

Natural Gas Piping Pressure Testing, Purging, and Equipment Restarts Ten Hazards and How to Avoid Them!

By Bryan Baesel & John Puskar, P.E.

The Danger

Whenever gas piping is repaired, extended, or newly installed it must be purged. The rules and best practices for handling these situations are often misunderstood, even by those conducting the work. This has caused much pain and suffering including deaths, explosions, and the loss of billions of dollars in industrial assets. This document seeks to clear up some misconceptions and provide the insights needed to make sure this work is done safely at your facility. This article speaks to three areas of codes and standards that apply to these kinds of situations. These are OSHA 1910, NFPA 54, and the equipment standards like NFPA 85 or NFPA 86.

First of all there are two codes that directly apply to this kind of situation. The first is OSHA 1910.147 for lockout/tagout of hazardous energy sources. There's been a lot written about this issue and most people make some attempt to comply with it, at least on the electrical side. In our opinion it's followed religiously for electrical equipment. It's only followed less than half the time for gas piping, steam, and other things that could be dangerous in a pipe. We often find a lock on an electrical disconnect and a gas valve that is just closed but not locked. Even when people try to isolate equipment correctly we find that they often do not understand the issues surrounding lubricated plug valves and their need to be sealed in order to hold properly. Lubricated plug valves (which represents 60 to 80% of natural gas piping system valves) have a small gap between the plug and the valve body. If the 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 plants do not have the knowledge or the equipment to seal these and have never sealed them in the life of the valve. Hence, closing or locking out a valve in this condition does not necessarily isolate the energy source. Our website, www.combustionsafety.com, has a paper specifically about this issue.

The other code that applies to this issue is NFPA 54 (found at and available for purchase from the National Fire Protection Association's website, www.nfpa.org). This is also called the National Fuel Gas Code. It provides all that you would ever want to know about this topic. It is a rather large document and takes some time to study and truly understand. We find that many consulting engineering firms and contractors do not understand it and in some cases have not even heard of it. We know this because of the lack of isolation points (i.e. blanks, blinds, pancakes, etc.) and the lack of purge points installed in most industrial plants. There seems to be little forethought given to the actual installation of the gas pipe and how the gas pipe will be put into service and the equipment started up. Here are some highlights from NFPA 54 about getting piping into service or the more complex matter of adding to an existing system.

10 Gas Piping & Equipment Start-up Hazards and How to Avoid

Shown below are ten hazards involved in purging natural gas piping and how to avoid them. These tips and techniques should be incorporated into a comprehensive documented procedure for natural gas piping purging, piping system design, and equipment start-ups.

Design/Planning

1. Purge Points

Purge points are pipe nipples installed at strategic locations in the piping system for the purpose of introducing or removing nitrogen and natural gas at various stages of the process.

These are generally 1" schedule 80 nipples with natural gas rated ball valves on the ends. It is important to select locations or orientations to make sure these are not susceptible to damage from things like vehicle traffic (being run into with a tow motor or scissors lift).

2. Isolation Points

You have to be very careful that fuel trains are not exposed to excessive pressures that can damage components during pressure testing. This can be done with the use of line blinds. Valves can be left open or leak through in the closed position. Blinds provide positive isolation and eliminate the possibility of damaging devices in a fuel train that are not rated for the elevated test pressures (like regulators and pressure switches). In some cases blinds also help to do pressure testing correctly as pressure testing cannot be done against a valve.

3. Piping Support

During repairs sections of piping may be disconnected to allow the addition of tees or to install blinds. It is important to ensure that adequate pipe supports exist to ensure that sections of pipe will not fall when disconnected. The closest support may be on the other side of the disconnected joint.

4. Gaskets

NFPA 54 does not allow the reuse of flange gaskets even if they appear to be in good shape. To ensure leak free joints it is important that new gaskets are used as well as properly rated bolts for the flanges. Remember too that if you are mating up flanges, it is raised face to raised face and flat face to flat face.

5. Material Specifications

It is important that only proper rated pipe and fittings are used. Validate that reputable suppliers are used and material is free from manufacturing and installation defects. This would include things like pinholes in cast fittings, fittings where the threads are misaligned, and pipe that is not of the proper grade.



Picture 01: Typical Purge Point

Implementation**6. Nitrogen**

The air we breathe is 78% 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. Also, verify pressure ratings of hoses and regulators; large liquid nitrogen tanks are capable of producing high discharge pressures. 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.

7. Discharge Locations

Make sure that purge end points where natural gas may be released are outside and at least 25' from any ignition source. Have areas roped off for security to keep ignition sources (including vehicles) and people away



Picture 02: Nitrogen Tank



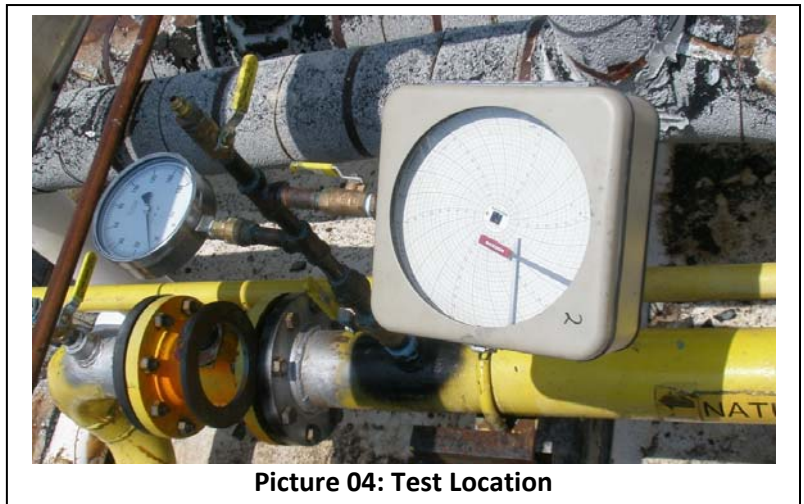
Picture 03: LEL Meter

8. Sampling Devices

Do not use a combustion flue gas analyzer; use a good quality, recently calibrated LEL (lower explosive limit) meter during natural gas introduction and removal. A four gas meter can be used to monitor oxygen levels during Nitrogen post repair purging. Make sure that two LEL meters are available. Stopping the process due to instrumentation error can create a hazard. One LEL meter can be used as a barrier protector for the people near the purge end point and the other for use with at least a 6' long sensing tube that can monitor conditions at the actual discharge point. Don't actually stand in harm's way at the discharge point. Instead do a timed and measured discharge and then with the flow stopped carefully approach to do an LEL check in the end of the purge hose.

9. Piping Integrity

During repairs or additions piping may not be installed properly or disturbed during work. NFPA 54 requires that you have documentation of pressure testing for new or repaired piping systems prior to introducing natural gas. The results of these tests should be retained for the life of the piping system. Any section of piping that has undergone recent additions or repairs should be evaluated if no test records exist. Our firm has established as a best practice the use of pressure chart recorders. These paper and pen battery powered recorders come with very small pressure increment gradations (1 psig) and provide excellent records of pressure and hold times of tests.



Picture 04: Test Location

10. Emergency Isolation

During the reintroduction of natural gas after the post repair purge it is imperative that the natural gas valve source valve be continuously attended during the reintroduction process. Communication with this individual should be continuously maintained. If a problem is detected the supply of natural gas can be immediately isolated. In addition, valves should be serviced, handles installed, and valve function verified.

Anytime natural gas piping systems are designed or worked on these potential hazards should be evaluated and addressed. While the process is not simple, it can be completed safely if planned and properly implemented.

Our firm does reviews of piping systems, consulting for start-ups, and actual hands-on pressure testing and start-up of natural gas piping systems and gas fired equipment. Our new website, www.purgesafe.com can show you more about what's available. If you should have any questions please call us at 216-749-2992 or contact us on our website www.combustionsafety.com.

About the Authors:

Bryan Baesel holds a Bachelors degree in Mechanical Engineering from Ohio University. He is the Engineering Manager at Combustion Safety Inc and serves on the NFPA 86 (Standards for Ovens and Furnaces) and NFPA 85 (Boilers) committees. He has participated in and or managed over 1,000 fuel train inspections in many different industries and countries.

John Puskar, P.E. holds a Bachelors degree in Mechanical Engineering from Youngstown State University and is the Principal of Combustion Safety Inc. He serves as an alternate on NFPA 86 and ASME CSD-1 committees and is also on the NFPA 85 committee. He has been practicing for over 28 years and is a licensed Professional Engineer in several states.