

Assessment of Occupational Risk in a Typical Natural Gas Compression Facility

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Summary

In Europe, a considerable amount of legislation in the area of workplace accident prevention is in place, but companies differ greatly in their level of compliance. This problem, which is also valid in Romania, generates important social concern. Health, Safety and Environment are enablers for economic development. All the three aspects of business are measured by their negative impact on people, assets and environment. Integrating risk assessment in an organization is a process that generally follows a sequence of phases. Occupational Health and Safety is important because it protects all laborers and employers from harm and health risks caused by their occupations. Unfortunately, many Romanian employers are not really concerned about the protection of their employees' occupational health and safety, and even worse, some employers do not even realize that they have the moral, and often legal, responsibility to protect their employees. In every working environment, it needs to be safe and conducive to the workers so that there will be a productive output from the workers. If all humans can adapt to their work, then there would be a better employment and service. The national ROMGAZ SA company from Medias is the most important unit in Romania for extraction and storing natural gases in underground facilities and the most important work equipments within ROMGAZ SA Medias are the gases compression stations. For the most representative one, Botorca Gas Compression station in the company, in the present article, the risk assessment of occupational accidents and diseases was carried out and the appropriate protection and prevention measures have been established. The obtained results will allow the safety and health level of the workers to increase in the field of natural gas extraction industry. The paper highlights how a rational risk assessment approach can lead to adequate risk control, to pro-active prediction of occupational risk injuries and ultimately to safety of workers.

Keywords: compressor station, pipeline, risk assessment, prevention, protection, occupational safety and health

Introduction

Improving safety and health at work in the natural gas extraction industry depends on the manner in which the European Directives provisions are acknowledged and implemented in practice or the provisions of the laws and the government decisions applicable to the natural gases extraction industry, which specifies the minimum requirements in order to encourage improvements in the work environment and at the same time to ensure a better level of health and safety.

The National Society of Natural Gases “ROMGAZ - SA Medias” was established in June 2001 under HG nr.525/14 by the merger of the Commercial Company Exploration and Production of Natural Gases” EXPROGAZ “SA with the National Society of Natural Gases Underground Storage” DEPOGAZ “- SA ROMGAZ S. A. main object of activity is the extraction and storage of natural gases. The exploitation activity of natural gases deposits under the society concession are in progress through the three branches of production: Medias, Tg. Mures and Ploiesti which together exploit the gas pools with productive wells and compression stations. The wells are bounded by incoming conduits to the group of wells and are connected to the National Gas Transmission System.

The compressor stations used in transportation on the

gas mains can be of three types:

- compressor stations from the initial point of the pipeline;
- intermediate stations
- final point stations

In the intermediate stations there are used single-stage compressors and a compression ratio of 1.6 to 2. The initial stations are similar to the intermediate ones having in addition, if necessary, a drying and a gas purification station. At the initial stations, the delivery pressure is the same with the adequate pressure from the intermediate stations. Instead the input pressure is not constant, depending on the pressure in the collection pipeline of the gas field. The final station must provide a sufficient delivery pressure because once the gases reach the delivery station it must have necessary pressure to supply various consumers.

The Botorca gas compression station - Sibiu County (Fig. 1) belongs to Romgaz SA Medias Branch and performs the compression process of the extracted natural gas which is transmitted at the transportation pressure in the SNGN national networks.

The Botorca gas compression station consists of:

- Moto-compressor room
- Driving, command, signaling, measurement and lighting electrical installation

- Tap manifold, gates, pipelines, over-pressure jet valves, electrical and mechanical installation afferent to the technological installation, mounted outside in the open-air. Occupational risk assessment at Botorca Compression Station

Occupational risk assessment method description

The proposed evaluation method aims to determine the quantitative risk level at Botorca compression station within SNGN ROMGAZ SA Medias, based on the systematic analyze and the risk assessment of occupational accidents and diseases. The essence of the method rests in identifying all risk factors from the analyzed system based on some predetermined checklists (list of risk factors) and the risk size quantification based on the combination between the severity and frequency of maximum foreseeable consequence. Due to the accumulated and processed data, the adopted evaluation method allows the substantiation of the technical and organizational measures, having a preventive character in order to reduce the risk of injury. The workplace is conceived as a complex system, structured with the following elements that interact: work equipment, work environment, work task, worker.

The global risk level (N_r) per workplace is calculated as a weighted average reality, as much as possible. It is used as weighting factor the risk factor rate of the established risk levels for the identified risk factors, in order that the obtained result to reflect the extent which is equal to the level of risk.

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

where:

N_r = global risk level per workplace

r_i = risk factor rate 'i'

R_j = the risk level for the risk factor 'i'

n = the number of risk factors identified at the workplace

The description of the work system afferent to the Botorca gas compressor station

Within Botorca gas compression station, the compression process of natural methane gas is carried out and it is transmitted into the afferent SNGN national networks

The work system component elements for Botorca Compression station are:

a) *Work equipment (WQ)*: motor-pump, command button, electrical valve, pressure switch, magneton, cooler engine, electromagnet, electrical heater, bendix, plugboard, connection box, relay box,

b) *Work task (WT)*: The work task for each professional category within Botorca compression station is described in the job description that were made available by the beneficiary.

c) *Work environment (WE)*: The workers develop their activity in the area of the compression station, the work environment is characterized by normal values of the parameters: temperature, humidity, air currents' speed and also the presence of noise and vibration nuisances.

d) *The worker (W)*: The main professionals categories of surveillance and execution that develops its activity within the Botorca compression station are: 6 team leaders, 1 motorist, 7 compressor operators, 6 electricians, 6 mechanical locksmiths and 1 milling machine operator

The professional risk assessment for the "compressor operator" position – botorca gas compression station

The aim of the work process is to ensure the exploitation and maintenance of the gases compression facilities and equipment components in safety conditions. The evaluated component elements of the work system are integrated below

a) Capital goods

- Moto-compressor
- Turbo-compressor

b) Work task

The work tasks are those recorded in the job description

c) Operator

- Qualification: Specialized High School, vocation



Fig. 1 The gas compression station

Rys. 1 Stacja kompresji gazu

al school - mechanic profile;

- Experience: minimum 5 years;
- Others: dexterity and good coordination of movements; will perform an annual medical examination to confirm the occupied position

d) Work environment

Work environment in which the compressor operator develops his activity, is characterized by:

- The air variable temperature - depending on the meteorological conditions
- The air currents in open air and also within the station- due to the natural draft and leakiness
- Background noise

All these aspects make the workplace assessment necessary and the quantification risk level of occupational injury and disease at the Compressor operator post.

For the “Compressor operator” position, considering the data from the evaluation card and applying the calculation formula of the adopted method, the global risk level may be calculate:

$$N = \frac{\sum_{i=1}^{25} r_i \cdot R_i}{\sum_{i=1}^{25} r_i} = \frac{2(4 \times 4) + 14(3 \times 3) + 5(2 \times 2) + 4(1 \times 1)}{2 \times 4 + 14 \times 3 + 5 \times 2 + 4 \times 1} = 2,84$$

where:

N = global risk level per work;

R_i = the risk level for each risk;

r_i = risk factor rate

For the “Compressor operator” position, the quantified value of the risk level of 2.84 indicates a low risk according to the classification scale of risk levels. The risk level value indicates an acceptable work situation but also in this case it is necessary to adopt technical-organizational prevention measures of occupational accidents and diseases, which have been established but are not presented in the article.

In Figure 2 there are presented the partial risk levels depending on the risk factors for the workplace / “Compressor operator” position, for which the global risk level has the value of 2.84.

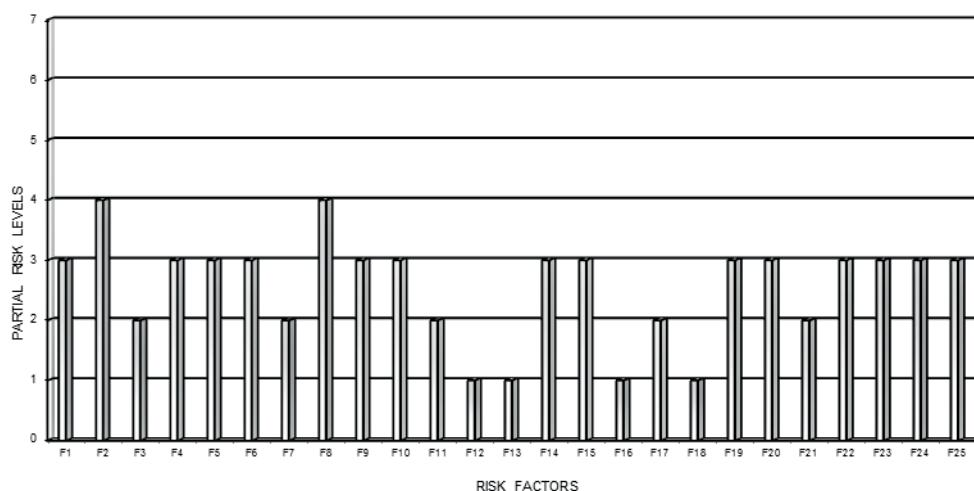


Fig. 2 The partial risk levels depending on the risk factors for “Compressor operator” position

Rys. 2 Częściowe poziomy ryzyka w zależności od czynników ryzyka dla stanowiska operatora sprężarki

The interpretation of the evaluation results at Botorca compression station

The global risk level calculated for the “compressor operator” position is equal to 2.84, this value encloses it into the job category with unacceptable risk level.

The result is backed by the “Evaluation card of the workplace/ “Compressor operator” position from which it can be observed that from the total of 25 identified risk factors, only 2 exceed as a partial risk level, value number 3 fits in the medium risk factors category. The two risk factors which fit in the unacceptable area are:

F2 - Dangerous movements - lack of protectors in the hazardous areas – transmissions by belts, cardans, couplings - *N.V.P.R.* 4

F8 - Electrocutation by direct touch – non-insulated cable heads, non-secured panels, improvised connections - *N.V.P.R.* 4

The weight risk factors identified depending on the work system elements for the “Compressor operator” position with a global risk level = 2.84 is shown in Figure 3.

From the analysis of the workplace/ “Compressor operator” position evaluation card, it can be observed that 48% of the identified risk factors can have irreversible consequences (Death) on the worker. The weight risk factors identified depending on the maximum expected consequence for the “Compressor operator” position having a global risk of 2.84 is shown in Figure 4 as follows:

ITM 3-45 = 40%;

ITM 45-180 = 8 %;

INV Gr.II = 4%;

Death = 48%

According to the presented method we have determined the risk level for all the professions and for the other Compression stations within SNGN Romgaz Medias (table 1).

From the values analysis it appears that the global risk value for the same profession categories, regardless of workplace is the same. The electrician, motorist and welder operator’s professions belonging to the compressor stations poses a medium risk level and the other professions rep-

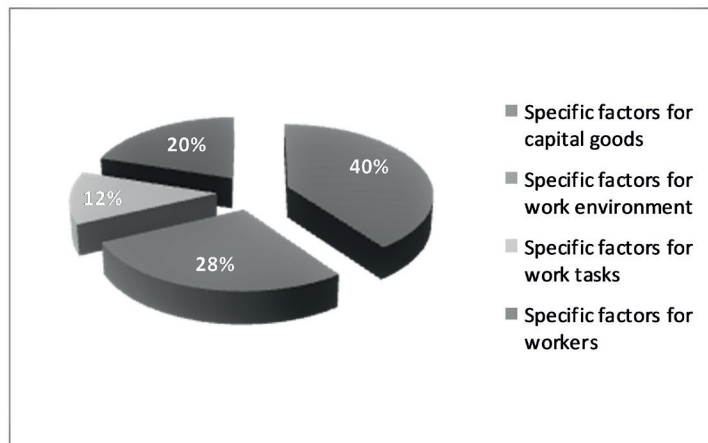


Fig. 3 The weight risk factors identified depending on the work system elements - Workplace/”Compressor operator” - global risk level: 2.84

Rys. 3 Czynniki ryzyka zidentyfikowane w zależności od elementów systemu pracy na stanowisku operatora sprężarki – globalny poziom ryzyka: 2.84

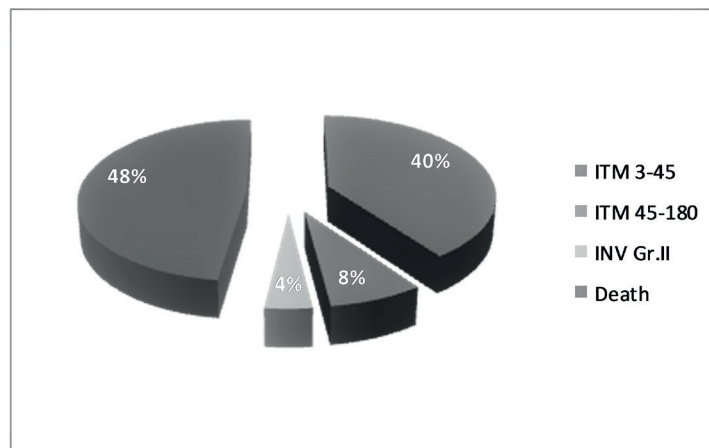


Fig. 4 The weight risk factors identified depending on the maximum expected consequence- workplace/”Compressor operator” position- global risk level: 2.84 (ITM 3-45 = 40%; ITM 45-180 = 8 %; INV Gr.II = 4%; Death = 48%)

Rys. 4 Czynniki ryzyka zidentyfikowane w zależności od maksymalnych spodziewanych konsekwencji na stanowisku operatora sprężarki – globalny poziom ryzyka: 2.84 (ITM 3-45 = 40%; ITM 45-180 = 8 %; INV Gr. II = 4%; śmierć = 48%)

Tab. 1 The global risk level associated with the compression stations / workplaces

Tab. 1 Globalny poziom ryzyka związany z pracą przy sprężarce

Branch / Profession	Botorca station
Station manager	2,38
Work team leader	2,38
Electrician	3,09
Compressor operator	2,84
Mechanical locksmith	2,90
Milling machine operator	2,97
Motorist	3,44

resent low-risk. From all of the professions that belong to SNGN ROMGAZ Mediaş compression stations, the motorist profession represents the highest risk value. The risk value level indicates an acceptable work situation, but it is necessary to adopt technical-organizational measures to prevent occupational accidents and diseases.

Conclusions

Safety and health at work represents in the present one of the most substantial and important sectors of the European Union social policy. Framework directive 89/391/EEC represents the legal applicable instrument in the whole European Union, with the purpose to introduce measures to promote the improvement of workers safety and health at the workplace. The Framework Directive underlay the elaboration and adoption up to the present of a series of legislative texts, named specific directives in areas where there are significant health and safety issues which constitute the EU legislative framework for the respective problem.

The occupational risk assessment method adopted for

gas compression station complies with the evaluation principles and consists in identifying all the risk factors of occupational injury and disease and risk level determination based on the combination between severity and likelihood of the maximum foreseeable consequence. The global risk level per workplace was calculated as an average weighted of risk levels established for the identified risk factors.

The global risk level for the „Compressor operator” position is 2.84, being considered a representative one within the gas compression station - meaning a low risk level. The greater the number of shares for the implementation of legislative provisions on the employer’s part and also being acknowledged by the employees, the greater degree of safety from the society. To increase the security degree at the surface installations used for natural gas extraction, concentrated actions are required from the employer’s part by applying the legal provisions of Occupational Health and Safety as well as the employee’s part by applying and implementing the actions which come to support his and the collective safety.

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Ocena Ryzyka Zawodowego w typowym zakładzie kompresji gazu ziemnego

W Europie znaczna część prawodawstwa w zakresie zapobiegania wypadkom w miejscu pracy jest uregulowana, jednakże firmy są bardzo zróżnicowane pod względem poziomu jego przestrzegania. Problem ten, który występuje również w Rumunii, generuje istotny niepokój społeczny. Zdrowie, bezpieczeństwo i środowisko są czynnikami wpływającymi na rozwój gospodarczy. Wszystkie te trzy aspekty działalności są mierzone przez ich negatywny wpływ na ludzi, majątek i środowisko. Integracja oceny ryzyka w organizacji jest procesem, który na ogół złożony jest z następujących po sobie etapów. Bezpieczeństwo i higiena pracy jest ważna, ponieważ chroni wszystkich robotników i pracodawców przed krzywdą i zagrożeniami zdrowotnymi występującymi na ich miejscach pracy. Niestety, wielu pracodawców w Rumunii nie zajmuje się w wystarczającym stopniu ochroną zdrowia swoich pracowników oraz bezpieczeństwem i higieną pracy, a co gorsza, niektórzy pracodawcy nie zdają sobie nawet sprawy, że mają moralny, i często prawny, obowiązek chronić swoich pracowników. Każde środowisko pracy, musi być bezpieczne i korzystne dla pracowników, tak aby zapewnić najlepszą wydajność produkcyjną robotników. Gdyby wszyscy ludzie mogli odpowiednio dostosować się do swojej pracy, zapewniłoby to lepsze warunki zatrudnienia i lepsze usługi. Krajowa firma ROMGAZ SA z Medias jest najważniejszym zakładem wydobywania i magazynowania gazu ziemnego w podziemnych obiektach w Rumunii, najważniejszymi urządzeniami w ROMGAZ SA Medias są stacje kompresji gazu. W niniejszym artykule przeprowadzono ocenę ryzyka wypadków i chorób zawodowych oraz zostały ustalone odpowiednie środki ochronne i zapobiegawcze dla jednego z najbardziej reprezentatywnych w firmie dworców kompresji gazu - Botorca. Uzyskane wyniki pozwolą zwiększyć poziom bezpieczeństwa i zdrowia pracowników w zakresie wydobywania gazu ziemnego. Artykuł podkreśla, jak racjonalne podejście do oceny ryzyka może prowadzić do odpowiedniej kontroli ryzyka, do aktywnego przewidywania obrażeń, a ostatecznie do bezpieczeństwa pracowników.

Słowa kluczowe: stacja kompresorów, rurociąg, ocena ryzyka, profilaktyka, ochrona, bezpieczeństwo i higiena pracy