BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LX No. 4A/2008	145 - 148	Seria Tehnică

Safety Analysis of a Local Romanian Gas Distribution System

Marcela Vasile

EONGAZ Sibiu
e-mail:marcela.vasile@eon-gaz-romania.ro

Abstract

The paper presents the basic protection concepts and safty procedures taken to prevent or minimize the potential of negative consequences of mulfunctions of a gas distribution system. The results of a statistical analysis of the events produced during the operating process of a local Romanian gas distribution system are also discussed.

Key words: *gas distribution system, protection concepts, safty procedures, statistical analysis*

Introduction

Ussualy gas distribution systems operate according to design, gas travelling from the supplyer through a system of pipelines to user end. During most of this process everything operates according to plan, but occasionally, problems occur, things break, mulfunctions happen, settings change, and shut-ins take place. Some problems can be solved quickely and easily, but unfortunately some of them have negative consequences. In order to prevent or at least to minimize those potential consequences, one has to make use of basic protection concepts and safty analysis.

The paper summarize the basic concepts required for the seif design and operation of a gas distribution system. The paper begins by develpoing a hazard tree for a generic gas distribution facility and then illustrates how hazards analysis can be used to identify, evaluate, and mitigate process hazards. In addition this paper reviews a safty analysis technique applyed for a local Romanian gas distribution system.

Basic Protection Concepts

The main threats to safty from a gas distribution facility involve the release of gas and therefore the analysis and design of a gas distribution facility safty system should focus on preventing such releases, stopping the flow of gas to a leak if it occurs, and minimizing the effects of released gas.

Prevention is assured by two levels of system protection, one primary and one secondary, such that if the first level fails to function properly, the second level of protection is available.

Stopping the flow of gas to a leak should be operated as soon as possible by shutting-off of the inflow in order to *minimize* the effect of a bad situation.

Hazard Tree

A hazard tree identifies potential hazards, determines the conditons necessary for a hazard to exist, determines sources that could create this conditions and, by eliminating those conditions and sources, allows to break the hazard chain.

Figure 1 shows a hazard tree for a generic gas distribution system. As one can see the major potential hazards are those of fire, explosion and injury.

Sources and Conditions for a Hazard to Exist

As one can see from figure 1, the main sources for a hazard to exist are provided by the equipment failure and the opening of a closed system.

The equipment failure can be caused by overpressure, leaks due to corrosion, errosion or maintenance, excessive temperature, hit by another object, material quality, or by sudden failure of a mechanical seal.

The opening of a closed system may be caused mainly by a valve operation.

A gas leak provides air pollution and conditions for asphyxiation or poisoning. A gas leak provides also fuel for a fire and/or explosion, and the necessary conditions in this case are provided by the existence of the oxigen and the ignition source.

The ignition source can be provided by the lightning, the static electricity, the electrical short cut, the electrical sparks, the flashback, the hot souces, the exhaust sparks, open flames, fire tubes, or may be human induced.

A large fire can occur in case of insufficient or inoperable fire fighting equipment, wrong location of fire fighting eqipment, inability to shut off the fuel, or lack of adequate warning.

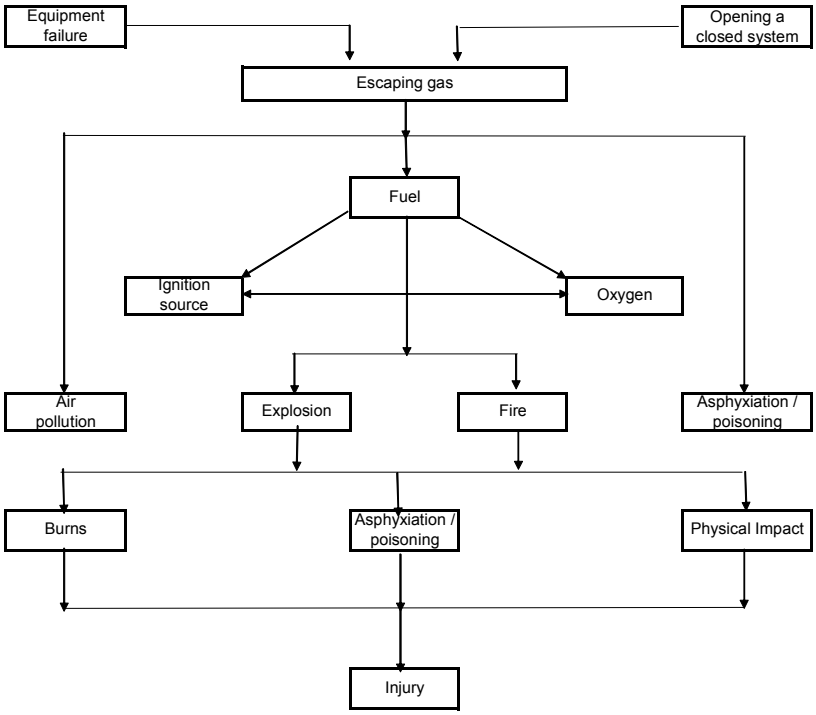

Fig. 1. – Hazard tree for a generic gas distribution facility

One of the main sources for a hazard to exist is the inability to escape for a human being as a result of blocked escape route, lack of fire barriers, lack of adequate worning, or inadequate training.

Injuries

Injuries are the worst result of the hazard. The worst injuries can occur as a result of an explosion or of an out-of-control fire.

The conditions generating injuries in case of an explosion or fire are caused by burns, asphyxiation/poisoning and physical impact. Hot surfaces, flare radiation and burning fluids are the main sources for injuries in case of burns. In case of physical impact the sources of injury are falls, slip on slick surfaces, hit by objects, and trippings. Sources of generating injuries in case of asphyxiation/poisoning are the gas leak and discharge of fire extinguishing agents in confined spaces and the smoke from fire.

Hazard Analysis

A hazard analysis identifies potential hazards. A hazard analysis starts at the hazard tree lowest level and atempts to eliminate the hazard by eliminating one by one the conditions and sources generating the hazard and thus breaking the path leading back to the hazard.

Safety Analysis

The purpose of a safety analysis is to identify potential threats to the proper safety of a gas distribution system which will cause undesirable events and define the recommended protective measures that will prevent such events or minimize their effects in case they will occur.

Potential threats to safety are identified through an appropiate hazard analysis technique.

Recommended protection measures are common industry practices concluded as a result of many years of operating experience.

A safety analysis is based on the following considerations:
- process components function in the same manner regardless of specific facility design;
- each process component is analyzed for the worst case of imput and output conditions;
- if fully protected when analyzed standing alone, the analysis will be valid for that component in any configuration;
- when components are assembled in a system, some devices can be eliminated.

Analysis of a Local Romanian Distribution System

The analyzed gas distribution system started functioning in 1937. As repported in 2007 the gas distribution system is 820 Km long having 65000 custumers consumming les then 2400 Nmc/yr and 1200 custumers consumming more then 2400 Nmc/yr.

The gas distribution system has a low pressure network of 723 Km, and a high pressure network of 97 Km. The pipe distribution sistem has a steel distribution netwoork of 799 Km and a polyethylene distribution network of 21 Km.

Figure 2 and figure 3 are presenting the number of undesirable events taking place during the last 35 years. As one can see the main hazard causing the failure of proper functioning of the gas distribution system is presented by corrosion. It has to be mentioned that in the last years the

main financial effort to reduce that hazard was done by extending the length of the polyethylene pipe distribution network by replacing the old steel pipes. From figure 3 one can see that this effort reduced by more then 4 times the hazard caused by corrosion.

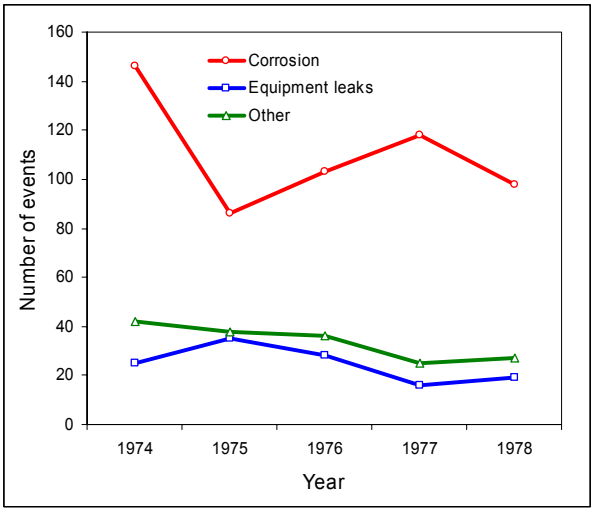

Fig.2. Distribution of number of undesirable events 30 years ago

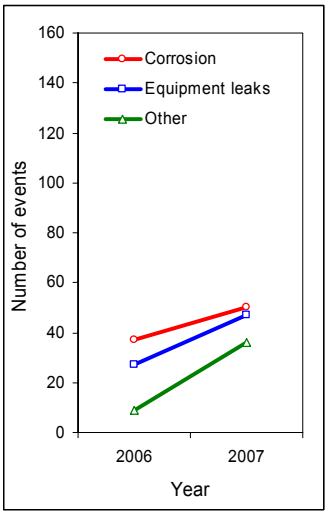

Fig.3. Current distribution of number of undesirable events

However from figure 2 and figure 3 one can see that the current distribution of number of undesirable events due to equipment leaks and other circumstances, remains unchanged, almost constant, as 30 years ago. Thus, it will be necessary to improve the equipment quality and also to develop a higher standard training program.

References

1. Vasile, Marcela Maria – *Defecte în rețelele de distribuția gazelor și depistarea acestora* – Referat doctorat, Universitatea Petrol Gaze, Ploiești, 2008.
2. Vasile, Marcela Maria – *Reducerea pierderilor de gaze naturale prin optimizarea rețelelor de distribuția gazelor* – Referat doctorat, Universitatea Petrol Gaze, Ploiești, 2008.
3. Stewart Jr., Maurice I. and Arnold, Kenneth E. – *Safety Systems* – Chapter 10 in Petroleum Engineering Handbook, SPE 2007.

Analiza siguranței în exploatare a unui sistem local din Romania pentru distribuția gazelor

Rezumat

Articolul prezintă conceptele de bază precum și principalele proceduri necesare asigurării siguranței în exploatare a unui sistem de distribuție a gazelor naturale, pentru prevenirea sau minimizarea potențialelor consecințe negative în cazul accidentării unor astfel de sisteme. Lucrarea prezintă totodată rezultatele unei analize statistice a defecțiunilor produse în decursul exploatării unui sistem local din Romania pentru distribuția gazelor naturale.