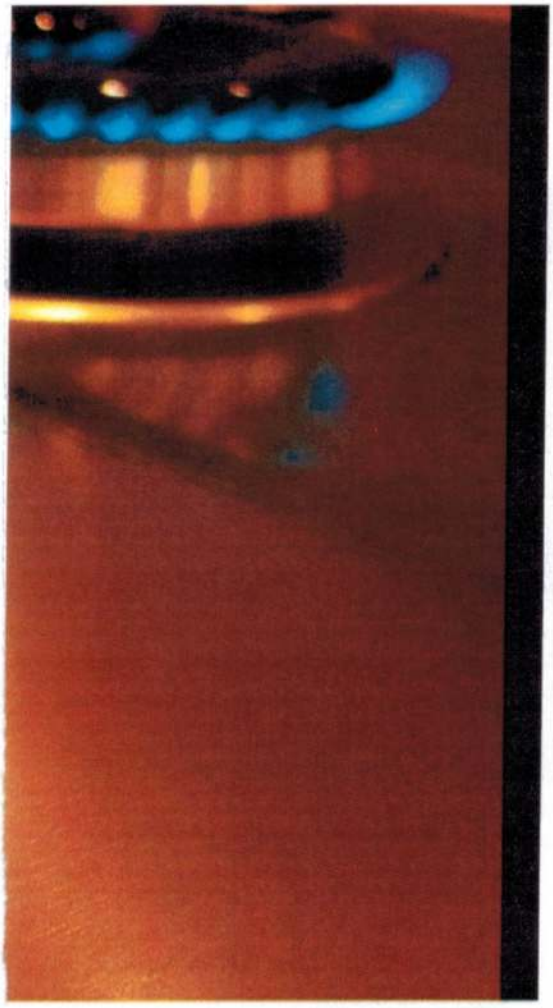
How the **Bottom Line** is Changing

Residential Gas Systems

Part 1 of 2

Traditionally, natural gas systems have been installed in homes by connecting rigid steel-threaded pipe and fittings. Though for decades black steel has been the most popular material used to carry out this work, many jurisdictions allow galvanized steel to be used as well.

In recent years, the high labor costs required to install rigid pipe has motivated many contractors to switch to alternative piping materials. Copper tubing and CSST have become the materials of choice for many installers. For some, the solution has been 2-psig systems. We'll discuss the first two this month and 2-psig systems next month.



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Key Concepts

- ✔ Copper tubing and corrugated stainless steel tubing (CSST) are less expensive to install than steel pipe.
- ✔ Copper tubing can be purchased in 50-foot coils and does not require a fitting at every change in direction; therefore, it saves the installer time and money while reducing the threat of leaks.
- ✔ CSST is semi-flexible, lighter than conventional steel gas pipe and uses self-sealing fittings at the joints.
- ✔ Because of concerns over corrosion and flaking of copper tubing, copper is not allowed for use on natural gas work in some localities.
- ✔ Studies conclude that for some, the concerns with copper tubing either are unjustified or can be overcome.
- ✔ CSST manufacturers and code authorities require special bonding connections that may reduce the risk of damage and fire due to lightning.
- ✔ It is unlikely home inspectors will see complete residential gas jobs installed with copper tubing or CSST, so they need to be adept at identifying the different materials used and understand how they are connected, supported and protected.
- ✔ For both copper tubing and CSST, inspectors should be aware of the position of the authorities having jurisdiction in their area and guide themselves accordingly.

By Kenny Hart, ACI and
Alan Carson, ASHI past-president

Copper tubing use for natural gas systems can be controversial

At one time, copper tubing was widely accepted for natural gas systems. According to the *Official*, a magazine published by the International Association of Plumbing and Mechanical Officials (IAPMO), it was removed from many codes because of concerns about the tubing's vulnerability to mechanical damage and corrosion, both internally and externally.

External Corrosion

The IAPMO article also points out that the codes addressed the vulnerability concern with strict installation guidelines. Furthermore, it states concerns about the exterior corrosion issue are unwarranted, explaining that the brown film or blue-green patina seen on copper tubing actually protects it.

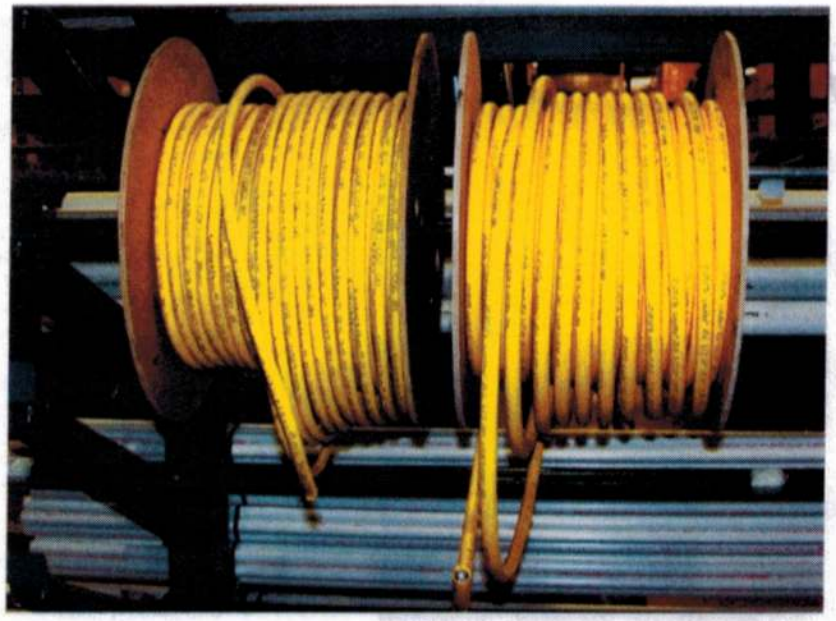
Internal Corrosion

The internal corrosion issue, manifested by thinning and flaking caused by hydrogen sulfide, generates the most concern. A UK study, titled "Safety Aspects of the Effects of Hydrogen Sulfide Concentrations in Natural Gas," and a Southern California (SC) study, titled "Copper Tubing in a Natural Gas Environment," note that different levels of thinning take place depending on the hydrogen sulfide content of the gas.

The studies concluded that tubing failure from the thinning of the copper wall is unlikely. The UK report suggests the tubing could have a life expectancy of 100 years, and the SC report noted that the bare copper tubing would maintain structural integrity for the duration of its "service life."

As for internal flaking or sulfidation, both reports stated that it does occur. The SC report recommended further study to determine if the flakes produced over time would be large enough to create a blockage. The UK report stated that only one accident had been reported due to gas valve failure because of the flaking. According to the IAMPO article, almost all natural gas piping in Great Britain is done with copper. But the authors of the report believe the problem can be tied directly to higher levels of hydrogen sulfide in some newer gas supplies.

Providing that the natural gas has less than 0.3 grains of hydrogen sulfide per 100 cubic feet, copper is approved for use by the International Residential Code and the Uniform Plumbing Code, as well as many other authorities. Despite this, there are localities that do not allow copper to be used for natural gas work. Inspectors should verify its acceptance in their jurisdictions. ▸▸



To reduce labor costs, traditional steel pipe *(top left)* is being replaced by CSST *(right)* and copper tubing *(bottom left)*.

New Method for Connecting Copper Tube and Fittings

A newer method for connecting copper tube to fittings used in gas systems is the ProPressG method by Viega *(see photo)*. With this system, the copper tube is inserted into fittings that contain a yellow HNBR (Hydrogenated Nitrile Butadiene Rubber) sealing element. The HNBR seal is designed specifically for fuel piping work. The fittings are compressed to set the seal and are installed without the use of a flame or mechanical flaring. The copper fittings have a bright yellow dot on the outside of each joint to distinguish them from those used in other plumbing applications.

PHOTO COURTESY OF VIEGA

Corrugated Stainless Steel Tubing (CSST)

Corrugated Stainless Steel Tubing (CSST) was introduced in the 1980s. Typically wrapped in yellow plastic, the thin, flexible stainless steel tubing has been approved by many of the major codes, including the International Residential Code and the Uniform Plumbing Code. It is used in traditional low-pressure systems and 2-psig systems as well. We'll review 2-psig systems next month.

Like copper tubing, CSST is semi-flexible and does not require a fitting at every change in direction. The thin-wall steel is much lighter than conventional steel pipe, and is usually cut to length with tubing cutters. Many of these products are self-flaring or self-sealing in some manner, and the joints are sealed as the fittings are tightened. These differences make it faster, easier and thus cheaper to install than rigid steel pipe.

CSST installers typically are certified by the manufacturer to work with its product. Despite this, at least one brand is being sold by some hardware stores. Inspectors should not assume that all CSST work has been performed by a certified installer.

Installing copper

Types K, L and ACR (Air Conditioning and Refrigeration) copper tubing are used for natural gas work. The primary approved methods used to make connections are brazing and flaring. In some jurisdictions, systems that use press-connect fittings that comply with ANSI LC-4, Press-Connect Copper and Copper Alloy Fittings for Use in Fuel Gas Distribution System, are showing up *(see sidebar at left)*.

Brazing should be done using a filler metal containing not more than 0.05% phosphorus, and it should have a melting temperature of more than 1000 degrees F. It is unlikely home inspectors will be able to identify the composition of a brazed joint, but it is important that they can distinguish a brazed joint from a soft-soldered one. Soft-soldered joints are prohibited.

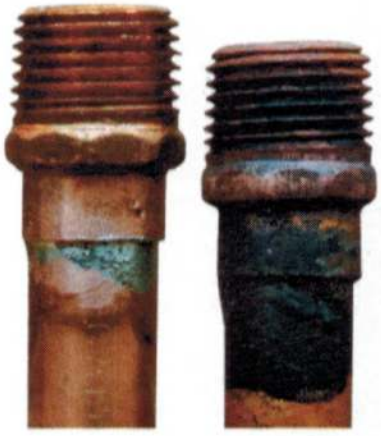
Soft solder is commonly used in residential water piping. Brazing is common with air conditioning and refrigeration piping.

Brass compression fittings, like those used to connect faucets and toilet supply tubes, are not allowed for use in fuel gas piping.

Bending copper and CSST tubing

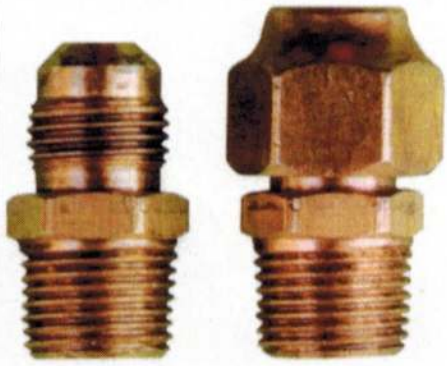
Professional installers can bend soft copper tubing and CSST into a 90° turn with relative ease if the space allows. However, both can be kinked if bent too abruptly. This restricts the gas flow and weakens the tubing. Inspectors should identify kinks or areas where kinks appear to have been repaired. Kinked sections of tubing should be replaced.

Below: Soft-soldered joint left and brazed joint right. Soft-soldered fittings are not allowed in gas work.



A National Pipe Thread (NPT) to compression adapter is not approved for gas work. This fitting compresses a brass sleeve around the copper tubing as the compression nut (top left) is tightened onto the fitting below it. The lack of a tapered surface at the top of the nut is a good indicator that the fitting is not an approved flare fitting.

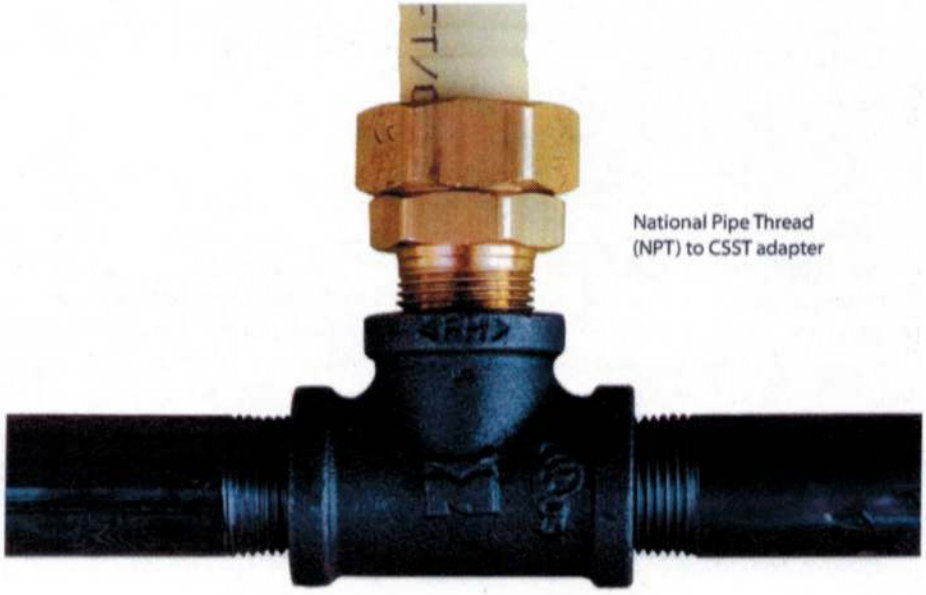
Below: A National Pipe Thread (NPT) to flare adapter is approved for gas work. This fitting pulls the flared end of the copper tubing against the tapered end of the fitting. The tapered surface at the top of the nut is a good indicator that the fitting is a flare fitting and should help inspectors distinguish it from a compression type.



PHOTOS © KENNY HART

Identifying Materials

The plastic covering over the CSST provides corrosion protection for the steel, and the (typically) yellow color identifies the material as gas tubing. Copper tubing used for gas systems must be labeled to differentiate it from other piping systems. Yellow peel-and-stick labels should be placed on the tubing, no more than 5 feet apart, according to the 2006 International Residential Code. The labels should be placed no more than 6 feet apart according to Copper.org. (Labels are not needed on tubing that is in the same room as the gas equipment.) Unidentified copper gas tubing should be noted as a major safety concern in an inspection report. Copper gas lines cut by mistake can create a hazardous situation.



National Pipe Thread (NPT) to CSST adapter

Connecting Different Materials

Complete residential gas jobs installed with copper tubing or CSST are rare. Black or galvanized steel typically is used somewhere in the system. For traditional operating pressure systems, a large steel gas main often extends from the gas meter to the far end of the house, and copper or CSST tubing serves the smaller branch runs.

Copper.org recommends the use of brass NPT (National Pipe Thread) to flare adapters to connect copper to steel. CSST is connected to steel with a NPT-to-CSST adapter.

For both copper and CSST, installers frequently use steel nipples and fittings at the gas equipment to pipe in a gas cock and sediment trap, as well as other components. Tradesmen routinely braze a male adapter onto the copper tubing and use the gas cock to transition to the steel (*see photo next page*).

Both materials are used to extend an existing service to connect a barbecue grill or to install a new gas range or clothes dryer. They also are used to supply fuel to a gas log set or gas fireplace.

How Much is Too Much?

Wondering what the manufacturers consider the proper bending radius for CSST and copper? Go to these links for more information:

www.copper.org/applications/plumbing/techref/cth/cth_main.html *(Page 42)*

www.wardflex.com/images WARDFLEX_D&I_GUIDE_Eng.pdf *(Page 29)*

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Plastic sleeves are allowed in many areas.

PHOTOS © KENNY HART

According to some codes and manufacturer's instructions, CSST or copper can be used to directly connect some stationary equipment, but both should be protected from damage at equipment cabinet penetrations.

Moveable appliances, such as a stove, dryer or portable barbecue grill, need an approved flexible appliance connector. They should not be connected directly to CSST or copper tubing. Neither material is approved for this type of use because both can kink or break if the appliance is moved.

Protecting the pipe

Like rigid steel, CSST and copper need protection when passing through concrete or block walls. This often is done with metal sleeves going through the wall to protect the tubing. Plastic sleeves are allowed in many areas. Protective tape often is required for copper tubing passing through a metal sleeve. Copper.org recommends it for copper passing through a plastic sleeve as well.

Sealing the annular space between the gas piping and sleeve helps prevent air, moisture and small critters from passing between the spaces. In some situations, fire barrier materials must be used to fill the void between the pipe and sleeve.

CSST and copper tubing are easily damaged by nails or screws. Striker plates protect CSST and copper that are within 1-¾ inches (1-½ inches for some jurisdictions) of the edge of the framing member. The plate should extend 4 inches beyond the penetration to help prevent a nail or screw from doing serious and possibly explosive damage.

With the protection 4 inches above a sole plate or 4 inches below a top plate, the tubing

is less likely to be pierced when baseboard or crown molding is installed. Several CSST manufacturers want 5 inches of protection for their products.

CSST manufacturers have produced a number of protection devices for their products, including carbon steel strike plates and steel flexible sleeves that look like flexible conduit (sometimes called Greenfield).

Holes in framing members typically are much larger than the copper or CSST tubing. A nail or screw is less likely to penetrate the tubing if it can move out of the way.

Strike plates and continuous metal sleeves are needed to protect the tubing where foam insulation prevents the tubing from moving.

Gas tubing installed outside should be secured above the ground. Depending on snow and ice, the height that the tube should be suspended can vary. The IRC requires that all gas tubing installed outdoors or above the surface of a roof should be at least 3-½ inches above the ground or roof surface. Many CSST installation guides reference the snow and ice concerns, but defer to the local code.

CSST should be protected against mechanical damage to a height of 6 feet above the ground when installed outside. This can be done by placing it in a protected location against the house or concealing it in conduit, for example.

Exposed sections of CSST should be wrapped with an approved vinyl tape to prevent corrosion when CSST is installed outside. Sometimes, the stainless steel tubing becomes exposed when the plastic sheathing is cut back to install a fitting.

Supporting CSST and copper tubing

It is unlikely that pipe hangers will damage rigid steel pipe. On the other hand, inappropriate hangers or straps can cause dangerous leaks on CSST or copper tubing. In general, the codes require material-specific pipe hooks, straps, bands, brackets, hangers or structural components. There are a number of hangers and straps specifically for copper and CSST tubing. They should not interfere with the normal expansion and contraction of the system or the structure. The National Fuel Gas Code states that the supports should not become disengaged as a result of pipe movement.

When hanging from joists, copper and CSST should be well supported. For ½-inch CSST, the TracPipe® and Diamondback™ installation manuals require support every 6 feet. The IRC and UPC require support every 4 feet for ½-inch tubing. According to TracPipe®, the pipe hangers for ¾-inch and larger CSST should be installed at intervals of 8 feet in the United States and 6 feet in Canada.

Gas logs and fireplaces

CSST and copper tubing can be run directly into the control cabinet of a manufactured gas fireplace. Both should be protected where they pass through the cabinet. The plastic covering can be left on when CSST is terminated in the control cabinet under the fireplace.

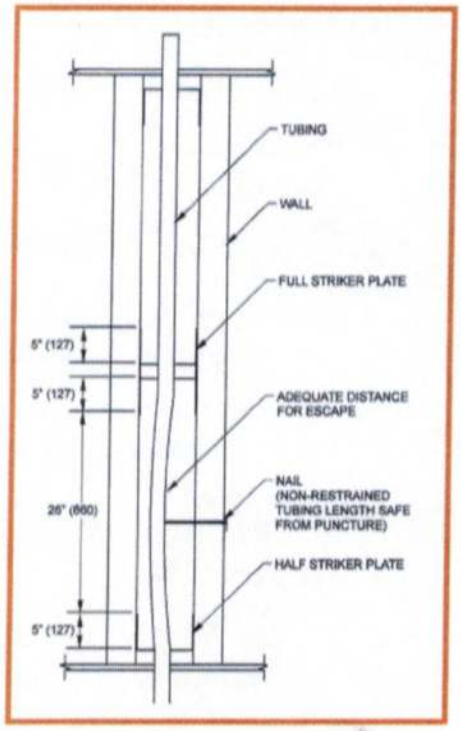
When routed through a masonry firebox to connect to a gas log, both copper and CSST should be protected as follows:

- They should pass through a sleeve at the point of penetration to protect them from damage.
- The space around the tubing should be sealed where it passes through the sleeve.
- Many localities require that a high-temperature caulk or a fire-stopping sealant material be used for this work.
- The plastic covering should be removed from the CSST tubing where it extends inside the firebox of any gas fireplace because it can melt.

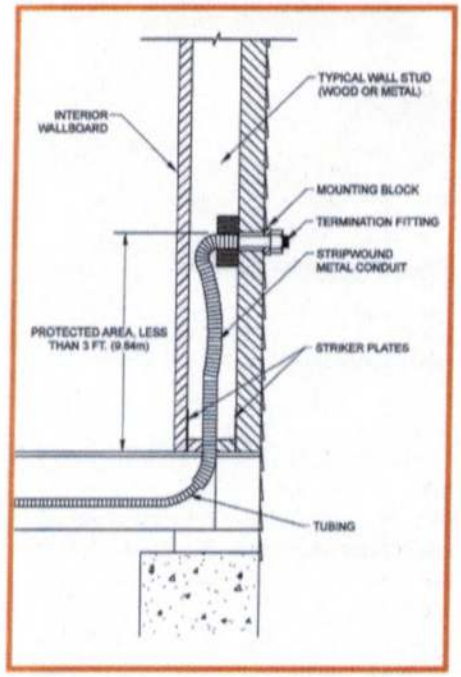
CSST and electrical bonding

According to some authorities, CSST may be particularly susceptible to damage from lightning strikes. During electrical storms, the metallic systems and the building itself can become highly energized. Metal siding, gas piping, water piping, electrical wiring, communication and entertainment cables may be affected. Arcing from one metallic path or conductor to another can take place, resulting in physical damage. (Arcing is electrical energy jumping through air from one conductor to another or from a conductor to ground, typically accompanied by considerable heat, light and sound. Arcing occurs only where there is a significant difference in potential energy between two materials.)

This is especially dangerous with CSST because of the gas inside. There are several cases of CSST leaks related to electrical storms. At least one class action lawsuit has been brought against manufacturers as a result of this. See **www.csstsettlement.com.**



CSST and copper tubing easily are damaged by nails or screws. Striker plates protect CSST and copper. Here are recommendations from the Diamondback™ Design Guide and Installation Instruction Manual.



Here's an example of how the flexible conduit can be used to provide protection. It is referred to as stripwound metal conduit in this illustration from the Diamondback™ Design Guide and Installation Instruction Manual.

In response to this issue, installation manuals now have a special electrical bonding and grounding procedure for their CSST systems that may help prevent electricity from jumping (arcing) between metallic systems. Some jurisdictions require the CSST be kept away from other metallic systems such as metal ducts, vents and other pipes to reduce the chance of arcing.

Special bonding requirements for CSST (not copper tubing) typically include the following:

- The tubing itself should be electrically continuous and should be directly bonded to a reliable ground-fault current path.
- There should be a minimum 6 AWG (American Wire Gauge) bonding jumper connected to the electrical service grounding system for the building.
- The bond connection to the gas tubing should be accessible and just downstream of the meter, near the service entrance into the house.
- The bond connection should be upstream of any CSST. Listed bonding/grounding clamps (UL 467) should be used, and connections should be made to a brass fitting, steel manifold or unpainted black iron pipe, not to the CSST itself.

At least one manufacturer has developed a product with greater resistance to lightning. It is clad in a black jacket rather than the typical yellow jacket. Special products such as this may have only normal bonding requirements.

Where the bonding system is suspect, document it as such and recommend a specialist to verify acceptability.

10 key points for home inspectors

1. Know whether or not copper tubing or CSST is accepted in your area.

Check -

2. For gas labeling on copper tubing.
3. For kinked or damaged tubing.
4. Protection where tubing passes through the appliance cabinet.
5. Support for tubing.
6. For appropriate protection for outdoor CSST.
7. For proper installation at masonry fireboxes.
8. For an approved appliance connector on moveable appliances (not direct to tubing).
9. For protective sleeves through walls.
10. Bonding on CSST.

Next month, 2-psig systems. ■

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ASHI Past-President Alan Carson, Carson Dunlop Assoc., has been a pioneer in home inspection since 1978. His work includes home and commercial building inspections, inspection training and the HORIZON report writing systems. He has developed many educational programs, most significantly the ASHI@HOME Training Program.