

PMG LISTING CRITERIA FOR FLEXIBLE PIPING FOR SOLAR THERMAL APPLICATIONS

LC1029

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PREFACE

Plumbing, mechanical and fuel gas (PMG) listings issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the *International Plumbing Code*®, *International Mechanical Code*®, *International Residential Code*®, *Uniform Plumbing Code* and *Uniform Mechanical Code*. Section 105.2 of the *International Plumbing Code*® reads as follows:

Alternative materials, methods and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material or method of construction shall be approved where the code official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes.

ICC-ES may consider alternate listing criteria, provided the listing applicant submits valid data demonstrating that the alternate listing criteria are at least equivalent to the listing criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew a listing, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Listing criteria are developed solely for use by ICC-ES for purposes of issuing ICC-ES PMG listings.

1.0 INTRODUCTION

1.1 **Purpose:** The purpose of this listing criteria is to establish requirements for the use of corrugated stainless steel tubing (CSST) serving in a solar collection system to be recognized in an ICC Evaluation Service, LLC (ICC-ES), listing. Solar collection equipment controls and pumps are excluded from this criteria. Tubing shall not be used in potable water system.

1.2 **Scope:**

This listing criteria defines test methods and performance requirements applicable to corrugated stainless steel solar thermal distribution systems, and covers general requirements and performance tests for such products in addition to methods of markings and identification. Components within this system include CSST insulated as well as metallic fittings, intended for a maximum working pressure of 150 psi (1034.2 kPa) service up to and including a maximum working temperature of 300°F (149°C).

1.3 **Codes and Referenced Standards:**

1.3.1 2009 and/or 2006 *International Residential Code*® (IRC), Chapter 21, Hydronic Piping, International Code Council.

1.3.2 2009 and/or 2006 *International Mechanical Code*® (IMC), Chapter 12, Hydronic Piping, International Code Council.

1.3.3 2009 and/or 2006 IAPMO *Uniform Mechanical Code*™* (IAPMO UMC), Chapter 12, Hydronics, International Association of Plumbing and Mechanical Officials.

1.3.4 ASME B 1.20.1, Pipe Threads, General Purpose (Inch), American Society of Mechanical Engineers.

1.3.5 ASTM A 240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications, ASTM International.

1.3.6 ASTM C 518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, ASTM International.

Note: Any standard referenced herein shall be the current edition of that standard. In instances where the applicable code references a different edition of a given standard, the applicant shall also provide documentation of conformance with the code-referenced standard edition.

2.0 BASIC INFORMATION

The following basic information shall be provided:

2.1 Material Requirements:

2.1.1 Corrugated Stainless Steel Piping

The stainless steel materials for the corrugated stainless steel piping shall be a minimum T316 or T316L complying with the requirements of ASTM A 240.

2.1.2 Insulation

Insulation materials, when provided, shall have a maximum K-value of 0.27 Btu in / ft² hr °F at 75° per ASTM C 518.

2.1.3 End Fittings

End fitting material shall be either alloy 360 or 377 brass or 300 series stainless steel.

2.1.4 Coatings

Coatings applied to the exterior of insulation, or the exterior of tubing, shall be polypropylene material complying with the requirements in ASTM D 4101, or polyethylene material complying with the requirements in ASTM D 3350, or other materials with a minimum thickness of 0.045 inch.

2.2 **Installation Instructions:** The product shall be installed in accordance with the manufacturer's instructions and the requirements of the applicable codes and referenced standards noted in Section 1.3.

2.3 **Product and Packaging Identification:** Piping shall be marked at minimum 3-foot intervals with the information below:

2.3.1 Manufacturer's name or logo

2.3.2 Nominal size

2.3.3 Manufacture date

2.3.4 The ICC-ES PMG[®] listing mark. Additionally, the ICC-ES listing number shall be placed on the listed product's packaging or installation instructions.

3.0 TEST METHOD AND PERFORMANCE REQUIREMENTS

3.1 **Test Assemblies:** Test assemblies shall, at a minimum, consist of six lengths of piping and five fittings (such as couplings, elbows and end connections) assembled in accordance with the manufacturer's instructions. A separate assembly shall be tested for each size of tubing to be recognized in the listing.

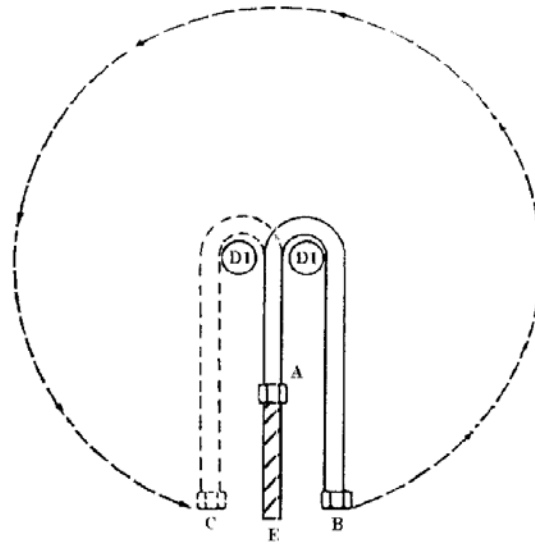
3.1.1 **Leakage Test:** The test specimen shall be internally pressurized to 1.5 times the manufacturer's rated pressure, at a temperature of $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($20^{\circ}\text{C} \pm 3^{\circ}\text{C}$). It will be held at this pressure for a period of five minutes. No signs of leakage shall occur.

The same test specimen shall then be internally pressurized to 1.5 times the manufacturer's rated pressure at a temperature of $300^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($149^{\circ}\text{C} \pm 3^{\circ}\text{C}$). It will be held at this pressure for a period of five minutes, with no signs of leakage occurring.

Note: For testing, if the heat transfer fluid cannot reach the target temperature, a substitute or suitable fluid shall be used.

3.1.2 **Hydrostatic Strength Test at 68°F (20°C):** The test specimen shall be filled with water and the internal pressure increased to four times the manufacturer's rated pressure, at a temperature of $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($20^{\circ}\text{C} \pm 3^{\circ}\text{C}$). It will be held at this pressure for a period of five minutes. No signs of leakage shall occur.

3.1.3 **Bending Test:** The test specimen shall be bare corrugated piping at least 2 feet (610 mm) in length, randomly selected from specimens assembled per the manufacturer's instructions. One end of the sample shall be securely attached to a fixed pipe to which an air supply is connected. The other end shall be closed air-tight until a pressure equivalent to the rated operating pressure is obtained. Two mandrels whose radius is per the minimum bend radius specified shall be placed, one at each side of the fixed end of the sample, in contact with the sample fitting and with centerlines opposite the inner end of the internal or external retention skirt. The sample shall be bent into the starting position, as in Figure 1, and the unattached end then bent by hand from the position indicated by "B" along the path shown by the dotted circle to position "C." It shall then be bent back to the starting position. Each bending (as from "B" to "C" or from "C" to "B") shall be constituted as one cycle. This process shall be repeated until six cycles have been completed, the bending motion being applied uniformly at a rate of 5–6 cycles per minute. No signs of leakage shall occur during the test sequence.



- A - Fixed end.
- B - Position of free end at start of cycle.
- C - Position of free end at completion of cycle.
- D - Mandrel.
- E - Fixed pipe.

FIGURE 1

3.1.4 **Flattening Test:** A specimen of bare corrugated piping at least 2 feet (610 mm) long shall be prepared. One end of the sample shall be securely attached to a fixture to which a pressure equivalent to the rated operating pressure is obtained. The other end shall be plugged closed. The specimen is inserted into two flat plates with the welded end set to 90 degrees opposite of the pressing direction (see Figure 2). The tube shall be pressed to $\frac{2}{3}$ D height of the outer diameter until the tube is flat. No signs of cracks or leakage shall be found.

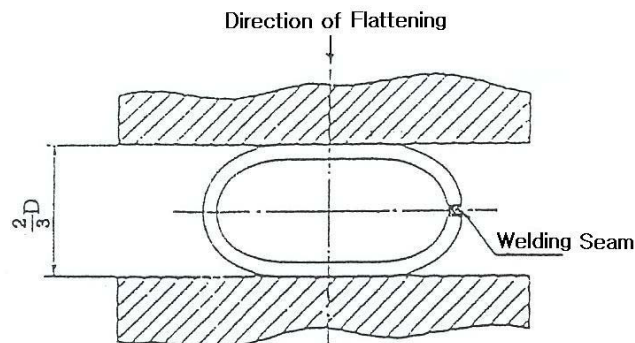


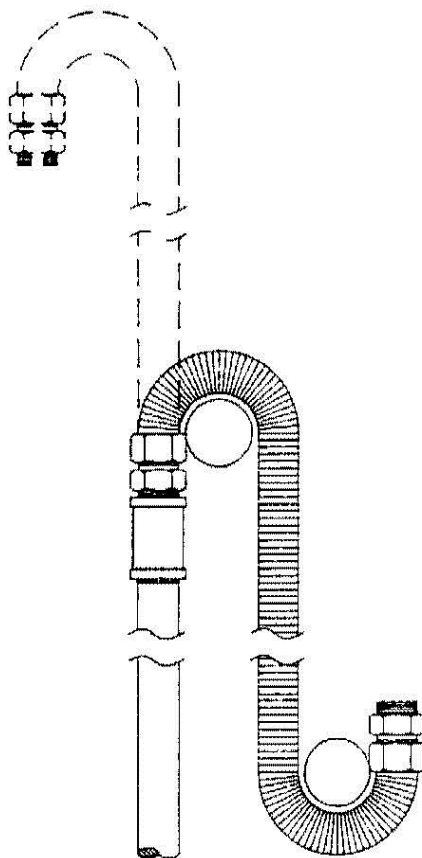
FIGURE 2

3.1.5 Torsion Strength of Threaded Fittings: Each type of threaded fitting shall be assembled in accordance with the manufacturer's installation instructions to its mating half or other fitting as intended. One end of the assembly shall be connected leak-tight to an air supply system which includes a pressure gage. The other end of the assembly shall be sealed. The assembly shall be internally pressurized to the manufacturer's rated pressure. Each threaded connection in the assembly, including any pipe thread connections, shall then be tightened by the application of a torque of 1040 in-lb (117.5 N m) per inch of nominal tubing inside diameter. No signs of cracks or leakage shall be found.

3.1.6 Resistance to Freezing and Thawing: The "S" shaped tubing assembly and test setup described in Figure 3 shall be used for this test. The assembly shall be mounted in an environmental chamber in the vertical position and pressurized at 1.5 times the rated pressure throughout the test. With the environmental chamber initially at $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($10^{\circ}\text{C} \pm 1^{\circ}\text{C}$), the entire test assembly shall be sprayed for one minute with a fine spray of water. The temperature of the test chamber shall be reduced to $-40^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($-40^{\circ}\text{C} \pm 1^{\circ}\text{C}$) within a period of 30 minutes following the spraying. The temperature of the test assembly shall be allowed to cool to $-40^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($-40^{\circ}\text{C} \pm 1^{\circ}\text{C}$), as indicated by the thermocouple attached to end fitting. After reaching chamber temperature, the assembly shall be maintained at a temperature of $-40^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($-40^{\circ}\text{C} \pm 1^{\circ}\text{C}$) for one hour, after which the chamber temperature shall be increased to $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($10^{\circ}\text{C} \pm 1^{\circ}\text{C}$) within a period of 30 minutes. The temperature of the test assembly shall then be allowed to warm to $50^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($10^{\circ}\text{C} \pm 1^{\circ}\text{C}$), and shall be held at that temperature for one hour. The cycle of spraying, freezing and thawing shall be repeated continuously for a total of 25 cycles. No signs of leakage shall occur during the test sequence.

The entire test shall be repeated with the tubing assembly mounted with the bends in a horizontal plane.

3.1.7 Vibration Test: Two specimens, at least 2 feet (610 mm) in length, shall be fabricated and subjected to a hydrostatic pressure of 14.7 psi (101.3 kPa). Each sample is to be fitted with pipe plugs, filled with water in such a manner as to exclude all air and connected to a hydrostatic source. The samples are to be extended to their intermediate position, locked, filled with water, and mounted in the pendant position on a test fixture attached to the table of a vibration machine. The amplitude of the vibration is to be 0.2 inch (5 mm), and the frequency is to be 25 Hz for three hours. No signs of leakage shall occur.

**FIGURE 3****4.0 LISTING RECOGNITION**

- 4.1 Installation shall be in accordance with the manufacturer's instructions and the applicable code.
- 4.2 Pressure relief valves, with a relief setting, shall be provided for each system.
- 4.3 Connections with the potable water system must be protected as required by the applicable code.
- 4.4 The system must be protected from freezing.
- 4.5 Water hammer shall be considered in the design when the system operates at or above 80 psi.