| BULETINUL Universităţii Petrol – Gaze din Ploieşti | Vol. LXVII No. 4/2015 | 55 – 60 | Seria Tehnică |
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# Assessment of the Explosion Risk in a Natural Gas Regulating and Metering Station and Usage of a Modern Software for Indicating Areas with Explosion Hazard

Alina Maria Gligor

Universitatea Lucian Blaga din Sibiu, Blvd. Victoriei 10, Sibiu, Romania
e-mail: alina.gligor@ulbsibiu.ro

## Abstract

*This paper aims to contribute to increasing the safety degree in natural gas regulating and metering stations, reducing work-related accidents and the occurrence of professional illnesses by using an assessment method based on the one elaborated by the National Institute for Research and Development for Environmental Protection Bucharest and the software package AutoCAD Plant 3D.*

*The goals of this paper are focused on two research directions. The first one is to assess the explosion risk for employees working in the technological installation of the natural gas regulating and metering station, while the second one concerns the marking of areas with explosion hazard by using a modern software that allows their presentation in 3D.*

**Key words:** *natural gas regulating and metering stations, explosion risk level, explosion hazard area,*

## Introduction

In natural gas engineering facilities, the assessment of explosion and fire hazards has to play an important role in deciding on what equipments to use and how to configure these [1].

The usage of electrical equipments in areas with explosion hazard imposes an approach that differs from the case of normal areas, in several aspects.

Firstly, for ensuring the explosion safety of the operating personnel and of the installations that function in these industrial environments, it is necessary, even before any implementation of technical solutions, to carry out a detailed analysi of the possibility of the occurence of flammble substance accumulations, that may generate an explosive atmosphere.

Secondly, it is necessary to determine the probability for the occurence of an explosive atmosphere within the industrial space taken into account and to identify all types of employed flammable substances in order to facilitate the grouping of that area within one of the standardised types of explosion hazard areas.

While various authors have discussed the possibilities of assessing the explosion risk in various other parts of a natural gas extraction, storage and transportation system [1, 2, 3, 5], in the current paper, the author has used a consecrated method to determine the explosion risk in a

natural gas regulating and metering station and also used a specialised 3D computer-aided design software to indicate the main problem areas.

## Presentation of the Natural Gas Regulating and Metering Station

The natural gas regulating and metering station is the assembly of apparatusses, fittings and accessories by means of which the gas pressure is reduced and regulated and the gas flows are measured.

The natural gas regulating and metering stations used in the Romanian natural gas industry can be divided into delivery stations, sector stations and regulating posts.

The analysed natural gas regulating and metering station is attached to the Romanian National Natural Gas Transportation System. Its main components are: gate valves, natural gas filters, pressure regulators with indirect actuation, safety valves, measurement system for the amount of natural gases, panel for SCADA data transmission, odorisation installation, electric panel for the control and supply of the automated odoriser, electric panel, radio station etc. and it has been modelled by the author using the software *AutoCAD Plant 3D* (fig. 1).

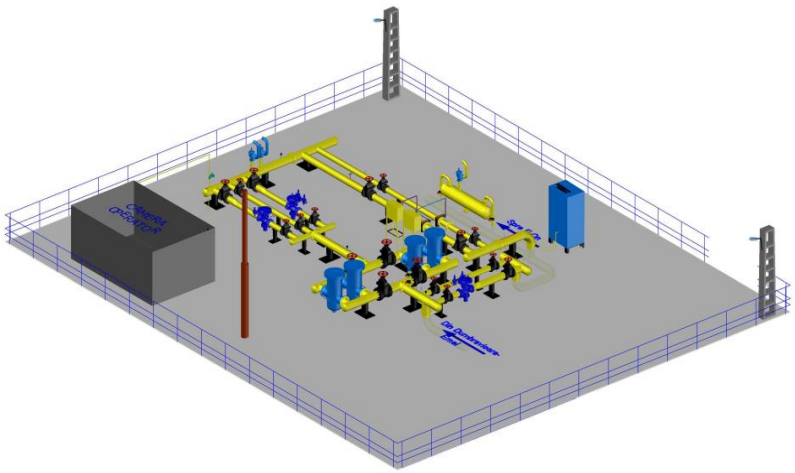

**Fig. 1.** Schematic presentation of the analysed natural gas regulating and metering station

## Presentation of the Risk Assessment Method

For determining the explosion risk level within the analysed natural gas regulating and metering station, the author has used a method based on the one elaborated by the National Institute for Research and Development for Environmental Protection Bucharest (I.N.C.D.P.M.). This method targets the quantitative determination of the risk/security level for a workplace, sector, section or plant, based on the systemic analysis and the assessment of the risks for accidents and professional illnesses.

The method consists in identifying all explosion risk factors within the analysed system (workplace) based on predetermined checklists and in the quantification of the risk size based on the combination of the gravity and frequency of the maximal predictable consequence. The security level for a workplace is inversely proportional to the risk level.

For applying the method, one has to pass through following mandatory stages:

- defining the analysed system (workplace);
- identifying the risk factors in the system;
- assessing the explosion risks;

- ranking the risks and determining the prevention priorities;
- prosing prevention measures.

In order to be able to go through the above-mentioned stages, following work instruments are necessary:

a. List for the identification of risk factors;
b. List of possible consequences of the action of risk factors on the human body;
c. Scale for ranking the gravity and probability of consequences;
d. Risk assessment grid;
e. Risk level scale and safety level scale, respectively;
f. Workplace assessment form – centralising document;
g. List of proposed measures.

The global risk level for a workplace ($N_r$) can be determined as weighed average of the risk levels determined for the identified risk factors. In order for the obtained result to reflect reality as closely as possible, the rank of each risk factor is used as weighing element, it being equal to the risk level.

The formula for calculating the global risk level is given in (1):

$$N_r = \frac{\sum_{i=1}^{n} r_i \cdot R_i}{\sum_{i=1}^{n} r_i} \tag{1}$$

where: $N_r$ is the global risk level for a workplace; $r_i$ – the rank of the risk factor „*i*"; $R_i$ – the risk level for the risk factor „*i*"; $n$ – the number of risk factors identified for the considered workplace.

## Assessing the Explosion Risk in the Analysed Natural Gas Regulating and Metering Station

In order to identify the explosion risk factors for the natural gas regulating and metering station, the author has taken into account the attributions indicated in the job description files for the personnel unfolding its activity within this system, as well as the corresponding technological processes. The risk factors were identified and grouped by the generating element within the work system (operator, work task, production means and work environment).

By using the work instruments mentioned in the previous paragraphs, the author then determined the partial risk level for each risk factor.

Using the formula (1) and the partial risk levels as indicated in Figure 2, the global risk level for the workplace "Natural gas regulating and metering station operator", was calculated as follows:

$$\mathrm{N_r} = \frac{\sum_{i=1}^{24} r_i R_i}{\sum_{i=1}^{24} r_i} = \frac{0x(7x7)+0x(6x6)+2x(5x5)+4x(4x4)+7x(3x3)+2x(2x2)+9x(1x1)}{(0x7)+(0x6)+(2x5)+(4x4)+(7x3)+(2x2)+(9x1)} = \frac{194}{60} = 3.23$$

Thus, the global risk level calculated for the workplace "*Natural gas regulating and metering station operator*" is 3.23, a value that places it among the workplaces with small to medium risk levels.

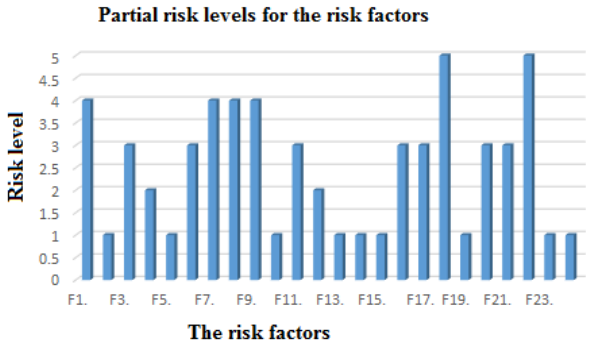


**Fig. 2.** Partial risk levels for the risk factors at the natural gas regulating and metering station

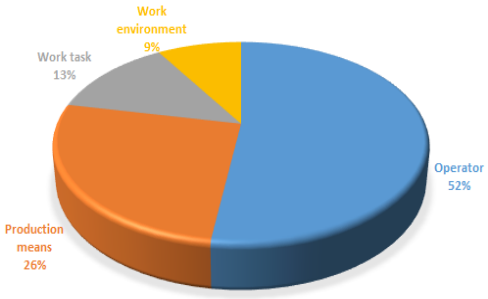


**Fig. 3.** Distribution of the risk factors on generating sources

From Figure 2 it can be noticed that of the total of 24 identified risk factors, 6 surpass, as partial risk level, the value of 3, thus being considered medium to high risk factors.

By determining the explosion risk level, it is possible to determine the priorities in prevention measures for the workplace, but also to optimise the usage of resources allocated for this purpose.

An advantage of the method elaborated at the I.N.C.D.P.M. Bucharest is the fact that its application is not limited by the condition of the physical existence of the system that needs to be assessed. It can be used in all stages related to the lifecycle of a work system or of an element of this work system: conceiving and design, physical creation, putting into production, unfolding of the work processes.

## Indication of the Explosion Risk Areas

An explosion risk area represents an industrial space in which, under normal functioning conditions, there can accumulate, permanently or accidentally, gases, vapours of flammable liquids, dusts or powders in sufficient amounts to give birth to an explosive atmosphere. Explosion hazard areas can be classified into several types, function of the length of the periods during which the explosive atmosphere is present [4, 6]:

- area 0 is the area in which the explosive atmosphere is present during the normal functioning of the technological installations, permanently or for a period of more than 1000 hours per year.
- area 1 is the area in which the explosive atmosphere can occur during the normal functioning of the technological installations for intermittent periods with durations comprised between 10 and 1000 hours per year.
- area 2 comprises the industrial areas within which an explosive atmosphere cannot occur during the normal functioning, but only in cases of predictable defects or for periods between 0.1 and 10 hours per year.

The zoning of industrial spaces represents the process of classification of spaces within an industrial installation function of the probability of occurrence of an explosive atmosphere and is important for the subsequent correct selection of the electrical and mechanical equipment that will be used in that area. The electrical apparatus for normal environments cannot be used, in general, in areas with explosion hazard due to the risk of the explosive atmosphere igniting due to electric sparks or arcs, hot surfaces of equipment, electrostatic discharges etc. [4].

Therefore, at the execution of the electrical apparatusses and equipments for potentially explosive areas, there have to be applied certain supplemental constructive measures that would offer them safety during functioning and in the presence of the explosive atmosphere.

For the zoning of the natural gas regulating and metering station, the author has used the software package AutoCAD Plant 3D, that allowed o clearly emphasise the areas with explosion hazard, as shown in fig.3.

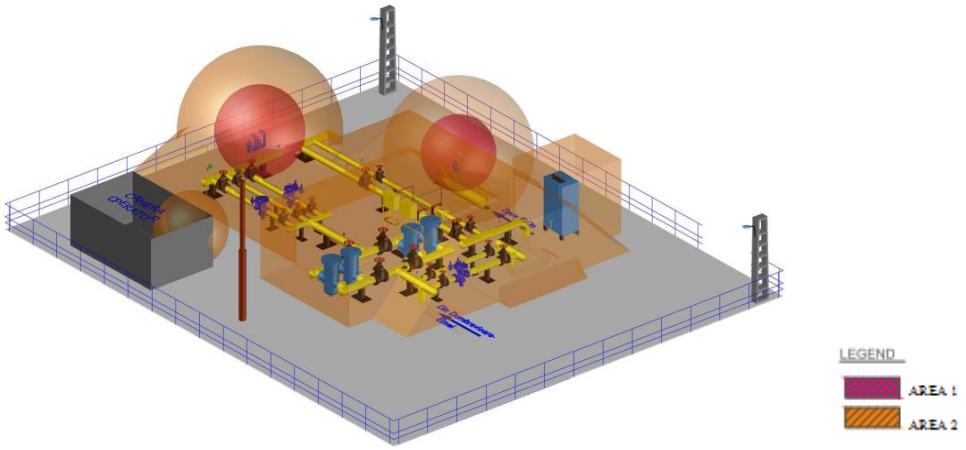


**Fig. 4.** 3D zoning plan showing the physical location of areas with explosion hazard

The computer-aided zoning allowed to notice that for the analysed natural gas regulating and metering station, area 1 is found for the following equipment: odorisation room, refulator, safety valve, inner technological installation, while area 2 is encountered for the outer technological installation.

Figures 5 and 6 show the extent of the explosion hazard areas in vertical cross-section (fig.5) and in horizontal cross-section (fig. 6).

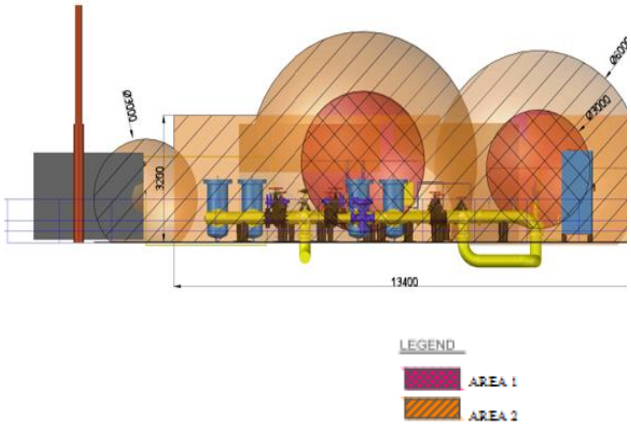


**Fig. 5.** Vertical zoning plan showing the physical location of the areas with explosion hazard

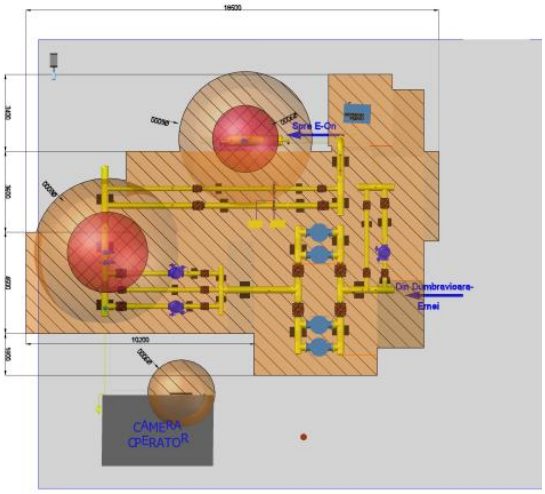


**Fig.6**. Horizontal zoning plan showing the physical location of the areas with explosion hazard

## Conclusions

One of the main advantages of the method presented in this paper is that its application is not limited by the condition of a physical existence of the system to be assessed. It can be used in all stages related to the lifecycle of a work system or of an element of such a system: conceiving and design, physical creation, putting into production, unfolding of the work processes.

The application of the gravity/probability method for the analysed workplace has allowed the identification of explosion risk factors and to determine the dimension of risks for the occurence of an explosion at this workplace.

For this, for each identified risk factor there will be indicated technical and organisational measures that need to be taken in order to keep the risk level in the „area of acceptable risks".

After the division of the space into specific hazard areas, the electrical installations can be conceived either through the usage of electrical equipments certified for such areas, or, if no such equipment is available, through conceiving new equipments and the certifying it.

## References

1. Nolan, D.P. – *Handbook of fire and explosion protection engineering principles for oil, gas, chemical and related facilities*, 3rd edition, Elsevier, 2014.
2. Jo, Y.-D., Crowl, D.A.- Individual risk analysis of high-pressure natural gas pipelines, *Journal of Loss Prevention in the Process Industries*, **21**(8), pp. 589-595, 2008.
3. Cioca L.I., Popescu Stelea M., Moraru R.I. – Occupational safety and health risk assessment in Romanian surface gas extraction facilities, *Proceedings of the 14th International Multidisciplinary Scientific GeoConference*, SGEM 2014
4. Huidan, A-S. – *Echipamente electrice de automatizare și control în medii cu pericol de explozie*, Editura Tehnică, București, 2008.
5. Moraru, R.I. et al. – Safety and health at work risk assessment in a compression station from the major Romanian natural gas company, *Proceedings of the 18th Conference on Environment and Mineral Processing*, pp. 37-42, 2014.
6. * * * – SR EN 60079-10-1 - *Atmosfere explozive.* Partea 10-1*: Clasificarea ariilor periculoase.*

# Evaluarea riscului la explozie într-o stație de reglare măsurare gaze naturale și utilizarea unor software moderne pentru prezentarea zonelor cu pericol de explozie

## Rezumat

*Scopul aceste lucrări este de a contribui la creșterea gradului de siguranță în natural gas regulating and metering stations prin reducerea accidentelor de muncă și a apariției bolilor profesionale utilizând metoda elaborate de Institutul Național de Cercetare-Dezvoltare pentru Protecția Mediului București și software-ul AutoCAD Plant 3D.*

*Obiectivele acestei lucrări sunt axate pe două direcții de certare. Prima direcție de cercetare este evaluare riscului la explozie pentru angajații care lucrează în instalația tehnologică a stației de reglare și măsurare gaze naturale. A doua direcție de cercetare este marcarea zonelor cu pericol de explozie cu ajutorului unui software modern care permite prezentarea acestora sub formă 3D.*