

**INTERNATIONAL ASSOCIATION OF PLUMBING
AND MECHANICAL OFFICIALS**

**EVALUATION CRITERIA
FOR**

**BRACING SYSTEMS FOR WATER
HEATERS**

EC 001 – 2005

1. PURPOSE

- 1.1** The purpose of this standard is to establish a generally acceptable standard for bracing systems for water heaters to wood studs. Its purpose is to serve as a guide for producers, distributors, architects, engineers, contractors, installers, inspectors and users; to promote understanding regarding materials, manufacture and installation; and to provide for identification for installation complying with this standard.
- 1.2** The provisions of this standard are not intended to prevent the use of any alternate material or method of construction provided any such alternate meets the intent of this standard.

2. SCOPE

- 2.1** This standard serves to supplement the provisions of the Uniform Building Code 1997, International Building Code 2003, or other codes adopted by Authority Having Jurisdictions.
- 2.2** This standard covers minimum standards for materials in the construction of bracing systems, and to prescribe minimum test requirements for the performance of bracing systems for water heaters, together with methods of marking and identification.

3. REFERENCED STANDARDS

- 3.1** All standards referenced herein shall be the current edition of that standard or as published in Table 14-1 of the Uniform Plumbing Code.

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|----------------|---|
| ASME A112.18.1 | Plumbing Fixture Fittings |
| ASTM A 653 | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 1008 | Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Superceding ASTM A 366) |

4. DEFINITIONS

- 4.1 Bracing Systems** – A bracing system that prevents the overturning or excessive movement of a water heater in case of seismic activity. Bracing systems shall consist of two restraints each to be located within the top 1/3 and bottom 1/3 of the water heater. Lower strap shall not interfere with controls. Each restraint shall consist of two points of attachment to affix restraint to the wooden studs in the wall, one on each side of the water heater, a strap element that is affixed to the wall attachments and can either extend around the front of the heater or wrap completely around the heater to hold it up against the wall and a method of tensioning or ensuring that slack is removed from the strap element.
- 4.2 Spacer** – Spacers shall be constructed from non-combustible materials and in a manner compliant with codes and the water heater manufacturer's instructions, to provide a support between the water heater and the wall behind it. The spacers shall be located in approximately the same place as the bracing system (one within the top third of the heater and one within the bottom third) and solidly affixed to the wall structure.

5. GENERAL REQUIREMENTS

- 5.1** Brackets and buckles shall be manufactured from minimum 14 gauge (AISI) steel complying ASTM A 653 or ASTM A 1008.
- 5.1.1** Brackets and buckles formed of unfinished steel shall be protected from rust by a finish such as zinc plate, paint, powder coat, etc. and comply with Section 2.2.1(c) Corrosion Test in ASME A112.18.1.
- 5.2 Straps**
- 5.2.1** Polyester Straps shall be no less than 1 3/4" in width and shall have the following specifications that shall be affirmed to by the manufacturer or supplier:
- a) Breaking strength: 2000 - 3000 daN (4400 - 6600 lbs)
 - b) Thickness: 1.1 - 1.6 mm (0.04 - 0.06 inches)
 - c) Webbing is UV resistant
 - d) Melting point of 265°C (509°F) nominal
- 5.2.2** Metal Straps shall be no less than 1 1/2" in width and shall not be less than 24 gauge (AISI) steel complying with ASTM A 653 or ASTM A 1008. Straps of unfinished steel shall be protected from rust by a finish such as zinc plate, paint, powder coat, etc. and comply with Section 2.2.1(c) Corrosion Test in ASME A112.18.1.
- 5.3** Lag Bolts used to attach brackets or straps to the wooden wall studs shall be minimum 1/4" X 2 1/2" and shall be manufactured from heat-treated carbon steel. Graded bolts shall be a minimum SAE-Grade 3. Lag bolts shall be hot-dipped or plated with a suitable finish to resist rust and corrosion and comply with Section 2.2.1(c) Corrosion Test in ASME A112.18.1.

- 5.4 Bracing systems shall be rated to withstand no less than 212°F.

6. TESTING REQUIREMENTS

- 6.1 The bracing system specimens submitted to the laboratory for testing shall be representative samples of the manufactured product. The bracing system must have both static load tests and dynamic load tests performed by the testing laboratory. The test fixture shall include a wood stud wall (straight segment of wall with gypsum board sheathing), the water heater (of a specified size) filled to capacity with water, and the bracing system (installed in accordance with the manufacturer's published installation instructions for the type of construction).

6.2 Static Test

- 6.2.1 A minimum of two static load tests must be performed, the load being applied horizontally approximately at the center of gravity of the water heater. One test must have the horizontal load applied in a direction perpendicular to the supporting wall, and another test must have the horizontal load applied in a direction parallel to the supporting wall. The maximum applied load is equal to 1.1 times (the measured weight of the water heater full of water). The horizontal load in each test is to be applied in increments of 20% of the maximum applied load.

- 6.2.2 **Performance Requirements.** If the bracing system fails below the maximum applied load on either test it shall be found unacceptable. If the test wall fails above 90% of the maximum applied load the bracing system shall be found acceptable. If the test wall fails below 90% of the maximum applied load the test must be repeated.

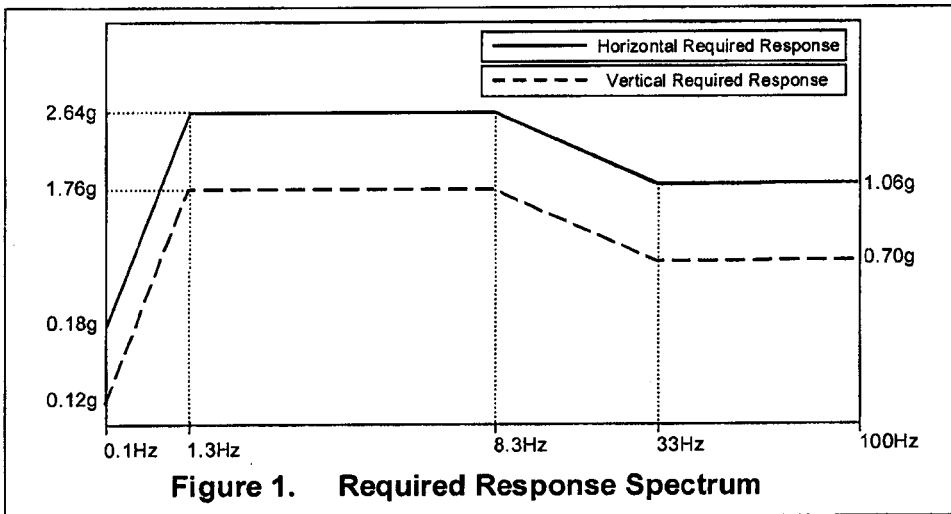
6.3 Dynamic Test

- 6.3.1 **Setup.** The Water Heater Bracing System shall be attached in accordance to the manufactures instructions to the test wall on the shake table, around a filled water heater in a manner that simulates in service mounting. The following describes the two setups required for biaxial or vector biaxial shake table testing; setups may be performed in either order. For one test the fixture shall be oriented in the X-Y axis, such that the horizontal input is perpendicular to the simulated flat wall. For the other test (Z-Y axis) the fixture shall be rotated such that the horizontal input is parallel to the simulated flat wall of the test fixture. Alternatively, if the test is performed using a true independent triaxial shake table, all testing (X, Y and Z axes) may be done in one setup, without the need for rotating the fixture. Accelerometers shall be used to on the seismic table (control) and on the water heater (response) to record test.

- 6.3.2 **Resonance Search.** A Low level (approximately 0.1g horizontally and vertically) sine sweep may be performed prior to seismic testing to establish major resonances, in order to assist with determining the appropriate RRS adjustments which may be allowed, if any, per Section 6.3.3 of this standard. The sweep shall be from 1 to 33Hz at a rate of one octave per minute. Record measurements from control and response accelerometers.

- 6.3.3 **Seismic Test.** Seismic test shall be conducted non-coherent or vector biaxially; each

horizontal axis is excited separately but each axis is excited simultaneously with the vertical axis. The bracing system shall be subjected to a seismic random motion with its amplitude controlled in one-third octave increments from 1 to 33Hz; phasing shall not be coherent (unless testing vector biaxially). The duration of the motion shall be 30 ± 4 seconds, with an input signal build-hold-decay envelope of 5 seconds, 15 seconds, and 10 seconds, respectively. Required Response Spectrum (RRS) is as shown in Figure 1, where the RRS is valid for both horizontal axes:



If it is shown by use of the resonance search in Section 6.3.2 that no resonance response phenomena occur below 6 Hz, it is required to envelop the RRS only down to 3 Hz. Excitation shall be maintained in the 1 Hz to 3 Hz range, up to the maximum limits of the shake table. If there are resonances below 6 Hz the test shall envelop the response spectrum only down to 65 percent of the lowest frequency of resonance. Any failure to envelop the RRS above 3 Hz shall be justified.

6.3.3.1 Analysis of the test table motion shall be performed with a response spectrum analyzer set to a damping ratio of 5% of critical at one-sixth octave intervals from one to 100 Hz. Control and response accelerometer outputs shall be recorded and plotted for each run.

6.3.4 Performance Requirements. If the bracing system fails at any time during the dynamic test it shall be deemed unacceptable. If the test wall fails during seismic testing the interrupted test must be repeated.

6.4 Water Heater Volume Rating

6.4.1 Bracing system shall be rated for use on water heaters up to the size of the heater used in testing.

6.4.2 If desired, and agreed to by the testing facility, a smaller water heater can be used to test for a larger water heater as long as the increase results in a water heater that when filled with water is no more than 20% greater in weight than the water heater tested. In

order for such a replacement to be made the force levels in both the Static and Dynamic tests shall be recalculated in order to account for the change in weight.

6.4.3 Example to increase rating from 100 gallon to 120 gallon water heater. A 100 gallon water heater when full of water weighs 1,100 pounds. This is a standard gas heater. There is another water heater that is built on the same basic frame (same height and diameter) that is an electric heater. The electric heater has more room for water internally and is classified as a 120 gallon water heater. The weight of a full 120 gallon water heater is 1,257 pounds, a 14% increase. The test lab can account for the extra 157 pounds of the 120 gallon water heater by raising the force requirement on the static test and g-level of the RRS on the dynamic test by 14% on the static and dynamic tests. This would allow the bracing system manufacturer to rate their bracing system for water heaters up to 120 gallons.

7. MARKINGS & IDENTIFICATION

7.1 All bracing systems shall permanently bear the following marking:

a) Manufacturer's name or trademark.

7.2 Installation instructions shall provided and clearly indicate the following;

- a) Water heater shall be secured against the spacer(s);
- b) Lag bolts must attach to studs, and cannot attach to spacer(s);
- c) Utilities behind wall may present a hazard to installer;
- d) Product may be used unless materials or method would violate water heater manufacturer's instructions;
- e) Lower strap shall not interfere with controls.

Adopted: July 22, 2005