ICC EVALUATION SERVICE
Most Widely Accepted and Trusted

www.icc-es.org/pmg | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

PMG LISTING CRITERIA FOR

CORRUGATED STAINLESS STEEL TUBING UTILIZING A PROTECTIVE JACKET (A MINIMUM 4.5 COULOMB CHARGE TRANSFER)

LC1024

Approved February 2010 (Revised February 2012, Revised July 2016)

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:

> **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 the effectiveness of a protective exterior jacket factory-applied to corrugated stainless steel tubing (CSST) which is currently recognized as code-complying in another ICC-ES PMG listing report. The exterior jacket is intended to protect the inner CSST from leakage due to transient arcing (a minimum 4.5 Coulomb charge transfer) from exposure to lightning voltage/currents that may exist inside a building; utilize the appliance bond as the sole bonding method; and be recognized in an ICC Evaluation Service, Inc. (ICC-ES) listing. This listing criteria addresses a proposed level of arcing from lightning, not a direct strike.

1.2 Scope: This listing criteria defines test methods and performance requirements applicable for evaluating simulated indirect lightning resistance of a protective exterior jacket factory-applied over CSST which is currently recognized in an ICC-ES PMG listing. The lightning-resistant CSST system, for use in fuel gas piping, is intended for use in normal installations when installed in compliance with the manufacturer's instructions and with Sections 309 and 310 of the *International Fuel Gas Code*© and Sections G2410 and G2411 of the *International Residential Code*©.

1.3 Codes and Referenced Standards:

Note: Any standard/code referenced herein shall be the current edition or version adopted by the jurisdiction.

1.3.1 *International Residential Code*© (IRC), Chapter 24, Fuel Gas, International Code Council.

1.3.2 *International Fuel Gas Code*© (IFGC), International Code Council.

1.3.3 *Uniform Plumbing Code*™* (IAPMO UPC), Chapter 12, Fuel Gas Piping, International Association of Plumbing and Mechanical Officials.

1.3.4 *Uniform Mechanical Code*™* (IAPMO UMC), Chapter 13, Fuel Gas Piping, International Association of Plumbing and Mechanical Officials.

1.3.5 ANSI LC 1 / CSA 6.26, Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST) Fuel Gas. American National Standards Institute.

2.0 BASIC INFORMATION

The following basic information shall be provided:

2.1 Product Description: The product consists of corrugated stainless steel tubing (CSST) and brass fittings for fuel gas piping systems recognized in another current ICC-ES PMG listing as conforming to ANSI LC 1 / CSA 6.26, and satisfying the referenced codes listed in Section 1.3, but, with a different covering. The CSST is covered with an electrically conductive protective jacket.

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 listed in Section 1.3.

2.3 Product and Packaging Identifications: The unit and the package shall be permanently and legibly marked with the manufacturer's name or trademark, and the model number. The product shall also bear the ICC-ES PMG listing mark. The ICC-ES listing number shall be placed on the listed product's packaging or installation instructions.

3.0 GENERAL REQUIREMENTS

3.1 Corrugated Stainless Steel Tubing: Corrugated stainless tubing shall be currently recognized in an ICC-ES PMG listing as complying with the requirements of ANSI LC 1 / CSA 6.26.

3.2 Electrically Conductive Protective Jacket: The jacket may consist of a single or multi-layers as designed by the manufacturer and shall be tested in accordance with Section 4.0 of this standard.

4.0 TEST METHOD AND PERFORMANCE REQUIREMENTS

4.1 Testing: Testing shall be performed by an International Accreditation Service (IAS) recognized lightning testing laboratory or by a signatory to a Mutual Recognition Agreement to which IAS is a signatory.

4.2 Specimen Conditioning: The specimen used for testing shall be previously subjected to a 96-hr corrosion test conducted in accordance with ASTM B117 without evidence of pitting, flaking, cracking or signs of corrosive attack. The specimen must include the protective jacket on a section of CSST and be joined to a fitting in accordance with the manufacturer's installation instructions.

Note: Additional conditioning is only applicable to specimens that contain any metallic components that were not previously evaluated in accordance with ASTM B117 under ANSI LC1. These specimens shall also be tested with fittings installed in accordance with manufacturer's instructions.

4.3 Test Wave Forms: The waveform is defined by its rise-time to peak current and fall-time to 50% of peak amplitude. The applied current wave form shall be determined by the lightning laboratory and shall be representative of induced lightning effects that could appear on gas piping inside a building. For the purposes of this listing criteria, the assumed energy associated with a transient arc inside a building is less than two coulombs and the recognized CSST system must resist a minimum of 4.5 coulombs, which includes a factor of safety in excess of 2, when tested as noted in this listing criteria. A typical current wave form is shown in Figure 1.

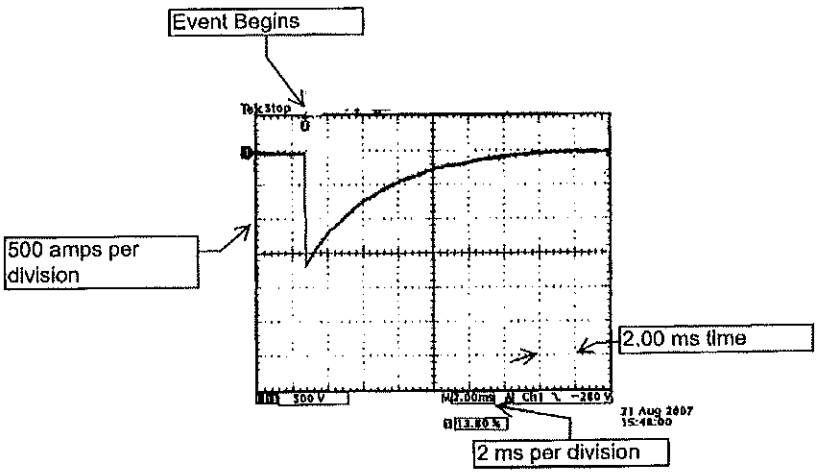

FIGURE 1—TYPICAL CURRENT WAVE FORM

4.4Test Procedures: The procedures noted below shall be used to evaluate the performance of CSST piping. Testing shall be conducted on two samples each of the smallest, largest and an intermediate diameter tubing to qualify all sizes. The minimum performance criteria shall be 1,000 amps minimum peak delivering 4.5 coulombs within 20 milliseconds (0.020 seconds). Following exposure to this level

of arcing, the sample shall be pressure-tested to 5 PSI for 1 minute with air and submerged in water without signs of leakage.

4.4.1Calibration: A test generator is configured to produce and measure the desired current waveform. An appropriately sized copper pipe is installed $^1/_8$ inch underneath the generator's test electrode and grounded to the generator return with a minimum AWG 6 wire or braided strap. The generator is charged to the appropriate level. The generator is then discharged through the copper pipe, and the applied current waveform is recorded. The generator is verified as producing the desired current waveform. The measured current waveform is integrated to determine the applied charge to the copper pipe. The current waveform and charge transfer waveform are recorded. If the high current generator does not yield the desired current waveform or charge transfer, the generator is reconfigured, and the calibration procedures are repeated. The copper pipe is removed from the generator.

4.4.2 Testing:

4.4.2.1 Arcing Resistance: A minimum 3-foot-long CSST test article is installed at least $^1/_8$ inch beneath a $^1/_4$-inch-diameter test electrode. The electrode shall be placed at least 12 inches from the ends of the test article. The brass fitting or inner stainless steel piping of the CSST is grounded to the generator return using a minimum AWG 6 wire or braided strap. A dielectric may be required underneath the test article to ensure the test currents flow along the length of the test article and not to the test bench or support equipment. The lightning generator is charged to the appropriate level, and is then discharged to the test article. If the test generator does not discharge to the test article, it shall be confirmed that sufficient voltage is present to achieve dielectric breakdown of the jacket (energy enter the jacket and not to ground) and adjustments are made accordingly. It is verified that the test current enters the protective jacket and did not arc to any exposed tubing or fittings on either end of the test article. If all or a portion of the test current arced to the exposed ends or fittings of the test article, the test is invalid and must be repeated. The applied current waveform is recorded. The measured current waveform is integrated to calculate the applied charge. If the calculated applied charge is equal to or greater than the values stated in Section 4.4, the applied charge transfer is recorded. The jacket is cut away from the test article at the test location and a visual inspection of the tubing is made to determine if the stainless steel tubing is punctured. If no puncture of the tubing is

noted on visual inspection, the test article shall be pressure-tested to the requirements of Section 4.4. If the test article fails visual inspection or pressure test after being subjected to the required applied charge, the test article fails. If the calculated applied charge is less than the values stated in Section 4.4, the test is performed again at a different location on the same test article, or another test article from the same production lot, until the calculated applied charge requirements are satisfied. The test article is deemed to have passed if all of the requirements are met. In order to achieve a listing to this standard, no test articles can fail this test routine. See Figure 2 for test schematic.

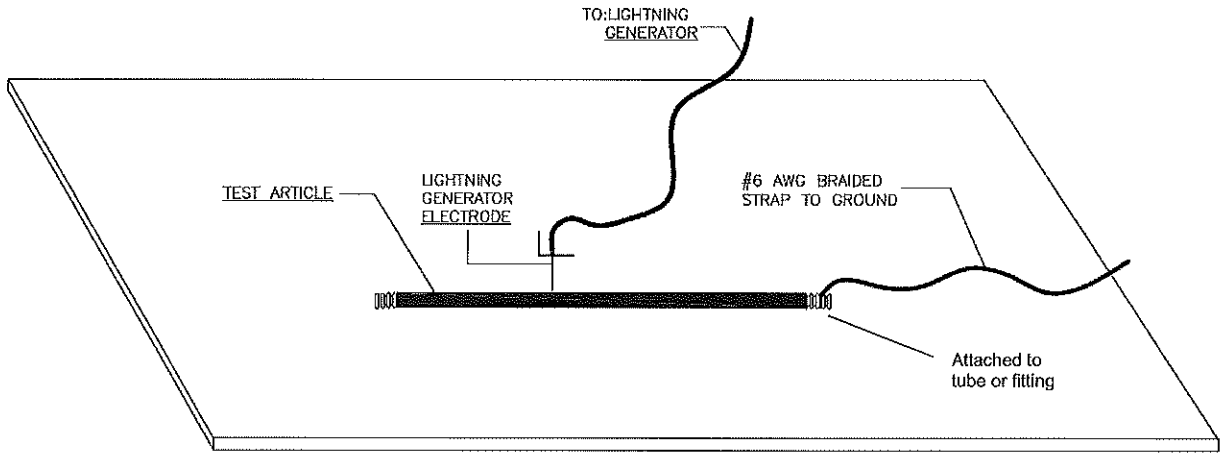

FIGURE 2—TEST SCHEMATIC

4.4.2.2 Bonding Equivalence: For the purpose of evaluating the conductive jacket for resistance to transient arcing using different bonding methods, testing in accordance with this section shall be performed using a simulated appliance consisting of:

1. A steel sheet metal chassis
2. An NPT connection point for the CSST
3. An electrical box with a minimum 10-foot-long, #14 AWG bonding conductor attached
4. A bonding clamp attached to the fitting on the free end of the CSST and a minimum 10-foot-long, #6 AWG bonding conductor

A minimum of two samples of an intermediate size of CSST shall be tested using the following configurations:

1. The #14 AWG conductor as the bond
2. The #6 AWG conductor as the bond
3. Using both as the bond

If the test results for all three configurations comply with Section 4.4.2, bonding of the conductive jacketed corrugated tubing, using a #14 AWG appliance bond, shall be deemed equivalent to using a #6 AWG bond required by IFGC 310.1.1. See Figure 3 for a test schematic.

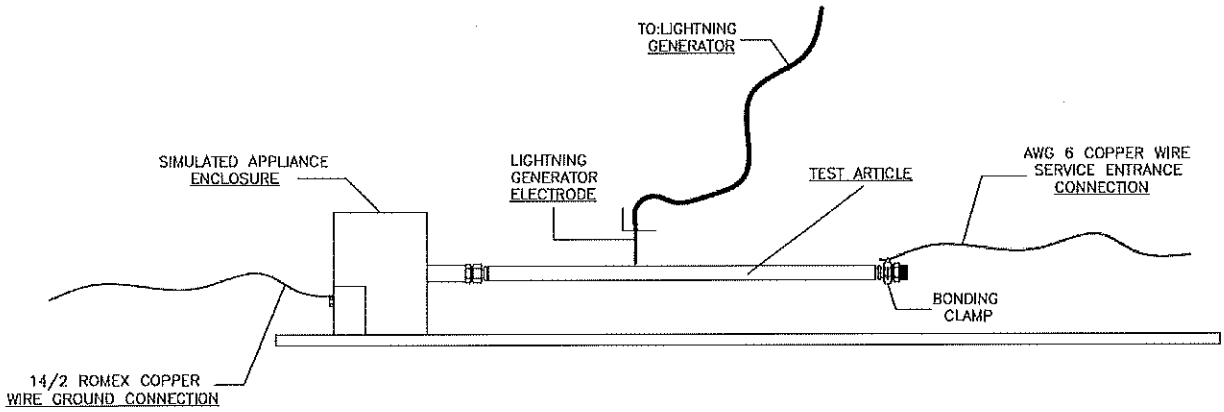

FIGURE 3—TEST SCHEMATIC

4 LISTING RECOGNITION

4.2 Installation shall be in accordance with the manufacturer's instructions and the applicable code.

4.3 The listing shall state that the documented level of resistance to arcing is 1000 amps minimum peak delivering 4.5 coulombs within 20 milliseconds (0.020 seconds).

4.4 The listing shall state the covering has been tested in accordance with ASTM E 84 and meets the minimum ratings of 25 for flame spread and 50 for smoke developed.

4.5 Upon documentation of satisfactory passing of tests noted in Section 4.4.2.2 of this criteria, the listing shall state the following: "Electrical Bonding: The Conductive Jacketed Corrugated Stainless Steel Tubing System is electrically continuous and is considered to be bonded where it is connected to appliances that are connected to the equipment grounding conductor of the circuit supplying that

appliance. Additional bonding prescribed by Section 310.1.1 is not required for Conductive Jacketed Corrugated Stainless Steel Piping Systems when installed in accordance with this listing."