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CodeNotes™

Bonding of Corrugated Stainless Steel Tubing (CSST) Gas Piping System

Based on the 2018 International Fuel Gas Code® (IFGC®)

General

The permanent bonding of corrugated stainless steel tubing (CSST) piping system directly to the grounding electrode system of the structure in which the CSST is installed will lower the voltage build-up on the CSST caused by unintentional energizing from outside sources such as power surges and lightning strikes. The bonding will help achieve an equi-potential state between the CSST and other similarly bonded metallic systems (such as the water piping, structural steel, electrical raceways and coax cable). The bonding will help reduce the possibility and/or severity of arcing between these conductive systems when energized by a lightning strike on or nearby the premises.

The 2018 editions of the *International Fuel Gas Code* and the *International Residential Code* include revisions to the requirements for the electrical protection of corrugated stainless steel tubing either by installation of an extra bonding connection (Section 310.2) or by the use of a listed arc-resistant jacket (Section 310.3) in accordance with the national ANSI LC-1 Standard. The installation of an extra bonding conductor is in addition to the bonding required in Section 310.1 for ground fault protection. The arc-resistant jacket is subject to special performance testing contained in both the ANSI LC-1 Standard and the listing criteria specifications issued by the ICC Evaluation Service. The following summary highlights the various steps, hardware and practices needed for the successful electrical protection of the CSST gas piping system using both approaches.

Grounding vs. Bonding

Ground: A direct connection to the earth. Only the electrical distribution system is grounded.

Bonding: A conductor intentionally installed to electrically connect metallic gas piping to the grounding electrode system to create a low-impedance pathway to ground.

Grounding Electrode: Electrodes must be metallic and in contact with the Earth. The following items are typically used as electrodes:

- Plates
- Rods
- Structural steel
- Concrete encased reinforcing steel

All electrodes used on the premises must be bonded together into one common grounding electrode system. A separate grounding electrode and grounding system must not be established just for the fuel gas piping system.

Grounding Electrode System: The system includes all of the grounding electrodes and the grounding electrode conductors. The installation of the grounding electrodes and grounding systems is generally the responsibility of the electrical contractor and electrical inspector.

Bonding Conductor

The bonding conductor can be a solid or stranded copper or aluminum conductor. The conductor can be installed indoors or outdoors.

Example of Bonding Conductor

The bonding conductor must not be smaller than a 6 AWG copper wire or the equivalent size if made of aluminum.

The means for attaching the bonding conductor to the grounding electrode system must be in accordance with NFPA 70.

The bonding conductor must be not longer than 75 feet (22,860 mm). The location of the bonding clamp on the gas piping system must be selected so as to comply with the maximum allowable conductor length. In general, the shortest bonding conductor will be the most effective.

Grounding Electrode Connection

Bonding Clamp and Locations

The bonding conductor must be attached to the CSST gas piping system downstream of the point of delivery (either the natural gas meter or the LP 2nd stage regulator). The bonding clamp can be located at any location within the piping system. In general, the shortest bonding conductor will be the most effective.

Bonding at the Service Entrance

Bonding at the Downstream LP 2nd Stage Regulator

The corrugated stainless steel tubing must never be used as a point of attachment of the bonding clamp.

Only a single point of attachment is required regardless of the length or complexity of the piping system. A CSST piping system is considered to be electrically continuous (using CSST and other code-approved piping materials) and requires only one bonding clamp.

A HISTORY NOTE:

Corrugated stainless steel tubing (CSST) originated in Japan as a solution to damaged gas piping caused by earthquakes.

Thank you, Omega Flex, Inc., for allowing use of the photos on pages 2, 3, and 4.

The conductor must be attached to the piping system using a listed bonding clamp in accordance with UL 467. The bonding clamp must be accessible and can be located outdoors or indoors.

The bonding clamp can be attached to a length of rigid pipe, a malleable iron pipe fitting, a prefabricated manifold, or a brass CSST fitting. The clamp used must be listed for the location and type of mechanical attachment. Bonding clamps exposed to the weather must be listed for such application.

Bonding of CSST Gas Piping

Where the clamp is attached to rigid pipe, the pipe surface must be clean and free of paint and coatings to permit a metal-to-metal connection.

Clamp Attachment on CSST Fitting

Piping System Considerations

Existing steel or copper piping systems must be retroactively bonded when modified by adding yellow (non-arc-resistant) CSST to the system regardless of the length of CSST added. If any segment or portion of a piping system contains CSST, then the entire piping system is treated as if it was all CSST. Piping systems assembled using arc-resistant CSST must include only arc-resistant CSST or otherwise be bonded in the same manner as conventional yellow CSST.

Example of Multi-piping Material System

ICC Evaluation Service PMG Listing Directory

For additional information on the installation of CSST from specific manufacturers, please search the ICC-ES PMG Listing Directory at **www.icc-es-pmg.org**. An ICC-ES listing is a document issued on a product that has demonstrated compliance with the specified standard and has also demonstrated compliance with one or more of the following codes: *International Plumbing Code®*, *International Mechanical Code®*, *International Fuel Gas Code®*, *Uniform Plumbing Code®*, *Uniform Mechanical Code®* or *International Residential Code®*. ICC-ES also has Listing Criteria(LC) that can be used for PE sleeved CSST, Conductive Jacketed CSST, and Protective Jacketed CSST.

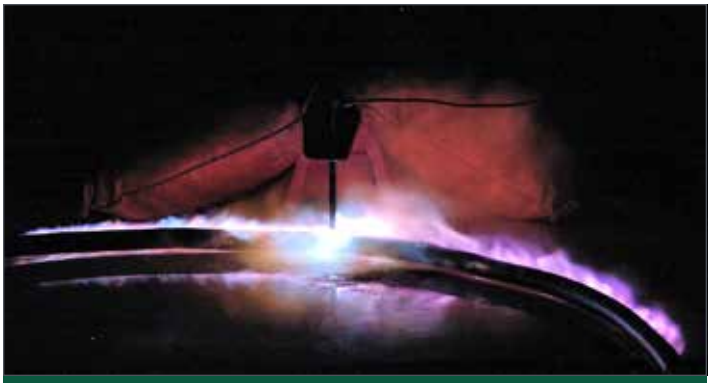
For complete coverage of the IFGC, please contact the International Code Council to order the *International Fuel Gas Code, International Residential Code*, the *IFGC* or *IRC Code and Commentary*, and other code support publications.

www.iccsafe.org/store | 1-800-786-4452

Arc-Resistant CSST

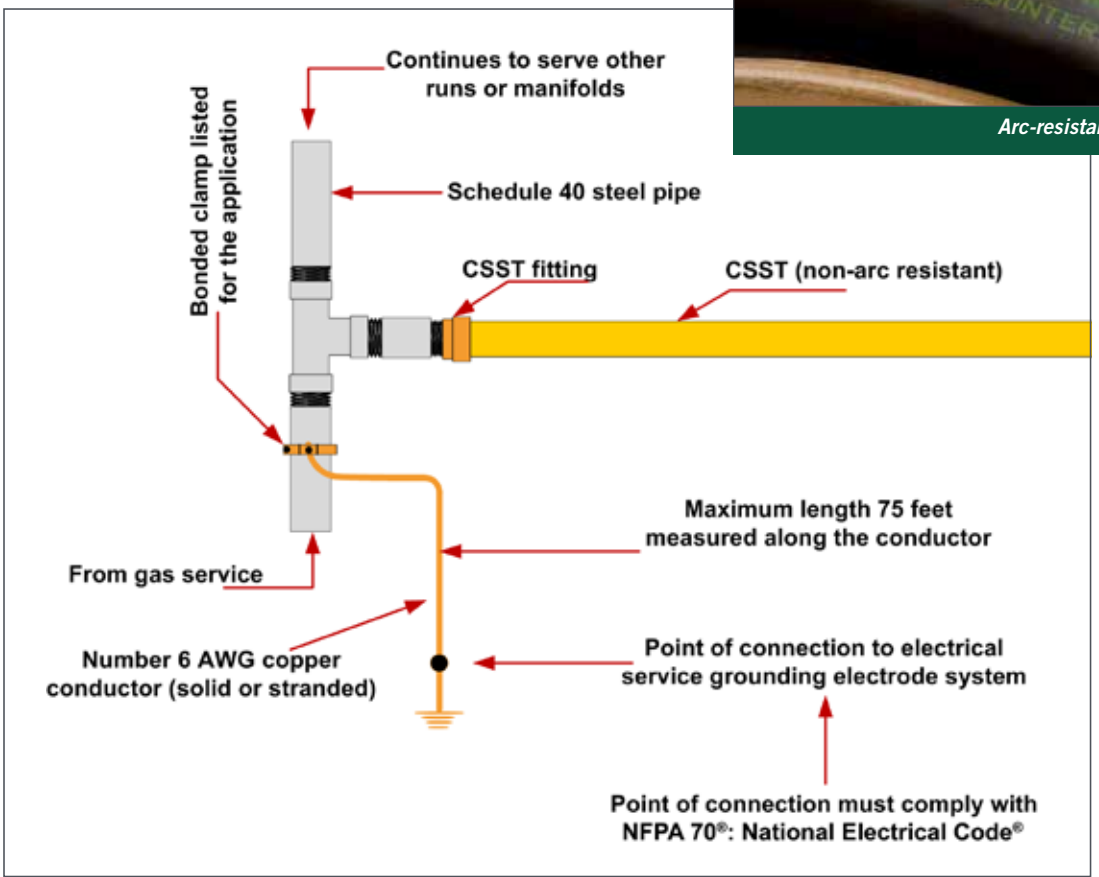
Arc-resistant CSST is characterized by a thick black jacket designed to absorb arcing energy caused by lightning and intends to prevent perforation of the tubing wall. The jacket provides equal protection along the entire length of the piping system, and the extra bonding described in this CodeNotes is not required. The electrical protection afforded by the arc-resistant jacket has been shown to be equal to or greater than the electrical protection provided by the bonding conductor. Ground fault protection of arc-resistant CSST is handled in the same manner as steel pipe, and depends only on the presence of an equipment grounding conductor contained within a branch circuit which powers one or more of the gas appliances served by the piping system.

For jurisdictions using an earlier edition of the IFGC, the bonding requirements for arc-resistant CSST (black jacket) are the same as for the yellow jacket CSST except where the AHJ allows otherwise based on the jurisdiction's authority under the alternate approval provisions of the code.



Dissipating Arcing Energy within Arc-Resistant Jacket

Arc-resistant CSST



Bonding Jumper length