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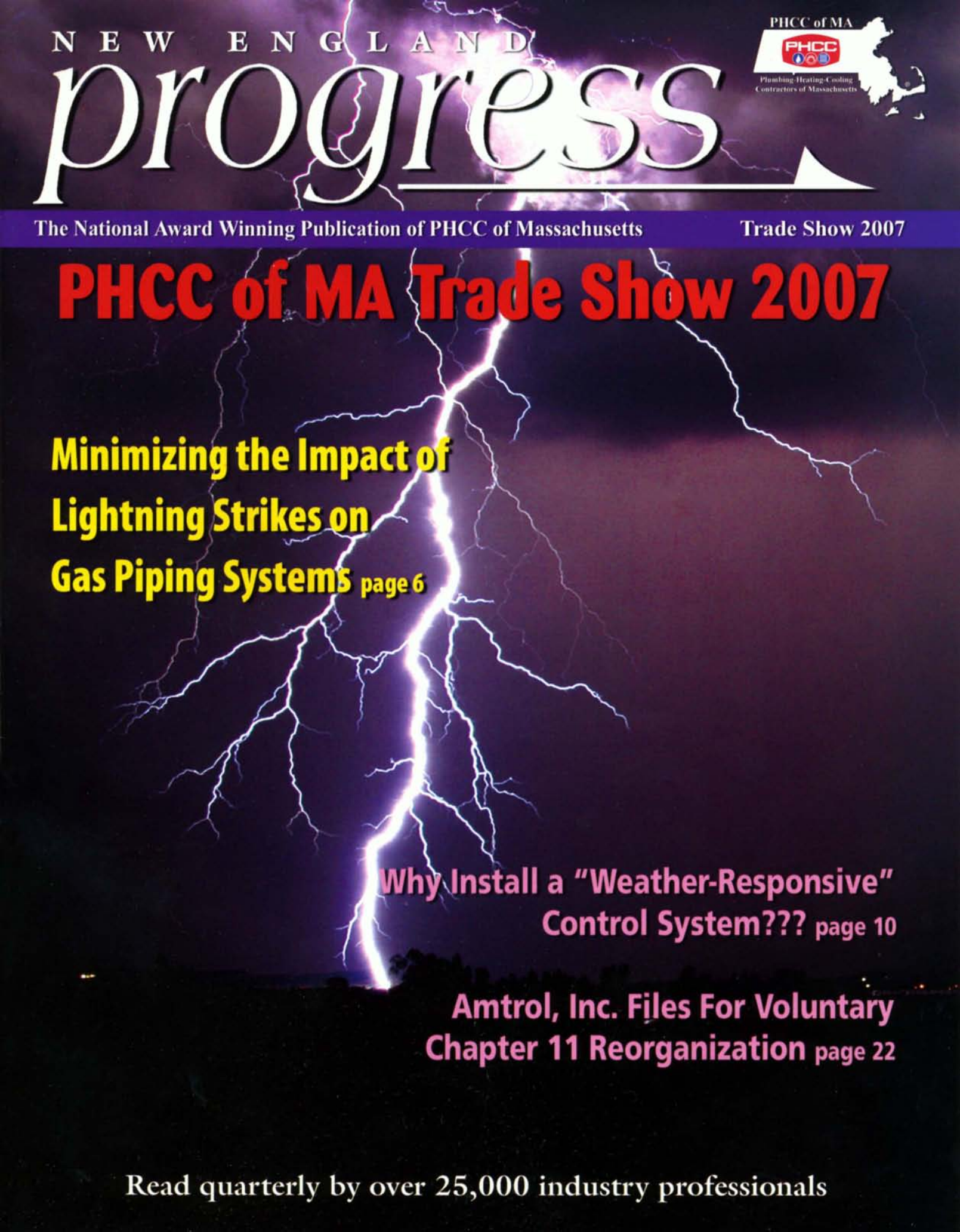

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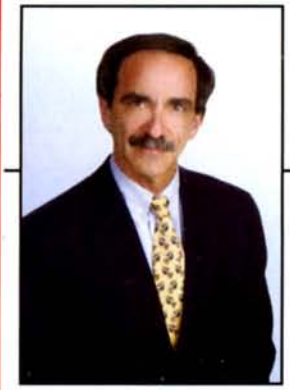

Minimizing the Impact of Lightning Strikes on Gas Piping Systems

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Summary

Lightning is one of the most destructive forces of nature. Direct and indirect strikes on or near structures can cause severe damage to the building and initiate fires that can result in the loss of property and lives. Despite this destructive power, most jurisdictions throughout the United States do not require the installation of lightning protection systems. Instead, the "protection" of the building is left to the electrical grounding system. However, the grounding system is only designed to protect the building occupants from ground-faults and not from lightning strikes. It should be no surprise that many metallic systems (such as wiring, coax cable, piping and ducting) fail during electrical storms. One method that is utilized to minimize the damage caused by a lightning strike is the bonding together of alternative metallic pathways to ground. When properly sized and installed, bonding can minimize the electrical potential difference between these pathways and significantly reduce the occurrence of arcing.

The protection of structures from lightning strikes is considered outside the scope of the various building codes, including the electrical, fuel gas and plumbing codes. Furthermore, none of the nationally recognized appliance standards include any requirements for resistance to lightning surges and/or voltages. All gas piping materials and systems are prone to damage (in a variety of ways) from lightning strikes. The CSST system is vulnerable to damage because of its thinner wall. As a result, the manufacturers of CSST have instituted their own new requirements for the protection of CSST from lightning induced damage. These new practices require the installation of bonding clamps and a bonding conductor at the service entrance between the gas piping and the grounding conductor, grounding electrode or the service panel enclosure.

Introduction

The independent and evolutionary development of the numerous model building and life safety codes, product standards and manufacturer's instructions can often result in unintended consequences that put one code in conflict with other codes or product standards or instructions. The code requirements for electrical safety systems have recently come under scrutiny regarding the impact of lightning strikes on gas piping systems. Although not considered within the scope of the National Electrical Code (NEC) or the National Fuel Gas Code (NFGC), protection of electrical and piping systems from lightning strikes was a central issue (nonetheless) to a recently settled class-action law suit against the corrugated stainless steel tubing (CSST) industry. As a result, the gas and electrical industries are re-evaluating the need for and the level of bonding required to protect the gas piping system against potential damage caused by both ground-faults and indirect lightning strikes.

Impact of Lightning Strike

Lightning is a capricious, random and unpredictable event, and represents one of the most destructive natural forces on earth. Its physical characteristics include current levels sometimes in excess of 40,000-A, temperatures as high as 50,000-deg F with over thirty million volts of potential. In the United States, there are some 20,000,000 lightning strikes to earth each year. Annually, lightning causes more than 8,600 house fires with appreciable property damage.

A lightning strike to an unprotected building can be catastrophic. Packing millions of volts of electricity, lightning has the power to rip through roofs, explode walls of brick and concrete, and ignite deadly fires. In addition to structural damage and fires, lightning will also surge throughout the power and communication lines causing wire damage as well as destruction of valuable electronic equipment including computers, televisions, stereos and security systems. In fact, no part of the structure, including **ANY** metallic piping system, is safe from damage caused by the power of a lightning surge.

Lightning effects can be direct and/or indirect. The effects from a direct hit on a structure are from resistive heating, arcing and burning. The effects from an indirect strike near a structure include capacitive, inductive and magnetic behavior. The lightning current can branch off to a building from a nearby tree, fence, light pole, or other tall object. In addition, a lightning flash may conduct its current through the ground into a building. The current also may travel through underground power cables, telephone lines, or metallic piping.

Lightning "protection" (in an absolute sense) is impossible. The protection of both structures and people from the dangerous effects of a lightning strike requires that both the structure and all metallic systems within the structure be bonded together so as to act as a single unit. To accomplish this goal, the following steps are required:

- Grounding of all electrical systems to the earth
- Bonding of all metallic structures to this grounding system
- Installation of a lightning protection system (including air terminals, associated grounding conductors, and additional grounding electrodes) that integrates all of these systems

The lack of any of these three important elements essentially leaves the structure vulnerable to the deleterious effects of a direct and/or indirect lightning strike.

Grounding and Bonding – The Basics

Effective grounding depends on a low-resistance electrical pathway connected to the earth. The pathway to ground is affected by the resistance within the voltage system, the grounding electrode(s) and the soil conditions. The electrical resistance of the pathway to ground must be 25 ohms or less. If not, an additional grounding electrode must be installed. The 2005 National Electrical Code states that:

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"Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation. Non-current carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials. Non-current carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path."

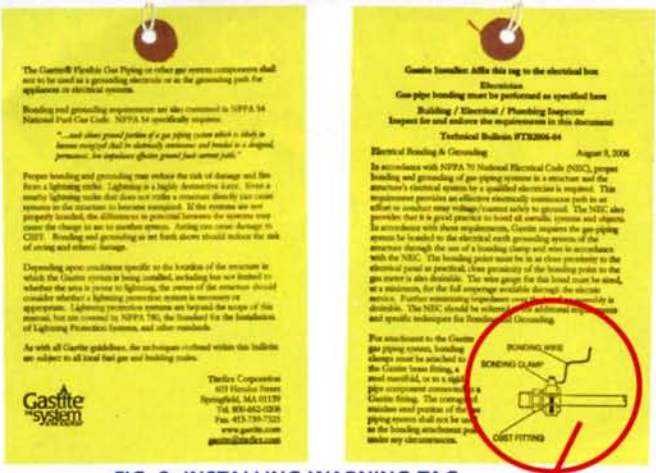

FIG. 2: INSTALLING WARNING TAG

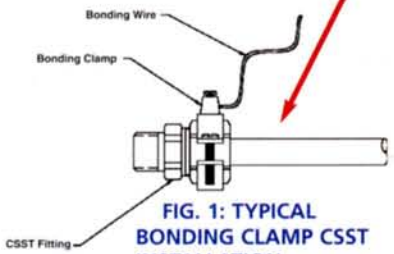

FIG. 1: TYPICAL BONDING CLAMP CSST INSTALLATION

Where installed in or attached to a building or structure, metal piping system(s), including gas piping, that is likely to become energized shall be bonded to the supply side of the voltage system in accordance with Article 250.104(B). The 2005 NEC permits the bonding means to be the grounding conductor of the appliance. However, if there is no electric power connection to the appliance, then bonding is not mandatory. In the 1999 edition of the NEC, all gas piping had to be directly bonded without regard to whether or not the appliance was powered.

Direct bonding of metallic structures, such as piping systems, to the ground on the power supply-side provides a low resistance path back to the voltage system and an over-current protective device for clearing ground faults. It also bonds the metallic structures, including the gas piping, with the earth in order to keep the metallic system at or near earth potential (very near 0 volts). This type of bonding for gas piping is a safety feature not mandated by the NEC, but is considered good practice. Bonding metallic gas pipe is not intended to protect the gas piping against lightning (per se), but it will provide a low resistance path to direct a lightning surge off the gas piping and into the earth. This may stop, or at least minimize, any arc-induced perforation of the CSST by significantly reducing the difference in electrical potential between the gas piping and the electrical grounding system.

Action Plan

In response to the class action law suit, the CSST industry has taken a pro-active position regarding the bonding of the CSST system to the electrical grounding system. It should be noted that the following recommendations apply to any approved gas piping material and system for the reasons expressed earlier: direct bonding provides a greater level of protection against both normal and abnormal operating conditions within the electrical system.

Direct bonding of the CSST gas-piping system (by a qualified electrician) to the electrical grounding system is required, and must be performed in accordance with local electrical code. This requirement provides an effective electrically continuous pathway to safely conduct ground-fault and other current to ground. The gas-piping system shall be bonded to the electrical earth grounding system of the structure through the use of a bonding clamp and wire. To keep it simple, the maximum size of the bonding conductor should be a number 6 AWG wire for most residential applications. The bonding point shall be either the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor (if of sufficient size) or the grounding electrode(s). For single-family homes, the sizing of the bonding conductor can be based on the full amperage available through the electric service to the house which may allow the installation of a smaller bonding conductor. For commercial buildings, the sizing of the bonding means requires an engineered approach that may include a lightning protection system.

The bonding clamps shall be attached to the gas piping system at the CSST brass fitting (as shown in Figure 1), steel manifold or to a rigid pipe component connected to a CSST fitting. The corrugated stainless steel tubing portion of the gas piping system shall not be used as the point of attachment of the bonding conductor at any location along its length under any circumstances. The points of attachment of the bonding jumper shall be accessible and located in as close proximity to the electrical panel if practical.

The CSST industry will implement some additional steps to address this important issue. A notice will be provided on each reel of tubing to alert and remind the installer about the need for adequate bonding. Another tag (example shown in Figure 2) will be attached to the electric service panel (or on the wall at its expected location) clearly alerting the electrician about the need for direct bonding of the gas piping. Technical bulletins are being issued to all installers and are being displayed by plumbing distributors at the point of purchase. Design and installation manuals are being updated to reflect the new bonding requirement. Training of installers and electrical inspectors will be expedited throughout 2007. Trade jurisdiction issues regarding the responsibility to install the bonding clamps and jumper are being addressed on a state-by-state basis.

Depending upon geographic and topographic conditions specific to the location of the structure, including but not limited to whether the area is prone to lightning strikes, the builder/owner of the structure should also consider whether a lightning protection system is necessary or appropriate. The design of lightning protection systems are covered by NFPA 780 (Standard for the Installation of Lightning Protection Systems) and other standards such as UL-96A. ■