Lightning Safety Recommendations for Gas Piping Systems

using TracPipe® by OmegaFlex®.

CounterStrike™
Pre-Enhanced Lightning Protection by TracPipe®
Lightning is unpredictable; the chance of an individual building’s being struck either directly or indirectly (nearby lightning strike) is based upon the geographical location and the topography of the site. Lightning has such high levels of voltage that many paths to ground with high resistance can be overcome. It is common for lightning to exceed 100,000 volts and 40,000 or more amps. The current induced by lightning strikes does NOT “take the path of least resistance” as popularly believed. Current from lightning takes ALL paths of resistance to ground. The amount of current is inversely proportional to the resistance/impedance in the path taken.
Provisions for grounding of the electrical system and bonding other metallic systems are contained in the NEC (National Electrical Code NFPA 70) and The NFGC (National Fuel Gas Code NFPA 54). The requirement for grounding per code is very specific and will be accomplished by the Electrical Contractor in most new home construction. The bonding requirement for the fuel gas piping system is a fairly recent addition to the NEC and the NFGC and is not as well understood as proper grounding techniques. Lightning protection for buildings and building systems are covered in NFPA 780.

**Definitions:**

**Grounding:** The process of making an electrical connection to the general mass of the earth. This is most often accomplished with ground rods, ground mats or some other grounding system. Low resistance grounding is critical to the operation of lightning protection techniques.

**Bonding:** The process of making an electrical connection between the grounding electrode and any equipment, appliance, or metal conductor: pipes, plumbing, flues, etc. Equipment bonding serves to protect people and equipment in the event of an electrical fault.

**Equipotential Bonding:** The process of making an electrical connection between the grounding electrode and any metal conductor: pipes, plumbing, flues, etc., which may be exposed to a lightning strike and can be a conductive path for lightning energy towards or away from the grounding electrode.

Each year, new methods, materials and standards for home construction are developed. While these methods create efficiencies for contractors and accelerate the availability of finished housing, some of these methods have left mechanical systems increasingly vulnerable to the effects of lightning. If a building is hit by a direct lightning strike, the potential for damage and resultant insurance loss is extremely high. In nearby lightning strikes, the energy of the lightning is transmitted to the building through ground current transfer. Nearby lightning strikes change ground potential and induce voltage waves through magnetic flux and ground saturation.

Nearby strikes may present hazards for mechanical systems due to differences in potential between the grounded electrical system and any non-bonded metallic supply or communication system. Gas piping systems present a unique problem because they convey flammable fuel gas which may add to the fire hazard if any system components fail, including valves, regulators and appliance connectors. Black iron piping systems as well as copper tube and the newer corrugated stainless steel tubing (CSST) can all be compromised by nearby strikes causing electrical arcing and damage to components. Leakage can cause a fire or, potentially worse, if there is not an immediate fire, the resulting gas buildup can lead to a catastrophic explosion.

To diminish the risk to gas piping systems presented by lightning strikes, Omegaflex research and development efforts have lead to CounterStrike™, a product which is an effective but affordable tool in increasing the protection of CSST gas piping systems from the damage caused by lightning strikes. The use of this new product when coupled with improved routing techniques and proper grounding/bonding practices can considerably improve the resistance of CSST gas piping systems to the lightning strike hazard.
CounterStrike

CounterStrike is a TracPipe patent-pending CSST innovation that is engineered to significantly decrease the potential for lightning induced damage to fuel gas piping systems. CounterStrike has been designed with a proprietary jacket material in place of the standard yellow jacket. This black jacket has energy dissipating properties which will help protect the TracPipe stainless steel pressure liner as well as other fuel gas system components if the CounterStrike becomes energized due to lightning. Energy which is dissipated will reduce the energy and attendant risk transferred downstream to valves, regulators, appliance connectors, controls and other mechanical systems, all of which could result in the potential for fire and/or explosion.

The capability of CounterStrike to withstand electrical energy has been evaluated by a leading U.S. lightning laboratory. Typical CSST field failures were duplicated in the laboratory for multiple brands of CSST. The electrical energy levels in coulombs (the amount of electricity provided by a current of one ampere flowing for one second) which were known to cause failures were then used as a baseline to determine the performance level of CounterStrike when compared to the other brands of CSST. When tested against competitive products, the CounterStrike performance exceeded the conventional CSST product’s performance by from 725% to 6500%.

CounterStrike™ Performance

Testing location: Lightning Technologies, Inc. Pittsfield, MA
TracPipe PS-II

Improved routing techniques which place CSST gas piping systems lower in the building or underground can reduce the amount of piping used as well as improve lightning strike resistance. Gas piping which is underground and enclosed in a non-metallic conduit provides an extra measure of safety. TracPipe PS-II is the second generation product of pre-sleeved CSST which provides contractors with an efficient and dependable method for installing gas piping underground and underneath buildings. TracPipe PS-II can be part of the total system approach to passive lightning protection. The trunk line leading from the meter to the manifold is the elevated pressure (2 psi) part of the system; this can be installed beneath the building slab for the BEST protection from lightning for the high pressure part of the system. TracPipe PS-II has been used extensively throughout the U.S. for school science laboratory installations.

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For additional information on TracPipe PS-II request OmegaFlex Brochure FGP-099

GasBreaker® Excess Flow Device

An excess flow device is a protective device to help control the discharge of fuel gas in the event of a complete breakage of pipe lines or flex connector rupture. Excess Flow Devices have been of help in limiting gas loss in many incidents involving catastrophic fracture of piping including those caused by lightning strikes. They do provide a useful safety function in gas systems when a system component fails and the breakage or rupture leads to excess flow. GasBreaker devices should be installed at both the meter and appliance piping locations to provide coverage over the CSST gas piping system.
Good, Better, Best

Technical Solutions

The Gas Piping Recommendations shown in the following Technical Section “GOOD, BETTER, BEST” can be expected to add nominally to the cost of installing mechanical systems in homes. For the “GOOD” system with equipotential bonding of the gas system to the grounding electrode in the service equipment enclosure, there is the cost of the bonding jumper wire sized in accordance with NEC Table 250.66 (based upon the rating of the largest overcurrent device protecting the feeder that supplies the building - typically 200 amps), a grounding clamp and the labor to install this bonding jumper. It is estimated that the use of CounterStrike and PS-II for this system in place of TracPipe for a typical home with four drops will add 6% approximately to the gas piping materials. For the “BEST” system, the use of TracPipe PS-II will actually reduce the footage of gas piping because of the straight line routing from the meter to the manifold. The labor for this run under the slab should also be reduced because it can be installed at the same time as other underslab piping services.
The **GOOD, BETTER, BEST** approach for Lightning Safety recommendations takes into account the range of differences in a geographical area’s susceptibility to lightning strikes. There are areas along the west coast of the U.S. where there is barely any occurrence of damaging lightning strikes. On the other hand, Central Florida is nicknamed “Lightning Alley” with an average of 90 thunderstorm days per year. See map of the United States for the average number of thunderstorm days per year for a specific region or state.

The 5-year Flash Density Map below shows the average amount of lightning recorded in 1996-2000.

Lightning density map provided by Vaisala-GAI (formerly Global Atmospheric).
Passive Lightning Protection Recommendations for Gas Piping Systems

1. The application of passive lightning protection principles is well suited to residential structures and the cost-benefit impact for implementation of passive lightning protection is within the scope of new construction costs in the US today. The areas which require close attention for passive lightning protection include:

   A. Proper grounding of the electrical system per the National Electrical Code (NEC) ANSI/NFPA 70
   B. Proper Bonding of the fuel gas system in accordance with the National Fuel Gas Code NFPA 54/ANSI Z223
   C. Bonding of all other metallic systems and exposed structural steel (ref NEC section 250.104). Bonding should include water pipe, metallic vents and flues as well as other metallic systems
   D. New technologies which can be integrated into a systems approach for passive protection as dictated by the lightning strike threat for a geographical region. These include TracPipe® CounterStrike, TracPipe PS-II and GasBreaker® overflow devices.

2. Bonding serves to protect people and equipment in the event of an electrical fault (equipment bonds) by eliminating touch potential differences, and bonding is also critical in protection of the structure and mechanical systems in the event of a lightning strike or nearby lightning strike.

3. Equipotential bonding of all metallic supply lines entering a building is a vital but often overlooked requirement when considering protection of a building and its contents during an electrical storm. Gas piping systems are specifically required to be bonded to a grounding electrode in accordance with the National Fuel Gas Code NFPA 54/ANSI Z223 and the National Electrical Code ANSI/NFPA 70. The grounding electrode is a requirement of the National Electrical Code.

4. Nearby lightning strikes during an electrical storm can induce differences in potential between electrical systems and unbonded mechanical systems. Bonding of these systems to a grounding electrode allows the mechanical systems to move at the same rate as the electrical system. The electrical system third wire (life safety ground) is not intended to provide this benefit. The path to bond is typically much longer than the distance between mechanical systems, and arcing is therefore likely to occur. Equipment bonds are intended for personnel safety and to remove the touch potential between the elements of the electrical system in the event of an electrical short. In any event, the 1999 and 2002 editions of the National Fuel Gas Code require that “each above ground portion of a gas piping system upstream from the equipment shutoff valve shall be electrically continuous and bonded to any grounding electrode, as defined by the National Electrical Code, ANSI/NFPA 70.” Bonding jumper shall be sized in accordance with NEC Table 250.66.

6. It is well known that direct lightning strikes can cause serious damage to building structures and to the electrical and mechanical systems within and are a life safety issue. The installation of a lightning protection system per NFPA 780 and UL standards is highly recommended in areas prone to lightning. Lightning protection systems as outlined by NFPA 780 and UL are outside the scope of these recommendations.

Good, Better, Best

1. The “Good, Better, Best” approach to designing a passive lightning protection system for a building is based upon principles developed by Omegaflex, Inc.® with guidance from experts in lightning protection and system hardening against lightning strikes.

2. New Technology:

   A. Omegaflex’s new flexible gas piping (CSST) product, energy dissipating CounterStrike, has been verified by testing performed at a recognized laboratory to provide orders of magnitude improved capability over currently available CSST products.
   B. Omegaflex TracPipe PS-II provides code-compliance for underground and under building slab installations with major time savings versus pulling pipe through sleeve on-site.
   C. GasBreaker overflow protection devices are an optional component in this approach. Some local administrative authorities require the installation of these devices in new construction. They serve to provide a positive shut off of fuel gas in the event of a catastrophic break in the gas piping system. GasBreaker devices should be installed in the trunk line downstream of the meter and in all appliance branch lines upstream of the appliance at the manifold or before the shutoff valve. (Continued)
3. The first diagram illustrates a BASELINE installation of TracPipe Corrugated Stainless Steel Tubing (CSST). The installed system pictured meets the requirements of the NEC and The Fuel Gas or Plumbing Codes currently adopted throughout the US. The electrical ground should meet the intent of the NEC (less than 25 ohms to ground).

Notes:
1. Bonding of the gas piping system is through the equipment bond (third wire).

4. GOOD TracPipe CSST Installation. This will improve the passive lightning protection and should be considered in regions with average lightning strike history.

All of the above BASELINE considerations apply, in addition:

A. An equipotential bonding connection shall be made between the fuel gas piping system and the electrical service grounding electrode. The bonding jumper should be sized in accordance with NEC Table 250.66 (based upon the rating of the largest overcurrent device protecting the feeder that supplies the building - typically 200 amps). Bonding and grounding connections are to be made by a qualified technician.

Notes:
1. If possible, avoid running the bonding jumper a long distance through the building. The connection should be as short as possible. Gas meter location should be near the electrical service.
2. Lightning induced voltages seeking ground are subject to impedance; utilize a braided bonding jumper for greater surface area, rather than solid wire.
3. Upon Completion of the TracPipe Gas Piping System and prior to gas service initiation, check to see if the bonding has been completed.

B. Wherever possible TracPipe CSST runs should be installed with a bend radius of 8 inches or more to reduce the possibility that energy will jump from the piping to other conductive surfaces.

C. Optional: Install GasBreaker excess flow devices. (Mandatory where required by code.)
5. BETTER TracPipe CSST Installation. This provision will further improve the passive lightning protection capability of the structure and should be considered in regions with above average lightning strike history.

All of the above GOOD considerations apply, in addition:
A. Use TracPipe CounterStrike for all gas piping inside the building.
B. Optional: Install GasBreaker excess flow devices. (Mandatory where required by code.)

6. BEST TracPipe Installation. This configuration will provide a gas piping system with the maximum passive protection consistent with available technology. This level of protection should be considered in high lightning strike regions.

ALL of the above BETTER provisions apply including CounterStrike. In addition:
A. TracPipe PS-II underground and under building slab distribution line shall be run from the gas meter to the mechanical area, water heater location, garage, or other suitable ground floor location where the manifold station is located. The inside containment fitting shall be plugged to prevent the possible entrance of any gas leakage. The outside containment coupling shall be vented above grade and be installed so as to prevent the entrance of water and insects.
B. Optional GasBreaker excess flow devices. (Mandatory where required by code.)
### Estimated Incremental Cost for Good, Better, Best Model Homes

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### Note

The use of GasBreaker excess flow devices may be considered for areas with above average lightning strikes (see map of the US). In order to protect the gas system when a pipe ruptures or breakage of components occurs, GasBreaker devices can be installed both at the meter and at each appliance run from the manifold. Some local jurisdictions have adopted ordinances which require the installation of GasBreaker devices on all new homes. Consult local administrative authority to determine applicable provisions.

CounterStrike is approved by CSA in accordance with requirements of ANSI LC1 CSA 6.26