**Session No. 769**

# New Gas Piping Rules Will Change the Way You Do Business

**John R. Puskar, PE**
**Principal and Owner**
**CEC Combustion Service Group**
**Cleveland, OH**

## Introduction

If your facility has a gas line running onto your property, there are new rules that will impact you, no matter what kind of business you are in.

Spurred on by the recent explosions at the Kleen Energy power plant under construction in Middletown, CN, and the ConAgra plant in Garner, NC, the National Fire Protection Association has adopted more than 40 changes to the National Fuel Gas Code (NFPA 54). These changes outline new procedures for purging gas lines, a process which has led to numerous explosions, injuries and even fatalities in recent years – including 6 deaths and millions of dollars worth of damage at Kleen Energy in February 2010.

It's time that risk management and safety professionals better understood the unique design and safety requirements for working with and purging natural gas piping systems. If you maintain and service gas-fired equipment, are planning to add equipment, commission it into service, or even build a new plant in the U.S. or overseas, this is an issue you must pay attention to. Beyond the obvious risk of death and injury, explosions on the scale of the Kleen Energy System disaster can cause extreme damage property worth hundreds of millions of dollars, cause significant lost production time, and irreparably damage a company's reputation.

You may think, "We don't purge gas lines," or, "we're not a power plant. This doesn't apply to me." But consider that the new rules say you cannot discharge natural gas into a building. How does that work when you are maintaining a fuel train or piping system? Furthermore, consider that these rule changes now apply to piping as small as 2 inches in diameter or as low as 2 psig in gas pressure. Whether you are a power plant or auto plant, chances are these new rules will have consequences for you.

Gas piping design, operation, and safety require a very specialized level of expertise. Those responsible for risk management need to make sure that everyone in their organization knows the rules and understands what needs to be done to protect your facility. Engineers and designers must be thoroughly trained in the applicable codes like NFPA 54 and practical design requirements for natural gas piping. Contractors and maintenance staffs should be especially

cognizant of the safety requirements and worker training required when isolating, purging, and re-introducing gas into piping systems.

The issues that are now required are understood by very few. It is unlikely that even your property insurer will even fully understand how to direct you on these issues. This is all compounded by the recent gas pipeline explosion in San Bruno, CA. – which killed eight people, destroyed 38 homes, and is estimated to cost the gas company more than $750 million. In light of this, many local gas distribution companies and their insurers are no longer willing to take on the liability for purging gas lines without professional third-party support. In the past a new building hook-up or a service outage might have found friendly technicians willing to bend the rules. They might have provided advice about things on the other side of their meter and even performed some simple purge and leak checking operations. This is usually no longer the case. These people are now told to stay on their side of the meter and everything else is a customer issue.

## The Purging Process

Whenever natural gas piping is installed, extended or repaired, it must be purged to remove explosive air/fuel mixtures. If natural gas is sent into a pipe containing air, it can create a spot in the pipe that has a flammable mixture. If this mixture moves toward a burner or ignition source, essentially, you have made a pipe bomb! This is why you have to carefully clear the gas, make the repair and then clear the air before you let gas back in.

Purging should not be confused with venting. The term venting is usually used to describe the release of gas when a piping section is opened and gas is allowed to be released to the surrounding area. This might occur from opening a flange, a union, or a purge vent. Purging is different. It involves the use of an inert medium such as nitrogen to push gas out of the pipe to an end point. There are many different types of purges that depend on the flow rate and the velocity of the purge medium.

There are six basic steps to conducting a safe and proper gas piping repair or installation, which include:

1. Isolation
2. Pre-repair purge
3. Making the repair
4. Pressure testing/Leak checking
5. Post-repair purge
6. Re-introduction and light off

You will see that in a proper piping repair, purging is performed twice. First, the pre-repair purge removes natural gas from the line before opening the pipe to make the repair. Then once the repair is completed, the post-repair purge removes air from the line before reintroducing gas.

Nitrogen is the most common purge medium, but it comes with its own set of hazards. The air we breathe is 78 percent nitrogen, but two full breaths of pure nitrogen can kill you. This inert gas is nothing to fool with. Make sure everyone understands this hazard and make sure purge points are marked and located in well-ventilated areas. When discharging nitrogen the purge discharge areas need to be monitored. Everyone involved in the purging and pressure testing

needs to be trained on the safe handling of nitrogen. Nitrogen can also be used for leak checking and pressure testing, which works as a precursor to the post-repair purge.

## Planning a Safe Purge

In our experience, we have found that many designers, engineers, contractors, and maintenance workers do not understand that natural gas piping repairs are quite different from the more familiar fluid or air piping, and therefore, require special knowledge and training.

However, if a good plan is prepared by engineering experts and the correct precautions are taken by those doing the work; you can have an incident-free project.

Consider this list of important tasks and key questions when planning a gas-piping repair:

- Is there a written purging plan (pre-repair and post-repair) that identifies all of the pressure testing needs and standards that must be complied with? Does everyone on the team understand the plan and the role they play in its execution?

- Has a gas re-introduction plan been prepared? Has re-introduction and start-up been discussed with the startup team, including any unique hazards?

- Were the local emergency services or fire department involved in the planning? Is firefighting equipment centrally located for workers?

- Has the gas piping design been reviewed for mechanical issues, including piping materials, rated valves and fittings, purge points, and blinds? Where are the isolation points and how will isolation be safely achieved?

- Is there a natural gas isolation and equipment lockout plan? Is there a plan for cleaning lines and re-testing fuel train automatic valves after the project has restarted? Verify that all special shutoff valves are serviced. Verify that all piping is properly marked.

- Is (or should) the gas utility involved in the purge process? Do they have any special requirements like what the leakage criteria needs to be before they will turn the gas back on?

- Have you determined the amount of nitrogen needed for the purges and leak checks and how it will be introduced to the piping system? Does everyone understand nitrogen hazards? Conduct safety training on the use of nitrogen as part of the planning process.

- Where will the purge be directed? What are the prevailing winds? Are there building vents or other equipment air inlets nearby? If a high pressure pipeline blowdown or pressure release is to occur, modeling of the plume may be helpful.

- Are all electrical services secured in the area of the gas purge and where the venting of natural gas may occur? Have all ignition sources such as even static electricity been considered and planned for?
- The portion of the project site where gas purges take place should be cleared of all workers, except those performing the gas purge. Spectators should not be allowed; personnel

must be kept to a minimum.

- Document all of the pressure testing results (i.e. test pressures and how long they were held). Do the goals you have outlined meet code, gas utility, and state or local building code requirements?

## What Codes and Rules Apply?

There are many codes that can have some application to natural gas piping repairs. As we've discussed, the main code that applies to natural gas piping is NFPA 54. The rules are rather lengthy and it does take time and effort to fully understand the intent and requirements of the code, and the recent changes. Often we run across consulting engineering firms and contractors that do not understand the basic code requirements. This lack of understanding often appears with a plant design that lacks proper isolation points (i.e. blanks, blinds, pancakes) and/or purge points. There seems to be little forethought given to the NFPA requirements in the installation of the gas pipe or how the gas pipe will be commissioned after installation or inspected and serviced in the future.

Another important code to consider is OSHA 1910.147 for lockout/tagout (isolation) of hazardous energy sources. Much has been written about these requirements and most workers make some attempt to comply with it – at least for electrical devices. However, the OSHA requirements also cover other plant systems, such as natural gas and steam piping. For instance, we often find a lock on electrical disconnects, but seldom on a closed gas valve.

Even when workers attempt to isolate equipment correctly, one area often overlooked is the lubricated plug valves used in gas lines. Lubricated plug valves, which represent 60% to 80% of natural gas piping system manual shut-off valves, have a small gap between the plug and the valve body. If a sealant is not applied annually, as required by code and the manufacturer, gas will leak past the plug even when the valve is in the closed position. We find that most facilities do not have the knowledge or the equipment to seal these and have never sealed them during the life of the valve. Hence, closing or locking out a valve in this condition does not adequately isolate the energy source. The more serious issue is that if these are not regularly sealed the valve can become impossible to close. This means you may not be able to shut off the gas supply in the case of an emergency.

## New Code Changes

In August 2010, the NFPA officially adopted a number of emergency code changes related to purging as part of a tentative interim amendment (TIA) to NFPA 54. (The NFPA 54 cycle for revisions is every three to five years. The next revision is due to be released in 2012.) These recommendations may change the way companies operate.

For instance, the new requirements are designed to require outdoor purging for any industrial, large commercial, or large multifamily buildings. [Section **8.3.1.3 Outdoor Discharge of Purged Gases:** The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location.] Previously, NFPA 54 only called for gas to be released to a "safe area." But "safe area" was not defined, and in many cases companies would purge into what they believed were spacious or well-ventilated area indoors.

You may not think this is a drastic change, but there are some situations where directing gas piping discharge outdoors adds dramatically to the job scope. Consider, for example, the replacement of small diameter gas piping in an integrated steel facility measuring millions of square feet in area and having 100-foot-high ceilings with large vent spaces in the roof. Discharging outside could be a very difficult requirement to satisfy.

Other new code changes prohibit the purging of gas pipelines by using natural gas – a common practice among utility companies – and change the way that purging events should be monitored on site. Let's take a look at a few of the highlights in detail.

**A. The discharge point shall be at least ten feet from sources of ignition and shall be at least ten feet from building openings and a minimum of 25 feet from mechanical air intake openings.**

One thing to remember is that every 1 cubic foot of gas released makes more than 23 cubic feet of air/gas mixture flammable. Modeling shows that where venting is occurring, the LEL threat zone can be up to 100 feet.

The distances mentioned in this provision will almost never offer protection from vented gasses, and certainly not for high-pressure purges. While designing vent systems and locating vent discharge points from fuel trains and gas relief valves, you cannot not find much formal guidance in NFPA 54; it simply does not address the issue. However, there are several rules of thumb that may be used.

We try to locate temporary purge vents for natural gas pointing up and at least three feet above and at least ten feet horizontally from any building openings. Fuel train vents, on the other hand, should be directed down and have insect protection. You have to consider the purpose of the vent. In the case of permanently installed vents for gas relief valves and manual venting systems for piping, you have to consider ingress of rain water and even the formation of ice. Small holes may be drilled in elbows where rain water can collect. These holes can also be used as sample ports for purging. Drip legs may be installed with valves that allow them to be drained occasionally. The key is to not obstruct the discharge and not create a situation where rain water can accumulate on the seat of a valve causing it to corrode and fail.

**B. The point of discharge shall be controlled with a shutoff valve.**

Having a point of discharge controlled with a shutoff valve allows for more control over the purge operation in the case of an error. This is a provision that has to be studied before implementation. In my opinion, it makes sense for a shutoff valve to be outside of the 25-foot safety perimeter. You would never want to have to be at the point of discharge where natural gas or nitrogen was flowing in order to shut down the purge if something was going wrong.

**C. During discharge, the open discharge point shall be continuously attended and monitored with a combustible gas indicator.**

This code change also requires some interpretation. In our opinion, one can never put personnel in jeopardy by requiring them to monitor an end point actually standing at the end point in harm's way. In many cases, vent points are high up on building roofs. In some cases,

they are not accessible. In such situations, you should consider drilling temporary monitoring holes in vent pipes. Note that you should never drill a hole in a line that is not known to be clear of residual gas because the drilling process can cause an explosion.

The purge end point may be monitored from outside the perimeter of the safe zone, and then also occasionally sampled with the purge flow shutdown. We believe the best practice is to have two personnel involved with monitoring at the end point – one with an end point meter and one with a meter to monitor the atmosphere at the safe zone perimeter. Make sure that spare meters are available and that the meters in use have been recently calibrated. In some cases breathing air may be required of the person moving towards the end point. You must also have the proper metering in place. Consider sending someone into a nitrogen cloud to get a sample. Your LEL meter may not go off, but if you are not monitoring for oxygen you could be sending someone into an area to be asphyxiated.

**D. All persons not involved in purging operations shall be evacuated from the area within a 25-foot radius from the point of discharge.**

To put it bluntly, gas piping repairs are not a spectator sport. Depending on the scope of the project and the nature of the purge or venting, all non-essential personnel should be removed for the entire duration of the operation. Or when possible, operators of purging and venting projects should conduct these operations when very few personnel are around.

However, as long as the gas is being directed upwards and wind conditions are correct, the 25-foot barrier zone rule should serve most situations well. Remember that this (barrier) zone should be monitored, and if an LEL of ten percent or more is detected in the zone or a depletion of Oxygen, personnel should be evacuated and the purge process stopped for further evaluation.

In addition to the 25-foot barrier zone, traffic through or near the area should be restricted. A review should be conducted for possible ignitions sources and any such sources removed. In most cases, security personnel should cordon off the area to prevent vehicular and foot traffic.

**E. Purging operations introducing fuel gas shall be stopped when 90 percent fuel gas by volume is detected within the pipe at the point of discharge.**

Introduction of fuel gas is the last step in the process before trying to light equipment. Reaching LEL means the piping system has only 4.4 percent methane. This may not be enough to light the equipment. Hence, a meter that can safely detect the percent of gas in the stream up to 100 percent and in an oxygen-deficient environment is what is needed here. There are many different types of meter technologies. If all that you have is a standard 4 gas meter like for confined space entries, you probably don’t have all that you need.

## Controlling the Risks

So whose job is natural gas piping and purging safety? The design engineers may prepare the drawings to the applicable codes and standards, but may never even visit the project site. The project manager must ensure the project meets those codes and standards, but is usually consumed with schedules and budgets. Contractors are focused on meeting the project specifications, staying on schedule, and making a profit. The project safety director is usually worried about lockout, trip hazards, slip and falls, tie-offs and other more common issues. Most

city building code inspectors don't understand the intricate details of gas piping commissioning because there usually aren't any local ordinances with which the project must comply. Fire departments usually understand something about gas hazards, but not piping systems.

When the responsibility for safe natural gas pipe purging is everyone's responsibility, then it's no one's responsibility. In the most recent disasters, very experienced people were conducting the work. But in the heat of battle, many things can and do get overlooked. There are countless daily stresses and pressures on a construction site. That's why proper planning and commitment to safety from the top down is needed to provide the focused disciplined that can make the difference between success and failure.

It all comes down to three simple elements: People, Policies, and Equipment. Make sure your people are well trained in the area. Make sure you have the proper policies requiring purge and re-introduction plans that are detailed and define roles and responsibilities. Finally, make sure that your equipment is correct, including the right types of meters, piping design, and equipment design to accommodate safe and compliant gas piping and fuel system work practices.

## References


National Fire Protection Association, *NFPA 54: National Fuel Gas Code Handbook (2009 Edition)*. www.NFPA.org

National Fire Protection Association, *NFPA 54: National Fuel Gas Code, Tentative Interim Amendment*, Aug. 5, 2010. http://www.nfpa.org/Assets/files/AboutTheCodes/54/TIA54-09-3.pdf

U.S. Chemical Safety Board, *Kleen Energy Natural Gas Explosion.* http://www.csb.gov/investigations/detail.aspx?SID=91&Type=2&pg=1&F_InvestigationId=91

Occupational Safety & Health Administration, *OSHA 1910.147: The Control of Hazardous Energy Lockout/Tagout*. www.osha.gov