°F (43.3 °C).

### 1.2.8 Inlet temperature range

The water heater shall be capable of operating with inlet water temperatures between 39°F and 80°F (4 °C and 27 °C).

### 1.2.9 Maximum Permissible Temperature Variation

The water heater shall have a maximum permissible outlet temperature variation based on the water heater's maximum flow rate when tested in accordance with section 3.1.

## 1.3 Reference Documents

Referenced industry standards shall be to the revision stated below.

- ANSI Z21.10.1-2014 / CSA 4.1-2014, Gas water heaters - Volume I, storage water heaters with input ratings of 75,000 BTU per hour or less
- ANSI Z21.10.3-2015 / CSA 4.3-2015, Gas Water Heaters – Volume III, Storage Water Heaters, With Input Ratings Above 75,000 BTU per hour, Circulating and Instantaneous
- ASME A112.18.1-2018/CSA B125.1-18, Plumbing Supply Fittings
- ASSE 1016-2017 / ASME A112.1016-2017 / CSA B125.16-17, Automatic Compensating Valves for Individual Shower & Tub/Shower Combinations
- UL 353-1994, Standard for Limit Controls
- UL 795-2016, Standard for Commercial-Industrial Gas Heating Equipment
- UL 873-2007, Standard for Temperature-Indicating and -Regulating Equipment
- UL 60730-1-2016, Automatic Electrical Controls – Part 1: General Requirements
- UL 60730-2-9-2017, Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls

## **2. Test Specimens and Test Laboratory**

### **2.1 Samples Submitted**

1 sample shall be submitted for testing.

### **2.2 Test Order**

Tests shall be performed in the order listed in this standard on 1 sample.

### **2.3 Rejection**

Failure of 1 sample shall result in a rejection of that model/size.

### 3. Performance Requirements and Compliance Testing

The water heater shall be installed and operated per the manufacturer's specifications in coordination with the testing apparatus.

#### 3.1 Maximum Flow and Conditioning Test

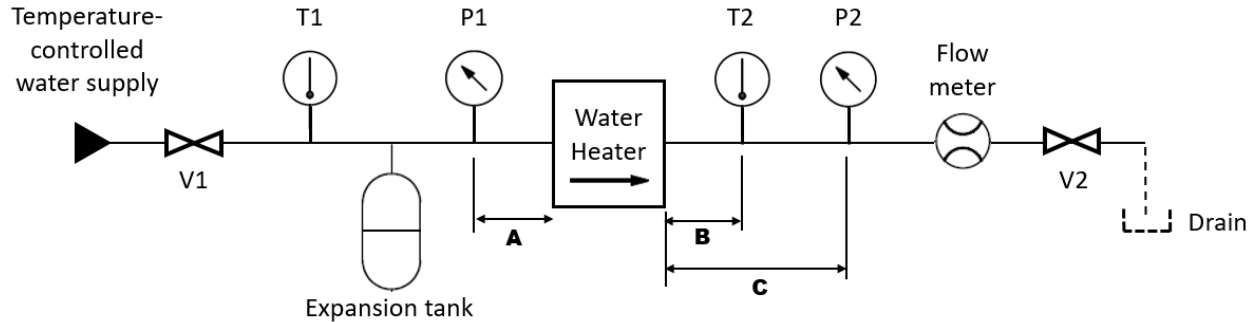


Figure 1 - Test apparatus setup. See Appendix A (normative) for data gathering requirements.

Note: the length of dimensions “A” and “B” are 6 inches (152 mm) from the outlet of the water heater and the length of “C” is 12 inches (305 mm.) The nominal diameter of the test apparatus shall meet the nominal connection size of the water heater.

##### 3.1.1 Purpose

The purpose of this test is to verify that the water heater shall continue to function when subjected to the manufacturer’s stated maximum flow at which the water heater can deliver a +50°F (+27.8°C) temperature rise.

##### 3.1.2 Procedure

Install the water heater per the manufacturer’s installation instructions and per Figure 1.

1. Fully open valves V1 and V2 and verify flowing pressure at P1 to be 45 psi ± 5.0 psi (310 ± 34.5kPa). The supply water shall be less than 60°F (15.6 °C). Maintain inlet temperature to within ± 2°F (1.1 °C) per T1 and maintain inlet pressure per P1 for the duration of the test.
2. Upon completion of the water heater start-up procedure, adjust the setpoint on the water heater’s controls to +50°F (+27.8 °C) higher than inlet temperature at T1 if the setpoint is adjustable.
3. Open and adjust valve V2 to allow the water heater to maintain a temperature rise of +50°F ± 2.0 °F (+27.8°C ± 1.1°C) to determine the maximum flow rate.
4. After 5 minutes, record the flow rate, the temperatures at T1 and T2, and the pressures at P1 and P2. The temperature rise can be computed by subtracting the T1 reading from the T2 reading. The pressure drop can be computed by subtracting the pressure at P2 from the pressure at P1.
5. Flow water per section 3.1.2.3 for 5 minutes. Continuously record the temperatures at T1 and T2.

Table 1 – Maximum permissible temperature variation

Maximum Flow Rate (Q)		Maximum Permissible Temperature Variation Above or Below the Set Point	
GPM	L/min	°F	°C



$Q < 7.0$	$(Q < 26.5)$	+3.0/-5.0	(+1.7/-2.8)
$7.0 \leq Q < 20.0$	$(26.5 \leq Q < 75.7)$	+5.0/-8.0	(+2.8/-4.4)
$20.0 \leq Q < 50.0$	$(75.7 \leq Q < 189.3)$	+7.0/-12.0	(+3.9/-6.7)
$Q \geq 50.0$	$(Q \geq 189.3)$	+7.0/-15.0	(+3.9/-8.3)

### 3.1.3 Criteria

Over the duration of 3.1.2.5, the temperature at T1 shall meet the criteria in 3.1.2.1, and the temperature at T2 shall meet the criteria of .

## 3.2 Steady State Temperature

### 3.2.1 Purpose

The purpose of this test is to determine that the water heater can heat the water to the set temperature within an allowable range.

### 3.2.2 Procedure

1. Install the water heater as shown in Figure 1. Fully open valve V1.
2. Cold water temperature settings:
  - a. For setpoint-adjustable water heaters,
    - i. Set the water heater setpoint to its maximum setting per the manufacturer's specification sheet.
    - ii. Set the cold water supply temperature to be 50 °F (28 °C) less than the maximum setpoint temperature per the manufacturer's specification sheet.
  - b. For non-adjustable water heaters,
    - i. Set the cold water supply temperature to be 50 °F (28 °C) less than the temperature stated on the manufacturer's specification sheet.
  - c. Maintain the cold water supply temperature to  $\pm 2^\circ\text{F}$  ( $\pm 1.1^\circ\text{C}$ ) per T1 and maintain inlet pressure per P1 for the duration of the test.
3. Turn on the energy source for the water heater.
4. Open the valves V1 and V2 and set the flow rate at the manufacturer's minimum flow rate for the water heater per section 1.2.4.
5. Wait for the output water temperature to rise to the setpoint temperature.
6. Measure the outlet temperature of the water heater within 6 inches (152 mm) of outlet with a temperature measuring device (e.g., a thermocouple) having an accuracy of 0.3°F (0.17°C).
7. Continue the test for a period of 5 minutes.

Repeat sections 3.2.2.4 through 3.2.2.7 at the maximum flow rate per section 1.2.5.

### 3.2.3 Criteria

The maximum temperature variation shall comply with Table 1 for the full length of the test after the water reaches the set temperature.

## 3.3 Pressure and Temperature Variation

### 3.3.1 Purpose

The purpose of this test is to determine if the outlet temperature is maintained within a set temperature and to a maximum of 120 °F (49 °C) when the inlet temperature and pressure are varied.

### 3.3.2 Procedure

See mandatory Appendix A for data gathering requirements.

Install the water heater as shown in Figure 1. Controllers with pressure feedback loops may be used to set test parameters, but shall be disabled during testing.

1. Establish the following test parameters:
  - a. For water heaters integral to fittings that comply with ASME A112.18.1 / CSA B125.1, fully open valves V1 and V2 and set the fitting to the fully open position with any intended flow-control device(s) attached.
  - b. For all other water heaters, fully open valve V1, then adjust valve V2 so that the water heater delivers the manufacturer's maximum flow rate +0%, -10% at which the water heater complies with the requirements of sections 3.3.3 and 4.2.d.
2. Set and maintain incoming temperature at 60 °F ± 2 °F (15.6 °C ± 1.1 °C). Turn on the energy source.
3. Adjust the temperature limit of the water heater such that the temperature at T2 is 105 °F ± 1 °F (40.5 °C ± 0.5 °C), or maintain at the factory setting for non-adjustable water heaters. Flow for 120 seconds.
4. Decrease supply flow rate by 67% in less than 1 second. Flow for 60 seconds.
5. Return supply to flow rate as per 3.3.2.1.
6. Increase the incoming water temperature through the water heater. Increase the water temperature linearly from 60°F ±2°F (15.6°C ± 1.1°C) to 120°F +0 / -5°F (48.9°C +0 / -2.8°C) over a period of 2 minutes and measured at T1. Return temperature as per 3.3.2.3

### 3.3.3 Criteria

1. After the initial 5 seconds following the decrease in flow rate during section 3.3.24, the outlet water temperature shall not exceed 120 °F (49 °C).
2. During the linear increase in water temperature during section 3.3.26, the outlet water temperature shall not exceed 120 °F (49 °C).

## 4. Detailed Requirements

### 4.1 Materials

Water heaters covered by this Standard and that are in contact with drinking water intended for human ingestion shall comply with the applicable requirements of NSF/ANSI 61.

Solder and fluxes in contact with potable water shall not exceed, by mass, 0.2% lead content.

Metal alloys in contact with potable water shall not exceed 8% lead content.

Water heaters intended to convey or dispense water for human consumption through drinking or cooking shall not contain a weighted average lead content in excess of 0.25% when evaluated in accordance with the test method specified in NSF 372.

#### 4.1.1

Pipe connections shall comply with the standards listed in section 1.3 or per local codes.

### 4.2 Installation and Maintenance Instructions

Instructions for installing, adjusting, and maintaining the water heater shall be included with each water heater.

The installation instructions for the water heater shall include the following information:

- a. Inlet and outlet connection sizes.
- b. Manufacturer's maximum working pressures.
- c. The statement: "This product complies with ASSE 1084 for X minutes at Y gpm," where X is defined by the manufacturer, and Y is the maximum flow rate per section 3.1.
- d. Manufacturer's stated minimum temperature rise and the corresponding maximum flow rate.
- e. Manufacturer's stated minimum flow rate and corresponding maximum temperature rise.
- f. Procedure for adjusting the setpoint outlet temperature of the water heater.
- g. Pressure losses at maximum and minimum flow rates.

The instructions shall indicate that the water heater shall be accessible for replacement and repair.

### 4.3 Identification and Markings

Each water heater shall have the following information marked on the label:

- a. Name of manufacturer or trademark.
- b. Model number.

## **5. Definitions**

Definitions not located in this section are located in the Plumbing Dictionary, Sixth Edition, published by ASSE.

Setpoint – the target value for the control system to achieve as an output.

## 6. Appendix A (normative)

Data shall be gathered as follows:

- a) The temperature-recording device shall be started 10 s before the step changes.
- b) Temperature measurements shall be taken at temperature sensors T1 and T2 in Figure 1 with measuring equipment capable of detecting a 63.2% step change within 0.3 s with a frequency rate of 20 Hz (one value every 0.05 s) for  $25 \pm 5$  s unless otherwise specified in this Standard.
- c) Temperature sensors T1 and T2 shall be located as follows:
  - a. temperature sensors T1 and T2 within the flow stream in Type K or Type L copper water tube;
  - b. temperature sensors T1 and T2, within 152 mm (6 in) of the water heater; and
  - c. for water heaters integral to a plumbing supply fitting, temperature sensor T2 shall be within 25 mm (1.0 in) of the discharge outlet to the fixture in the flow stream. For specimens with multiple discharges, the test shall be conducted for each discharge outlet except for the rim flush mode of bidet fittings. The outlet tube shall be the same size as the outlet connection size of the water heater.

## 7. Appendix B (informative)

Per section 1.2.6, the following is a list of applicable standards for water heaters.

Standard	Title
ANSI Z21.10.1 / CSA 4.1	Gas water heaters - Volume I, storage water heaters with input ratings of 75,000 BTU per hour or less
ANSI Z21.10.3 / CSA 4.3	Gas Water Heaters – Volume III, Storage Water Heaters, With Input Ratings Above 75,000 BTU per hour, Circulating and Instantaneous
ANSI Z21.13 / CSA 4.9	Gas-fired low pressure steam and hot water boilers
ANSI-Z21.17 / CSA 2.7	Installation of Domestic Gas Conversion Burners
ASME BPV Code	ASME Boiler and Pressure Vessel Code
CSA B140.7	Oil-Burning Equipment: Steam and Hot Water Boilers
CSA C22.2 No. 0	General Requirements - Canadian Electrical Code, Part II
CSA C22.2 No. 165	Electric Boilers
CSA CAN1-3.1-77	Industrial and Commercial Gas-Fired Package Boilers
NSF 5	Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
UL 1453	Standard for Electric Booster and Commercial Storage Tank Water heaters
UL 174	Standard for Household Electric Storage Tank Water Heaters
UL 2096	Standard for Commercial/Industrial Gas and/or Oil-Burning Assemblies With Emission Reduction Equipment
UL 295	Standard for Commercial-Industrial Gas Burners
UL 499	Electric Heating Appliances
UL 508A	Standard for Industrial Control Panels
UL 726	Standard for Oil-Fired Boiler Assemblies
UL 732	Standard for Oil-Fired Storage Tank Water Heaters
UL 795	Standard for Commercial-Industrial Gas Heating Equipment
UL 834	Standard for Heating, Water Supply, and Power Boilers - Electric