A translation from Bulgarian

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SUPPLEMENTED SAFETY REPORT
ON UNDERGROUND GAS STORAGE FACILITY ""CHIREN""
OPERATED BY "BULGARTRANSGAZ" EAD

/in conformity to the provisions of Art. 13 of the "Ordinance on the prevention of major accidents and on the limitation of their consequences", endorsed by Council of ministers letter No 2 dated 11.01.2016, promulgated in the State Gazette, issue No.5 from 19 January 2016/
and

/Instruction for preparation of a safety report/

2022

GLOSSARY OF THE ABBREVIATIONS USED

(**Bul.**)

AVR	Automatic Reserve Activation
BPGG	Fuel Gas Preparation Unit
BPSOV	Municipal Wastewater Treatment Plant
VAP	Internal Emergency Plan
GIS	Gazoimervatelna station
MMC	Gas-Engine Compressor
GTD	Gas turbine engine
GTKA	Gas turbine compressor unit
E/PPGA	Report on/ major accident prevention policy
ZBUT	Healthand safety at work
ZZ	Protected area
ZOOS	Law on the Protection of the Environment
ILB	Information safety list
ISZ	Individual means of protection
KS	Compressor Station
LASSO	Local Automated Emergency Alert System
LPS	Personal protective equipment
MPS	Motor vehicles
OHV	Hazardous chemicals
PB	Fire Safety
PBZN	Fire Protection of the Population
UGS	Underground gas storage facility
PEB	Production and energy supply Block
PI	Land property
PP	Fire fighting
RZI	Regional Health Inspectorate
RZPRN	Areas with significant potential risk of floods
RIEW	Regional inspectorate of environment and water
RD "PFZN"	Regional Directorate "Fire Safety and Protection of the Population"
SZH	Loss of pressurization
SNAVR	Rescue emergency restoration works
SUZBR	Occupational health and safety management system
SUMB	Safety management control system
TEG	Triethylene glycol
CK	Centrifugal compressor
STIAP	Headquarters for the implementation of the emergency plan
BLEVE	Boiling fuel vapour explosion
[№]	The number of the relevant Appendix to the report

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The present report has been prepared in conformity with Art. 13 and Appendix No 4 of the Ordinance on the prevention of major accidents with dangerous substances and the limitation of their consequences (*promulgated in the State Gazette (SG) No. 5 dated 19 January 2016, amended and supplemented in the SG. No. 67/2019*) and in accordance with the Instructions for the preparation of a safety report. **Additions have been made in connection with the opinion of the Ministry of Environment and Water resources w**

ith Reg. No OBOC-17/19.04.2022.

I. REPORT ON THE MAJOR ACCIDENT PREVENTION POLICY AND THE SYSTEM FOR THE MANAGEMENT OF THE SAFETY MEASURES

1.1. Official statement of the management of the enterprise

In carrying out the activities targeted at the to ensuring of the safe flow of the technological processes in “Bulgartransgaz” EAD, the Regional – the ““Chiren”” underground gas storage facility. The management of the company is committed to complying with the following principles:

1. To develop its activities in accordance with the basic requirements of the policy for reducing the risk of major accidents and for limiting their consequences, by pursuing the following objectives:

- prevention of accidents that may cause harm to people, destruction of material property and lasting adverse effects on the environment:
- compliance with the national legislation and the European directives:
- assessment and reporting of accidents that have occurred and the accidents which have been prevented.

2. To develop its activities for the implementation of the policy for reducing the risk of major accidents and for limiting their consequences through a safety management system described in the Safety report.

3. The policy for reducing the risk of major accidents and limiting their consequences is the responsibility of:

- all employees of the enterprise, as reflected in their job descriptions and work instructions:
- all natural and legal persons, employed by the operator, the conditions for which are entered in the performance contracts.

4. To develop its activities with the commitment to the safe exploitation of the ““Chiren”” underground gas storage facility (UGS).

5. To manage the activities related to protecting the health of staff, the quality of the environment, the ensuring the safety of the technological processes and the occupational health and safety .

6. To develop its activities without causing harm to the workers, the population and the environment within the area of the enterprise, subject to the conditions for safe operation of the available machinery and equipment.

7. To build a company culture through which all employees of “Bulgartransgaz” EAD shall be committed to the policy for the prevention of major accidents.

In order to implement this policy, “Bulgartransgaz” EAD shall:

1. Implement a Safety management control system that ensures a high level of protection of human life and health and the environment.

2. Perform a careful selection, training and annual assessment of the progress of the staff which is a prerequisite for ensuring the long-term sustainable operation of the production processes.

3. Carefully evaluates the capabilities of everyone working on behalf of “Bulgartransgaz” EAD, includig partners, suppliers, contractors or other third parties.

4. Set up the organization and control over the strict adherence to the labor and technological discipline requirements, the fulfillment of all instructions and normative documents concerning the nature of work performed.

5. Work with clearly identified parameters that ensure a sufficiently low level of technological risks and in this connection shall:

- regularly assess and manage changes in the production processes, equipment, organization and the personnel;
- manage the risks related to non-routine operations.

6. Shall report the incidents/the accidents prevented, and will continue to:

- perform the necessary activities to improve performance;
- take the necessary corrective and preventive actions;
- maintain the emergency plans, the appropriate equipment, facilities and the trained personnel;
- protect the public, the environment and the employees of “Bulgartransgaz” EAD in the event of an breakdown or an industrial accident.
- and employees of the

7. Conduct a thorough investigation of all real and potential incidents and shall keep in touch with and promptly notify interested stakeholders.

8. Perform assessments of the technical condition and maintenance of the drilling equipment in the Underground gas storage facility in order to maintain a high standard

of safety of the operational and observational boreholes, shelters, fountain fittings, gas fittings and other ground-level and underground equipment.

9. Prepare a funded program for investment and maintenance, the purpose of which is to build and put into operation new, modern facilities and installations and the rehabilitation of the existing equipment in order to increase capacity, development of the gas market and increase the reliability of the system as a whole, with a view to preventing accidents that would lead to interruption of the supply of natural gas, as well as endangering human life and health and for protecting the environment.

10. Require of the counterparties, subcontractors and all other entities related to the business activity of “Bulgartransgaz” EAD to control and develop their activities in accordance with the company policy; to maintain a high standard of safety, production discipline and occupational health and safety.

11. Encourages safe practices and the work discipline as well as individual self-awareness on the work place in order to avoid potential accidents.

12. Requires commitment and active support of the entire management of the company regarding the policy for the prevention of major accidents.

In the capacity of Chief Executive Director of “Bulgartransgaz” EAD I hereby

DECLARE

My personal commitment to providing the necessary financial and human resources for the implementation of the adopted Policy for the prevention of major accidents.

Executive Director of “Bulgartransgaz” EAD:

/**Vladimir Malinov**/

1.2. The identified major accident-related dangers in the enterprise and the relevant specific measures to be taken by the operator are intended to reduce the risk of major accidents after taking into account the risk of major accidents which may occur in the company.

Within the meaning of § 1, item 54"a" of the Environmental Protection Act (*ZOOS*, Bul.), a "**major accident**" is the occurrence of a major emission, fire or explosion which occurs as a result of uncontrollable events in the course of the operations of any enterprise or facility within the scope of Chapter seven, Section I of ZOOS, and which leads to a serious danger to human health and/or the environment and which is immediate, delayed, inside or outside of the area of the enterprise and includes one or more dangerous substances classified in one or more of the hazard categories a set out in Part 1 of Appendix 3 or by its name listed in Part 2 of Appendix 3 to the Act.

Section II of the present report examines the hazards associated with the storage of hazardous substances/waste falling within the scope of Appendix 3 of the ZOOS that are available on site.

A risk assessment is presented in **item II.3.2.2** consisting of an analysis the scenarios of the major causes of accidents by on the "Risk matrix" method and CEL (the triple factor method), which allow for the prioritization of the major accident scenarios.

The following major accidents, that may occur on the territory of the enterprise, have been identified:

- leakage of natural gas accompanied by fire / explosion at the site of "Bulgartransgaz" EAD;
- methanol tank accident accompanied by toxic dissipation or fire in a puddle/fireball.

The properties and quantities of hazardous chemicals and mixtures stored on the territory of "Bulgartransgaz" EAD define the enterprise as bearing the risk of major fire accidents and/or toxic effects on people. Only the natural gas meets the criteria for reporting a major accident in conformity with Appendix No 5 of the ZOOS - in respect of the possibility of an accident with dangerous substances in quantities not less than 5 percent of the set quantity limits in conformity with Appendix III, Part I, column 3 or Part 2, column 3. Methanol is on the borderline under this criterion - 4.5 per cent – and therefore we also consider it as a dangerous substance with a potential risk of a major accident.

The operator has taken basic measures to simultaneously ensure:

- compliance with the requirements for storage of hazardous substances, mixtures and waste;
- the reduction of the risk of the occurrence of major.

The specific measures taken to reduce the risk of major accidents, implemented by the “Chiren” Underground gas storage facility (UGS) as part of the structure of “Bulgartransgaz” EAD, are as follows:

- Hazard identification and assessment, major accident risk assessment, in-depth assessment of the consequences from the accident on people, sites and the environment;
- Careful selection, training and regular assessment of the competence of the staff to maintain normal and safe working conditions;
- Assessment of the skills when selecting external organizations, such as trading partners suppliers and other stakeholders;
- Maintenance of the technical facilities and means of transport on a level on which the risks of the occurrence of an accident are minimized;
- Development and updating of an Internal Emergency Plan of the enterprise to reduce the consequences from the accident for people, facilities, adjacent sites and the environment to the lowest possible level;
- Detailed awareness of the personnel regarding the potential hazard of any facility in the enterprise in the event of an accident. Regular training of all staff members for adequate and effective actions in an emergency situation and in the elimination of the consequences from an accident;
- Requirement that the staff should strictly observe the measures set in place to ensure safe operation of the facilities; awareness and commitment to the entire policy for the prevention of major accidents;
- Assessment of all of the necessary changes in the technological facilities and processes, the organization of the production and the personnel from the point of view of accident prevention;
- Reporting and investigating accidents and preventing cases of accidents and taking corrective and preventive action to improve the performance;
- Providing the necessary information to the public concerned on the potential accident hazards, the possible consequences and protective measures;
- Planning and implementation of the tasks set out in the annual Investment and maintenance program concerning the “Chiren” UGS;
- Organization and control over the strict observance of the labor and technological discipline regarding the fulfillment of the requirements of the *Regulation* on the *structure* and *safe operation of transmission and distribution pipelines*, *gas* equipment and *installations* and *devices for natural gas* (State Gazette No. 67/2004), as well as all additional instructions and normative documents typical of the nature of work;
- Implementation of systematic control over all facilities and installations and during complex meteorological situations, additional observations rounds are also to be made. In case of established deviations, urgent measures are taken according to the emergency plan and they are aimed at preventing larger accidents;

- Compliance with the provisions of the *Technical requirements of the products act* (promulgated in the State Gazette No. 86 dated 1.10.1999) and the *Regulation* on the *structure* and *safe operation of transmission and distribution pipelines*, *gas* equipment and *installations* and *devices for natural gas* (State Gazette No. 67/2004), on the safe operation of gas equipment and installations;
- Compliance with the requirements for which the Certificate for the installation, repair, maintenance and reconstruction of gas pipelines, gas facilities and installations has been issued by the State Agency for Metrology and technical supervision;
- Maintenance of technical dossiers containing the technical documentation, drawings, calculations and documents for carrying out repairs of the facility concerned;
- Keeping audit books for all gas pipelines, gas facilities and installations in which the technical supervision record the results from the supervisory activities carried out and the prescriptions for eliminating the deficiencies found;
- Continuous observations by the operating personnel for compliance with the technological regime of the production facilities, machines and apparatus, which is reflected in the relevant technical documentation. The periodic technical supervision is carried out on the facilities by licensed persons in accordance with the current legislation;
- Control over the observance of internal regulations and instructions regulating the activity of safe operation and repair of gas facilities and installations. The instructions shall specify the tasks, functions and responsibilities of the service personnel, the procedure for starting, servicing and stopping the facilities; the actions in case of emergency stops and in case of accidents and breakdowns;
- Conducting mandatory training and briefings in accordance with the requirements of *Regulation РД 07-2 / 16.12.2009 on the terms and conditions for conducting periodic training and instruction of workers and employees as per the rules for ensuring healthy and safe working conditions;*
- Annual verification of the knowledge of technical staff about the structure and safe operation of gas pipelines, gas facilities and installations;
- Compliance with the requirements for safe performance of gas-hazardous, repair, fire and earth works and "Instructions for ensuring fire safety in “Bulgartransgaz” EAD" (ZBR/PPB-31-BTG-SC1D) and its Appendixes;
- Assessment of the technical condition and safe operation of the drilling equipment used by “Chiren” UGS with the aim of maintaining a high standard of the safety of the operational and observation boreholes, plumes, fountain fittings, gas fittings and other ground and underground equipment;

- Periodic inspection of fire equipment and the fire alarm systems as well as measurement of earthing and lightning protection systems by accredited laboratories.

No	Activity	Measurement criteria	Lead time
1.	Inspection of fire alarm system and fire extinguishing equipment in accordance with the applicable legislation	Inspection reports from a licensed company.	Once a year
2.	Verification of the technical means for initial firefighting	Protocols from an inspection by a licensed company.	As per a schedule
3.	Prevention of the release of hazardous chemical substances and mixtures into soils, water and air due to accidents	Availability of operating instructions for safe operation	Permanent
4.	Exercising internal control over the implementation of the rules under Art. 4, item 8 of the Ordinance on the Storage of Hazardous Chemical Substances and Mixtures	Continuous inspections	Permanent
5.	Compliance with instructions to ensure safe and healthy working conditions	Continuous inspections	Permanent
6.	Preparation of an internal emergency plan addressing all major accident risks	Annual training/playback of scenarios from the plan	Annually
7.	Security of the enterprise under a contract with a licensed company – providing physical security, strict access regime, prohibiting unauthorized intrusion or any possibility of a terrorist act in the enterprise	Contract with a licensed company	Permanent

1.3. Means, structures and organization adopted by the enterprise with a view to preventing major accidents and limiting their consequences for human health and for the environment

"Bulgartransgaz" EAD has introduced an internal procedure named *"P-BTG Preparedness for emergency situations and response capabilities*". The procedure defines the order and responsibilities of the enterprise for the establishment of an organization and the implementation of preventive measures for the adequate and timely response in the event of emergency situations in view to reducing the related adverse effects on the health and safety of the employees and in fulfillment of the obligations to society specified in the *Disaster Protection Act* (promulgated in the State Gazette No. 102/2006).

For the production activity at “Bulgartransgaz” EAD, the “Chiren” UGS there is a prepared Internal emergency plan, which provides for the relevant measures in the event of accidents, the ways to notify and inform the affected population and the external structures as well as the key units of the unified rescue system and the actions to be undertaken to deal with the consequences from the event.

Internal emergency groups and means of response

Based on the procedure and in compliance with the regulatory requirements, under the Order of the Head of RZ (*Regional Unit*, Bul.) “Chiren” UGS, Headquarters for the Implementation of the Emergency Plan (*STIAP*, Bul.) were established. At the “Chiren” UGS, STIAP is responsible for setting up and maintaining in constant readiness the overall organization of the activities related to the prevention, localization and elimination of disasters, accidents and catastrophes. It is also responsible for liaising with and informing the official authorities.

In support of the STIAP in “Chiren” UGS four auxiliary groups were formed as follows:

- ***Observation and announcement group***
- ***Sanitary post***
- ***Group for the maintenance and exploitation of individual means of protection:***
- ***Group for the maintenance and exploitation of collective means of protection:***

Maintenance of communication channels, equipment, materials and means for undertaking action in emergency situations

The elements of the “Bulgartransgaz” communication system, providing the communication links between the company's sites during rescue and emergency recovery works, are described in the Emergency plan of the central directorate of “Bulgartransgaz” EAD.

The announcement, in the case of an accident, in “Chiren” UGS - drilling, plume, compressor station, etc., - is done in conformity with the schemes applied to the Internal Emergency Plan (*VAP*, Bul.).

To the VAP of the UGS there is an attached contact information for the announcement to the emergency groups, a list of the available motor vehicles with standard and specialized equipment and contact information for announcing the emergency to the STIAP.

In order to satisfy the need of materials in case of emergencies, the warehouses of the company contains special reserves of materials for emergency events. The

maintenance of this readiness at the workplaces of the means and the equipment specified in the evacuation plans as well as the emergency exits, firefighting equipment, audio signaling as well as the necessary first aid kits I sunder permanent control.

After receiving a positive OVOS decision, approval of the project documentation and construction of the site, on the basis of the project documentation, a Local Automated Alert System (*LASO*, Bul) will be built, in conformity with the requirements of Art. 35, para. 3, item 5 of the Law on Protection from Disasters, which will be integrated is the National Early Warning and Alert System, in conformity with the requirements of the Ordinance on the terms and conditions for the functioning of the national system for early warning and notification of the executive authorities and the population in case of disasters and for notification in case of areal danger.

Planning and conducting training and training for emergency situations

In order to maintain the state of readiness and responsiveness of the company as a whole and the responsible persons and structures in particular, “Bulgartransgaz” EAD plans and conducts training and evacuations with training simulations of emergencies as follows:

- emergency drills - to simulate situations and scenarios in accordance is the approved emergency plans;
- firefighting drills.

- training evacuations in accordance with the requirements of *Ordinance No 8121”z”-647 of 01.10.2014 on the rules and norms for fire safety in the operation of the sites*;

- drills to simulate emergencies in conformity with the specialized action plans, part of the emergency plans of the company.

All trainings and drills are planned in the "Annual Schedule of Emergency and Fire Drills of “Bulgartransgaz” EAD" and a protocol is drawn up for each drill.

The emergency notification schemes are attached to the “Chiren” general emergency plan (*VAP*, Bul.). Any other additional information, related to emergency actions, can be found in the attached general emergency plan of “Chiren” UGS

List of the materials, tools and inventory needed to carry out the repair and restoration works

1. Means of fencing and warning:
   - ➢ ropes - 2 pcs.
2. Tools for earthworks:
   - ➢ shovels, straight - 3 pcs.;
   - ➢ shovels, curved - 2 pcs.;
   - ➢ picks - 2 pcs.;

➢ steel levers - 1 pc.

3. Tools and instruments for preparatory operations

– electric water pump – 1 pc.

– insulation cutting knife – 1 pc.

4. Locksmith tools:

➢ locksmith hammer 500 g- 1 pc.;

➢ locksmith hammer 200 g- 1 pc.;

➢ hacksaw bow - 1 pc.;

➢ hacksaw sheets - 2 pcs.;

➢ steel brushes - 2 pcs.;

5. Gasket and insulation materials:

➢ tallow graphite packing - 3 kg;

➢ grease for the Russian cranes - 10 kg;

➢ grease gun with packing grease - 4 pcs.

6. Means of technical safety:

➢ fire blanket - 1 pc.;

➢ fire extinguisher - foam - 2 pcs.;

➢ fire extinguisher - powder, CO2- 2 pcs.;

➢ gloves of tarpaulin / leather - 10 pairs.;

➢ First aid kit (complete suitcase)- 2 pcs

1.4. Safety measures management system

The System for the management of the safety measures (*SUMB*, Bul.) is an integral part of the Major Accident Prevention Policy Report (*DPPGA*, Bul.). It includes that part of the general management which covers the organizational structure of the enterprise, the responsibilities, procedures, processes and resources which ensure that the major accident prevention policy is strictly followed.

The safe operation of the enterprise, based on a system of administrative structures, responsibilities and activities, takes into account the available safety means and various technological solutions. Since 2016, “Bulgartransgaz” EAD has implemented and certified an environmental management system in accordance with the requirements of the standard ISO 14001:2015 as proof of its commitment to all aspects of the environmental protection issue. Through the implemented standards, a a toolkit for achieving the objectives set before the enterprise for safe operation is maintained as well as information security and environmental protection.

The applied management system of safety measures reflects the traditions of the company in the field of observance of safe and healthy working conditions, strict observance of the technological discipline and environmental protection as a result of which “Chiren” UGS can be proud of the absolute absence of any emergency accident on its territory.

Taking into account the need to specify the rights and responsibilities of each official in the performance of his duties and by introducing a number of organizational, technical and other norms, the production activities in “Chiren” UGS are carried out in strict compliance with the regulatory requirements related to occupational safety, fire protection and emergency safety. Thus, the precise definition of the duties of each employee facilitates and protects not only his/her own life and health but also the entire production process and the local environment from pollution.

A characteristic feature of the adopted SUMB is that in order to achieve the objectives related to reducing the risk of accidents in the operation of the enterprise, relevant documents have been developed and they are aimed at the organization of the personnel, the identification of major accident and hazards and the assessment of their potential risks to people and the environment; the management of technological processes, emergency planning, managing the changes in the enterprise; the measurement (monitoring) of the progress in the implementation process, auditing and revision of the PPAG. The safety management system aims is a constant and effective control of the risk of major accidents by applying an iterative approach to the management of the enterprise: planning, implementation, assessment and revision.

In conformity with the requirements of the European and national legislation in the field of prevention of major accidents and the limitation of their consequences, SUMB consists of seven main aspects:

- Organization and staff;
- Identification and assessment of the major hazards;
- Operational control and management of the technological processes;
- Change management;
- Emergency planning;
- Monitoring;
- Audit and revision.

1.4.1. Organization and staff

“Bulgartransgaz” EAD is a combined gas operator, holding licenses for the transmission and storage of natural gas on the territory of the Republic of Bulgaria, in conformity with Art. 39 of the Energy Act (EA). The company develops the gas transmission system of the country, maintains the sites and facilities of the gas transmission network in accordance with the technical requirements and the occupational safety rules by observing the European requirements for environmental protection.

“Chiren” UGS is the “one of a kind” facility on the territory of the Republic of Bulgaria. It was established in 1974 on the basis of the exhausted “Chiren” gas condensate deposit, opened in 1963, attached to the local dragged geological structure of the same name. The “Chiren” structure is located about 20 km northwest of the city Vratsa, in the lands of several settlements within the municipalities of Vratsa and

Krivodol, and the site of the compressor station of UGS is located on the lands of the village of Chiren- Vratsa municipality, district of Vratsa.

The purpose of UGS is to compensate for the seasonal inequalities in the consumption of natural gas in the country as well as to store certain quantities of gas as an emergency reserve. The operation of the gas storage is cyclical, with the period for pressurizing natural gas being April-October and the extraction period – November through March.

“Chiren” UGS has been developed in conformity with technological and technical projects typical of the year 1974. Over the years, new facilities have been built and put into operation and at the same time old ones have been rehabilitated. In this way, the need for a comprehensive review, analysis and optimization of the operation of the repository has led to the need to develop of a technological project for the operation of “Chiren” UGS has gradually matured.

Currently, 24 operational wells have been built. They are connected by gas pipelines (plumes) to the UGS site, as well as 14 observation boreholes which serve to track the change in the static levels depending on the volume of the gas and its layered pressure in the productive horizons of the repository. The pipelines are located below the surface of the earth, at a depth of 0.8 to 1 meter.

After compression, which is carried out by the “Chiren” compressor station, the gas is injected into the boreholes through built plumes. Cathodic protection stations, power supply systems, technological and communication connections, etc., have also been built.

The servicing of the site and facilities is carried out by teams located working on the UGS site. There is a 24-hour Regional Dispatch Service (RDS), which receives telemetric information from the drillings and technical information on the operation of the facilities located on site.

Mode of operation

The gas storage has a continuous two/three-shift operation. The period of injection (three-shift operation) of natural gas in UGS is the time period starting from 08:00 on April 15 and ending at 08:00 on October 1. The extraction period (a two-shift operation) of natural gas from UGS starts at 08:00 a.m. on October 15 and ends at 08:00 a.m. on April I of the following calendar year.

The situation at present:

Extraction phase:

During this period, natural gas is extracted from the gas storage through 24 operational wells.

The extracted gas is subjected to separation of mechanical impurities and the liquid phase, successively at the "Individual Separation Site" and the "Separation and

division" site. The individual separators, together with the other constructed sites – the "Collective Manifold" and the "Telemetry Information System" - allows for the individual management of the work regimes of each of the drillings and the exercise of full current control. The purified gas enters a dehydration plant where the commodity parameters of natural gas are achieved. They are continuously controlled by a gas-chromatograph installed on the site of "Chiren" UGS.

The separated liquid phase enters successively in a degasser and separators, where it is divided into layered water and gas condensate. After the dividers, the layered water enters a degasser, and from there to a cleaning facility and through a pumping station and a water pipeline it is reinjected again into the layer. The separated gas condensate in the separators enters through an underground condensate pipeline in the tank of tax warehouse located on the site of the warehouse for flammable liquids. In the extraction mode, technical methanol is used in UGS to prevent the formation of gas hydrates in the facilities.

Compression phase:

The compressor station at "Chiren" UGS is used for the injection of natural gas in the underground gas storage during the period April - October of each year. The compressor workshop (*KC*, Bul.) is located in the southern part of the main site, in a covered room and for the injection process it uses 8 gas motor compressors type GMK-10GKNAM, with V-shaped, two-stroke water cooled gas engines with double action air cooled piston compressors, located horizontally. Natural gas is used for fuel and it is supplied in a collector common to all engines. Each compressor has a flue pipe with a height of 11.5 m directing the smoke out of the compressor room. The lubricant used for the system used is aviation oil type MC-20.

The compressed natural gas (*P oper.max = 12.5 MPa*) after being cooled in air coolers АВГ (1 and 2) passes successively through an oil filter to retain the gas compressor oil dragged by the gas through the sites "Individual separation" and "Collective manifold", from where the plumes are directed to the operational boreholes through which it is injected into the porous-cracked-cavernous space of the underground collector.

<u>Planned changes in the operation of the enterprise:</u>

"Bulgartransgaz" EAD has an IP which will expand the capacity of "Chiren" UGS by increasing the layer pressure to 150 bar (*currently 110 bar*). The volume of active gas will rise to 1 billion Nm^3 (currently 0.55 billion m^3) and daily flow rate of injection and extraction of up to 8 ÷ 10 million Nm^3 (*currently a maximum of 4.7 million m^3/day under an accelerated regime*).

The IP envisages the design and construction of new above-ground facilities – a compressor station (KC) with all its adjacent technical facilities to ensure reliable and continuous operation in the gas injection and production mode as well as a new gas meter station (GIS).

With the implementation of the IP, it is envisaged to build a unified system for supporting the technological processes. This will include the following individual nodes and facilities:

Common input separation and GIS;
GTCU with gas cooling and checkpoint and a KIP (control and measurement, Bul.*) and el*. buildings;
Manifold;
Individual separation;
Gas heating facility;
Gas drying;
Triple phase separation;
Fuel gas preparation unit (BPGG, Bul.*);*
Production and exploitation unit (PEB, Bul.*).*

For the purposes of the new IP additional terrain will be utilized, which will be included within the boundaries of the enterprise classified with high risk potential. The location of the new site for the construction of the facilities within the scope of the IP is mostly imposed by the technological need for the proximity of the existing drilling tracks, as well as the proximity of the administrative and storage facilities of the existing "Chiren" UGS site.

The new compressor station, and the facilities to it, will be realized on a new outdoor site, located in the land of the village of Chiren- Vratsa municipality, district of Vratsa. The required area for the realization of the IP - in view of the technological, fire safety and construction requirements - is approximately 82.24 *decares*. The site will measure 300 x 320 m located on agricultural land.

The new site is located in close proximity: (bordering with) to the southwest of the now existing facility. The equipment includes four gas turbine compressor units (GTCU), including a gas turbine engine (GTE), driving two centrifugal compressors (CC), auxiliary equipment to the GTCU, a unit for individual separation, GIS, manifold, gas purification and heating, general separation, gas drying plant, triethyllene glycol regeneration plant, layer fluid separation plant. In addition to the above equipment, the construction of a production and power unit (PPU), a fuel gas preparation unit (FGPU), a tank and a pumping unit for fire-fighting needs as well as a an entry checkpoint and a fence.

With the implementation of IP, the active volume of "Chiren" UGS will increase to 1 billion Nm^3 of natural gas (*700 000 t with a density of 0.7 kg/ m^3 at 0°C and 101.325 kPa*) and the total capacity will reach 1.752 billion *Nm^3*.

Compression phase:

The natural gas is fed to the site of the UGS via an underground gas pipeline (*Vratsa I/II or the "linear part of the site: "Expansion of the gas transmission infrastructure of "Bulgartransgaz" EAD parallel to the northern (main) gas pipeline to the Bulgarian-Serbian border at the valve junction "Bhutan - Chiren")* and the enters the input separation and GIS. The inlet filter-separators are vertical with two purification

phases - cyclone and with a filter element. In the cyclonic part, the largest contaminants are collected, and the filter cartridge eliminates particles with a size of > *5 μm*. The filter-separators are equipped with two independent level measuring systems and two drainage pipe lines for the automatic or manual discharge of the collected condensate and dust. After purification, the gas enters the GIS, where its quantity is measured by two measuring lines operating in parallel, each equipped with two measuring elements. In addition to the two active lines, there is also a third line as a reserve. After GIS, the gas passes through the CC, where its pressure rises to the required level. The link between the individual GTCU allows the CCs to work in parallel, or sequentially, depending on the current needs of the UGS. Working in parallel provides the possibility processing larger amounts of gas, but at a lower compression ratio and vice versa. After increasing its pressure, the gas is directed to the underground structure of the repository.

Extraction phase:

The gas is extracted from the underground storage and the passes through individual separation and manifold. The two are combined in a single node located on each of the 28 separate lines from the UGH boreholes. The individual separation and the manifold ensure separation of the main quantities of pollutants from the natural gas - layered water, gas condensate, sand, clay, etc. Fixtures are installed on each of the 28 lines, allowing control of the flow from the individual lines in conformity with the needs of the UGS. The lines are connected by a common collector that leads the gas to a node of three vertical filter - separators, protecting the system for heating the natural gas located after them. The system provides a temperature range of 23 - 45 °C of the natural gas (before reducing its pressure) and consists of a total of 5 heat exchangers operating with a common tank for cooling liquid (*a mixture of distilled water and propylene glycol*). Once heated, the pressure of the gas is lowered to a certain value and it then enters a common separation unit. In the common separation unit, the formed liquid impurities are released as a result of the pressure change. The gas purified from the liquid impurities enters a collector to the drying plant. It consists of a total of three absorption columns operating in the 2+1 mode. Triethyllene glycol is used as a drying agent, for which a regeneration system is also provided. After drying, the gas passes through the installation for input separation, then through the exit lines of the GIS where its quantity is measured prior to the outlet from the site to the relevant gas pipeline - Vratsa I / II or a linear part of the site: *"Expansion of the gas transmission infrastructure of "Bulgartransgaz" EAD parallel to the northern (main) gas pipeline to the Bulgarian-Serbian border at the valve junction "Bhutan - Chiren"*. In addition to the above-described equipment, a triple-phase separation system operates in the extraction mode which separates the layered waters, gas condensate and natural gas. The released quantities of natural gas are minimal and are directed to a torch located on a separate outdoor site. The separated layered water and gas condensate will be supplied through pipelines to tanks located at the existing site of "Chiren" UGS. The gas condensate will be stored as before - in a gas condensate tank *(see Appendix 1*) - while the layered

water will be directed to an industrial reservoir for reinjected water, from where it is reinjected into borehole P-15.

With the implementation of the IP, the use of new chemical substances / mixtures - propylene glycol and lubricating oil T 32 is also envisaged. Propylene glycol will be used as a heat carrier in the natural gas heating system and it is a safe substance in conformity with the classification criteria of *Regulation (EC) No 1272/2008 for the classification, labelling and packaging of substances and mixtures*. The lubricating oil used for the GTCU is also a safe substance.

1.4.1.2. Organization for the implementation of SUMB

The gas storage has a continuous two and three shift work organization.

Appendix 2 presents the organizational diagram of "BULGARTRANSGAZ" EAD, as of 01.11.2021.

The structure in question is subject to the approval by the Management Board of the company. "Bulgartransgaz" EAD - RU "Chiren" UGS has appointed the following categories of staff in conformity with the approved Staff list.

№	Category of personnel	№ of employees
1	Management	8
2	Analytical specialists	5
3	Technicians & other applied professionals	12
4	Administrative staff	4
5	Staff engaged with service for the population, trade and security	1
	Skilled production workers	26
7	Plant and machine operators and assembly workers	20
8	Occupations not requiring special qualifications	3
	TOTAL	**79**

"Bulgartransgaz" EAD has introduced the procedure *P-BTG Human resource management*. The procedure regulates the order and responsibilities in the management of human resources in order to provide competent and trained staff.

The organization and documentation of training courses and exercises related to emergency response and to the issues of occupational health and safety is carried out under the procedure *P-BTG Emergency preparedness and response ability*.

The human resource related management activities include:

- planning the need for employing personnel;
- defining and documenting the necessary competences of the personnel;
- selection and recruitment of personnel;
- initial, ongoing and unplanned training to maintain and increase the competence of the personnel and its requalification;
- assessing the effectiveness of the training process.

The requirements regarding the competences of the personnel are determined on the basis of the applicable legal requirements for the specific activity /if there are such/, and they are listed out in approved job descriptions. The main duties and functions, as well as the requirements for occupying the respective position, are formulated by the immediate managers responsible for each post. On the basis of a proposal, the employees of the Human Resources Department introduce content in the relevant standardized form of job characteristics.

The management of this type of document is in conformity with *P-BTG Document Management* internal regulation.

The selection of personnel is initiated by the head of the organizational unit, as a result from the established need of additional personnel. Such a necessity arises in connection with planned changes in the organizational structure, the forthcoming implementation of plans and projects of the company, expected changes in the current regulatory framework when the employer's need of workforce so requires (in case of an increased volume of the work done, in case of change, termination of employment, prolonged absence of an employee, etc.). In connection with the identified need for personnel selection, the head of the organizational unit carries out an analysis of the specific opportunities. In connection with the results from this analysis and the specific needs of staff the method of selection is chosen: it can be external or internal.

In general, the selection team performs a preliminary assessment based on documents and draws up a list of candidates who will be invited to an interview, a practical exam, a written assessment or a test. All applicants are assessed on the basis of predetermined criteria (education, professional experience, computer skills, knowledge of foreign languages, etc.). After the assessment of the compliance of the documents with the set requirements, the selection team draws up a list of candidates who will be invited to an interview, a practical exam, a written assessment or a test.

The appointment of employees whose work requires access to strategic sites or zones is made after obtaining permission for the access to strategic sites or areas by the State National Security Agency.

Before concluding the employment contract, the newly selected candidates to join the company shall submit to a human resources specialist the following documents:

- Application for employment;
- Autobiography;
- Criminal record certificate;
- Certificate of no registration in psychiatric medical institution;

- Document for lack of pre-trial or judicial proceedings for crimes of general nature, issued by the Prosecutor's office;
- Work or service record book;
- Documents for acquired education, specialty, qualification - in their original;
- Driving license (when required for the post);
- Medical certificate (ability to work night shifts, certified by a doctor - when required for the position);
- Dully signed job description;
- Application under Art.329 of the Labour code;
- Declaration for compliance with professional confidentiality;
- and other.

An individual work dossier is prepared for the new employee. The file must contain the employment contract and the job description signed by the employee, a reference for registration of the employment contract with the National Revenue Agency; a copy of a document for acquired education, specialty, qualification, legal capacity; official notes for initial instructions given and other documents.

Organization and personnel. Rroles and duties of the staff responsible for ensuring the safe operation of the facilities at the "Chiren" UGS

The selection of the personnel is carried out according to the criteria set out in the job descriptions. The job descriptions also define the responsibilities of the company's staff. **[2]**

The job description includes the following elements: **[2]**
- functional purpose of the position;
- direct job duties, requirements for their implementation, responsibilities;
- connection with external companies / customers;
- the set knowledge and practical skills required for the post;
- educational requirements, professional experience, etc.

The **Executive Director of „Bulgartransgaz" EAD** is responsible for the implementation of the overall corporate policy of the company and the achievement of its objectives, as well as for the implementation of policies regarding occupational health and safety, information security and environmental protection. The Executive Director provides the resources necessary for the implementation of the company's policies, which ensures a high level of protection of human life and health, environmental protection and the protection of information.

The **Manager of the Regional unit "Chiren" UGS** manages, organizes, coordinates and controls, on the basis of all normative and company acts, the overall activity of "Chiren" UGS and is responsible for its results. Performs analyses, forecasts and makes proposals for the development and management of the UGS. Consistently implements the company acts, directs the activities of the UGS, the modernization and

reconstruction of the technical capacities and the management process. Bears the responsibililty for keeping the facilities and equipment in good technical order. In the event of emergency situations of a different nature and disruption of the transmission system, organizes and directs their removal. He is responsible for the safe operation of the facilities and for compliance with the regulatory requirements in the field of fire and emergency safety, occupational health and safety protection and environmental protection.

Head of the regional unit / UGS "Chiren" – Deputy together with the head of the Control and Measurement Unit and A (*KIP*, Bul.): plans, manages and controls the work related to the maintenance, installation and operation of the equipment in UGS "Chiren". Performs the operational management of the activities of the following departments: "Compressor workshop", "KIP and A", "Information and Telecommunication Systems", "Energy supply". He is responsible for the immediate work of the individual services, giving orders and requiring their implementation within the limits of his competences. Bears the responsibility for the development of the highest level of technology in the UGS. Manages the development of operational and future plans to ensure the normal operation of all machines and equipment in the “Chiren” UGS. Manages the preparation of schedules for the PPR and directs the work for their implementation. Prepares the organizational and technical activities. Manages and controls particularly important events in the UGS for the review of the facilities and others. Identifies measures to combat corrosion, hydration and their realization. He is responsible for the proper operation and maintenance of the installed automation and instrumentation in the UGS and also for the measuring instruments to be checked. He is responsible for keeping records reflecting the condition and changes in the equipment entrusted to him and for the development of measures to improve automation in the production process; for ensuring compliance with the sanitary and hygienic standards and requirements for occupational safety. Participates in the consideration and establishment of the causes of accidents related to the activity for which he is responsible and develops measures for safe work and normal working conditions. He is responsible for controlling the quality of the materials used and compliance with the requirements of the design documentation for the maintenance and reconstruction of the facilities.

Head/ Head of department / Compressor workshop - performs the operational management of the activity in the "Compressor workshop" service and the open installation. Develops and controls the defined technological modes of operation of the GMC, prepares the annual schedules for the PPR. Bears responsibility for violations of the parameters of the technological process. Takes care for creating a good and effective organization of the work, as well as providing the necessary materials, spare parts, tools and devices. Participates in the implementation of tasks related to the implementation of new production equipment as well as in the implementation of new and more improved organizational and technical facilities. Ensures timely and high quality performance of examinations, inspections, tests, etc., on the installations,

machines, equipment, apparatus, etc., required by the normative documents. Ensures troubleshooting of the installations or the mechanization for which his post is responsible. Prohibits the operation of the installation or mechanization under a prerequisite or conditions for an accident, breakdown, ignition, fire or explosion. The post is responsible for the health and safety of those in operation, as well as newly installed, reconstructed, repaired, moved elsewhere, etc., installations, machines, equipment, instruments, etc. Controls the quality of the materials used and the compliance with the requirements of the project documentation and the ordinance on the repair, maintenance and reconstruction of the facilities. Monitors the implementation of production instructions. Does not allow work with malfunctioning, incomplete or unsafe installations, machines, equipment, instruments, devices, appliances, tools, etc. Controls and does not allow the operation of, servicing, repair of installations, machines, equipment, equipment, etc., to be carried out by persons who do not have the required aptitude or qualification or are not properly trained and instructed.

Manager/Head of the "Drilling" department – The officer holding this post performs the operational management of the activities of the "Drilling" department. He plans, manages and controls the work related to the maintenance, installation and operation of the drilling equipment and the respective plumes built. He is responsible for the direct management of the monitoring and research work of the drilling equipment as well as the documentation kept at the UGS. Organizes the work on the preparation of current and annual plans arranged by type of research and on the control of the available drilling facilities and offers an estimate of the possibilities for extraction and injection of natural gas in the repository, in view of the condition of the usable boreholes.

This manager directly control the work related to the monitoring and research of the drilling equipment as well as on the related documentation kept by the UGS.

Controls the results from the measurements of operational, piezometric and observational boreholes. These results are processed under his control and measures are set up for changing the mode of operation of the boreholes in the designated parts of the structure.

Gives instructions for taking preventive measures to maintain the boreholes in a good technical condition, as well as to prevent hydrate formation on their plumes. Participates in the development of organizational and technical training runs in view of the normal activities of UGS.

Participates in the decision-making when determining the locations of new exploitation boreholes and in the elaborated schedules for repairing and intensification works on the drillings as well as for conducting the necessary geophysical studies.

Together with the other departments in "Chiren" UGS, the head of the drilling dept., organizes the development of the technological mode of operation of the compressor station and the drilling equipment in the process and the above-ground facilities and the drilling equipment during the extraction process with a view to the implementation of the most progressive technologies corresponding to the achievements of well-known leading companies and the rational use of the available equipment.

Manager/Head of the energy supply dept. - performs the operational management of the activity in the "Energy" service. Plans, manages and supervises the work related to the maintenance, installation and operation of the power supply, heating, water supply. Ensures the regular electricity supply of UGS and the proper operation, repair and maintenance of the energy equipment. Directly checks and monitors the balance of the electrical grounding network. Organizes the preparation of annual plans for PPD of the electrical equipment. Takes constant care to improve the qualification of the members of the service and to strictly comply with the requirements of the existing regulations, guidelines and instructions for the operation of the entrusted equipment. He takes care of providing the necessary amount of water for the technical of the compressor workshop, the heating of the working premises on the site and the heating of the installations. Controls the quality of the materials used and compliance with the requirements of the project documentation and the ordinance in the repair, maintenance and reconstruction of gas pipelines, facilities, installations.

Manager/Head of dispatch service at "Chiren" UGS - carries out the operational management of the dispatch service in order to ensure an optimal mode of operation of the drilling and installations in extraction and injection, in coordination with the Head of RZ "Chiren" UGS. The Head of the Dispatch Service "Chiren" UGS fulfills the orders of the Central Dispatch Service on the operational management of the UGS. Leads the modes of operation of UGS in accordance with the developed schedules for the injection and extraction in UGS. Accepts the applications, coordinates them in writing with the CDU and prepares permits for the removal of basic equipment for revision or repair. Controls the keeping of a 24-hour journal on the accepted form with a complete and accurate record; analyzes the actual regimes. Prepares information, reports on the gas supplies, their distribution and storage. This officer draws up an hourly, 24/7 and monthly operating balance. Prepares reports (once a week) on the state of technological sites in the UGS and submits them to CDS. Controls the operation of the information system in the area and in case of malfunctions takes measures to eliminate them. Controls the alarm limits in the information system and, if necessary, gives a proposal for change. He is also responsible for the normal functioning of the facilities used at the "Chiren" UGS.

The Manager/Head of dept. on "Information and telecommunication systems" is responsible for the organization and functioning of the management of the information systems and the technological communication links. Bears the responsibility for the proper operation, implementation and maintenance of the automated systems and the technological communication connections. Installs and monitors the proper operation of the software related to automated systems and technological communication connections. Organizes the works related to the introduction and expansion of new and existing automated systems for the management of the technological processes. Maintains the existing databases, organizes new ones and monitors for unauthorized access to them. Bears the responsibility for the reliability of the technological

communication links of the UGS and develops measures the improvement of the organization in the operation and maintenance of exchange and amplifier systems, the telephone exchange, the cable routes as well as for the operation and maintenance of equipment concerning the reception of data from the boreholes and the gas meters of all users. Responsible for the normal functioning of automated production and technological process management systems as well as the information and telecommunication systems.

Manager/ Head of the Administrative and economic services department - carries out the operational management of the activity in the office of "Administrative and Economic Services". Plans, manages and controls the work related to the maintenance, installation and operation of the vehicle and the machine park, the food complex, the maintenance of the building stock, the warehouses. Organizes the implementation of the tasks assigned in conformity with the supply/use of the necessary materials and tools. Responsible for maintaining the working order of the available processing machines and equipment. Ensures the proper operation and maintenance of road vehicles. Organizes and personally monitors the quality of the technical inspections and repairs on them, as well as their preparation and presentation to the control organs for the obligatory inspections. Provides timely preparation of requests for the necessary spare parts for the vehicles. Exercises control over the primary documentation of drivers and keeps the necessary information and reports related to the road transport. Develops schedules (annual and periodic) for the technical inspections of the vehicles, organizes and monitors their implementation.

Technologist, exploitation - manages the work of the operating staff in the compressor workshop, prophylactic and operational activities on all above-ground facilities on the UGS site. Care for the observance of the instructions and regulations for operation, as well as for the discipline of his subordinates. Takes care of the proper keeping of primary records and the reporting of particularly important indicators of technological modes of operation. Participates in the development and supplementation of existing instructions within its competence. Periodically organizes the prophylaxis of all facilities. This officer proposes specific measures to combat hydrate formation and corrosion. Together with the operators, he accepts GMK from the repair group. Responsible for the technical and operational condition of the warehouse for flammable liquids (LPT). Responsible for the fulfillment of the obligations within the term of the prescriptions set by the control organs for safety, occupational health and safety and fire protection. Requires and controls the use of personal and other protective equipment. The technologist must know the instructions given under the Health and Safety and Fire Protection Act for the installations, machines, equipment, devices and others with which or on which he will work and comply with their requirements. He must not allow the use of faulty, incomplete or unsafe installations, machines, equipment, apparatus, devices, appliances, tools, etc., as well as such not used for their intended purpose. To suspend work immediately upon finding a malfunction in the used

equipment or under a prerequisite or condition as a result of which an accident, accident, ignition, fire or explosion may occur, notifying his immediate supervisor thereof.

The **Technologist, repair of GMC (gas-motor compressors)** is responsible for the overall activity of the repair group. Prepares PPR and other programs related to the work on the prevention and repair of GMCs and other facilities. Conducts instruction and training of the persons he is directly in charge of. Manages the revision and repair of the shut-off fittings. He manages fire-hazardous work on the facilities of the open installation. Responsible for the quality and deadlines for the implementation of the assigned tasks. Keeps the primary records of the performed PRPs. Responsible for the implementation within the time of the prescriptions of the control organs under the Health and Fire Protection act. Requires and controls the use of personal and other protective equipment.

Dispatcher of the gas transmission/distribution network – is responsible for the continuous supply of natural gas into the transmission and distribution system, exercises control and coordinates the work of the work shifts. Responsible for the implementation and maintaining the technological regime in the extraction and injection of natural gas. Directs the receiving and handing over the work shift. Violations found are noted in the dispatcher's journal and, at the same, the journal notes the changes in the mode of operation, performance of additional tasks, violations, opinions. He is responsible for keeping the primary documentation (for the quantitative and qualitative characterization of the production process) and recording it in the Operating Logbook. In particularly complex situations (accidents, violations) immediately notifies the management of the UGS and coordinates the relevant measures. Controls the timely draining of liquids in the production of natural gas. Controls the supply of certain quantities of methanol (if necessary, monitors the normal operation of the boiler room. Organizes the correct exploitation of the equipment in conformity with the operation instructions (basic and auxiliary), in compliance with the rules of the OHS and PAB). Before starting work, he is obliged to conduct a 5-minute instruction with the staff of the OHS and PAB shift.

Operator of the gas compressor units – The operator is responsible for the continuous operation of the main and auxiliary equipment of the compressor station and its maintenance in conformity with the technological documents, the mode of operation. Exercising control over the operation of the gas compressor units (GCA) and their auxiliary equipment, maintaining the most economical mode of their operation, monitoring the operation of the instruments. Keeps the required primary and operational technical documentation, preparation of the GCAs for starting, stopping and switching of GCAs. Control and maintenance within optimal limits of the temperature regime of the machines and the individual units on them. Adjusting the pressure of the gas at the inlet and outlet of the compressor stages, the cooling water, the oil in the lubrication system. Variation of the GCA load. Performs cleanings, removing gaps, replacing valves, spark plugs, etc., participating in the preparation of GMCs for the repair and in the repair itself. Annual reception and handover of the work. In the case of

compressorless operation of the station he controls the technological regime of the open installation. Upon reception and upon delivery provides a cleaned GMK and workplace. Participates in the acceptance of the machines by the repair group immediately before the start of the injection.

The **Operator of gas compressor units** exercises control over the operation of the GCU and their auxiliary equipment, maintains the most economical mode of their operation, monitors the operation of the instruments. Maintains the required primary and operational technical documentation, prepares the GCU for starting, stopping and switching. Controls and maintains, within optimal limits, the temperature regime of the machines, the operating parameters and the load variation of the GCU. Performs the required cleanings, removal of gaps, replacement valves, spark plugs, etc., participation in the preparation of the GCU for repair and in the repair itself. Performs daily reception and handover of the work. During the extraction period controls the technological regime of the open installation. Upon reception, and upon delivery, provides cleaned GCA and workplace. Participates in the acceptance of the machines by the repair group immediately before the start of the injection.

Electrical fitter/and compressor operator - serves el-substation 20 and 0.4 kV, transformer post 20 kV "Yazovira", the el-equipment to the UGS and GMC, the installed transformer power. Inspects the facilities and is familiar with the changes and peculiarities in the scheme by controlling the readings of the electrical measuring devices, servicing the facilities of the substation, establishing a load mode, etc. Ensuring uninterrupted operation of the main and auxiliary electrical equipment of the UGS. Performs mode operational switches in the distribution devices of the substation, performing periodic inspections of the electrical wiring. the equipment, in conformity with the instructions; inspection of the heating of cathode compounds, searches and removal of earth connectors of operational and power circuits. Determines the place of failure in the power lines, the parameters of the battery, disconnecting the equipment, securing them and preparing them for audits, prophylaxis and repairs. Keeps the operational documentation of the substation and on the maintenance of electrical wiring, the facilities in CC, (electric motors, panels, lighting, ventilation), electrical equipment in the boiler room, the pumping stations for water for technical needs, maintenance of the lighting masts. Maintains the technological mode of operation, exercises control over the operation of the GCA and the ancillary facilities to them. Preparation of GCAs for starting, stopping and switching, controls the operating parameters and the changes in the load.

Operator of drilling equipment (wells)

Complex servicing of the gas wells in all modes of operation:

- Participates in the gas-dynamic investigation of the boreholes and reads the diagrams of the pressure gauge;
- Controls and measures the pipe and intercolumn pressures of the boreholes;
- Conducts the water level in piezomstricts boreholes;

- Periodically checks and reports the static pressure of the working boreholes and is responsible for the condition of the pressure gauges;
- Keeps the drilling sites in good fire protected condition;
- Participates in the preparation and the testing of the drilling equipment;
- Removes, in a timely manner, the gas leaks from the taps of the fountain fittings and cranes of the column heads;
- Participates in the utilization of boreholes and in the various related operations;
- Takes measures to prevent the formation of hydrates in the extraction of gas from the boreholes;
- Transmits information about repair and drilling investigations;
- Takes gas and water samples and analyzes the mineralization of the water.

The employees engaged in the general technical, information and repair maintenance are not engaged in the production process. These individuals are subordinated to their respective superior and have the following obligations:

- Not to carry out works for which they do not have the required capacity or qualification, or if they are not instructed or trained accordingly;
- To use the appropriate special working garments, shoes, personal and other protective equipment;
- To know the instructions and orders given in the Occupational health, safety and fire protection act for their workplace, for the installations, machines, equipment, devices and others with / or on which they will work and to comply with these requirements;
- Not to use malfunctioning, incomplete or unsafe devices, tools, installations, machines, equipment, etc., as well as such which differ from the intended purpose;
- Must know the safety measures and the action plans in the event of emergencies;
- To suspend work immediately upon finding a malfunction in the used equipment or if a prerequisite or condition has been created as a result of which an accident, breakdown, ignition, fire or explosion may occur, notifying their immediate supervisor thereof.

Security

The security has the direct task of controlling the access regime on the territory of “Chiren” UGS, preventing undesired access and monitoring of emergency situations in the area of the company. The security guards comply with the instructions and safety measures of the Company. The security activities in “Chiren” UGS are also supported by a video surveillance system and a perimeter security system, which allows a continuous 24-hour control of the production site. The guards take care of opening and closing (locking) the entrance-exits, both in normal conditions and in the case of evacuation. The security guards shall keep account of the incoming and outgoing

individuals and vehicles in accordance with the *PCA-02-BTG-CMU "Rules for the security and admission regime on the sites of "Bulgartransgaz" EAD*. The company management policy of "Bulgartransgaz" EAD - "Chiren" UGS for the safe execution of Safety Report of "Bulgartransgaz" EAD for Site: "Chiren" Underground Gas Storage technological operations is a priority and it is expressed in a number of intradepartmental instructions and orders.

1.4.1.2.1. Organization of the rescue and emergency personnel

The organs of control, the manpower and means must be constantly prepared to act and prevent the consequences from natural disasters, catastrophes or industrial accidents and be notified immediately when a situation arises. To maintain this preparedness, periodic exercises (training) are held and measures are taken to eliminate accidents. In the "Chiren" regional unit there is an emergency warehouse for spare materials, parts, tools, equipment, protective equipment that will be needed to eliminate various accidents. Periodical inspections of their availability and technical condition are being performed.

The company has a separate Operational Headquarters for Action in Case of Disaster and Accidents (*STIAP*, Bul.), composed of a Chairman / Deputy chairman, members, and emergency rescue groups, each with a designated manager and members. The announcement of the management bodies, formations and workers for eliminating disasters and accidents is carried out by the Operational headquarters.

Duties and responsibilities of the Operational headquarters:

On the basis of a procedure named *P-BTG Emergency preparedness and ability to respond* and in compliance with the regulatory requirements, an Order by the Head of RZ "Chiren" UGS has lead to the establishment of Headquarters for the implementation of the "Chiren" UGS Emergency plan (STIAP). The "Chiren" UGS emergency plan is the basis for creating and maintaining in constant readiness the overall organization for the prevention, localization and elimination of disasters, accidents and catastrophes. The STIAP shall liaise with and inform the other authorized organs. It is composed of:

- Chairman - implements the announcement scheme for the members of the headquarters for coordinating the emergency formations;

- Deputy chairman - coordinates the actions of the different units in the elimination of the consequences from disasters and accidents. Monitors the compliance with the requirements of the plans for the elimination of the various disasters and accidents in "Chiren" UGS, as well as for the interaction with RS FSCP – city of Vratsa and other services from the city. Monitors the observance of the actions for the elimination of the consequences from disasters and accidents. Monitors the elimination of accidents in accordance with the Ordinance on the structure and safe operation of transmission and Distribution gas pipelines and facilities, Installations and natural gas appliances;

- and members – they carry out the rescue and urgent emergency and recovery operations and eliminate the consequences from disasters and accidents.

The following auxiliary groups are formed in support of the STIAP in the "Chiren" UGS:

Monitoring and announcement group

Common tasks of the group:

- To organize continuous monitoring in case of announced danger of disasters and accidents in the area of "Chiren" UGS;
- To survey the area of "Chiren" UGS immediately after a disaster or an accident and to provide the first information about the victims and the condition of the building stock;
- To assist the Chairman of the Headquarters for coordination of "Chiren" UGS in clarifying the overall situation after a disaster or an accident;
- To inform the Headquarters in a timely manner about any changes in the situation.

Sanitary post

Tasks:

- To participate in the conduct of all sanitary and anti-epidemiological activities in "Chiren" UGS.
- In a real situation to assist the medical emergency groups dispatched to the location in their efforts to save the health/lives of the victims.

Group for receiving and distributing individual means of protection

Tasks:

- To store and service the available ISZ, according to the instructions given;
- In case of shortage of the ISZ to make a request to the AOL Directorate in the Central Department to provide the necessary quantities;
- Keep an accurate account of the available and appropriate ISZ;
- To create the necessary organization for the rapid receipt and distribution of the ISZ;
- To draw up lists of the sizes of the necessary ISZs to be updated at the beginning of the year.

Group for the maintenance and exploitation of collective means of protection:

Tasks:

- If no protective equipment is in place, when/if necessary:
- To organize the immediate closing of doors, windows and vents in the buildings;

- To distribute the previously provided means for pressurizing the premises;
- To organize, if necessary, the rapid pressurization of predetermined rooms;
- To monitor the order and discipline in the pressurized rooms when are used for their intended purpose.

By Order of the Head of RZ “Chiren” UGS fire fighting groups in the administrative building and the area of “Chiren” UGS were appointed. The tasks of these groups are:

The tasks of the groups are defined in conformity with the instructions, orders and in the “Chiren” Emergency Plan.

For the timely elimination of accidents in “Chiren” UGS, two emergency groups (EGs) have been formed and function, determined by an Order of the Head of RZ “Chiren” UGS.

- Emergency group to eliminate an accident in a gas pipeline (plume) or borehole;
- Emergency group to eliminate an accident in the compressor workshop and the aboveground facilities.

The main task of the emergency groups is to organize the elimination of the consequences from the accidents. The emergency groups perform their activities in continuous liaison and coordination with the Central Dispatch Service and the District Dispatch Services to the Main Dispatch Department.

All other teams and staff are ready to act if necessary.

In case of damage to the communication systems, a team from the Information and Telecommunication Systems Service is activated. In case of need, other specialists, machines and equipment from other organizations/institutions may be brought in support of the activities of the emergency groups.

An organization is established for regular supply of the groups with food, water, hot drinks, etc.

1.4.1.3. Training and instruction programs for personnel

The following types of briefings are applied in “Bulgartransgaz” EAD:

- Initial instructions - are given to all newly recruited workers and employees, the aim being to make them aware of the type and nature of the work and the existing dangers in the area of the enterprise;
- Instruction at the workplace - practical acquaintance of the employee with the specific requirements for the safe performance of his/her duties before being assigned to perform independent work;
- Periodic briefings are aimed to maintain and supplement the workers' knowledge of occupational safety and health. It is carried out not less than once every three months;

- Daily instructions are given to the workers and employees engaged in activities with high production risk: extraction and injection of natural gas, drivers performing loading and unloading works and transportation of explosive and fire-hazardous substances and materials, directly engaged in construction and assembly works in carrying out reconstructions and modernizations. The daily briefing is carried out by the dispatcher on duty, the direct supervisor of the work or by an official designated by order for each specific case;
- Extraordinary instruction: this is performed after each accident at work, after a fire, industrial accident or natural disaster, in case of gross violations of the norms and requirements for occupational safety and health , in case of change of the technological process, in the case of introduction of new machines and equipment, in case of change of the workplace or the organization of work, in conformity with the prescription of a control body, as well as with workers who have been absent from work for more than 45 calendar days, after their return to work and before starting work as well as at the discretion of the employer or the immediate supervisor/manager.

For conduct of the types of briefings a special Order has been prepared and approved by the Head of RZ “Chiren” UGS. **[3.1]**

The instructions given to the personnel of external organizations - contractors of activities for the company working at the sites of “Bulgartransgaz” EAD, they are conducted in accordance with ZBR-10-BTG-SKI "Instructions for the working personnel of external organizations".

The documentation of the instructions is prepared in accordance with the current legislation and in the special instruction books.

PERSONNEL TRAINING:

By providing trained personnel, effective control over the operation of facilities and installations is ensured. “Bulgartransgaz” EAD plans and conducts the following types of personnel training:

Initial training on the requirements of the integrated management system

Initial training on the requirements of the integrated management system and its individual elements is conducted with all employees of “Bulgartransgaz” EAD. In connection with the specific employment duties, the immediate manager introduces the new employee to detailed information and requirements of the integrated management system, specifically and directly related to the post of the employee. Each newly hired employee signs a separate information sheet for becoming familiar with the implemented management systems in the company, its policies and goals.

Initial trainings for newly recruited employees

After signing the employment contract, the new employees must undergo the following training:

Initial instruction on occupational health and safety - the instruction is conducted and registered in conformity with the regulatory requirements by a specialist in occupational health and safety. Instructions should be given to all employees, as well as to all hired temporary workers, trainees, contractors for the company and visitors.

Every employee, upon starting work, regardless of the level of his training, education, qualification and work experience is admitted to the job only after getting the initial instructions on occupational health and safety and the fire safety rules.

Training related to the specific workplace requirements

Depending on the nature of the activity performed, the practical experience and knowledge of the newly appointed employee, the direct manager shall conduct introductory training. Before assigning the independent work, instruction at the workplace is also conducted and it is related to the practical acquaintance of the employee with the specific requirements for the safe performance of his/her work activity.

Current and unplanned training of employees

The planning of the current training sessions is carried out at the end of each previous year and for this purpose, an application form is filled in. The managers plan the training necessary for the activity of the respective organizational unit, setting the thematic areas, costs and the number of the participants. The applications, filled in by the managers, are summarized in, which is *ОД-ВТ025 Program for the qualification and retraining of the staff of "Bulgartransgaz" EAD* submitted for approval by the Executive director of the company.

The Personnel qualification and requalification program does not include the periodic briefings, the carrying out of which is determined by an order and is being documented in instruction books as well as the trainings and exercises related to emergency preparedness which are planned as per the order of *P-BTG Preparedness for emergency situations and response capability*.

In addition to the current training, included in the Program for qualification and retraining of the staff, unplanned trainings are also held when and if necessary.

Each form of training may end with: completing a test, a colloquy or a theoretical and/or practical examination.

Records, related to the human resources management, are stored in the personal dossiers of the employees. The employees of the Human Resources Department are responsible for their proper storage and use.

The records, related to the conduct and evaluation of the efficiency of the training sessions are stored by the Human Resources Department – Central headquarters. Instruction books, containing the records of the instructions carried out, shall be kept by the occupational health and safety specialists as well as by those responsible for conducting the periodic briefings.

Unplanned training:

- extraordinary briefings – given after any accident at work; in case of gross violations of the rules, norms and requirements for occupational safety and

health in conformity with the prescriptions of a controlling organ or to the employees who have been absent from work for more than 45 days;

- when necessary - for example, when using new equipment or other means of production; changing a previously used software product; a new workplace, change in position and/or responsibilities of the employee, etc.

The forms of training applied by the company are:

- internal training: briefings, lectures, demonstrations, practical exercises;
- external trainings: educational courses, seminars, etc.

Conducting annual examinations targeted at maintaining the competence of the staff

Once a year, all workers or employees of “Chiren” UGS mut take examinations in order to maintain the competence of the staff on topics related to fire safety, emergency safety, work with chemical substances, first aid medical assistance and the implementation of the production instructions. The management staff of “Chiren” UGS also has to pass an examination before a committee appointed by order of the Executive director of the company.

The annual examinations are conducted on the basis of the following normative documents:

- *Art. 247, para 2, item 4 of the "Ordinance on the Structure and Safe Operation of the Transmission and Distribution of Gas Pipelines, Facilities, Installations and Natural Gas Appliances" (NUBEPRG,* Bul.*).*
- *Art. 187, para.1, item 4 of the Ordinance on the construction, safe operation and the technical supervision of equipment under pressure (promulgated SG, issue 64/18.07.2008)* \
- *Art. 58 of the "Ordinance on the safe operation and technical supervision of hoisting equipment (promulgated, SG. 73/17.09.2010), for the individuals hanging the loads or the lifting accessories ("couplers") and for the individuals driving hoisting equipment under Art. 2, para. I, items 1-4 and 7 of the Ordinance;*
- *4.1. 31 of "Ordinance No 12 of 10.06.2004 on the activity of the operators of the gas transmission and distribution networks" (promulgated, SG. 79/10.09.2004), to test the knowledge and maintain the competence of the dispatching staff at “Chiren” UGS;*
- *Section III, Chapter 11 of "Regulations for safety and health when working with electrical installations in power plants, thermal power plants and with electrical networks" and Art. 20 of the "Occupational Safety and Health Regulations on equipment with voltage of up to 1000 V" for qualification groups responsible for managing electrical hazards;*
- *On the grounds of an Order for conducting periodic training and instruction of the workers and employees pursuant to Article 9, paragraph 2, item 5 of Ordinance No 8121 z-647 of 01.10.2014 on the Rules and norms for fire*

safety in the operation of the sites (promulgated, SG, issue 89 / 28.10.2014), Instruction to ensure fire safety in "Bulgartransgaz" EAD (ZBR/PPB-31-BTG-SKI) and the Training plan with practical application, internal instructions for fire and emergency safety, safe operation of appliances, equipment and installations, operations with chemical substances, medical first aid.

- *Art.2, para 2, Art. 6, para 1, items 1 and 3, Art. 7, para 5 of "Ordinance РД-07-2 / 16.12.2009 on the terms and conditions for conducting periodic training and instruction of the workers and employees on the rules for ensuring healthy and safe working conditions" (promulgated, SG, issue 102/22.12.2009)* for training and examinations related to occupational health and safety of the officials who manage the work processes and of the individuals designated by the employer to conduct the occupational safety briefings.
- *On the basis of an Order given by the Head of RU "Chiren" UGS, "Assessment of production risks in "Chiren" UGS", "Instruction for working with methanol at the gas fields and gas storage facilities",* for conducting periodic instructions and training of the engaged workers every 3 months.

Every year, schedules for training and exercises in fire and emergency safety and maintenance of the personnel`s competence are prepared and approved by the Executive director.

For the implementation of the trainings and refreshment courses, a Training program for each calendar year is approved in advance. The program for qualification and retraining of the staff for the year 2021 is presented in Appendix No 3.

For all suppliers, customers and visitors of "Bulgartransgaz" EAD, the respective specialist conducts an instruction in accordance with the level of risk to which they may be exposed.

The resources for conducting the external and internal, planned and extraordinary training and briefings are at the expense of "Bulgartransgaz" EAD.

The major task of the personnel working for "Chiren" UGS is to comply with the technological instructions for the safe operation of the facilities.

1.4.2. Identification and evaluation of the major hazards – adopting and implementing procedures for the systematic identification of major hazards under normal and abnormal modes of operation, including subcontracted activities (if any), and an assessment of the likelihood of the occurrence and assessment of the severity of the consequences and an identification of the necessary preventive measures

Item **II.1.2** of the present report examines in detail all of the dangerous chemicals (*OHV*, Bul.) which fall within the scope of Appendix No 3 of the EPA and which are located on the site of "Bulgartransgaz" EAD. Item **II.3.2.2** examines the probability of an accident occurring with hazardous substances within the scope of Appendix No 3 of the EPA and the expected negative impacts. The emergency situations with a high risk indicator are discussed in detail in item **II.3.2.3.**

The systematic identification of major hazards under normal and abnormal modes of operation is carried out through the Internal Emergency Plan of the enterprise and its periodic updates. The HHV accidents that may occur at the site of “Bulgartransgaz” EAD are described in detail and analyzed in item **II.3.1.**

Once the accident scenarios have been analyzed, information on the frequencies of the identified accidents needs to be gathered for risk assessment purposes. A good idea of the magnitude of the risk can be obtained on the basis of the general statistics on depressurization of equipment caused by failures: such as corrosion, construction errors, welding errors, loading and unloading and some human error; process, material and design specific errors. Such information is contained in the Manual for the preparation of quantitative risk assessment - the "Purple Book" SRK 18E - or any other appropriate approved document. Information on the frequency of the identified accidents for the enterprise is provided in **item II.3.2.1.**

An assessment of the probability of the occurrence of major accidents was carried out through the "Risk matrix" based on a preliminary analysis by the “triple factor” method.

A detailed analysis for damage zones for scenarios with a risk indicator above 20 is shown in item **II.3.2.3**.

Before proceeding to the assessment of the consequences from a major accident, the nearest sensitive ones (schools, kindergartens, hospitals, places with mass residence of people, etc.), residential, etc., are located as well the enterprises in which persons reside – item **II.1.1.2**.

The assessment of the consequences from a major accident ss carried out by appropriate computational models. Simulation program A BON A (- version 5.4.7), developed by the US Environmental Protection Agency (*Aerial Location Of Hazardous Atmosphere – version 5.4.7*), developed by the (Environmental protection agency of the USA) which is a methodology for quick assessment of the possible damages from a major accident with hazardous chemicals, etc. The assessment of the consequences from a major accident is detailed in **item II.3.2.3.**

In order to manage the risk of major accidents in the activity of an enterprise, it is necessary and very important that the assessment of the risk of occurrence of major accidents is a continuous process, studying not only possible accidents and incidents, but also by taking into account the changes in the experience and practical activities of the enterprise, the modifications made to it and the surrounding environment. This need is also reinforced by the fact that the analysis itself leads to the generation of new and the improvement of the currently existing safety measures.

In practice, there are different methods of hazard identification and risk assessment that complement each other. In choosing the appropriate method for hazard identification, substantial attention is paid to those methods which require teamwork of experts from different fields. The aim is to provide a broad assessment base covering hazardous substances and products, equipment, process management, possible human errors and safety the measures applied, which is a guarantee for a more complete and in-depth analysis.

There are several stages of risk identification and assessment. First of all, preliminary information related to hazard identification is collected in connection with the risk assessment and management process. Classification (prioritization) of activities and processes that are a source of risk is then carried out. The next stage is the identification of majora accident hazards (scenarios) and their effect on the normal and abnormal course of the work processes and an assessment of the adequacy of the existing measures to control risks. This is followed by an analysis of the elements of the risk: probability of occurrence, affected elements (personnel, infrastructure, environment) and the severity of the consequences. In the final stage the residual risk is assessed and additional preventive risk control measures are being identified.

A procedure for hazard identification planning, risk assessment and control, called *P-BTG Risk Assessment of risks and opportunities*, has been developed. In accordance with the procedure all workplaces with a developed workplace risk assessment with regard to occupational safety and health for which the risks of occurrence of accidents, incidents and breakdowns are also assessed. Based on the risk assessment a Program for Reduction and Limitation of Occupational Risks in “Bulgartransgaz” EAD has been developed.

Analysis of the probable accident occurrence and development scenario

The causes of an emergency can be divided into four distinct groups:

1. equipment shutdown;
2. deviations from the technological regulations;
3. errors by the production personnel;
4. external causes (natural disasters, floods, terrorist acts, etc.).

For each of the indicated groups, methods exist to determine the possible scenarios for the conditions of the occurrence and the expected stages in the development of the accident.

For analyzing the phase for initiating accidents induced by equipment shutdown (Group I) the “fault tree” method is most often used. One of the main merits of the method is the systematic, logically justified construction of the group of failures of the elements of the system that can lead to an accident.

Deviations from the technological regulations (group 2), capable of leading to the occurrence of an emergency situation can be of both random and a deterministic nature. The first include climatic conditions, deviations from the parameters of some of the substances used, voltage fluctuations in the electricity supply network, etc. The latter include changes in the passage sections in the process of operating of the equipment, changes in the efficiency of filters, heat exchangers, separators, dividers, etc.

After a thorough investigation of the production processes and technologies, machines and equipment in “Chiren” UGS the following report was elaborated: "*Mathematical modeling of the distribution of the harmful effects from various types of predictable accidents at “Chiren” UGS" performed by the company "Risk Engineering*" AD - city of Sofia, in which possible emergency situations in the UGS are analyzed in

detail and an assessment of the expected impact on people, infrastructure and neighboring settlements is made.

Each technological process is characterized by variable parameters, deviations from the critical values which may lead to unforeseen situations, exceeding the operating pressure and/or temperature and, as a consequence, to damages (destruction) of the technological equipment.

Every major accident in a facility processing natural gas begins with the depressurization of some element of the facility and to gas leakage into the surrounding area. The reasons for the depressurization of technological equipment can be different, but in the most general case they can be divided into 2 groups: reasons caused by the technological process itself and external causes. External causes can also be various - sabotage, landslide processes, external mechanical influence during repairs or other activities, etc.

The impacting factors arising as a result of the depressurization of the facility are possible in that so far as natural gas-fueled equipment is under relatively high pressure, it is possible in some cases that depressurization may take place in the form of an explosion. The damaging factors from such explosions depend on the location of the point of depressurization.

If the depressurization takes place in a facility above the ground, the striking factors of the explosion will be:

- ✓ shock wave;
- ✓ impulse from the shock wave;
- ✓ fragments (shrapnel-like pieces of equipment dispersed at the explosion).

If depressurization has occurred underground the striking factors will be:

- ✓ shock wave;
- ✓ impulse from the shock wave;
- ✓ fragments (pieces of equipment and mineral objects located on or underground);
- ✓ seismic impact.

The review of accidents in underground storage facilities for natural gas, as well as the analysis of the course and consequences from possible emergency situations on the territory of “Chiren” UGS, has allow to determine which emergency situations should be subjected to mathematical modeling and the impact of which of their striking factors should be analyzed.

The possible major accidents on the territory of “Chiren” UGS are:

1. Accidents around the boreholes;
2. Accidents on gas plumes;
3. Accident caused by gas connections to the compressors;
4. Accident in the gas drying plant;
5. Spillage of chemicals.

The risk identification and assessment shall also be carried out on the basis of the results from the technical supervision carried out.

All high-risk facilities are registered and subject to technical supervision. In conformity with Art. 359 (I) of the NUBEPRG, the technical supervision organs carry out the following technical inspections of the facilities:

1. initial - after the registration of the facilities;
2. periodic:
   a) of the facilities under Art. 1 a, items 1 - 5 - once every 12 months;
   b) of the gas appliances under Art. 1 a, item 8 - once every two years;
3. periodic with strength and density tests - of the facilities under Art. 1 a, items 1 to 5 - at least once every 10 years;
4. after reconstruction;
5. when they have not been in operation for more than 12 months;
6. after replacement or repair of the pressurized elements;
7. at the request of the user of the facility;
8. unexpected

The element of SUMB "Identification and assessment of the risk of major accidents" is a part of the internal documents prepared and implemented by “Bulgartransgaz” EAD, incl., the "Internal emergency plan". In this case, there is no need to adopt and implement additional procedures for the systematic identification of major hazards, the assessment of the likelihood of an occurrence, the assessment of the severity of consequences and the identification of preventive measures.

An assessment of the likelihood of occurrence and assessment of the severity of the consequences and identification of preventive measures are detailed in item **II.3.2** and **II.4** of the present report.

The main elements of SUMB are presented in the Appendixes:

- Procedure P-BTG “Assessment of the risks and possibilities”;
- Procedure P-BTG “Operational management of occupational health and safety;
- Procedure P-BTG ”Investigation of accidents and inconsistencies in the occupational health and safety policy;
- Internal emergency plan - independent attachment to the Application for the approval of the safety report prepared by “Bulgartransgaz” EAD.

1.4.3. Operational control and management of the **technological processes – adoption and implementation of procedures and instructions for safe operation, including maintenance of facilities, work processes, equipment, and for the management of emergency signalization and temporary production stoppages after taking into consideration the available information on the best practices for monitoring and control which are aimed at reducing the risk of system errors; management and control of the risks associated with the obsolescence of the equipment installed in the enterprise and corrosion; a list of the company’s**

equipment, strategy and methodology for monitoring and controlling the technical condition of the equipment; appropriate follow-up activities and any/all necessary preventive measures

One of the main elements of the safety management system is operational control. In conformity with this control, procedures and operating instructions have been adopted and implemented to ensure the safe operation of the plant, including its maintenance, the process of operation, equipment and the temporary shutdown of the operations. They define the duties of the personnel in the operation and maintenance of the facilities, processes and apparatus as well as their obligations under abnormal and transitional modes of operation or the violation of the technological regime.

For each workplace on the territory of "Bulgartransgaz" EAD, detailed official operating instructions and procedures have been approved, covering both the normal management of the technological process and the maintenance activities during possible emergencies. The set working procedures and instructions are mandatory for the entire personnel of the enterprise.

The enterprise has developed and implemented working instructions and orders which ensure the safe management of the technological process.

The following instructions have been prepared and are applied: [4]

- Fire safety instructions:
  - Instructions for ensuring fire safety in "Bulgartransgaz" EAD;
  - Fire safety instructions for the maintenance of electrical, heating and ventilation systems;
  - Instructions for the control and maintenance of portable and carriage based fire extinguishers;
  - Rules and norms for ensuring fire safety when performing, electric welding and fire-related works and other appliances using gas and easily inflammable liquids;
- Instructions for the safe storage of OHV (*dangerous chemicals*, Bul.):
  - Instructions for the safe storage of fuel and lubricants;
  - Instruction for safe operations with methanol;
  - Instructions for the safe handling of triethylene glycol;
  - Instruction for the safe storage of hazardous chemical substances and mixtures on the territory of "Chiren" UGS;
  - Instructions for the safe operation of gas condensate and environmental protection from pollution;
  - Instruction for the safe handling of natural gas;
- Instructions on occupational safety and health

To ensure safe operation and to minimize the risk of a major accident, the following preventive activities are being carried out;

- preventive external inspections of the integrity of the OHV warehouses;

- control checks are periodically carried out for compliance with the rules and standards for PB by the PBZN;
- annual maintenance, refilling or hydrostatic pressure resistance tests (in combination or separately) of the fire extinguishers; **[8]**
- prophylactic examinations of the fire alarm and fire extinguishing installations;
- prophylactic checks of the gas alarm system; **[8]**
- control of the corrosion of the operating equipment;
- control of the lightning protection earthing system (*resistance of the earthing devices in the protective grounding systems; impulse resistance of the earthing systems in* the *lightning protection grounding systems*); **[8]**
- **control of the electrical protective equipment in operation; [8]**
- **control of the non-electrically protected personal protective equipment (*LPS*, Bul.); [8]**
- **control of individual means of protection; [8]**

Appendix 11 contains: List of LPS and working garments kept in reserve; Positions and jobs where LPS and work garments are used; Order on the storage of LPS other than the ones provided to the employees under the order of Art. 5 of Ordinance No 3 of 19.04.2001 on the minimum requirements for the safety and health protection of workers when using LPS at the workplace: Order on the verification of the suitability, the shelf life of LPS and the documentation of the results from the inspections.

In order to ensure the fire protection and safety on the site, the following Orders have been prepared and strictly followed by the personnel: **[5]**

- Orders and protocols for the performed training sessions;
- Order on the assignment of the fire protection and safety activities;
- Order for determining the methods for carrying out fire-related works;
- Order for the use of heating appliances and equipment;
- Order determining the non-smoking areas and the use of open fire;
- Order for determining the procedure for using of electrical appliances and equipment, including the disconnection of the power supply after the end of the working hours;
- Order determining the procedure for training and preparation of the personnel for the provision of PB at the site;
- Order determining the rules for PB outside of work hours;
- Order for determining the procedure for the control, maintenance, recharging and hydrostatic testing of pressure resistance of portable and carriage-based fire extinguishers and for maintenance of PIS, PGS, SGU of fire hydrants and smoke and heat control systems;

- Order for the appointment of an official with the relevant competence to coordinate the activities related to the provision of PB in “Bulgartransgaz” EAD;
- Order concerning the periodicity of cleaning of the buildings, the technological and electrical equipment, heating bodies and the installations from explosive and fire hazardous powders and other combustible materials;
- Order on the procedure for the collection and removal of combustible waste as well as residual products from solid fuel stoves.

A Fire Action Plan and an Evacuation Plan have also been prepared. [7]

The company has implemented a procedure conforming to the integrated management system *P-BTG "Operational management of health and safety issues*" (Appendix 9), which regulates the order and responsibilities for exercising control over the activities carried out in relation to the protection of the occupational health and safety. In accordance with the regulations of the procedure, work is carried out in the following directions:

- providing the necessary organizational safety measures in the implementation of activities with increased risk, in particular: gas-hazardous works; fire-related works; operation of electrical equipment and electricity facilities; other activities;
- control of the implementation of safety measures by the staff of the company and by the subcontractors;
- control of the technical condition of the work equipment and the facilities, including the requirements for the risk management organization in order to: ensure the protection of the occupational health and safety (OHS); to implement measures to improve the OHS and to ensure compliance with the adopted OHS policy.

A separate order specifies the individuals representing “Chiren” UGS before the technical supervisory authorities in carrying out inspections of the enterprise or technical inspections of gas facilities and installations;

The initially given instructions upon employment are documented as well as the periodic instructions held for each quarter; an extraordinary and annual verification of the knowledge of the personnel about the structure and requirements for the safe operation of the gas pipelines, the gas facilities and the industrial gas installations;

A constant concern of the management and all employees is to carry out all activities in the safest possible way, without adverse effects on human health and the environment. In this regard, the activity is aimed at defining adequate safety measures in accordance with all regulatory requirements.

Procedures, instructions and working methods are developed together with the personnel entitled to implement and execute them so that they will possess full understanding of the jobs they perform. The management of the enterprise shall monitor the application of these procedures, as well as the relevant training - if necessary - and

the periodic review of their accuracy and their implementation with the official statement of the management of the enterprise.

There are signs placed, containing instructions for the safe use of the gas pipelines, the gas facilities and the industrial gas installations as well as signs for safe working conditions in conformity with Ordinance 07-8 / 20.12.2008 on the signs and signals for occupational safety and fire protection.

Job descriptions of the staff have been prepared with their exact duties and responsibilities for the safe operation of the enterprise. **[2]**

The operator has concluded a service contract with the Occupational medical service. In conformity with this contract, the contractor provides medical services to the workers in accordance with the requirements of the OHS. It also carries out monitoring, analysis and assessment of the health status in relation to the working conditions of all employees in the enterprise and performs the mandatory periodic preventive medical examinations.

There is an Internal emergency plan prepared and approved by the Executive director (presented as an independent appendix) for conducting a SNAVR in the event of natural disasters, accidents and catastrophes at the enterprise which defines the procedures and rules for the actions to be performed in an emergency situation.

Various emergency situations are periodically simulated in conformity with a scenario with the emergency plan, after which an analysis of the effectiveness of the training is made and, if necessary, measures for its improvement are set. **[3]**

Restricting the access of unauthorized individuals to the site:

The “Bulgartransgaz” EAD facility is guarded by 24-hour shift armed security personnel with the implementation of an admission regime set up by “Sirius Security” OOD. The contract with the security company is presented in Appendix № 10.

I.4.3.1. Organization of the internal transport, including along the pipelines /transport of raw materials, intermediate and finished products and waste, personnel, etc. /.

The transportation activity is carried out with contracted transport means and the company`s own vehicles (technologically specialized).

On the territory of “Bulgartransgaz” EAD the maximum allowed speed is 5 km/h for all vehicles.

I.4.3.2. Safety critical equipment, apparatus and preventive measures

The facilities of importance for the safe operation of the enterprise can be divided into four distinct groups:

A) Technical facilities with the potential to cause major accidents;

B) Equipment designed to maintain and control the normal course of technological processes, to record and signal occurring deviations and to trigger measures to prevent major accidents;

C) Facilities designed to eliminate possible accidents and reduce their consequences;

D) Surveillance, security and signaling equipment.

A/ Technical facilities with the potential to cause major accidents

On the territory of “Bulgartransgaz” EAD-”Chiren” UGS production accidents may occur in connection with the use of methanol which we have in stock and use to prevent the formation of hydrates during the extraction of natural gas from the underground gas storage.

A production accident in the region of the gas storage can occur in the mode of extraction and gas injection. In the gas injection mode, it is possible to see a severe gassing of the compressor room as a result of rupture of the gas connections of the compressors. Depending on the concentration of the gas in the air, a suffocating or explosive mixture can be formed (see ***item II.3.2.3***).

Main technological facilities - gas pipelines, compressor stations, gas regulating stations, drill holes, etc.;

Pressure equipment - pressurized vessels, boilers, compressors, etc.;

Methanol storage tanks;

Hoisting equipment - cranes, hoists, etc.

B) Equipment designed to maintain and control the normal course of technological processes, to record and signal occurring deviations and to trigger measures to prevent major accidents

On the site of “Bulgartransgaz” EAD the following safety systems are in place:

- Fire alarm system;
- Gas alarm systems;
- Smoke and heat detectors;
- Emergency gas unit;
- etc.

The maintenance of the equipment, designed to maintain and control the normal flow of technological processes is carried out by qualified companies on a contractual basis.

C) Facilities designed to eliminate possible accidents and reduce their consequences

The enterprise is in possession of the following facilities, the purpose of which is to eliminate the accidents which may have occurred:

- Fire hydrants and hydrants located on the territory of the site;
- Fixed firefighting boards;
- Fire extinguishers;
- Fire extinguishing systems:
- Fire ring at the main site of “Chiren” UGS;
- Automatic fire alarm and fire extinguishing system in an emergency gas generator;

- Fire protection equipment in the warehouse for highly flammable liquids and the tax warehouse;

(D) Equipment for monitoring, security, signaling and announcements

Telemetric information system for the individual measurement of borehole parameters (TCC), transferring technical data on the condition both from the mouth of each borehole and information from each element of the gas transmission system.

Some of the facilities of group "D" are listed in the remaining groups, since there is a close relationship between them - they are part of the general safety system.

In the event of an accident at the site of “Bulgartransgaz” EAD, no loss of life, trauma or other health consequences is expected outside the site. The external boundaries of the safe zone around the enterprise do not affect other buildings (residential, manufacturing, public, etc.), installations and facilities of any other operators.

The design of the buildings, facilities and installations takes into account the seismic characteristics of the area.

All facilities and installations on the territory of “Chiren” UGS are designed and built to meet the requirements of the "Ordinance on the Structure and Safe Operation of Transmission and Distribution Gas Pipelines, Facilities, Installations and Appliances for Natural Gas". At the dispatch point, where 24-hour duty is provided, the shift manager monitors the operation of all facilities and installations through the information system built and put into operation. It is integrated with the existing information system WPS 32 in “Bulgartransgaz” EAD, which enables the dispatchers in the company's Physical Dispatching and Modes Department to monitor the operation of the facilities and installations in “Chiren” UGS.

All facilities and installations on the UGS territory are equipped with safety fittings. The pipelines are designed and implemented to ensure safe operation and controlled gas release during repairs. The pipes have a wall thickness sufficient to absorb the internal gas pressures and the expected external pressures and loads to which the pipeline will be subjected in its operation.

The steel gas pipelines, their chemical composition and mechanical characteristics, the initial determination of the wall thickness of the pipes, the design pressure and the maximum design coefficient for internal pressure are determined according to BDS EN 1594.

In 2004 drill E-70 was put into operation and in 2008 - borehole E-71; in 2016 borehole E-72 and in 2017, borehole E-73. In addition to their different structures compared to the structures built so far, these boreholes are also distinguished by a new type of fountain and underground equipment, providing interruption of the gas flow in case of fire. An underground safety valve is included in the composition of the operating lift, which stops the flow of gas to the surface when the mouth of the borehole is destroyed in emergency situations.

In 2003 the then existing substation (built and equipped in the early 1980`s as a 20 kV RU) was completely reconstructed. Complex switchgear - 20 kV and switchgear

- 0.4 kV were built, with the equipment being supplied by "Merlin Gerin". The equipment as well as the installed transformers do not contain polychlorinated biphenyls (PCBs). The list of inventory equipment has been checked and certified by RIEW – city of Vratsa. An AVR (automatic incorporation of the reserve) has been built at 20 kV and at 0.4 kV. The bus system from transformers to 0.4 kV switchgear is of the closed type. Programmatic, electrical and mechanical interlocks are installed to prevent unauthorized switching, which ensures the security of the service personnel. The switch from operating to backup power is done in about 4 seconds. In the switchgear - 0.4 kV is provided programmatically with automatic switching on of an emergency gas generator in case the electrical supply fails from both power transmission lines.

The emergency gas unit was put into operation in early 2010. The unit is designed to provide the necessary electricity to existing installations in the event of emergency situations where the voltage to the “Chiren” UGS site drops.

Explosion-proof emergency lighting was built in the compressor workshop. An installation with EX terminals at 24V for the explosion-proof mobile lamps used in examinations and repairs of the machines has been built. In the administrative building and the garages are designed and built lighting and power installations. All contacts are connected to current circuits with defective current protections set for a current of up to 30 mA. In this way, the risk of accidents in case of damages to the electrical power plant is significantly reduced.

All equipment, installations and gas pipelines are marked with permanent signs (license plates, working pressure, pressure of which the safety fittings are activated, etc.). The drilling sites, crane junctions, NUP, KC are surrounded by fences to prevent encroachments, with warnings and information boards placed on the fences.

A fire ring of pipes, high-density polyethylene, was built on the site. Nine self-draining hydrants are also installed so that the use of the fire ring does not depend on the ambient temperature. One operating pump and one spare pump with flow rates of 180 m^3/h automatically maintain a pressure in the ring of not less than 0,4 *MPa*.

On the site of “Chiren” UGS there are automatic systems with sensors for combustion, smoke and gas detectors in places which can be potential sources of ignition and gassing. These systems are connected to the notification systems.

After receiving a positive OVOS decision, an approval of the project documentation and for the construction of the site, on the basis of the project documentation a LASO will be built in conformity with the requirements of Art. 35, para. 3, item 5 of the “Disaster protection act”, which will be integrated with the National early warning and alert system, in accordance with the requirements of the Ordinance on the terms and conditions for the functioning of the national early warning and alert system of the executive authorities and the population in case of disasters and air danger notification.

Security:

The “Bulgartransgaz” EAD facility is guarded by 24-hour shift armed security personnel with the implementation of an admission regime set up by “Sirius Security” OOD. **The contract with the security company is presented in Appendix № 10.**

1.4.4. Change management – adoption and implementation of procedures for planning changes and / or expansion of the activity of the existing or designing and construction of new installations, production and/or storage facilities and/or processes

Substantial amendments to the existing facilities and installations or the construction of new ones are carried out only after they are included in the annual investment program of the company and the investment plans are approved by the Board of directors and funding is secured for them for the completion of the project.
Any repairs or new construction works must begin with:

1. Preparation of terms of technical reference;
2. Check for the obligation to perform an OVOS;
3. Design phase;
4. Coordination of the projects with the competent authorities;
5. Obtaining a construction permit;
6. Selection of a contractor under the Public Procurement Act;
7. Implementation of the project with the inclusion of construction supervision;
8. Acceptance committee and an exploitation permit.

In carrying out the above, all requirements of the Spatial Development Act are observed. Contractors for such projects shall be placed under the supervision of a designated authority, including compliance with the safety and health plan which is a part of the project.

Depending on the volume and design objectives, the following types of projects are implemented:

- Design of separate technical facilities in conformity with the specifics of the activity;
- Design of new installations;
- Reconstruction and modernization of existing installations and technical facilities;
- Organizational projects the goals of which are aimed at ensuring the implementation of the main tasks and are related to the development and improvement of the management.

Each project contains mandatory texts with requirements for the environmental, safety and health protection. The designed output elements are subject to review and acceptance by the Management in a manner adequate to the type of the project.

In the process of control over the design phase, compliance with the following criteria is sought:

- the requirements of the input elements of the design;
- functional acceptability criteria;
- safety and environmental requirements;
- legislative, corporate and applicable regulatory requirements.
- effectiveness and efficiency of the project.

Each project is subject to preliminary and final control arranged by phases and in accordance with the stages of its implementation by representatives of "Bulgartransgaz" EAD or by technical commissions at certain key stages.

Commissioning of new technologies and equipment:

1. When new technologies and equipment are put into operation, a production instruction is prepared on the basis of the technical documentation of the new technology, which describes in detail the way of operation, the description of the hazards, the means of protection and the safety technique;
2. The instruction shall be included in the syllabus of the relevant operational and repair personnel for conducting annual examinations and maintaining the competence of the staff;
3. Upon commissioning of new technologies and equipment, mandatory safety briefing of the executive and repair staff shall be carried out by the relevant officials;
4. For the instruction and training of the staff to work with the new technology, records shall be kept by the responsible officials.

In case of any future change in the activity of the enterprise, a Report on the classification of the enterprise will be prepared in accordance with the requirements of Art. 7 of the Ordinance on the prevention of major accidents with dangerous substances and the limitation of their consequences, which contains a conclusion from the classification taking into account the need to update the DPPGA. The Enterprise Classification Report acts as a procedure for planning changes and/or extensions of the enterprise's activities. Upon the inclusion in the Report of new or of changes in the existing major-accident hazards in the enterprise or of new endangered sites or components of the environment, the DPPGA shall be updated with the appropriate risk assessment attached thereto.

Each change is coordinated is PBZN, RZI, RIOSV, MOSV, IAOS and others.

1.4.5. Emergency planning - adoption and implementation of procedures for determining foreseeable emergencies through systematic analysis for the preparation, testing, verification and review of emergency plans for these situations as well as ensuring appropriate training of the company`s personnel and the subcontractors working on its territory

"Bulgartransgaz" EAD has introduced an internal procedure called *P-BTG Preparedness for emergency situations and response capability*. The procedure defines the order and responsibilities for the establishment of organization and implementation of preventive measures for the adequate and timely response in the event of

emergencies in order to reduce the associated adverse effects on the health and safety of the employees and in fulfillment of its obligations to society.

For the setting up of an operational organization for an emergency response in accordance with the "*Disaster Protection Act*", "*Ordinance No 8121 "z" - 647 dated 01.10.2014 on the rules and norms for fire safety during the operation of the sites*" and "*Ordinance No 7 of 23.09.1999 on the minimum requirements for occupational health and safety at workplaces and when using work equipment*" the following are created, developed and approved as follows:

- Emergency plan for the Central headquarters;
- Emergency plan of each of the regional units, including "Chiren" UGS;
- Emergency plan of each of the sites in the regional units;
- ZBR/PPB-31-BTG-SKI Instructions for ensuring the fire safety at "Bulgartransgaz" EAD;
- Evacuation plan in each building for which the requirement is relevant;
- Action plan for fire and elimination of accidents for each site of the company;
- Plan to ensure fire safety when carrying out ongoing repairs, construction and assembly works.

In accordance with the procedure *P-BTG-Emergency preparedness and response capability*, and in view of the need to maintain a state of preparedness and responsiveness within the company as a whole and the responsible persons and structures in particular, "Bulgartransgaz" EAD plans and conducts training and evacuations with simulation of emergencies. The annual schedule of emergency and fire drills of "Bulgartransgaz" EAD is approved by the Executive director and provides information about the planned training at the Head office and the regional units of the company.

The company maintains the necessary technical means and equipment in conformity with the evacuation plans. The premises in the company have appropriate entrances/exits and first aid facilities are maintained. The reasons for the occurrence of emergencies shall be investigated in accordance with the *P-BTG Emergency preparedness and response capability* and the data from the analysis serves as the basis for updating the above plans or taking other corrective and preventive actions.

For the production activity of "Bulgartransgaz" EAD, "Chiren" UGS has prepared an Internal Emergency Plan, which provides for the relevant measures in the event of accidents, the ways of announcing and informing the affected population and the external structures and key units of the unified rescue system as well as the necessary actions to deal with the consequences.

Objectives of the plan

- Creating an optimal organization for taking measures to protect people's life and health, the environment and for identifying the necessary actions of the management organs and forces to respond to expected crises caused by

disasters, accidents and fires;

- Creating an organization to take measures to combat natural disasters, incidents and major industrial accidents, to protect people's lives and material property and ensure trouble-free operation of the facilities;
- Organizational and technical support of the activities;
- Creating an organization for the timely forecasting and analyzing the nature and consequences of the most frequent disasters or emergency situations;
- Implementation of preventive measures and preventive control to counter or reduce the consequences from disasters, accidents and fires on the territory of the gas storage facility;
- Introduction of European standards and good practices for risk assessment at the local level;
- Distribution of duties and responsible organs and individuals for the implementation of the envisaged measures;
- Planning of funds and resources for the prevention and elimination of the consequences from accidents;
- Performing organization of the work and actions of the management and staff in the event of disasters, accidents and fires, threatening their life and health after assessing the situation, the circumstances and their category;
- Identification of measures to reduce the dangers in the event of major accidents and fires.
- Preserving the life and health of the personnel.

Main tasks of the plan

- Development and maintenance of an action plan for disasters, breakdowns and fires;
- Immediate notification of the company's management in a crisis situation and destroyed facilities (boreholes, gas pipelines, installations and facilities, power lines and water pipelines);
- Timely information in the event of an emergency;
- Restricting the access of people to the affected area, redirecting traffic via bypass roads;
- Taking immediate measures to protect the staff and visitors to the site;
- Establishment of an organization for timely detection, removal and first aid to the victims;
- Timely announcement and, if necessary, evacuation of workers and employees caught in the pollution zone;

- Providing individual means of protection and creating a transportation organization within the shortest possible time;
- Provision of the necessary protective facilities and their adaptation;
- Introduction of strict radiation control to prevent the contamination of food, water, environmental components and compliance with sanitary and hygienic requirements;

Organization and implementation of the plan

Based on the procedure and in compliance with the regulatory requirements, by an Order of the Head of RZ “Chiren” UGS, a headquarters for the implementation of the Emergency Plan (STIAP) was established. The STIAP at “Chiren” UGS is responsible for creating and maintaining in a state permanent readiness the overall organization to prevent, locate and eliminate disasters, accidents and catastrophes. The STIAP shall liaise and inform the other dully authorized bodies.

In support of the STIAP in “Chiren” UGS auxiliary groups are set up as follows:

- Observation and announcement group
- Sanitary post
- Group for the maintenance and exploitation of individual means of protection:
- Group for the maintenance and exploitation of collective means of protection:

By a separate order of the Head of RZ “Chiren” UGS groups were set for extinguishing fires.

For the timely elimination of accidents in “Chiren” UGS, two emergency groups (*AG*, Bul.) have been formed and they function as determined by an Order of the Head of the regional unit.

- Emergency group to eliminate an accident in a gas pipeline (plume) or borehole;
- Emergency group to eliminate an accident in the compressor workshop and the aboveground facilities.

The main task of the emergency groups is to organize the elimination of the consequences from the accidents. The emergency groups perform their activities in constant liaison and coordination with the Central dispatch service and the district dispatch services within the structure of the “Physical dispatching and operational regimes” department.

Maintenance of emergency preparedness

The staff, and in particular the personnel of the emergency groups, shall be familiar with the plan and shall undergo annual training and examination of the aquired knowledge as per the "Ordinance on the structure and safe operation of transmission and distribution gas pipelines, facilities, installations and appliances". Periodic training

activities are prepared and implemented to simulate the actions of the workers in the event of emergency situations.

In order to reduce the risk of accidents and breakdowns, the company must be able:

- To exercise ongoing control over the operation of the gas storage, the KC, the cleaning and other facilities and take in time the necessary measures for their normal operation in accordance with the current legislation (instructions, regulations, etc.);
- To carry out periodic checks of the condition and operation of the methanol containers installed at problematic boreholes;
- To maintain in full readiness the available off-road vehicles, heavy machinery, units and other equipment with a view to their use, where/when necessary;
- To keep a permanent reserve of functioning electric motors, pumps, nitrogen, oxygen, propane-butane containers and others;
- To conduct briefings of the staff on duty at all work sites on the critical situations, at low (high) temperatures and bad weather conditions;

The operator has prepared the information required by the competent authority for the preparation of an external emergency plan pursuant to Art. 35, para. 4 item 9 of the LPB, which is provided to the competent authorities.

Annual training of the personnel is performed to maintain a state of preparedness for preventing emergency situations and the mode of action in critical situations. **[3]**

I.4.6. Monitoring - adoption and implementation of procedures for ongoing assessment of the consistency between the objectives set out in the major accident prevention policy report and SUMB (*Safety management control system*, Bul) and the results achieved. Mechanisms for investigating and correcting SUMB in case of non-compliance.

The existence of the risk of major accidents occurring in the operation of the enterprise is a prerequisite for the development and implementation of a safety monitoring system. The rules for safe production management, as an integral part of the overall management system of the enterprise, are incorporated in the technological regulations, instructions and regulations.

SUMB monitoring is a procedure involving the assessment of whether the plans or the measures to control technological risks are applied preventively. Monitoring is carried out by controlling the key activity indicators, which are generally classified as preventive and corrective.

Preventive monitoring consists of inspecting:

- Installations, equipment, apparatus and pipeline networks in relation to the existing safety regulations;
- The knowledge of the staff by conducting annual exams on topics related to emergency safety, working with chemical substances, medical first aid, the implementation of production instructions and the regulatory requirements for the safe operation of natural gas facilities and installations;
- The system for maintaining and developing the competence of the staff - assessment of the condition and updating of the "Plan for development and maintenance of the competence of the staff";
- The state of the safety management system - review of the organizational structure, responsibilities, procedures and available means for the safe operation of installations, facilities, equipment and pipeline networks;
- The state of individual means of protection.

Corrective monitoring is a system for:

- Reporting of accidents/breakdowns;
- Reporting on the potential accidents and the prevented accidents;
- Investigation of:
  - The established causes of the breakdowns and the prevented accidents;
  - The management errors.
  - Analysis and follow-up measures:
  - Investigation and development of corrective measures;
  - Evaluation of the procedures to prevent recurrence of the accidents.

“Chiren” UGS has prepared:

- Instruction on the order and sequence of actions of the dispatcher on duty at “Chiren” UGS regarding the organization and activity for the prevention of the consequences from disasters and accidents;
- Notification schemes in the event of a danger of major accidents;
- The staff are trained to act in the elimination of accidents;
- The equipment and the installations shall be inspected and tested periodically, including for their strength and density.

The investigation of accidents and breakdowns that have already occurred shall be carried out in accordance with the provisions of Chapter ten Section IV of the "Ordinance on the structure and safe operation of transmission and distribution gas pipelines and facilities, installations and appliances for natural gas" (Prom. SG. No. 67 dated 02.08.2004).

1. For any accident or breakdown occurring during the operation of a gas facility and installation, the user shall immediately notify the regional department of GD "IDTN" and the territorial administration of the Executive agency "Chief

labor inspectorate", and until their arrival shall take measures to assist the injured individuals and to prevent the expansion of the accident;

2. Until the inspectors of GD "IDTN" arrive, the user is obliged to keep the situation created during the accident or breakdown` unchanged, if this does not create an additional danger for the further development of the accident or for the occurrence of new accidents. Where a change in the situation becomes necessary, the user shall provide the inspectors with a written statement of the changes made and of the reasons for doing so;
3. The GD "IDTN" inspectors shall examine the causes of the accident or breakdown. A protocol shall be drawn up on the results from the investigation;
4. The repair of damaged gas pipelines, facilities and installations for natural gas is carried out in conformity with the documentation approved by the technical supervisory authorities, on the basis of which the respective sites have been built.

“Bulgartransgaz” EAD has developed and applies the *P-BTG Procedure for investigating incidents and discrepancies in occupational health and safety policy compliance*. This procedure regulates the order and responsibilities for the:

- investigation of occupational accidents;
- taking action to limit the consequences for the health of employees with reduced working capacity as a result of accidents at work, non-traumatic injuries, occupational diseases, etc.;
- management of cases of "close calls”;
- management of the non-conformities identified during the internal occupational health and safety inspections,
- management of non-conformities identified by authorized control bodies.

Actions to identify and document the established non-conformities are discussed, as well as the undertaking - whenever possible - of adequate actions for their immediate elimination (correction).

The investigation of incidents and inconsistencies in the sphere of occupational health and safety is in accordance with the principles described in P-BTG Corrective actions, which regulates the principles of applying corrective actions to eliminate the causes of the established nonconformities and is aimed at preventing their recurrence or minimizing the risks of their occurrence. At the same time, the procedure reviews the activities within which non-conformities can be identified and in relation to which corrective actions can be identified and implemented. The general order and responsibilities in the implementation of the corrective actions are indicated. The identification and documentation of non-conformities, as well as the definition of the measures for correcting the occupational health and safety inconsistencies is in accordance with the procedures governing the management of individual groups of non-conformities.

In an Appendix to this section one will find:

P-BTG Investigation of accidents and inconsistencies in the occupational health and safety sphere. **[9]**

I.4.7. Audit and review – adoption and implementation of procedures for periodic systematic evaluation of the major-accident prevention policy report and of the effectiveness and suitability of the SUMB; a documented review of the implementation of the MAPP and SUMB and their updating by the management of the company, including reporting and introducing the necessary changes reported by the audit and the review.

The SUMB will be reviewed periodically, as well as when planning modifications, in the event of accidents at work, incidents and accidents or in the receipt of new information related to the safe operation of the plant and its facilities. A review of the SUMB may also be performed when non-conformities have been found as a result of internal monitoring, of checks by the competent authorities or of any internal or external audits.

Proposals for changes in the technological instructions are offered when introducing new equipment, new raw materials or changing the technological parameters of the work equipment. The changes are discussed and accepted by the management of the company. The safety instructions are reviewed also when new standards are introduced, in the cases of accidents and accidents, or in the case of changes in the regulatory framework. The periodicity of these reviews is not fixed. The instructions are set up, entered and updated in accordance with the internal procedure *P-BTG-Document management*.

Evaluation of the effectiveness of individual technological operations is carried out continuously.

Periodically, in conformity with a predetermined schedule, the condition of the main apparatus and equipment critical to the technological process is being checked. The results from these checks shall be presented in a protocol of findings and/or audit registration books.

In connection with the introduced system for the management of the occupational health and safety policy, the Company has developed and applies the procedure *G1-BTG Internal audits*. The internal audits are an important process by which the efficiency of the implemented management systems is checked and their maintenance and improvement is ensured.

The performance of internal audits is planned annually in the Bulgargransgaz EAD Audit program the Annual schedule for Internal audits, approved by the Executive director of the company.

The procedure for conducting the internal audits, the responsibilities, documentation of their results and the maintenance of records are defined in the *P-BTG Internal audits procedure*.

Based on the audit records, an annual summary report is prepared on the results from the internal audits of the efficiency of the audit program and the opportunities for its improvement. The information is a part of the input data serving the management of

the periodic overall assessment of the efficiency of the implemented management systems.

At least once a year, a review of the implemented management systems is planned and conducted. During the review, the management shall take decisions regarding:

- possible changes in the adopted policies;
- future objectives or changes to the existing occupational health and safety, environmental protection and information security objectives;
- the necessary actions and documents related to improving the efficiency of the implemented management systems;
- providing material and human resources for the functioning of the management systems in relation to the identified solutions and for their continuous improvement.

The decisions shall be documented in a separate protocol.

The results from the investigation of the accidents and breakdowns which have already occurred are input as the data used for updating the Safety measures management system.

II. INFORMATION ON THE ADJACENT ENVIRONMENT, THE FACILITIES, PROCESSES AND ACTIVITIES IN THE ENTERPRISE; AN ASSESSMENT OF THE RISK OF MAJOR ACCIDENTS AND THE MEASURES APPLIED TO LIMIT THE CONSEQUENCES FROM MAJOR ACCIDENTS

II.1. Environmental information about the area of location of the enterprise

II.1.1.Description of the enterprise and its environment, including its geographical location, meteorological, geological, hydrographic conditions, subject of activity and territory

II.1.1.1. Description of the enterprise

“Bulgartransgaz” EAD is a combined gas operator, holding licenses for the transmission and storage of natural gas on the territory of the Republic of Bulgaria, in conformity with Art. 39 of the Energy Act (EA). The company develops the gas transmission system of the country, maintains the sites and facilities of the gas transmission network in accordance with the technical requirements and the occupational safety rules by observing the European requirements for environmental protection.

The “Chiren” UGS is the “one of a kind” facility on the territory of the Republic of Bulgaria. It was established in 1974 on the basis of the exhausted “Chiren” gas condensate deposit, opened in 1963, attached to the local dragged geological structure of the same name.

The purpose of UGS is to compensate for the seasonal inequalities in the consumption of natural gas in the country as well as to store certain quantities of gas as an emergency reserve. The operation of the gas storage is cyclical, with the period for

pressurizing natural gas being April-October and the extraction period – November through March.

Currently, 24 operational wells have been built. They are connected by gas pipelines (plumes) to the UGS site, as well as 14 observation boreholes which serve to track the change in the static levels depending on the volume of the gas and its layered pressure in the productive horizons of the repository. The pipelines are located below the surface of the earth, at a depth of 0.8 to 1 meter.

After compression, which is carried out by the “Chiren” compressor station, the gas is injected into the boreholes through built plumes. Cathodic protection stations, power supply systems, technological and communication connections, etc., have also been built.

The servicing of the site and facilities is carried out by teams located working on the UGS site. There is a 24-hour Regional Dispatch Service (RDS), which receives telemetric information from the drillings and technical information on the operation of the facilities located on site.

At present, the main existing site of the Company is an area of 53 313 m^2 and a built-up area of 5 174 m^2, the following main buildings and facilities are located:

- Administrative building with dining room and kitchen;
- Internal gasoline station;
- Compressor workshop;
- Garages;
- Warehouses;
- Service-operational unit;
- Gas metering station;
- Ventilator cooling towers;
- Gas drying installation;
- Installation for cooling the gas AVG and the water;
- Common manifold;
- Industrial water pumping station;
- MS-20 oil tank store, GSM warehouse, etc.

In the immediate vicinity of the main site there is a warehouse for LZT, with a separate excise tax warehouse for energy products - gas condensate containing:

- Methanol tank;
- Automatic filling device (stand) and auto-discharge for methanol;
- Gas condensate tank, equipped with fire extinguishing and cooling systems;
- Automatic filling device (stand) for gas condensate;

- Gas condensate and methanol pumping station;
- Modular mobile container to the tax warehouse for administrative, domestic and servicing activities;
- An underground water tank for the fire extinguishers with a pumping station, storm fire hydrants and carriage based hoses;
- Underground drainage water tank.

The plans include the design and construction of a new compressor station with all of the required adjacent technical facilities to ensure a reliable and continuous operation in the gas injection and extraction mode, as well as a new gas metering station (GIS).

With the implementation of the IP, it is envisaged to build a unified system for supporting the technological processes site of the UGS. This includes the following individual major units and facilities:

- A common input separation and GIS;
- GTKA and adjacent gas cooling, KIP and el-buildings;
- Gas pipelines;
- Manifold;
- Individual separation;
- Gas heating;
- Installation for drying the gas;
- Triple phase separation;
- TEG regeneration plant;
- Burner gas preparation unit;
- Electrical and KIP buildings (building for: BPGG; Compressor for KIP air; boiler room for heating, installation for preparation of sealing gas);
- Production power unit, transformer substation, common distribution switchgear;
- Emergency diesel generator;
- Tank and pumping station for PP water;
- Site for water supply and sewerage;
- Infrastructural connections.

Detailed information on the technological process at the site is provided in item II.2.2.

II. 1.1.2. Geographical location

In conformity with the physical-geographical location of Bulgaria, the area around “Chiren” belongs to the Western Preabalkan zone of the Stara Planina region. In landscape terms, the Western Predbalkan region (II 1) is of the moderate continental forestland northern valley type=

The area of “Chiren” UGS falls within the altitude belt at absolute levels from 240 to 460 m, and the main industrial site itself is located at an altitude of about 260 meters. In close proximity to the boundaries of the industrial site, are located mainly arable agricultural lands belonging to the village of Chiren and a small part belongs to the forest fund. Within the boundaries of the anticlinal structure, the highest elevation is the "Kaleto" peak (434.4 m). In an eastern direction, the underground structure of the gas storage reaches the “Milin Kamak” ridge (460 m).

The river system is poorly developed. From a karst spring in the village of Chiren a small river is formed called “Barata” (flow rate up to 30/L). The seasonal waters around Kaleto accumulate in the “Chiren” III Dam, located at about 500 m northwest of the main UGS site.

The site is located in an out-of-town area at about 1 km from Chiren and at about 20 km from the city of Vratsa. The nearest settlement to the site is the village of Chiren, 5 km away is the village of Devene and 4 km - the village of Ossen which are mayoralties to the Municipality of Vratsa and Krivodol.

The nearest sites of more important public use are:

- The "Children's universe" kindergarten in the village of Chiren, at a distance of about 2 km from the site;
- The "St.St. Cyril and Methodius" primary school in the village of Devene at a distance of 6 km from the site;
- the nearest general hospital, "Hristo Botev" – city of Vratsa is at a distance of about 16 km (≈ 21 km via the Republican road network),
- the nearest railway station (in the city of Vratsa) is at a distance of about 15 km.

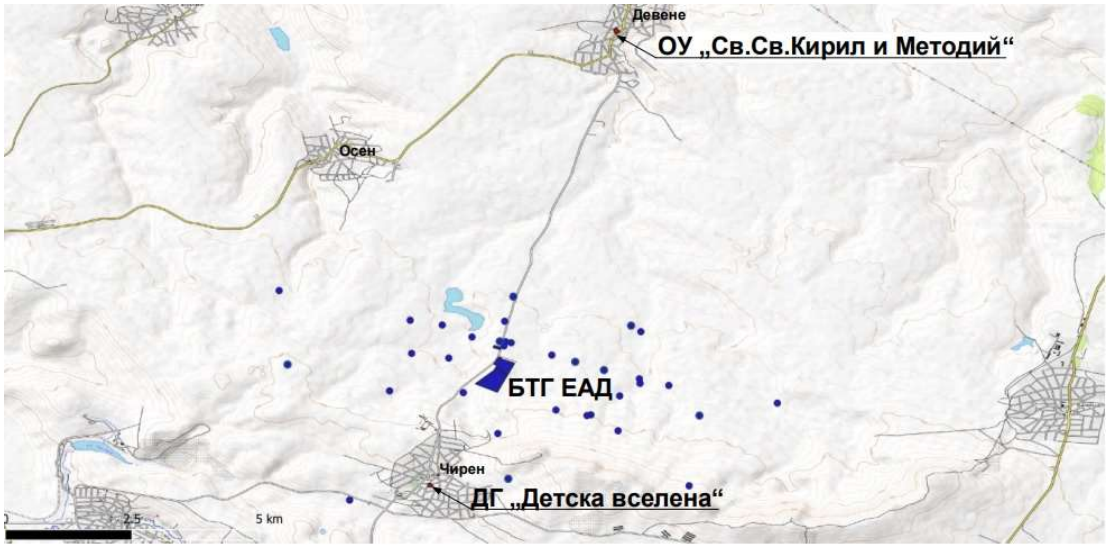


Figure II.1.1.-1 Location of the “Bulgartransgaz” EAD and the closest settlements and sensitive sites

Roads: In close proximity to the site passes a third-class road connecting the villages of Chiren and Devene. Access to the available boreholes is gained via unpaved earth roads on the map of the reclaimed property. The nearest highway to the borders of the site is Republican road II-15 (*Vratsa-Oryahovo*), at a distance of about 8 km from the site.

The nearest settlement to the site of the enterprise is the village of Chiren. In conformity with a report of the National Statistical Institute, the population of the village of Chiren, municipality of Chiren - Vratsa, as of 31.12.2020 is 789 people. In the other settlements located in the area of the enterprise, the population is 875 people in Devene and 205 residents of the village of Osen. The population density in the nearest settlement is only 0.6 E-03 people/m^2 (*with 789 people inhabiting ≈ 1 300 000 m^2 of estimated built-up area of the settlement*).

II. 1.1.3. Environment

Climatic and meteorological conditions

In conformity with the climatic division of Bulgaria, the region of UGS “Chiren” belongs to the European continental climatic region, the north Bulgarian temperate continental Predbalkan sub-region.

The climatic features for the area of the site under consideration are determined both by the location of Bulgaria in the temperate latitudes of the northern hemisphere and by the orography of the region with the characteristic elements of the topography and relief of the Western Predbalkan and the Danube hilly plain. Typical of the Predbalkan are the deep valleys, the valley extensions and the hollows and under the influence of the Hemus mountain ridge natural conditions for the redistribution of air currents, precipitation and temperatures are formed.

The complex of physico-geographical and hydrometeorological factors determines the moderately continental to continental nature of the climate in the area of the site under consideration - relatively high frequency of quiet weather (about 55 - 60%), where the prevailing winds are west and southwest and the proximity of the Vratsa Balkan creates conditions for increased rainfall.

The absolute maximum temperatures for Vratsa reach 40 to 41° C in August, and the absolute minimum temperatures reach - 20° C in January. The duration of the negative temperatures is 35 to 40 days a year, and the duration of the days with temperatures above 10° C is by an average of 200 days per year.

In the Chiren area, local factors (land elevations, rivers, water basins, etc.) have a minor influence on the temperature regime. Temperature events are often recorded south of the site under consideration - on the border between the Predbalkan and the Vratsa mountain and are of greater importance for the region of the town of Vratsa.

In conformity with its genesis, rainfall in Bulgaria is frontal, intra-massive and orographic. The region is dominated by frontal rainfall, i.e., year-round in quantity and quality. The northern slopes of the Vratsa mountain (about 20 km south of Chiren) retain the invading northwest oceanic wet masses the supporting the formation of orographic precipitation.

Solar activity:

Solar radiation is the main climatic factor and the main source of thermal energy for the natural processes occurring on the Earth's surface, in the atmosphere and the hydrosphere. For the area of UGS “Chiren” the available information about the town of Knezha is being used as it is the closest settlement to the site for which there is available data on sunshine (Climatic guide of Bulgaria, Volume 1 – sun radiation).

Total sunshine duration in the area reaches up to 2180 hours per year (Table II.1.1-1) and its maximum is registered in July and August. The days without sun during the year are on average 78, with the least in number - only 15 days without sun, being during the period May - October (Table II. 1.1-2).

Table II.1.1-1 Duration of the sunshine by month in hours

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annually
70	91	132	194	240	282	320	308	234	166	82	59	2178

Table II.1.1-2 Number of days without sunshine but months and annual average

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annually
15	9	9	4	2	1	1	1	2	6	12	16	78

Air temperature

The air temperature is formed mainly by solar radiation. For the borders of the Western Predbalkan the temperature conditions are of a pronounced seasonal nature - the temperature minimum is in January and the maximum - in July. The Climatic Guide of Bulgaria (volume 3) uses data for the nearest station to the area of the site – located in Vratsa.

Table 11.1.1-3 Mean monthly and mean annual diurnal air temperature (in °C)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annually
1.9	0.6	5.0	11.6	16.4	19.8	22.2	22.0	17.8	12.0	6.2	1.0	11.1

Table 11.1.1-4 Monthly mean and annual mean maximum air temperature (in °C)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1.9	4.8	9.6	16.8	21.6	25.4	28.1	28.4	24.2	17.3	10.1	4.5	16.0

Table II.1.1-5 Monthly mean and mean annual minimal air temperature (in °C)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual.
-3.5	-3.1	0.9	7.0	11.5	14.8	16.7	16.4	12.8	7.9	3.1	-1.8	6.7

Table II.1.1-6 Absolute maximum air temperature (in °C)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual

19.8	23.2	34.3	31.1	35.9	36.3	39.8	41.5	40.8	35.6	28.3	21.7	41.5

The absolute maximum temperatures for the city of Vratsa reaches 40 to 41 ° C in August, and the absolute minimum temperatures can reach -20° C in January. Duration of the low temperatures is 35 to 40 days a year, and the duration of days with temperatures above 10 °C is on average of 200 per year.

In the Chiren area, local factors (land elevations, rivers, water basins, etc.) have a minor influence on the temperature regime. Temperature events are often recorded south of the site under consideration - on the border between the Predbalkan and the Vratsa mountains and are of greater importance for the region of the city of Vratsa.

Clouds and precipitation:

The cloudiness - the annual picture of the clouds in the region is clearly pronounced where the prevailing cloudy days are in December, January and February, and insignificant clouds are witnessed in the summer - July and August. The peculiarities of the region include frontal fogs, which are formed in the Predbalkan under the influence of local factors - the steep slopes of the Vratsa mountain, the indented relief, the forest massifs, etc.

Table II.1.1-7 Average monthly and annual number of clear and gloomy days but total cloudiness

HMS Vratsa	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Clear days	3.2	2.7	3.6	4.4	3.9	5.3	10.4	12.9	9.9	8.3	2.8	3.2	72
Cloudy days	15.9	13.3	13.4	9.2	8.8	5.6	3.4	3.0	4.3	9.8	16.2	16.5	119

Rainfall - in its genesis rainfall in Bulgaria is frontal, intra-mass and orographic. The region is dominated by frontal rainfalls, i.e., year-round in quantity and quality. The northern slopes of the Vratsa mountain (about 20 km south of Chiren) retain the invading moist masses from the northwest oceanic favoring the formation of orographic precipitation. North of the Predbalkan, in the transition to the more flatter areas of the Danube plain, the average annual rainfall decreases significantly (681 mm for the station in Gabare and 580 mm for Knezha).

Table 8- Monthly average rainfall (in mm) for the nearest station (Vratsa) to the Chiren UGS.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

48	41	52	71	112	106	78	61	59	65	62	54

Table II.1.1-8 Mean seasonal and mean annual rainfall (in mm) for the Vratsa station

Winter	Spring	Summer	Autumn	Average annually
143	236	246	187	812

Table II.1.1-9 Average duration (in days) of rainless period by months and year for Vratsa station

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
7	7	8	8	6	5	7	10	11	11	8	9	97

For Vratsa the average number of snowy days per year is 30, of which 17 days are in January and February. The average date of occurrence of the first snow cover is December 8, with the earliest occurrence of snow around November 11, and the latest around February 3. Snow cover remains until 26 February at the earliest and until 29 April at the latest.

Air humidity, fog and horizontal visibility

The average monthly and annual relative humidity (in %) for the nearest station to UGH “Chiren” is shown in the following table.

Table 11.1.1-10 Relative air humidity data (in %)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
81	77	72	66	68	66	59	59	64	73	81	85	72

Fog, as an air condition, is a characteristic phenomenon for the cold half-year period and it is the result of condensation of water vapor in the low atmosphere. For Vratsa, the number of days with fog is higher than the average for the country, with the maximum seen in November - January and the minimum in August and September.

Table 11.1.1-11 Number of foggy days by month and year

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual

5.7	4.2	4.3	1.1	0.5	0.4	0.1	0.0	0.3	3.4	7.8	8.3	36.3

Fogs are formed as a result of a certain combination of climatic conditions and physico-geographical characteristics of the area. This is a condition of the ground layer in which visibility is below I km. The condensation of the water vapor in the air causes an increase in the concentration of various pollutants, which act as condensation points. So, the reduced visibility in fog with the result of condensation of water vapor as well as dust and smoky air from harmful substances - soot, dust, gaseous oxides which are the products from the combustion of liquid and solid fuels, etc.

Winds

The winds in the area have variable speed, direction and frequency. Northwest and northeasterly winds are predominant, with a recurrence rate of more than 50% The relative share of "quiet time" is large - from 49.7% in March to 66.3% in November. The average annual speed of the winds in the region is over 1 m/ sec. Low winds, whose speed is below 1 m/sec occur in up to 60 days a year. Strong winds (speed 11-15 m/sec) have a frequency of manifestation up to 5 - 6 days a year. They are predominantly north-western (44.5%), southwestern (28.7%) and significantly less frequent are the western winds (13.1%). The rose of the winds in the region of Vratsa for the four characteristic seasonal months and the average rate for the year is presented graphically in Figure II. 1.1-2.

Table II.1.1-12 Wind frequency but direction (in %) and quiet weather (in %) for the region of Vratsa

Direction	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual average
N	8.1	8.5	7.2	10.1	7.5	7.1	7.0	9.8	6.8	9.4	5.3	5.9	7.7
№	3.8	5.4	9.2	5.8	8.8	6.1	6.5	6.9	6.4	5.2	5.8	4.3	5.9
E	9.0	5.5	5.5	8.9	9.5	9.0	7.8	9.2	10.9	8.4	9.3	10.0	9.0
SE	24.3	18.5	10.4	18.1	22.7	20.2	19.7	19.6	21.8	20.4	23.4	23.9	21.0
S	5.6	5.3	17.3	5.4	7.5	6.3	7.2	8.1	8.5	8.9	9.3	6.4	6.9
SW	7.2	10.7	5.8	8.4	8.6	7.2	6.6	6.0	7.3	10.4	3.3	11.4	8.7
W	10.1	15.5	9.2	10.7	9.1	10.3	12.1	9.2	11.7	10.9	13.8	8.2	11.1
NW	31.7	30.7	14.9	32.6	26.3	33.8	33.1	31.1	26.6	29.5	27.2	27.5	29.7
Calm	61.4	53.3	49.7	50.1	56.7	54.3	54.0	56.4	61.0	64.2	66.3	64.0	57.5

The average annual speed of the winds in the region is above 1 m/s. Low winds, whose speed is below I m/s occur up to 60 days a year. Strong winds (speed 11-15 m/s) have a frequency of up to 5 - 6 days a year. They are predominantly north-west (44.5%), southwest (28.7%) and significantly less frequently western winds (13.1%).

Table II.1.1-13 Wind frequency in m/s (average days per season) for HMS - Vratsa

Speed in m/sec	Winter	Spring	Summer	Autumn	Annual average
0-1	66.3	63.0	65.2	69.6	264.1
2-5	18.7	23.5	23.6	18.4	84.2
>5	5.0	5.5	3.2	3.0	16.7

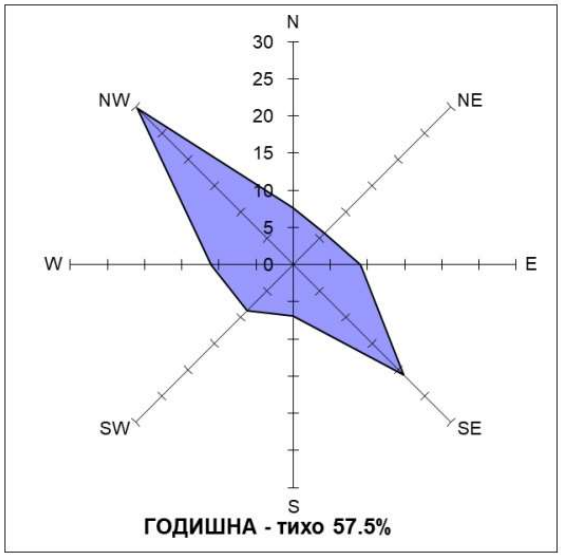


Figure II.1.1-2 Wind rose (ANNUAL – calm weather 57.5%)

Waters and geological conditions:

Surface water basins:

In hydrological terms, the area of the Chiren structure falls within the area of a rainy regime. South, at about 5 km from the UGS (the "Ponora" location) in the karst limestone a section is formed with a karst regime of atmospheric waters.

The hydrological network in the “Chiren” UGS area is poorly expressed. Above the arch part of the anticlinal north of the “Kaleto” there are there are constantly flowing rivers. The surface water in this region has a seasonal character and drains in the north - northwestern direction, accumulating in the “Chiren 3” dam, located about 500 m northwest of the site of the compressor station. The dam has a maximum area of 282 decares and a water capacity of 862 thousand m^3 (dead volume of 50 000 m^3) and a maximum depth of 13 m, crown length 264.00 m. Its waters are used for industrial water supply for the UGS - 60 000 m^3/year, and also for the irrigation of the agricultural areas.

“Bulgartransgaz” EAD has a permit, currently in force, for the use of a groundwater body for water reinjection - Decision No 12570003 of 16.12.2015, amended with Decision No 2757 from 30 September 2019 and Decision PP-05-3/30.10.2019.

The local river, "Barata", is formed mainly from a karst spring in the village of Chiren and the drainage of its waters follows the natural slope of the terrain in the southern and southwestern directions. The outflow of its waters, depending on the annual season, is from 3 to 30 dm^3 / h. These waters reach the Lilyashka Bara river and the subsequent water intakes - the Vurteshnitsa river (near Lilyache) and the Botunya river (near the town of Krivodol).

In hydrographic terms, the territory from Vratsa to the village of Chiren falls within the collector area of the Vurteshnitsa river, which is formed by the Leva river (Vrachanski Balkan), the Dabnika river (south of Veslets), the karst spring vill. Bistrets and the drainage waters from the Vratsa Proluvial cone. The Vurteshnitsa river from Beli Izvor to its confluence in the Botunya river has a total length of about 16 km.

For the discharge of wastewaters from the UGS site there is a permit for using the surface water bodies - two dry ravines and the “Chiren III” dam, issued by the Danube River Basin Directorate - Pleven.

In conformity with a letter from the BDDR, with Ref. No ПУ-01-128(1)/17.02.2021 with regard to PURB for the Danube region 2016-2021, the envisaged activities fall within the scope of:

Surface water basin Ribene river from the spring to inflow of the tributary at Lesura, incl. the “Three Wells” dam with code BG100400R1219, defined as being in a good ecological status and an unknown chemical status with the following objectives set in place: Preservation of the good ecological potential and proper chemical status.

Groundwaters and geological conditions:

As a geological structure, the Chiren gas condensate deposit falls into the Marmora Anticline - eastern zone of the Belogradchik anticline. The western pericline begins east of the Beloizvorska synclinal. To the east it is traced to the village of Drashan and to the south - to the foothills of the "Veslets" ridge (north of the Vratsa plain). The anticline has a length (in the east-west direction) of 50 km and a width of 14 km.

The collector part of the gas condensate deposit is built from the deposit aged back to the Lower Triassic to the pliinsbach. On the surface, the mantle is made of Lower Cretaceous deposits, along which the southern wing and the partially eastern periclinal part are well expressed.

In the vault of the structure, the lower departments of the apta and partly the barem (lower Cretaceous) are revealed, which over a large area - are covered by Quaternary and Sarmatian deposits. With drillings, the kernel was studied to a depth of about 5,300 m (P19), revealing Cretaceous, Jurassic, Triassic and Devonian deposits.

The groundwaters in the “Chiren” UGS area are attached to the Middle Upper Triassic, Lower Jurassic, Upper Jurassic and Lower Cretaceous sediments.

Middle-upper Triassic aquifer horizon

The carbonate deposits (the Milin kamak retinue), under which are found Lower Triassic aleuroliths and basalts collect the waters. The area of feeding and creating a head is located on the slopes of the Belogradchik rise. The regional movement of these deep-seated waters is in the east-northeast direction. The low filtration rate is due to the compaction of the rocks and their tectonic separation between the Mihaylovgrad and the “Chiren” anticlines. The absolute static levels are +109 m (in P15) to +166 m (in P2). The relative wamer capacity varies from 0.8 m^3/d mo 9.0 m^3/c1.

The Lower Triassic waters in the area are of calcium-chlorine type, with mineralization 54-60 g/dm3. The content of the specific micro components is high: Br- up to 183 mg/dm^3, J - up to 10 mg/dm^3, HBO2 - up to 50 mg/dm^3.

Lower Jurassic aquifer horizon

These waters are attached to the following chronostratigraphic layers: hetang-sinemurian-pliinesbach. The water-absorbing rocks are fine-grained quartz sandstones and the recrystallized organogenic limestones. As the upper waterproof layer serves the upper jurasic argilites. The lower water-tube is untenable due to the dilutions of the Upper Triassic deposits represented by clay-argillite deposits. The waters are of calcium-chlorine type, with a mineralization of 42-60% g/dm^3. The content of bromine and iodine J is up to 117 mg / dm^3 and up to 15 mg / dm^3. Currently, the Lower Jurassic deposits are revealed as narrow strips on the slopes of the Balkan and the Predbalkan. The water pressures decrease in northeastern and eastern directions, following the regional subsidence of the layers - (+193 m in the region of Montana to +134 at Chiren).

The Lower Jurassic aquifer is not developed independently in the Chiren structure. The layers rest on different middle and upper Triassic levels, which form a single aquifer – the Triassic-lower Jurassic horizon. A major factor for the groundwater movement in these horizons is the geostatic pressure. The waters formed in similar artesian basins under the influence of the rock pressure are push from the central to the peripheral zones of the basin, i.e., an elastic-pressure filtration regime is observed. In this regard, the waters in the basin do not refresh intensively and are characterized by a difficult water exchange.

Upper Jurassic-Wallange aquifer horizon

This horizon is developed everywhere within the boundaries of the Belogradchik anticlinore. The water-bearing rocks are limestones, which have high water capacity, with conditions for modern atmospheric water feeding. By type, the waters are sodium-sulphate with mineralization from 0.5 g/dm^3 to 8 % g/dm^3 north of the Balkan (P1, Glavatsi). At a depth of the layer on the average below 1400 m in the Chiren region the waters have a mineralization of 22 g/dm^3. The difficult filtration of the waters here is due to the Drashansko-Glavashki fault, located south of Chiren. For lower waterproof layer serve the Srednogorie argilites, and for the upper layer – the lower Cretaceous marls. The movement of the waters is in a north-northeast direction.

Aptic (urgonian) aquifer horizon

The groundwater is attached to the Urgonian limestones, which are revealed on the surface in the southern wing of the Chiren structure. The limestones in their upper

part are highly karst and in depth they pass into sandy and oolitic. The feeding zone is developed mainly in the "Milin Kamak" and "Ponora" ridge. In terms of dynamics, the waters are unpressured. Imperfect intermediate lower waterproof is considered to be marl layers that decline in the south and west directions. The waters are of the chlor-magnesium type, with mineralization below 1 g/dm^3, i.e., they are categorized as fresh groundwaters.

At a distance of 340 m east of borehole P15 there is a pipe well drill for drinking water supply of the village of Chiren from accumulated fresh groundwaters in the apta, which by chemical composition meets the potable water standards. There are no conditions for groundwater formation in Pliocene and the Quaternary.

A groundwater basin is directly related to the present site, namely BG1G000K1ap043 - Karst waters in the Marmara massif.

The characteristics of the groundwater basin are presented in Figure 11.1.1-3 and Table II. 1.1-14 below.

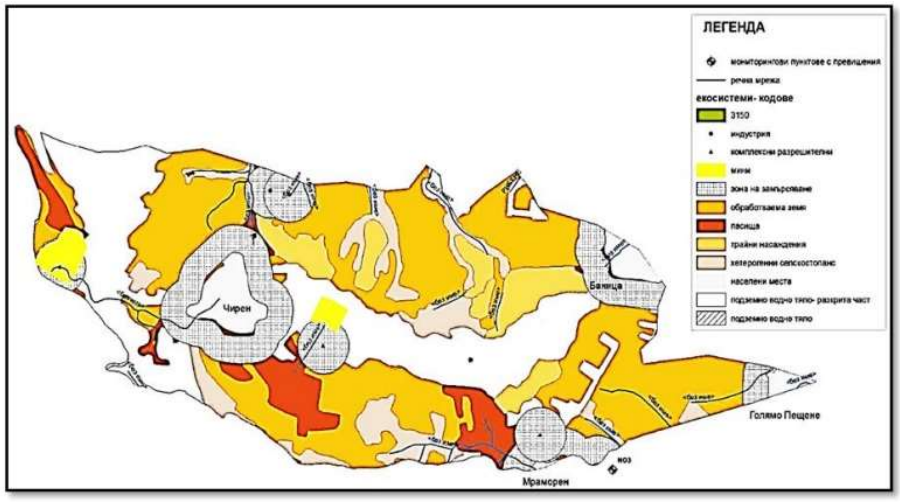


Figure 11.1.1-3 PVT BG1G000K1ap043 - Karst waters in the Marmara massif

The body of water considered covers the karst groundwaters accumulated in the Lower Cretaceous sediments in the area. The characteristics of the water basin are presented in the following table:

Parameter	Value
Water body:	Karst waters in the Marmara massif
OEM code:	BG1G000K1ap043
Area of PVT:	71,00 km^2
HTP type:	Non pressurised
Cover sediments on PVT:	Surface and subterranean karst forms
Lithological construction of PVT:	Intensively cracked and шисппеа limestones
Average thickness of PVT:	180,00 m
Average PVC conductivity:	<100,00 m^2/d
Average filtration coefficient:	<5,00 m/d
Area of the feeding zone:	70,00 km^2
Average modulus of underground	1,50 l/s/ km^2
Natural resource of PVT:	208,00 l/sec

Resource needed for ecosystems:	3,00 l/sec
We calculate the resource on the HTP:	205,00 l/sec
Permitted debit for business purposes:	4,00 l/sec
Permitted debit for personal needs:	5,00 l/sec
Total water abstraction of PVT:	9,00 l/sec
Free water quantities of PVT:	196,00 l/sec
Operating index:	4,00%
Exchange is surface water:	With obstructions
Quantitative state of PVT:	Good
Chemical state of PVT:	Good
Overall assessment of the state of the PVT:	Good
Anthropogenic load:	Areas for agriculture - nitrates, nitrites, phosphates, pesticides. Settlements - without sewerage and WWTP - ammonia, nitrates, nitrites, phosphates. Business - pollution is industrial waste.

Table 11.1.1-14 Summarized characteristics of PVT BG1G000K1ap043 - Karst waters in the Marmara massif

Floods:

Flooding is a temporary overflow covering a significant part of the land with water. It is a natural disaster that is somewhat predictable. It can be caused both by the action of natural forces (heavy prolonged rainfall, heavy snowmelt) and as a result of an accident in hydraulic structures (dams, safety dikes).

With regard to the PURN for the Danube region 2016-2021, the site does not fall within the scope of an area with a significant potential risk of flooding (RZPRN) and there are no prohibitions and restrictions on the implementation of the planned activities.

The potential danger for the operation of “Chiren” UGS is the rupture of the “Chiren-3” dam, as a result from which the pumping for industrial water for the compressor workshop on the existing site will fall into the floodplain zone, which will temporarily suspend the injection process. There is no such danger for the new site.

Seismic characteristics:

An earthquake is one of the most dangerous and unpredictable natural disasters. It occurs as a result of underground shocks (thrusts) and displacements of the Earth's surface caused by existing tensions in the Earth. Modern science divides these stresses into two types: all-round compressive stresses induced by the pressure of top lying layers, and system stresses accompanied by compressive force and perpendicular tensile forces. Under the influence of these stresses in the bowels of the earth, the layers bend and compressive energy accumulates in them, which when released, causing dislocation of these layers.

The territory of “Chiren” UGS falls within a seismic zone of secondary importance, where maximum earthquakes are expected to reach no more than 4th degree on the

Richter scale. The buildings and facilities are secured constructively for earthquakes of up to the 9th degree on the EM5-98 scale.

Protected sites:

The closest natural sites declared for protection by the Protected Areas Act are the following:

Natural landmark "God's Bridges" - located at a distance of over 4 km southwest of “Chiren” UGS (Figure II. 1.1 -4);

Natural landmark the "Ponora" - located at a distance of over 4 um southwest of UGS "Chiren".

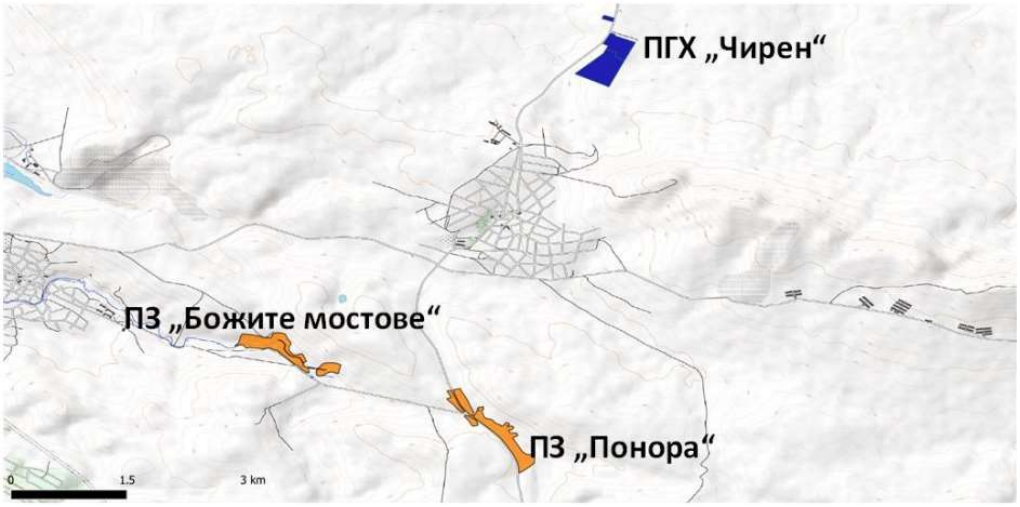


Figure 11.1.1-4 Location of the nearest protected areas

The following protected areas are located closest to the “Chiren” UGS site, approximately 3-4.5A:/?g in the south-southwest of it, (see Figure II. 1.1-5):

- PT "God's Bridge-Ponora" - code BG0000594 at a distance ≈ 3 km
- and PT "God's bridges" BG0000487.

^ “Chiren” UGS

Figure 11.1.1-5 Location of the nearest protected areas

II. 1.1.4. Neighboring enterprises

In the immediate vicinity of the site`s boundaries there are no other PSVRP/PSNRPs as well as other sites that may be the source of or may increase the risk or consequences from a major accident in the enterprise and no “domino effect” is possible.

II.1.2. Identification and description of the type of facilities, processes and activities in which a major accident may occur

Within the meaning of § I, item 54 “a” of the Environmental Protection Act (EPA), a "major accident" is the occurrence of a large emission, fire or explosion that occurs as a result of uncontrollable events in the course of the operations of any enterprise or facility within the scope of Chapter 7, Section I of the EPA, and which results in a serious danger to human health and/or the environment and which is imminent, delayed, inside or outside the enterprise and which includes one or more dangerous substances classified in one or more of the hazard categories referred to in Part 1 of Appendix I or by name listed in Part 2 of Appendix No 3 to the EPA.

Table **II.23-1** and **Table P.2.3-2** describe the OHS (including hazardous waste) that fall within the scope of Appendix No 3 of the EPA and which are located on the site of “Bulgartransgaz” EAD, including their names and identification, their storage locations, the maximum quantities (in tons) that may be available on the site as well as their hazard category and classification in conformity with Appendix No 3 to Art. 103, para. 1 of the EPA.

Tanks, production facilities and pipelines in which hazardous chemicals are present:

<u>METHANOL</u>

Storage of an existing warehouse for flammable liquids (*LZT*, Bul.):

The warehouse is located within the boundaries of ПИ 81400.37.179. There is with 1 tank with a geometric volume of 250 m^3 (197.5 t at a methanol density of 0.79 g/ m^3) and a diameter of 7100 mm. The tank is located above-ground and vertically; its is cylindrical with welded carbon steel structure. The roof of the tank is stationary, conical, with a strengthened steel structure. The tank is equipped with the necessary shut-off, safety and control instrumentation necessary for its normal operation. A vertical ladder is provided for servicing the fittings on the roof of the tank and a safety railing is built on the roof. The tank lays on a reinforced concrete foundation, built above the level of the terrain and is surrounded by an embankment (dyke).

Storage on the existing production site *(ПИ 81400.86.196)*:

- Methanol tank with a collector manifold with volume 2 m^3 (1.58 t) ;
- Feed pipe ½ for individual separation; collector manifold; separation site and separation with a total volume of 0.45 m^3 (0.361 t).

Storage of the newly designed production site:

The new production site occupies land properties No.81400.125.283, 81400.86.270, 81400.86.194,81400.86.267,81400.86.268, 81400.86.269. A new tank shall be built with a volume of 30 m^3 (23.71 t at a methanol density of 0.79 g/m^3).

NATURAL GAS

Currently, the “Chiren” UGS has a total capacity of 1.302 billion Nm^3 of gas, of which 752 million Nm^3 buffer and 550 million Nm^3 are active volume. On this basis, the total amount of natural gas available and stored is determined at 911,400 tons (*at a gas density of 0.7 kg/ m^3 at 0°C and 101.325 kPa*).

After the realization of the IP and raising the tank`s pressure to 150 bar (now 110 bar), the total capacity of the repository will increase to 1.752 billion Nm^3 natural gas (1 226 400 tons), of which 1 billion Nm^3 will be active volume (700,000 t).

The hazardous substance is present in gas pipelines and facilities (*compressor units, gas drying plant, etc.*) located within the boundary of the enterprise. Outside of this territory, but close by, natural gas can be found in the boreholes, the plumes and the gas pipelines.

An accident may occur during the production process within the boundaries of the site, connected with a rupture of the gas connections to the compressors or a decompression of the gas drying plant.

GAS CONDENSATE

Storage of an existing LZT warehouse:

- Tax warehouse, tank is total volume: 525.5 Nm^3 (413.7 t);
- Underground condensate pipeline from main site to the LZT warehouse: 1.9 m^3 (1.5 t).

AUTOMOTIVE FUELS:

Stored in existing fuel tanks at a departmental gasolene station:

- Underground gasoline tank with a total volume - 17.4 Nm^3 (13.3 t);
- Underground tank for diesel fuel - 5.2 Nm^3 (4.4 t).

HAZARDOUS SUBSTANCES AND MIXTURES IN THE EXISTING FUEL AND LUBRICANTS (*GSM*, Bul.) STORARE FACILITY:

The building of the departmental gas station is used as a GSM storage facility (warehouse) for the following hazardous substances and mixtures within the scope of Appendix 3 of the EPA:

- sealing lubricant for assembly pipes - 0.2 t. Used in drillhole repairs. It is stored separately in original packages on a metal grill 60 cm above the floor;
- winter windscreen wiper fluid - 0.007 l. Used to refill the wiper fluid tanks of transport equipment on the UGS site during the winter months. It is stored separately on metal-marked racks in its original packaging.

  A catchment vessel is provided in the warehouse to prevent spills.

SITES FOR THE PRELIMINARY STORAGE OF HAZARDOUS WASTE:

Hazardous waste which is assumed to possess equivalent properties in terms of major-accident potential can be found present in the following facilities/sites:

- waste coded 13 02 05* *Non-chlorinated motor and lubricating oils and mineral-based gear oils* - waste oil type MS-20 (for the operating site) is stored in a metal cylindrical, lying, tank with a volume of 4 m^3 in the open oil warehouse. The site of the oil storage is concreted, with packaging and sewerage system for rainwater, with the possibility for control and treatment. Waste oils are also collected in an dug-in tank to the natural gas filter with a volume of 6.8 m^3, in the production installations and the collection chamber of the oil catcher to the KC m^3, with a volume of 4 t3.

At the new site, waste oils will not be stored. If replacement is required, they are handed over directly for subsequent treatment to companies holding the relevant permits issued under the ZUO.

- waste coded 15 02 02* *Absorbents, filter materials (including oil filters, not mentioned elsewhere), wiping cloths and protective relief, contaminated with hazardous substances* - the waste is oil filters from GMK, cars and contaminated garments are collected and stored in 4 metal barrels and/or bags on a pre-storage site with a capacity of up to 0.6 t.
- waste coded 16 06 01 * *Rechargeable lead batteries* - this waste is stored on a pre-storage site with a capacity of up to 1.35 t. It is collected in a special metal container with a volume of 1 m^3 with a metal lid and 1 pallet container without a lid with a volume of 0.4 m^3, in the company`s road transport battery service (*covered site*).

- waste coded 16 06 02* *Ni-Cad batteries* - stored on a pre-storage site with a capacity of up to 0.015 t. Collected in a special metal container in the company`s road transport battery service (*covered site*).
- waste coded 16 07 08* *Waste containing oils and petroleum products* - the waste is not stored in advance on the site and in the facilities where it is formed until delivery to specialized companies. If replacement is required, they are handed over directly for subsequent treatment to companies holding the relevant permits issued under the ZUO.
- waste coded 20 01 21* *Fluorescent tubes and other wastes containing mercury* – this waste can be found on the pre-storage site, which is an indoor warehouse with a capacity of up to 0.08 t. Fluorescent and mercury lamps are collected and stored in their original packaging and cartons.

II.1.3. Description of the locations in the enterprise where a major accident is likely to occur, including a scheme/map of the premises of the enterprise and/or the facility marked at those locations.

The properties and quantities of hazardous chemical substances and mixtures and waste stored on the territory of “Bulgartransgaz” EAD define the enterprise as being at a risk of major fire accidents or toxic effects on the environment and in particular the aquatic environment. Only flammable substances (natural gas) and the chemicals hazardous to human health meet the criteria for reporting a major accident in conformity with Appendix No 5 of the EPA, in terms of the possibility of an accident with dangerous substances in quantities not less than 5 percent of the limit quantities in conformity with Appendix III, Part 1, column 3 or Part 2, column 3.

The risk assessment (see item II.3.2) shows that the most risky situations are related to the leakage of natural gas from a well, plume or compressed natural gas installation or an accident with a methanol reservoir at the site of “Bulgartransgaz” EAD. In these scenarios, the following it is possible to occur:

- fire/explosion of natural gas;
- methanol induced fire;
- toxic dissipation of methanol.

The sites(s) in the enterprise where the OHV are stored and where risks to human health and the environment may potentially arise are visualized in **Figure II.1.3-1** (colored in red). The warehouses, tanks and the places posing a potential danger for a major accident are as follows:

- Pos. 1 - condensate tank on the site of an existing LZT store;
- Pos. 2 - methanol tank on the site of an existing LZT store;
- Pos. 3 - departmental gas station of the existing production platform;
- Pos. 4 - installation for drying natural gas on the existing production site;
- Pos. 5 - GSM warehouse with stocks of sealing lubricant for assembly pipes and winter liquid for windscreen wipers on the existing production site;

- Pos. 6 - compressor workshop on the existing production site;
- Pos. 7 - a new methanol tank on the extension of the production site;
- Pos. 8-11- new GTKA 1 -4 of the extension of the production site;
- Pos. 12 - new natural gas drying plant on the extension of the production site.

Figure II.13-1 Map of the site of "Bulgartransgaz" EAD with the locations where a major accident may occur and the distances between them

II.1.4. On the basis of the available information - identification of the neighboring enterprises as well as the sites, areas and developments which do not fall within the scope of Chapter 7, Section I of the EPA, but could be the source or increased risk or consequences from a major accident and the domino effect

In the area of the "Chiren" UGS there are no other enterprises, sites, areas and constructions that do not fall within the scope of Chapter 7, Section I of the EPA, but could be the source of or may increase the risk of or the consequences from a major accident and the domino effect.

11.2. Information on the facilities, processes and activities in the enterprise

11.2.1. A description of the main activities and products of the sections of the enterprise which are important for the safe operation or may be the sources of a major-accident risk as well as the conditions under which major accidents may occur and a description of the measures planned to prevent them

The deviations from the normal operating conditions likely to result in an accident hazard are they are presented in column I of **Table 11.2.1-1**. The preventive measures against the occurrence of an accident are presented in column 2 of **Table 11.2.1 -1**. The actions to be taken in the event of deviations from normal operating conditions (independent of preventive measures) are presented in column 3 of **Table 11.2.1-1.**

Table II.2.1-1

№	Deviations from usual operating conditions	Preventive measures	Concrete actions in the event of deviations from usual operating conditions
1	Faulty electric installation	Annual loop impedance control "phase-protective conductor" and on the resistance of the protective earthing arrangements.	Immediate removal of the problem. If necessary turning off the power supply to the faulty installation, to fix the problem.
2	Carrying out fire/ welding works	Preparation of an Order for: - the order for carrying out fire works. - the prohibited places for smoking and use of open fire	Immediate termination of work to full securing the stored
3	Malicious actions	Perform strict throughput by hiring security for the site. A video surveillance system has been built. An internal emergency plan has been prepared, an emergency rescue group was formed and Operational headquarters for conducting SNAVR. Staff training and practical replays of various emergency situations	Notification to the authorities of The unified rescue system agreed in advance the prepared scheme for disclosure. Action as occurred setting, according to The internal emergency plan
4	Rupture of an OHV tank and spillage	Preparation of an Assessment of the cases of imminent threat of an environmental damage caused by the activity of the enterprise and a plan with remedial measures and a financial estimate of the costs for their implementation. In the event that the departmental gas station continues not to be operated- complete emptying of the tanks and subsequent removal of the tanks from the site. With regard to methanol and gas condensate: - regular inspections for possible defects in the valves of the tanks - regular checks regarding the degree of corrosion of the reservoirs.	Action according to the situation, according to the Internal Emergency Plan. Absorbing the spilled amount of OHV and cleaning the site. Replacement of the damaged tank
3	Malicious actions	Carrying out a strict admission regime by hiring security for the site. A video surveillance system has been built. An Internal Emergency Plan has been prepared, an emergency rescue group and an	Notification to the authorities of the Unified Rescue System according to the pre-established announcement scheme. Action according to

		Operational Headquarters have been formed to conduct the SNAVR. Staff training and practical replays of various emergency situations	the situation, and according to the Internal Emergency Plan
4	Breakthrough of an OHV and spillage	Preparation of an Assessment of the cases of imminent threat of environmental damage and damages caused by the activity of the enterprise and a Plan with remedial measures and a financial estimate of the costs for their implementation. In the event that the departmental gas station continues not to be operated: - complete emptying of the tanks and subsequent removal of the tanks from the site. With regard to methanol and gas condensate: - carrying out regular inspections for possible defects in the valves of the tanks - regular checks regarding the degree of corrosion of the tanks	Action according to the situation and according to the Internal Emergency Plan. Absorbing the spilled amount of OHV and cleaning the site. Replacement of the damaged tank
5	Fire in an adjacent terrain	Design and construction of: - site water supply for fire purposes; - external fire hydrants to cover the entire site. Provision of mobile fire extinguishers, additional tools and appliances for extinguishing fires	Notification to the authorities of the Unified Rescue System according to the pre-established announcement scheme.

II.2.2. A description of the technological processes and working methods, in particular the stages of the processes; reporting the available information on the best industrial practices

The exploitation of the “Chiren” UGS is carried out through operational-discharge and observation boreholes. In conformity with their purpose, these are arranged into the following categories:

- Operational (exploitation);
- Observational, and
- Observational for the pressure collector above the main gas saturated horizons.

Up to the present point in time, 24 operational wells have been built, connected by gas pipelines (plumes) with the UGS site as well as 14 observation boreholes, of which 14 are in operation and which serve to track the change in static levels depending on the volume of the gas and its layer pressure in the productive horizons of the underground repository. The gas pipelines are located below the surface of the earth at a depth of 0.8 to 1 meter. After compression, which is carried out by the “Chiren” compressor station, the gas is injected into the boreholes through built plumes.

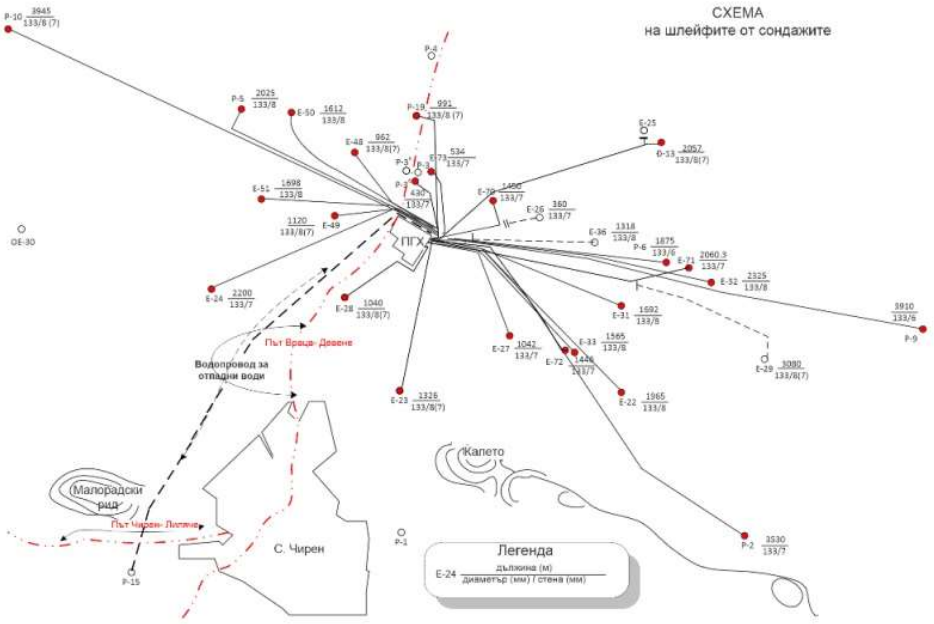


Figure 11.2.2-1 Layout scheme of the "Chiren" UGS boreholes

Item II. 1.1 presents information on the main buildings and facilities in operation on the n site and on the territory of the LZT storage facility (warehouse).

The total rated installed thermal capacity of the current site is **34.66 MW** as follows:

- Gas-engine compressors type GMK -10 GKNAM № 1+8 with a rated heat output 3,88 MW each;
- Boilers from the company "BUDERUS", type G 605-740/12 № 1+3 with a rated heat output of 0,74 MW each and
- Triethylene glycol regeneration unit No. 1 with a nominal heat output of 1.4 MW.

Additionally on the site there is an emergency gas unit No 1 with rated heat output 1.67 MW.

In conformity with detailed information the technological processes at the current site of "Chiren" UGS are as follows:

<u>Individual separation</u>

The gas flow rate to each individual separator is (2080 ÷ 20850) Nm^3/h.

The individual separation is composed of individual separators to each borehole, valves and pipelines. Individual gas metering and methanol feeding through a 1/2" pipe are carried out. The individual separators serve to capture and separate the liquid phase and the mechanical impurities from the extracted natural gas. Fluid emptying is automatic and a safety valve is available closing the borehole as per the fluid`s flow rate. Pressure and temperature are permanently measured.

Collector manifold

This is built of 7 groups of 4 boreholes. The gas flow rate at compression is 4.48 x 10E6 Nm^3/d, and at yield it is 4.38 x 10E6 Nm^3/d. Each of the groups enters a common collector. Filter, valves (regulating and shut-off), bypass connections and pipes are available. Individual adjustment of the flow of gas from each borehole is carried out, and a methanol injection plant is built. Pressure and temperature are permanently measured.

Low Pressure Separation

The separation for low pressure includes separators - 3 pcs. - through which the liquid gas phase is further separated at a pressure of 50 ÷ 55 bar. Ru 64 and throughput 4.38 x 10E6 Nm^3/d.

Liquid phase separation

Two separators are available, and they are used to separate the condensate from layered water on the basis on their relative weight.

Dehydration of natural gas

Dehydration of the gas is distinguished by the following characteristics:

- Minimum flow rate: 0.5 million Nm^3/d under standard conditions;
- Average flow rate: 2.3 million Nm^3/d;
- Working pressure: from 3.0 to 5.5 MPa;
- Temperature: from 0 to 35 ° C of water;
- Dewpoint: minus 10 °C at 3,92 MPa;
- Working fluid used - triethylene glycol.

Dew point control

A system for measuring the dew point by water "BARTEC" is in place.

Dust trap

This consists of 2 cyclone type dust collectors located at the entrance of the repository.

Filtration system for the injected gas

This system prevents contamination of the walls of the operating boreholes with oil from the compressors.

Gas injection compressors

Compressors type GMK 10 GKNAM - 8 pieces are built and functional. They are distinguished by a two-stage operation mode:

- 1st degree to 96 bar.g;
- 2nd degree to 150 bar.g;

The ignition of the compressors is "Altronic" and the cooling is done with water in two circles: open and closed cycle with cooling towers. The performance of one machine is as follows:

- 1-st stage up to 35 000 Nm^3/h;
- 2-nd degree up to 23 000 Nm^3/h.

Power supply

The power supply of the site is done through 2 oil transformers type TM 1600/20/04 with a power of 1600 kW - one is in operation and the other is in hot standby. The voltage is 380 ÷ 220 V +/- 5%; frequency: 50 Hz. Triple-phase current is used for industrial needs. An emergency gas generator, AGA 750 kVA, designed for voltage supply in cases of voltage drops on both inputs is also made available.

Compressed air system for the KIP and A

It consists of 3 piston and 2 screw-type compressors running on electricity. The maximum pressure is 0.6 MPa at a dew point of H_2O - minus 20°C; operating temperature up to 35 °C and productivity 96 Nm^3/h. An air drying system is also available.

Gas drying plant and pegeneration plant for TEG

The natural gas extracted from the underground gas storage, passes through a gas separation plant to separate the water and gas condensate carried by it, but since it is saturated with moisture, it passes through the installation in question where it is dried to a dew point of minus 10°C at a pressure of 39.2 bar_g.

Drying is carried out by absorption using tri-ethylene glycol as an absorbent medium.

The gas drying plant consists mainly of the following assemblies:

- Absorption column for absorption of water vapour carried by the gas through TEG;
- TEG regeneration plant for the further de-concentration of the diluted TEG and a possibility of further use. The separated TEG gases during the regeneration are burned at high temperature (380°C) in the regeneration plant`s furnace.

Additional systems

On the existing production site of the company is located a boiler park consisting of three water heating boilers of the company - "BUDERUS" - type G 605-740/12, each of which has a power of 0.74 MW. The boilers operate in 2+1 shifts only in the period of extraction when they produce the necessary heat for heating the administrative building, the production buildings and for heating the process lines. During these 150 days of the year the operation of the boilers is in the continuous mode.

The supply of the site with potable water and for other domestic purposes comes from the water pipeline of the vill. Chiren, while the supply is water for cooling purposes and fire extinguishing is carried out through a pumping station and the water is pumped from the "Chiren III" dam.

Open motor oil storage facility

The motor oil store is located in the northeastern part of the production site, on an area of approximately 267 m^2. The base of the warehouse is of concrete with reinforced concrete outer wall. These are, in effect, retaining walls with a height of 0.8 and 0.6 m, separating two compartments around the oil tanks with capacity as follows: I - 32 m^3; II - 35 m^3. In the first walled area are located two horizontal, aboveground, cylindrical tanks for fresh oil MC-20, with capacity: 24.6 m^3; 23.7 m^3, and in the second - three horizontal, aboveground, cylindrical fresh oil tanks, each with a capacity of 10 m^3 and one horizontal, aboveground, cylindrical tank with a total volume of 4 m^3 for the storage of waste oil.

All of the tanks are built of carbon steel welded construction. The tanks are 24.6 m^3 and 23.7 m^3; they have thermal insulation with an average thickness of 8 cm and a heating coil to maintain a positive oil temperature during the winter months. All tanks are flat bottoms and are located on concrete or metal foundations. Each tank is equipped with a metal ladder and a platform of metal grills built around the hatches of the tanks for servicing and oil level control. The tanks do not have a level measuring system. The volume control is achieved by manual measurement and calibration tables.

Each walled area has a separate connection with the industrial sewerage for the drainage of the rainwater collected in the walled out, with separate metal grills and shut-off fittings for each of the branches. Rainwater from the enclosures is directed to the KMU treatment facility to retain any possibly spilled oils.

The site of the warehouse is surrounded with a metal fence. Access is restricted. There is also a 24-hour video surveillance. In the immediate vicinity of the entrance to the warehouse there is a fire panel with absorbents available to collect possible spills and as means for initial firefighting. Fire hydrants are also located around the warehouse. Signs are placed at its front door indicating the number, volume and hazards of the stored quantities of oil.

Outside of the concrete enclosure, and in the immediate vicinity, there is an oil pumping station. The base of the site is of concrete and has a fence with a height of 15 cm to protect against possible spills. The pumping station is of the open shed type with a flat roof, where there is one pump for supplying fresh motor oil from the oil store to a compressor workshop. The parameters of the pump placed on a common frame with the motor are as follows: el-motor, triple -phase, 3 kW and a cog wheel pump: 150 dm^3 /min with a pressure height of 6 m water column.

The site of the oil warehouse has a connection with the industrial sewerage for the removal of rainwater to a treatment facility, as well as for the capture of the oil in case of a spill in emergency situations. A stop valve is also available to isolate the site.

All facilities and tanks are grounded, in conformity with the related requirements.

Fuel and oils warehouse and gas station

The departmental gas station on the territory of “Chiren” UGS was built in 1974 in conformity with a preset type of project developed by DSO "Petrol", with two filling columns - gasoline and diesel - and serves the fleet of the repository which includes 21 cars, 1 forklift truck, 1 excavator and 1 power supply. Part of the fleet are specialized

heavy machinery and off-road machinery. In 2004, a major renovation of the gas station building was carried out, and in 2009 the fuel tanks were equipped with a system for capturing the vapours (Phase I) released during refueling.

The use of the departmental gas station has been suspended with a resolution of the Executive director of “Bulgartransgaz” EAD on 01.09.2015.

The building of the gas station is now used as a warehouse for fuels and motor oils, other lubricants, antifreeze, wiper fluids and greases for production needs and for the car fleet.

The building of the warehouse and the gas station is a single storey, monolithic, with a flat, warm roof and external drainage. The building is 3.60 x 6.65 m in area and at a height of 3.30 m. The built-up area is 30 m and the total area of the warehouse and the gas station is approximately 252 m^2.

Common information system on the site

A common information system of the site (SCADA) has been built, including subsystems for operational and technological control, including for ongoing analysis of the operation of the site. The system provides full information on the operational activity of “Chiren” UGS.

The Information dispatch system, WPS832, is a software application for providing operational data on the main technological parameters from the “Chiren” UGS site. The application is an outsourced terminal station connected to the information dispatch system of “Bulgartransgaz” functioning in the dispatch center in the city of Sofia. The system covers all areas of the company and the dispatching information system at “Chiren” UGS collects the local users directly and are measured by electronic corrective devices. The remaining data entering the system is integrated by the local SCADA system ate “Chiren” UGS.

Telemetry information system for the individual measurement of the boreholes` parameters (TSS)

A "Boreholes" subsystem for the telemetric operational current control and individual measurement of the operating borehole parameters has been put into operation. The Telemetric Drilling System (*TCC*, Bul.) at the “Chiren” UGS serves to realize continuous measurement, transmission, storage, control and use for the analysis of field data from the UGS boreholes. The data from the system enters the existing SCADA system of the UGS. The equipment that is built TCC can be divided into field equipment and a base station. Field equipment is installed on each of the drillings in operation - field KIP instrumentation and A devices, controller, zener Ex barriers to protect the circuits of the instruments and field radio-communication equipment installed in the explosive area. The base station consists of:

- Server, communication interfaces, system and application software and auxiliary equipment for the realization of the communications;

- Radio-communication equipment - radio modems, antenna-feeder tracts, power supply units and auxiliary equipment for the realization of the galvanic separation and the protection of the individual devices.

Warehouse for highly flammable liquids (*LZT*, Bul)

The site of the Warehouse for Flammable Liquids (LZT) is located at about 190 meters northwest of the main site of the “Chiren” UGS and near the “Chiren” - Devene road.

On the site of the LPT warehouse are located the following technological facilities: gas condensate tank with a volume of 525 m^3 – with a semi-stable fire extinguishing plant and a stable cooling installation; a methanol tank with a volume of 250 m^3; a pumping station and an auto-storage for gas condensate and methanol, auto- discharge for methanol and a connecting pipe discharge. In conformity with the regulatory requirements, on the territory of the warehouse for flammable liquids there is a separate excise tax warehouse for energy products - gas condensate. The scope of the tax warehouse includes: the condensate tank, auto-discharger for condensate and a pumping station, control and measurement facilities, a movable container for administrative and household services, in which are located elements of the Measuring Instruments Control System (*SKIU*, Bul.) of the “Customs” Agency. Activities carried out in the tax warehouse: storage of the produced accompanying excise product "raw condensate from natural gas".

For the construction and enterprise of the tax warehouse for gas condensate, a fence has been raised which restricts the access of outsiders to goods under customs control. The fence is made of steel mesh at a height of 1.5 m on steel poles. There are entrances and exits for tanker trucks and service personnel which are equipped with lockable steel doors. For administrative, household and service activities of the tax warehouse modular movable container is 2.5 x 5.0 m is in place.

In the of extraction of natural gas mode from the productive layer of the repository, together with the natural gas, concomitant solid and liquid fractions are extracted, such as gas condensate, layered waters, sand, clay, rock materials, etc.

The separated gas condensate from the installations for separation and deviation of the layered fluids is transported by a condensate pipeline from the main site of the UGS to the LZT Warehouse.

Gas condensate tank;

The tank has a total volume of 525 m^3 and a diameter of 8800 m. The tank is a standing, overhead, vertical, cylindrical vessel with a welded carbon steel structure. The roof of the tank is stationary, conical, with a strengthened steel structure. The tank is equipped with the necessary shut-off, safety and measurement instrumentation necessary for its normal operation. It is equipped with a fixed fire extinguishing system. A vertical ladder is provided for servicing the fittings on the roof of the tank and a safety railing is built on the roof. The tank is mounted on a reinforced concrete foundation, built above the level of the surrounding terrain, in a ground shaft (embankment).

The transportation of the gas condensate from the existing plant, located on the main site to the gas condensate tank, is carried out through the DN65 (Ø 76x4) underground steel pipeline.

The condensate tank is equipped with measuring and controlling devices for the filling, removal and storage of the gas condensate as follows: two measuring modules with volumetric flow meters PK50 and built-in level measuring system of the magneto-strictive type. Both measuring units are equipped with thermal elements for temperature consumption correction and emergency "Stop" buttons. A grounding control device has been built to the measuring unit of the automatic condensate discharger.

Methanol tank:

The methanol tank has a geometric volume of 250 m^3 and a diameter of 7100 mm. The tank is overhead, vertical, cylindrical with a welded carbon steel structure. The roof of the tank is stationary, conical, with a strengthened steel structure. The tank is equipped with the necessary shut-off, safety and measurement instrumentation necessary for its normal operation. A vertical ladder is provided for servicing the fittings on the roof of the tank, and a safety railing is built on the roof. The tank is mounted on a reinforced concrete foundation, built above the level of the terrain, in a ground shaft (embankment).

Gas condensate and methanol pumping station:

The pumping station is built on the eastern side of the concrete enclosure as part of the tax warehouse and the pump for gas condensate, type CNM 65-125, Q = 20 $m^{3/}$h, H = 18 m water column, N. = 3,0 kW. This pump ensures the filling of the tanks with gas condensate;

Outside of the pumping station of the tax warehouse there is a pump for methanol, type SNM 65-125, Q = 20 $m^{3/}$h, H = 18 m water column, N. = 3,0 kW. Through this pump the filling and unloading of the tanker trucks with methanol. The pump is mounted on a concrete foundation is 500 x 1200 mm and a height of 400 mm, 100 mm above the level of the terrain in the area of the concrete embankment.

Automatic filling device for gas condensate:

The auto condensate device is built on the east side of the embankment of the tax warehouse and consists of a stationary one-sided hydrant (stand) for overhead filling of tank trucks, DN80, equipped with pipelines, spiral fittings and a flexible antistatic hose. The hydrant is mounted on a steel platform with protective railings and a ladder.

Automatic filling and discharge device for methanol

The methanol auto-filling device is built on the east side of the embankment of the tax warehouse and consists of a stationary one-sided hydrant (stand) for overhead filling of tank trucks, DN80, equipped with pipelines, spiral fittings and a flexible antistatic hose. The hydrant is mounted on a steel platform with protective railings and a ladder.

The methanol auto-discharge device is part of the methanol stand and consists of one stationary single sided hydrant (overloaded sleeve) DN80 for lower discharge of tanker trucks.

Between the gas condensate and the methanol tanks, pumps and auto-filling devices, an above-ground pipeline installation is built through which the technological connections and the joint operation of the equipment are carried out. The pipeline installation is equipped with shut-off and measurement instrumentation devices, flow meters and filters necessary for the normal operation of the equipment and the facilities.

Underground water drainage tank:

The drainage tank is an underground metal tank with total volume Y = 25 m^3, with inspection hatches and a vent. The tank is designed to collect the drained precipitated water from the gas condensate tank. Contaminated water from inside the embankment can also be collected int it.

Underground water for firefighting purposes with a pumping station

The PP water tank with the pumping station are designed to provide water for firefighting and extinguishing. The tank is underground, of reinforced concrete with a total useful volume of 264 m^3 (dimensions: 5.60 m x 16 m x 2.95 m).

Water pipes at the LZT site

A firefighting water pipeline is built. It is a high-pressure network consisting of one ring of pipes ø159 x 4,5 and ø 133 x 4. Deviations were made from the ring to feed the condensate tank cooling plant. 4 fire valves are installed. The existing semi-stable fire extinguishing installation of the gas condensate tank serves to supply foam solution from a fire truck. Simultaneously, the working pump is started to cool the tank through its cooling installation.

In connection with the reconstruction of the condensate and methanol warehouse, and in order to bring it in line with the requirements for a tax warehouse for condensate in conformity with the prepared project, a new fire water pipeline with steel pipes ø 125x6 has been built. Its is fed by the existing one. To the newly designed water pipeline deviations are made for the installation of stationary carriage-type nozzles to protect the condensate and the methanol tanks. These nozzles - 6 pieces - are symmetrically located outside the enclosure of the tanks, on the technological sites at a height of 0.9 m from the level of the adjacent terrain. The carriage nozzles are mounted on a high-pressure water supply network on separate technological sites. In conformity with the regulatory requirements a shaft for loading filling water from mobile fire pumps and trucks has also been provided.

<u>Lightning protection and grounding installation</u>

All non-conductive metal parts (metal structures, process equipment structures) are grounded. Lightning protection II category has been developed for the site and outdoor facilities, for protection against direct hits of lightning on linear objects.

To protect against the introduction of dangerous potentials on the external above-ground metal structures and pipelines, a connection to grounding with a pulse resistance of 10 ohms is constructed. To protect against induced voltages from electromagnetic induction, shunting connections are built. All flange joints on the

pipelines are bridged with flexible groundings (bridges) of copper rope. Lightning rods were built for the automatic fillers.

The Measuring Instrument Control System (*SKIU*, Bul.)

In conformity with the requirements of "Ordinance No 3 dated 19.02.2010 on the specific requirements and the control carried out by the customs authorities on the measuring instruments for excise goods", a System for Control of Measuring Instruments (SKIU) has been built for the transmission of quantitative data in real time to the Customs agency. The system is made up of:

- Control point 1 - located on the outlet line of the condensate tank - between the inlet and outlet shut-off valve after the pump for the auto-filler stand;
- Control point 2 - located on the inlet pipeline of the condensate tank;
- Integrating communication device for monitoring and control (*IKUNK*, Bul.) - made of: industrial controller (PLC), industrial computer (IPC) with installed software of the Customs agency; GPRS module and an antenna for data transmission; electronic certificate. All elements of the SKIU are powered by UPS.

NEW SITE, AFTER THE REALIZATION OF THE IP:

The newly designed equipment that will ensure work on the “Chiren” UGS will be located in a newly designated technological site (at a close proximity to the existing site), located to the southwest of the existing one. The equipment includes four gas turbine compressor units, a gas turbine engine driving two centrifugal compressors, accompanying equipment to the GTKA, an individual separation unit, a gas metering station, a manifold, gas purification and heating, general separation, a gas drying plant, triethylene glycol regeneration plant, layered fluids separation plant. In addition to the above equipment, the construction of a production and energy facility, a fuel gas preparation unit, a pumping station for fire protection needs, a security checkpoint and a fence are also planned.

Input separation and GIS

The purpose of the input separation and the GIS is to ensure the necessary purity of the gas and its measurement before passing through GTKA in the injection mode, as well as quality control of the gas and lowering its pressure to operational parameters in the production mode.

The system for input separation and GIS consists of two main parts: filter-splitters and measuring lines. The filter separators will be a total of 6 pieces; vertical, cartridge type, located outdoors. The collected condensate from them will be directed through pipelines to the plastic fluid treatment system. In the immediate vicinity of the filter separators will be built a building, housing the GIS. It is envisaged that the measurement

will be done by means of 6 lines which will be arranged into two groups of three in group, respectively serving the linear part of the site: “Expansion of the gas transmission infrastructure of “Bulgartransgaz” EAD parallel to the northern (main) gas pipeline to the Bulgarian-Serbian border” at the valve junction “Butan-Chiren” and Vratsa I/II. In the extraction mode, from the “Chiren” UGS the gas passes through a GIS, where its pressure is lowered to the operating parameters of the respective gas pipeline for which it is intended – 37 – 44 barg for Vratsa I and Vratsa II, and 50 – 75 barg for the linear stage part of the site “Extension of the gas transmission infrastructure of “Bulgartransgaz” EAD parallel to the northern (main) gas pipeline to the Bulgarian-Serbian border” at the valve junction “Butan-Chiren” where the quantity of passing gas is measured and the quality is checked with a gas chromatography analyzer.

GTKA 1, 2, 3, 4

At the new site of “Chiren” UGS the installation of GTKA units is planned, each with a rated heat output of 18 MW. The GTKA will provide the necessary pressure increase in the natural gas injection mode at “Chiren” UGS. The working configuration will be 3+1 - three functioning GTCA and one backup. Each GTKA consists of a GDT driving two CKs by means of a common shaft (tandem configuration). Each GTKA also includes and EL and KIP building, underground oil tank, drainage water and gas condensate, oil cooler, fire protection system and a fuel gas system.

The drainage water, gas condensate and oil separated from each GTKA will be collected in the atmospheric tanks provided for each of them and these will be treated as waste under the Waste Management Act. The formed condensate from the fuel gas system will be directed to the layered fluids processing system.

Gas pipelines on the site

The plan includes the construction of site pipelines with different diameters to ensure the transmission of natural gas between the different nodes and facilities. These gas pipelines will be designed for the following parameters listed in Table II.2.2-1 further below:

Table II.2.2-1 Permeability of pipelines

Operation mode	Expenditure (million Nm^3/day)	Pressure (barg)
Compressing	3-10	37 - 140
Yeald	2- 10	37-140
Recirculation	1,5-5	-

Individual separation

The node for individual separation will be used in the production mode from “Chiren” UGS and it will ensure the separation of liquid impurities from the natural gas

in the course of its production. The node will consist of 28 individual vertical filter-splitters (one for each of the boreholes). Besides separating the liquid phase in the node for individual separation, methanol will be injected; it is intended to prevent the formation of crystallo-hydrates in the equipment. The separated fluid, during extraction, will be transported by pipelines to the layered fluid separation plant (triple-phase separation).

At the new site at“Chiren” UGS, a methanol tank will be built with a capacity of 30 m^3, which will provide a workflow for 40 days.

The individual separation will be designed for the following conditions:

- Flow rate (for one separator) - 1500 - 25000 m^3/h;
- Pressure - 60 - 140 barg;
- Volume of the liquid phase - 0.53 l for 1000 m^3 of gas;
- Liquid phase density - 850-1000 ug/m^3.

Manifold

The designed manifold is a system which will ensure the separation of solid particles from natural gas (in the extraction mode from the UGS), as well as the measurement of the passing gas through an aperture. The manifold consists of 28 separate lines, one for each of the boreholes. Filters for individual separation will also be installed on the same lines. The separation of solid pollutants from the extracted natural gas will be provided by cyclone separators. The separated solids and condensate will be directed to condensate tanks to the layered fluid processing system. The auxiliaries to the manifold (filters, apertures, adjacent fittings, etc.) will be provided for the following operating parameters:

- Flow rate (per line) - 1500 - 25000 m^3/h;
- Temperature - +8 ÷ +55°C;
- Pressure - 60 - 140 barg.

Gas separation and heating

The separation and heating unit will ensure that the relevant natural gas parameters are reached before the next drying and depressurization phases. The unit will be designed for an expenditure 2 000 000 - 10 000 000 Nm^3/h, with a pressure of 60-140 barg at a temperature of 8-40°C.

It is planned to install 3 separators, which will operate in the 2 + 1 mode (two operating and one backup).

After purification, the gas will pass through a preheating system. The system will consist of five preheaters (4 +1 operational mode), connected with a common antifreeze tank (a mixture of distilled water and propylene glycol in a ratio of 62% to 38%). The heaters will be horizontal, running on natural gas and with an automatic control of the burner power depending on the temperature and the amount of the heated gas. The total coolant tank will have an approximate volume of 50 m^3 and will operate at atmospheric pressure conditions.

Pressure regulation

The unit will provide a depressurization of the extracted gas before its drying. The outlet pressure will be in the range (55+80 barg) and will depend on the direction to which the gas will be directed off the UGS site (Vratsa I/II stage linear part of the site: "Expansion of the gas transmission infrastructure of “Bulgartransgaz” EAD parallel to the northern (main) gas pipeline to the Bulgarian-Serbian border” at the valve junction “Butan-Chiren”. The operational process will be ensured by two lines operating in the in the 1 + 1 mode (one operating and one backup).

Gas drying plant

The installation will consist of three absorption columns drying the natural gas. The absorbent used in the columns will be triethylene glycol (TEG). The installation is envisaged for the total amount of passing gas in the yield mode of 2 000 000 – 10 000 000 Nm^3/d and will consist of three absorption columns operating in 2 + 1 mode (two operating and one backup). The columns will receive natural gas with a moisture content, which will be absorbed by a drying agent – TEG. After saturation, triethylene glycol will be separated automatically and passed through a regeneration plant.

Triethylene glycol regeneration plant

The triethylene glycol regeneration plant is an integral part of the gas drying system and will ensure the constant supply of "dry" TEG to the operating absorption columns. The plant will be designed for a capacity of 1100 kg/h of TEG at a pressure of 4.5 barg. The temperature range of the installation is +25 - +204 °C. After evaporation of the absorbed water, TEG will be cooled by about 5°C and directed to the absorption columns by means of pumps.

Layered fluids separation Installation

Drained waters and condensate which are separated in the above-listed installations in the extraction and injection mode are collected in the Layered fluids separation installation. The installation will include three drainage atmospheric tanks (each with a volume of 5 m^3) and two horizontal triple-phase separators operating in the 1 + 1 mode (one operating and one backup) and with overall dimensions D = 2200 mm and L = 6900 mm. Their construction will ensure the separation of three phases - gas, gas condensate and waters. The separated gas will be directed to a torch located on a separate fenced site measuring 100 x 100 m.

The separated layered waters and the gas condensate will be supplied through pipelines to tanks located at the existing site of “Chiren” UGS. The gas condensate will be stored in a gas condensate tank, and the layered waters will be directed to an industrial reinjected water reservoir, from where they are reinjected into borehole P-15.

The installation is designed for the following parameters:

- Consumption - 4200 kg/h
- Pressure - 3 barg;
- Temperature: -29 to +60 °C.

Electrical and KIP buildings

Four identical buildings located next to each of the four GTCA will be built. Each of the buildings is a single-storey, rectangular structure and the first one will contain the aggregate control systems for GTKA, the remotely located modules of the control system of the KC and electrical equipment.

Three more electrical and instrumentation buildings are planned for construction. They will provide the relevant technological facilities: installation for the TEG regeneration; individual separation; manifold; the separation installation, preheating and gas pressure regulation; common separation; installations for the separation of leyered fluids and for drying the gas.

A building for: BPGG; Compressor for KIP air; heating boiler, installation for the sealing gas preparation

The building includes: fuel gas preparation unit (BGG), compressor for instrumentation air, el. room and boiler room for heating. The construction of the building is on one level and is divided into four rooms, each with a separate entrance. Technological preparation of natural gas for its further use as fuel gas (for GTCA I, 2, 3 and 4) is carried out in the BEPG. There will be 3 pcs in the boiler room. (2 working and 1 spare) boilers for the technological needs of the BGUG and two boilers for household needs. In a separate room there will be two compressors for instrumental air - working and spare. In addition, the installation includes filters, dryers and KIP air. The installation will provide purified, dry KIP air for the needs of the facilities. There is no permanent workplace in the building.

Power production unit /*PEB*, Bul./, Transformer post, Common switchgear device (KRU 20/0,4 kV)

The premises in the building are located on one level, each with a separate entrance. The power substation, switchgear and two transformers are located in the southern part of the building. The premises are distributed between: operator room, KIP apparatus, TSV, laboratory with scales weight and an adjacent warehouse, plus changing rooms with showers, rest room and toilets, boiler room, conference room. Permanent jobs are set for this building.

Emergency diesel generator

This piece of equipment provides emergency power supply to the KC in the event blackout of the external power supply. Its electricity generating power will be 1.6 mW.

Firefighting water tank and pumping station

In conformity with "Ordinance No I “z”-1971 on the Construction and technical rules and norms for ensuring safety in case of fires, it is necessary to provide water for external and internal fire extinguishing of the buildings and the outdoor technological facilities.

The necessary water quantities for fire extinguishing will be stored in a tank with a volume of 205 m^3. The firefighting water tank will be covered, semi-encased, monolithic, of reinforced concrete, twin-chamber and covered with soil to prevent

freezing. It is envisaged that the emergency water backup stock will be restored in no more than 24 hours.

The building of the Pumping station for water for firefighting needs will be half-dug into the ground and monolithic in structure. In case of fire, the drawing of water will be done by electric pumps installed in the pumping station. The pressure in the system will be maintained by 1 operational and 1 emergency pump. A complementary “jockey” pump is also to be made available. The control of the system will be done manually on the spot and automatically.

Access to the site

At the entrance of the new site will be located a building that houses a porter and security guards plus an adjoining sanitary unit (toilet). The building provides the checkpoint mode of accessing the premises. Permanent jobs are provided for this activity too.

On-site water pipelines

At the existing site of the “Chiren” UGS there is a separate water supply system consisting of a potable water pipeline, a firefighting water pipeline with installed fire hydrants and an open water tank for fire and technological needs and a working water pipeline.

Water for firefighting and cooling purposes is delivered through an existing pumping station built on the nearby “Chiren III” dam on the basis of a permit for water extraction and water for drinking and domestic needs which is supplied by the local water supply and sewerage company on the basis of a separate valid contract.

The site water supply network of the newly built site will consist of three separate water pipelines:

- Water supply for drinking and domestic needs;
- Water supply for fire-fighting needs;
- Deviation from an existing water supply pipeline for firefighting needs from a pumping station built on the nearby “Chiren III” dam to the new firefighting water tank.

The water supply system at the site will include a new water meter shaft; a water supply network for drinking water; a fire extinguishing network with installed fire hydrants; a fire tank with a pumping station; internal plumbing for domestic drinking needs in the buildings; building installations for fire extinguishing with fire hydrants, plumbing shafts.

The fire-fighting water tank will be supplied with water through a deviation from a water pipeline for these needs from an existing pumping station built on the nearby “Chiren III’ dam to the new fire tank.

Road links

Three roads connections to the site will be built: a new road connection from the asphalt road Chiren - Devene to the newly designed KC and the entire site of the gas

storage facility /road connection 1 /, with a width of 6.0 m and a length of about 118.0 m of asphalt pavement, while the other two points of access will be from the existing “Chiren” UGS site to the new compressor station. The construction of the new road connection requires an area of about 1.8 decares is needed, for which a procedure for the acquisition of the real estate property rights will be conducted. The road connection in question affects the lands of the village of Chiren – municipality of Vratsa.

The drainage of the road surface waters will be done along on the slopes of the pavement, to the existing terrain. In the sections of the trench built along the newly designed road connection, a lined protective drainage ditch is envisaged which will take the surface waters out of the road.

Gas pipeline diversions, pipelines and plumes to the KC “Chiren” UGS

In the lands of the village of Chiren the following gas pipeline deviations will be designed:

- Gas pipeline deviation connecting the existing gas pipeline "Vratsa 1" with the newly designed Compressor station with a length of about 266 m and a diameter DN 500 mm;
- Gas pipeline diversion connecting the existing gas pipeline "Vratsa 2" with the newly designed Compressor station with a length of about 35 m and a diameter DN 500 mm;
- Gas pipeline connection between the new site and the new torch with a length of 160 m, consisting of pipelines for fuel gas (DN 25), instrumental air (DN25), natural gas emitted from the facilities with a diameter of DN250;
- Plumes (28 in number) for connection between the site of the Compressor station to the existing ones from the operational boreholes with lengths ranging between 400 and 500 m and diameter of DN 150 mm;
- Displacement of the track of an existing plume to borehole 28, passing through the territory of the new technological site for the KC with a length of 620 m with a diameter of DN 150 mm;
- Displacement of the route of an existing plume to borehole 23, passing east of the territory of the new technological site for the KC with a length of 180 m and a diameter of DN 150 mm;
- Displacement of the route of the existing "Nivego" pipeline with a length of about 840 m and a diameter DN 50 mm, owned by "Nivego" OOD;
- Drainage condensate pipeline with a length of about 845 m and diameter DN 100 mm between the new site and the tax warehouse located in the land property with identifier 81400.37.179;
- Pipeline for layered waters with lengths of around 350 m and DN 100 mm, which will be debited from the new site to the existing “Chiren” UGS site.

In conformity with the diameter of the pipes and *Ordinance No 16 from 09.06.2004 regarding the easement of the energy facilities*, a secondary zone with an area of 30 x 15 m is regulated on both sides of the newly designed plumes for connection with the gas pipelines Vratsa I and Vratsa 2 plus a torch system. The

condensate and layered water pipelines fall within the existing easement of the plumes toward the boreholes. The new connections to the boreholes (plumes) are located in parallel and an easement zone with a width of 5 m parallel to the axis of the end gas pipelines (plumes) is established. For the displaced routes of the plumes to boreholes 23 and 28 and the displaced route of the “Nivego” gas pipeline, an easement zone of 12 x 6 meters is established on both sides of the axis.

The plumes and gas pipelines will be laid underground at a depth of 1.0 m, measured from the upper ridge of the pipe and in conformity with the requirements of the Ordinance on the structure and safe operation of transmission and distribution gas pipelines and natural gas facilities, installations and appliances.

Access to this zone is not allowed for: any kind of construction, cultivation (ploughing) of the soil to a depth of more than 0.5 m, as well as lighting fires; planting of perennial vegetation; carrying out drilling works, exploration and extraction of underground resources; parking any/all types of vehicles; storage of waste and materials; actions of any third parties on the energy facilities, etc.

Technological torch site

It is envisaged to build a new technological site for a torch system to serve the gas combustion process. The gas emitted by the various systems and apparatus during repair works and normal work will enter the torch system via a gas pipeline.

The torch system will serve to burn natural gas from:

- Scavenging of technological production lines;
- Pressure discharge (manually);

All emergency and automatic discharging will be deviated to torches. The amount of gas to sustain the flame will be about 10 Nm^3/h in both modes of operation of the UGS (extraction and injection).

The area of the technological site for the torch system will be 100 x 100 m.

Anode grounding

In connection is the electrochemical protection of all underground metal pipelines (plumes to the drill wells) routes of anode groundings outside the technological site shall be built. The routes will be located east and west of the site and they will pass through the lands of the village of Chiren, municipality. Vratsa.

The route to the east is about 270 m long, and the route to the west - 95 meters. An easement zone for the routes is provided on an area of 4.0 m (*2.0 m on both sides along the axis of the cable*), where no construction and placement of perennials is permitted.

II.2.3. An up-to-date and comprehensive list of hazardous chemical substances in the establishment

Annex 6 presents the safety data sheets of the hazardous chemical substances (HCS) that may be present at the site of the establishment.

II. 2.3.1. Chemical name, CAS No, EU No, IUPAC name

Table II.2.3-1 Chemical names and identification of hazardous chemical substances at the site

Chemical name	CAS No	EU No	**IUPAC name**
Methanol	67-56-1	200-659-6	Methanol
Diesel fuel	68334-30-5	269-822-7	Fuels, diesel
Gasoline	86290-81-5	289-220-8	Gasoline
Sealing lubricant for assembly pipes	-	-	-
Winter windscreen washer liquid	-	-	-
Gas condensate	68919-39-1	272-896-3	Natural Gas Condensate
Natural gas	8006-14-2	232-343-9	Natural Gas

II. 2.3.2. Facility capacity and maximum quantity available or expected to be available at any time at the site of the establishment/facility

Table II.2.3-2 presents the hazard category and the classification under Annex No 3 to Art. 103, para. 1 of the Environment Protection Act (EPA) of the hazardous substances that may be present at the site of Bulgartransgaz EAD, as well as the capacities and maximum available quantities at the site.

Table II.2.3-2 Hazard category and classification of HCS within the scope of Annex 3 of the EPA

Chemical name	**CAS No**	**EU No**	**Hazard category (-ies) under Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) (OJ, L 353/1, 31 December 2008)**	**Classification under Annex No 3 to Art. 103(1) of the EPA**	**Design capacity of the technological installation (in tonnes)**	**Available Qty (t)**

Methanol	67-56-1	200-659-6	H225 Flam. Liq. 2; H301 Acute Tox. 3 H311 Acute Tox. 3 H331 Acute Tox. 3 H370 STOT SE 1	Part 2, individually named, item 22 Part 1, Section "P", Section "H"	Existing flammable liquids (FL) warehouse: - 1 tank 250 m^3: 197.5 t Existing production site: - 1 tank 2 m^3: 1.58 t - Supply pipe ½: 0.45 m^3, 0.36 t; At the new site within the IP scope: - 1 tank 30 m^3: 23.7 t	223.1
Diesel fuel	68334-30-5	269-822-7	H226, Flam. Liq. 3 H304, Asp. Tox. 1 H315, Skin Irrit. 2; H332, Acute Tox. 4; H351, Carc. 2 H373, STOT RE 2; H411, Aquatic Chronic 2	Part 2, individually named, item 34 (a), Part 1, Section "P", Section "E"	Existing company fuel station: - 1 underground tank: 5.2 m^3, 4.4 t	4.4
Gasoline	86290-81-5	289-220-8	H224 Flam. Liq. 1; H304 Asp. Tox. 1 H315 Skin irrit. 2; H336 STOT SE 3; H340 Muta. 1B; H350 Carc. 1B; H361 Repr. 2; H411 Aquatic Chronic 2	Part 2, individually named, item 34 (c), Part 1, Section "P", Section "E"	Existing company fuel station: - 1 underground tank: 17.4 m^3 , 13.3 t	13.3

Sealing lubricant for assembly pipes	-	-	H319 Eye Irrit. 2 H400 Aquatic Acute, 1 H410 Aquatic Chronic 1	Part 1, Section “E”, E1	In a warehouse for lubricants and fuels at the existing company fuel station: - in original packaging, up to 0.2 t	0.2
Winter windscreen washer liquid	-	-	H225 Flam. Liq. 2	Part 1, Section "P", P5c	In a warehouse for lubricants and fuels at the existing company fuel station: - in original packaging, up to 0.007 t	0.007
Gas condensate	68919-39-1	272-896-3	H350 Carc. 1B; H340 Muta. 1B H304 Asp. Tox. 1	Part 2, individually named, item 34 (e)	Existing FL warehouse: - 1 tank 525.5 m^3, 413.7 t - pipeline – from the existing production site next to the FL warehouse: 1.9 m^3, 1.5 t	415.2
Natural gas	8006-14-2	232-343-9	H220 Flam. Gas. 1	Part 2, individually named, item 18, Part 1, Section "P", P2	After implementation of the IP: Underground gas storage and installation 1.752 billion Nm^3 or 1,226,400 tonnes.	1.2264 million

Waste with code 13 02 05* - Non-chlorinated motor and lubricating oils and mineral-based gear oils	-	-	HP 14/ H411 Aquatic Chronic 2	Part 1, Section "E", E2	Site for preliminary waste storage and in tanks at the facilities, with expected amount of up to 18 t.	18
Waste with code 15 02 02* - Absorbents, filter materials, wiping cloths and protective clothes, contaminated with hazardous substances	-	-	HP 14/ H410 Aquatic Chronic 1 H411 Aquatic Chronic 2	Part 1, Section "E", E1/E2	Site for preliminary waste storage with a capacity of 0.6 t	0.6
Waste with code 16 06 01* - Lead rechargeable batteries	-	-	HP 14/ H410 Aquatic Chronic 1 H411 Aquatic Chronic 2	Part 1, Section "E", E1/E2	Site for preliminary waste storage with a capacity of 1.35 t	1.35
Waste with code 16 06 02* - Ni-Cd batteries	-	-	HP 14/ H410 Aquatic Chronic 1 H411 Aquatic Chronic 2	Part 1, Section "E", E1/E2	Site for preliminary waste storage with a capacity of 0.015 t	0.015
Waste with code 16 07 08* - Waste, containing oils and petroleum products	-	-	HP 14/ H410 Aquatic Chronic 1 H411 Aquatic Chronic 2	Part 1, Section "E", E1/E2	Stored in the facilities in which the waste is formed with a quantity of up to 16 t	16

Waste with code 20 01 21* - Fluorescent tubes and other waste, containing mercury	-	-	HP 14/ H330 Acute Tox. 1 (inhal.) H410 Aquatic Acute 1, H400, Aquatic Chronic 1	Part 1, Section "H", H1 Section "E", E1	Site for preliminary storage of the waste, in which up to 0.000004 t. of mercury may be available	0.000004

II.2.3.3. Physical, chemical, toxicological properties and category/categories of hazard (standard risk phrases) as well as a description of the direct and/or indirect (delayed) dangerous effects for humans and the environment

For all HCS and mixtures stored on the territory of Bulgartransgaz EAD, safety data sheets are provided, which are presented in **Annex 6.**

Methanol - CAS No 67-56-1. It is classified under Regulation 1272/2008 as H225: Highly flammable liquids and vapours, H301 + H311 + H331: Toxic if swallowed, in contact with skin or if inhaled and H370: Causes damage to organs (eyes, central nervous system).

Table II.2.3-3 Physical and chemical properties of methanol

Physical and chemical properties	Toxicological properties
Appearance: liquid, colourless Smell: similar to alcohol Flash point: 9.7° C Melting point: -97.8° C Ignition temperature: 455° C Solubility: in water ≥ 1000 g/l (at 20° C) Relative density: 0.79 g/cm ^{3} (at 20° C) Vapour density: 1.1 hPa	Acute toxicity: - oral, LD50 - rat 2528 mg/kg body weight - dermal, LD50 - rabbit 17100 mg/kg - inhalation LC50 - rat > 115.9 mg/l (4h) If swallowed, there is a risk of blindness. After absorption: nausea, vomiting, headache. Poisoning has an effect on the central nervous system and causes convulsions, disorders of breathing or insomnia.

Diesel fuel - CAS No 68334-30-5. It is classified under Regulation 1272/2008 as H226: Flammable liquid and vapour, H304: May be fatal if swallowed and enters airways, H315: Causes skin irritation, H351: Suspected of causing cancer, H373: May cause damage to organs (bone marrow, thymus, liver) through prolonged or repeated exposure, H304: May be fatal if swallowed and enters airways, H411: Toxic to aquatic life with long-lasting effects.

Table II.2.3-4 Physical and chemical properties of diesel fuel

Physical and chemical properties	Toxicological properties
Appearance: liquid, dark amber colour Smell: characteristic	Acute toxicity: - Inhalation LC50 Rat > 4100 mg/m3, 4

Flash point: > 56.0° C Melting point: -40° C Auto-ignition temperature: ≥225° C Density: 0.80-0.91 g/cm^3 Kinematic viscosity: >= 1.5 mm2/s (40° C)	Hours - Dermal LD50 Rabbit > 5000 mg/kg - Oral LD50 Rat 9 ml/kg

A95H motor gasoline - CAS No 86290-81-5. It is classified under Regulation 1272/2008 as H224: Extremely flammable liquids and vapours, H304: May be fatal if swallowed and enters airways, H315: Causes skin irritation, H361fd: Suspected of damaging fertility. Suspected of damaging the unborn child, H336: May cause drowsiness or dizziness, H340: May cause genetic defects, H350: May cause cancer, H411: Toxic to aquatic life with long-lasting effects.

Table II.2.3-5 Physical and chemical properties of A95H motor gasoline

Physical and chemical properties	Toxicological properties
Appearance: colourless liquid Smell: n. d. Melting point/freezing point: < -20° C Initial boiling point and boiling range: 30 - 210° C Flash point: < -35.0° C <0° C - <55° C Flammable limit – lower: 1.4% Flammable limit – upper: 7.6% Vapour pressure: 4 - 240 kPa (37.8° C) Relative density: 0.62 - 0.88 (15 °C) Solubility(-ies): Insoluble in water.	<u>Acute</u> - Inhalation. LC50 Rat > 5610 mg/m3 - Dermal LD50 Rabbit > 2000 mg/kg - Oral LD50 Rat > 5000 mg/kg Causes skin irritation. The exposure to the effect of this product may aggravate pre-existing skin problems, including dermatitis. May cause cancer.

Sealing lubricant for assembly pipes - a mixture classified under Regulation 1272/2008 as H319: Causes serious eye irritation, H400: Acute aquatic toxicity, H410: Very toxic to aquatic life with long-lasting effects.

Table II.2.3-6 Physical and chemical properties of the sealing lubricant for assembly pipes

Physico-chemical properties	Toxicological properties
Appearance: pasty with a metallic colour Odour: similar to petroleum Flash point: > 221° C Solubility in water: insoluble in water	Acute toxicity Not classified (Based on available data, the classification criteria are not met)

Winter washer fluid – a mixture classified under Regulation 1272/2008 as H225: Highly flammable liquids and vapours.

Table II.2.3-7 Physical and chemical properties of the ingredient defining the mixture as dangerous - Ethanol/ethyl alcohol

Physical and chemical properties	Toxicological properties
Appearance: liquid, blue colour Odour: of an alcohol Boiling point/boiling range: 82 - 100 C Flash point : > 15° C Density: ≈ 0.88 g/cm ^{3} Solubility: Soluble in water	Acute toxicity Not classified (Based on available data, the classification criteria are not met)

Natural gas condensate - CAS No 68919-39-1, classified under Regulation 1272/2008 as H 350: May cause cancer, H 340: May cause genetic defects, H304: May be fatal if swallowed and enters airways.

Table II.2.3-8 Physical and chemical properties of natural gas condensate

Physical and chemical properties	Toxicological properties
Appearance: light yellow to dark brown uniform, mobile fluid; Smell: specific for petroleum products; Density at 15° C: 787.3 kg/m3; Distillation characteristics: - start of boiling: 178.5° C; - end of boiling: 310.5° C; - 73% (v/v) distil at 250° C; - 98% (v/v) distil at 350° C; Kinematic. viscosity at 20° C: 2.78 mm2/s Flash point in a closed cup: 58.5° C Freezing temperature: -30° C	Acute toxicity Oral LD50 rat >5000 mg/kg Inhalation LC50 rat >5.2 mg/l; 4 hours Dermal LD50 rabbit >2000 mg/kg; 24 hours The condensate is potentially toxic to aquatics ecosystems.

Natural gas - CAS No 8006-14-2, classified under Regulation 1272/2008 as H220: Extremely flammable gas

Table II.2.3-9 Physical and chemical properties of natural gas

Physical and chemical properties	Toxicological properties
Type: Odourless gas Melting point: -184.9° C	Natural gas is non-toxic. It affects the central nervous system. At a high

Relative density at 15 °C: 0.60-0.70 kg/m ^{3} Solubility in water: insoluble in water	concentration in the air, it reduces the oxygen content and causes suffocation

II.2.3.4. Physical and chemical properties under normal conditions of use or in foreseeable emergency situations

The main physical properties under normal conditions for the hazardous chemical substances and mixtures that are available at the site of Bulgartransgaz EAD are presented in the previous point. The physical and chemical properties in emergency situations are presented below.

Methanol *is* a flammable and toxic liquid. In case of release, do not inhale vapours, avoid contact with eyes, skin or clothing. Personal protective clothing must be used. Keep ignition sources away.

Diesel fuel *is* a flammable and toxic liquid for aquatic life. Heating it may generate vapours that may form explosive vapours or air mixtures. In case of release, stay downwind, eliminate all sources of ignition, avoid skin contact, wear appropriate protective clothing, gloves and eye/face protection.

Gasoline - the product is highly flammable. Explosive vapours or air mixtures may form even at normal room temperatures. The material will remain floating on the surface of the water and may re-ignite. Thermal decomposition may lead to the formation of smoke, carbon oxides and organic compounds of lower molecular weight, the composition of which is not described. Sulphur oxides (SOx). Nitrogen oxides (NOx).

Ethanol - reacts with strong oxidants and strong acids. A violent reaction is possible with oxidizing agents, alkali metals, alkaline earth metals, strong acids and strong bases, metals, peroxides, metal salts, halogens, flammable materials.

Gas condensate - If released, vapours may ignite rapidly when exposed to heat, sparks, open flame, or other source of heat. When mixed with air and exposed to an ignition source, vapours may burn in open spaces or explode in closed spaces. Vapours are heavier than air and can travel long distances to an ignition source. Disposal into drains is associated with the risk of causing fire or explosion. It is possible that exposure to the substance during fire conditions may cause irritation of mucous membranes without residual damage. In the case of incomplete combustion, carbon monoxide, carbon dioxide, nitrogen oxides and unburnt hydrocarbons are released. In case of emergency releases, evacuate personnel and remove all flammable materials, use respiratory protection. Limit the spillage through dikes, canals, etc. Fire extinguishing foam can be used to reduce product vapours.

Natural gas - Natural gas is colourless and has no odour of its own. For protection, a strong-smelling substance - odorant - is added. The use and storage of flammable liquids and other products with flammable vapours near the gas equipment is prohibited. In combustion plants, monitor the combustion process, incomplete combustion of the gas can produce carbon monoxide and other toxic gases. Use personal protective equipment. In case of emergency releases, leave the room, do not turn on or off electrical appliances in the room. Do not light matches, do not smoke and do not cause any sparks. The gas leak must be stopped as quickly as possible without any risk, if not possible, provide ventilation and release the gas into the atmosphere. Do not enter the premises without special oxygen devices. Natural gas is almost twice as light as air, when released it dissipates into the atmosphere.

II.3. Identified hazards and assessment of the risks of accidents in the

establishment/facility and relevant preventive measures

Before proceeding with the risk assessment, the following definitions should be given:

A hazard is an intrinsic property of hazardous substances or a physical situation with the potential to harm human health and/or the environment. *(according to item 54c, § 1 of the Supplementary Provisions of the EPA);*

Risk is the likelihood of a specific effect occurring within a certain period or under certain conditions *(according to item 54e, § 1 of the Supplementary Provisions of the EPA);*

An incident is an unpredictable or difficult to predict action limited in time and space, with a high intensity of forces or as a result of human activity, endangering the life or health of people, property or the environment *(according to item 2, § 1 of the Supplementary Provisions of the Disaster Protection Act (DPA));*

An accident is a large-scale incident involving roads, highways and air traffic, fire, destruction of hydrotechnical facilities, accidents caused by activities at sea, nuclear accidents and other environmental and industrial accidents caused by human activities or actions (*according to item 3, § 1 of the Supplementary Provisions of the DPA);*

A major accident is the occurrence of a major emission, fire, or explosion that occurs as a result of uncontrollable events in the course of operations of any plant or facility within the scope of Chapter Seven, Section I, and that results in a serious hazard to human health and/or the environment, which danger is immediate, delayed, inside or outside the establishment and includes one or more hazardous substances classified in one or more of the hazard categories specified in Part 1 of Annex No 3 or individually named in Part 2 of Annex No 3 *(according to item 54a, § 1 of the Supplementary Provisions of the EPA).*

Hazardous substances are available on the territory of the establishment, which are:

A. Individually named in Part 2 of Annex 3 of the EPA *(methanol - item 22, diesel fuel, gasoline and gas condensate - item 34 and natural gas - item 18).* With the exception of natural gas, the remaining substances are in quantities significantly below the threshold values from column 2 and column 3 of Part 2 of Annex 3 - available methanol is 223.1 *t* at threshold quantities of 500 *t* for low and 5,000 *t* for high risk potential, diesel fuel, gasoline and gas condensate - a total of 432.9 *t,* at threshold quantities of 2,500 *t* for low and 25,000 *t* for high risk potential. The available amount of natural gas is 1,226,400 *t,* at threshold quantities of 50 *t* for low and 200 *t* for high risk potential.

B. Falling within the scope of Part 1 of Annex 3, Section "P" - Physical hazards - methanol, diesel fuel, gasoline, natural gas and winter washer fluid. In addition to being individually named in Part 2 of Annex 3, methanol, diesel fuel, gasoline and natural gas are classified as flammable liquids **(P5c)** and flammable gas category 1 (**P2**). Flammable washer fluid falls within the scope of Part 1 of Annex 3, Section "P" (P5c) *Flammable liquids, Category 2, which are not covered by P5a and P5b;* it is available on the site under atmospheric conditions, at a temperature below its boiling point and without the presence of high pressure.

C. Falling within the scope of Part 1 of Annex 3 of the EPA, Section "H" - Health hazards – In addition to being individually named in Part 2 of Annex 3, methanol is also hazardous to health, acute toxicity category 3, inhalation route of exposure - H2;

D. Falling within the scope of Part 1 of Annex 3 of the EPA, Section "E" - Environmental hazards - diesel fuel, gasoline and sealing lubricant. Apart from being individually named in Part 2 of Annex 3, diesel fuel and gasoline are also classified as hazardous to the aquatic environment in the category of Chronic Hazard, Category 2

(E2).The sealing lubricant falls within the scope of Part 1 of Annex 3, Section "E" - Hazardous to the aquatic environment in the category of Acute Hazard, Category 1, and Chronic Hazard, Category 1.

E. Hazardous wastes considered likely to have equivalent properties with respect to the potential to cause a major accident. These are wastes with codes under Regulation 2 on waste classification as follows: 13 02 05* Non-chlorinated motor and lubricating oils and mineral-based gear oils; 15 02 02* Absorbents, filter materials (including oil filters not elsewhere specified), wiping cloths and protective clothing contaminated with dangerous substances; 16 06 01* Lead rechargeable batteries; 16 06 02* Ni-Cd batteries; 16 07 08* Wastes containing oils and petroleum products; 20 01 21* Fluorescent tubes and other wastes containing mercury.

The establishment is classified as an "upper-tier establishment" due to the presence of natural gas in the establishment many times more than the threshold of 200 tonnes for high risk, according to Annex No 3 of the EPA, Part 2, item 18, column 3. The remaining available HCS are irrelevant for determining the potential of the establishment.

A more detailed analysis is made in the points below.

II.3.1. A detailed description of the possible scenarios for major accidents and the likelihood of their occurrence and the conditions under which they occur, including a summary of the events that may act as a root cause for such scenarios and a description of the factors inside or outside the establishment that may cause these scenarios to occur

Below we will present a preliminary assessment of the risk of a major accident, in terms of the amount of hazardous substance that is likely to be involved in the accident and its physical and chemical and toxic properties. In this case, the following criterion is used for reporting a major accident according to Annex 5 of the EPA:

"A major accident is one which:

1. includes hazardous substances in quantities not less than 5 percent of the threshold quantities according to Annex No 3, Part 1, column 3, or Part 2, column 3, and causes a fire, explosion or release of hazardous substances"

Before proceeding to a detailed description of the possible scenarios for major accidents, it is important to note that the majority of hazardous waste is included in this report in connection with letter with ref. No UK-2919/15.10.2021 of the Executive Environment Agency (ExEA). According to the letter, hazardous waste with codes 13 02 05*, 15 02 02*, 16 06 01*, 16 06 02*, 16 07 08* and 20 01 21* may have equivalent properties in terms of the potential to cause major accidents.

For example, waste with code 13 02 05*, which is used oil, is not likely to have equivalent properties in terms of major accident potential due to the lack of ingredients/substances that have such properties. As products, MC 20 Oil and TP 32 Oil are not classified as dangerous substances/mixtures according to the criteria of Regulation (EC) No 1272/2008. The waste is formed due to reaching the threshold hours of operation and deterioration of the quality indicators of the oils, which necessitates their replacement. In the facilities where the oils are used, there is no presence of fuels and/or other dangerous substances, which due to degradation of gaskets and other insulating elements could mix with the oils and possibly cause them to be assigned to the hazard categories within the scope of Annex 3 to the EPA.

The situation is also similar with waste with code 15 02 02*, which may contain waste oils and anti-freezing fluids, and none of the mentioned substances has properties that

assign it to the hazard categories within the scope of Annex 3 to the EPA.

Regarding waste with code 16 06 01* – lead rechargeable batteries – it can be classified with a hazard category of:

- HP 8 "Corrosive": Skin corrosion/irritation, hazard category 1A, 1B, 1C (contains sulphuric acid) due to the presence of HCS with hazard code: H314
- HP 10 "Toxic for reproduction": May be harmful to infants/ May impair fertility/ May harm the unborn child (contains a massive form of lead) due to presence of a hazardous substance with hazard code: H360FD and H362,

The possible hazard categories do not fall under the hazard categories specified in column 1 of Part 1 of Annex 3 of the EPA.

Rechargeable batteries as a product are not subject to any classification and no safety data sheets are even issued for them. The difference between the product and the waste is irrelevant in terms of the major accident potential.

Based on the scarcity of safety information available in the public domain, according to which lead rechargeable batteries as a product may be classified as "hazardous to the environment" - in "Category 3 (H412) Harmful to aquatic life with long-lasting effects", the conclusion is reached that, if the waste with code 16 06 01* is classified as dangerous for the environment, then it does not fall into Section "E" - Hazards for the environment, according to Annex No 3 to Art. 103, para. 1 of the EPA.

Table II.3.1-1 presents all hazardous substances and wastes at the site of Bulgartransgaz EAD that meet the above criterion:

Table II.3.1-1 HCS and wastes within the scope of Annex 3 of the EPA and potential for major accidents

No	HCS/waste	Hazard category	% of the threshold quantities for high risk potential (HRP)	Major accident potential
1	Methanol	Section P Section H	4.5	Threshold potential
2	Diesel fuel	Section P Section E	0.02	NO
3	Gasoline	Section P Section E	0.05	NO
4	Sealing lubricant for assembly pipes	Section E	0.1	NO
5	Winter windscreen washer liquid	Section P	1.4E-05	NO
6	Gas condensate	-	1.7	NO
7	Natural gas	Section P	>5	YES
8	Waste with code 13 02 05*- Non-chlorinated motor and lubricating oils and mineral-based	Section E	<5	NO

	gear oils			
9	Waste with code 15 02 02* - Absorbents, filter materials, wiping cloths and protective clothing contaminated with hazardous substances	Section E	<5	NO
10	Waste with code 16 06 01* - Lead rechargeable batteries	Section E	<5	NO
11	Waste with code 16 06 02*- Ni-Cd batteries	Section E	<5	NO
12	Waste with code 16 07 08* - Wastes containing oils and petroleum products	Section E	**_*1**	NO
13	Waste with code 20 01 21* - Fluorescent tubes and other wastes containing mercury	Section E Section H	<5	NO

* [1] *The waste with code 16 07 08* is not stored at the site. If a replacement is necessary, it is sent directly for subsequent treatment to companies holding the relevant permits issued under the WMA.*

A major accident is likely to occur with natural gas and/or methanol available on site in quantities reaching *(methanol)* or significantly exceeding *(natural gas)* 5 percent of the threshold quantities according to Annex No 3, Part 1, column 3 or Part 2, column 3 to the EPA.

The hazardous substances present on the territory of the site constitute a potential danger of fire/toxic dispersion with corresponding damage to people and material facilities.

The factors that can cause such incidents are mostly:

- Violation of the integrity *(destruction)* of tanks, pipelines and fittings, due to corrosion processes, poor performance of installation works or any external influences *(accidents with airplanes, physical-geological processes)*;
- Technical failure in warehouse facilities - control measuring devices and security systems;
- Extreme natural anomalies - hurricane wind, floods, icing;
- Major earthquakes or other natural disasters;
- Fires in the area of the establishment;

- Traffic accident;
- Human mistake;
- Malicious *(terrorist)* acts.

The main duties of the personnel arising from the position occupied and the workplace consist in the provision, maintenance and control of health and safety at work and preventive activities, regarding the prevention of accidents that would endanger the life and health of people and cause damage and pollution of the environment. In the case of normal operation of the establishment, there would be virtually no possibility of major accidents occurring. The potential critical events are a leak/spill/breach of a high-pressure HCS facility, and the reasons that would cause them are:

II. 3.1.1. Operational reasons

Incidents related to the use of hazardous chemical substances can occur as a result of industrial accidents, disasters, terrorist activity.

On the territory of Bulgartransgaz EAD – Chiren UGS, production accidents may occur related to the presence of dangerous chemical substances: methanol and natural gas. The remaining dangerous substances and mixtures are in quantities that do not presuppose the occurrence of a major accident.

Leakage of liquid HCS - flammable or toxic:

Leakage can occur:

- ***from a methanol tank*** :

1) in the event of disruption of the integrity of the casing of the vessel/tank, leakage of a flammable liquid will occur. In this situation, a fire may occur in the presence of an external ignition source or toxic dispersion.

- ***from pipelines*** - the pipeline network can lead to local contamination with a flammable/toxic liquid, due to gaps in flange connections and seals of fittings and pumps or in the event of a pipeline rupture;
- ***in case of violation of the technological discipline*** - in case of non-compliance with the technological discipline, there would be situations in which there would be a leakage of HCS.

All of the above reasons could bring about leakage of a flammable and toxic liquid with the possibility of fire if an open source of ignition is present and/or toxic dispersion.

Leakage of a flammable gas - natural gas:

This substance alone fully meets the criterion for available quantity and danger of a major accident, according to Annex 5 of the EPA.

A production accident in the gas storage area can occur during withdrawal and injection of gas. When gas is injected, strong gassing can occur in the premise of the compressor department or the area of the new natural gas GTCU. Depending on the concentration of the gas in the air, an asphyxiating or explosive mixture can be formed.

Other prerequisites for incidents/accidents along a network of stubs and the other components of the system:

- rupture due to corrosion of the material. In order to reduce the risk of such an accident, both active (electrochemical) and passive (through insulation) corrosion protection of the equipment has been established. Inspections of the stub network are periodically carried out *(every 10 years, tests are carried out with a pressure of 1.25 above the working pressure),* as well as of the CS, during which the presence of problem areas along the routes is established and their location is identified. Every month the potential

of the electrochemical protection (ECP) is measured.

- rupture due to a poor-quality weld. To minimize risks, all welding joints are subjected to non-destructive testing.

- damage to equipment *(facilities).* Planned repairs, maintenance and inspections are carried out in accordance with the requirements of *"Regulation on the construction and safe operation of transmission and distribution gas pipelines, facilities, installations and appliances for natural gas"* and the internal company documents (instructions, rules, etc.)

- violation of the integrity of facilities caused by third parties. The most common reason for this is unregulated excavation works or malicious encroachment.

A leak can also occur from a gas pipeline. Emergency situations are possible along the gas pipeline at the site of Bulgartransgaz EAD. In the event of a rupture in the gas pipeline, highly flammable gas will be released into the surroundings from the gas transmission network with the resulting consequences.

Figure II.3.1-1 presents a sample of emergency situations with gas pipelines registered for a 50 - year period. According to the data from the 11th Report of the European Gas Pipeline Incident Data Group, the most frequent events that lead to incomplete destruction of the gas transmission network are external intervention, corrosion and structural defects. The most dangerous events are related to the destruction of a gas pipeline along its entire diameter, and the most common reasons for this are again external intervention and, secondly, the movement of earth masses.

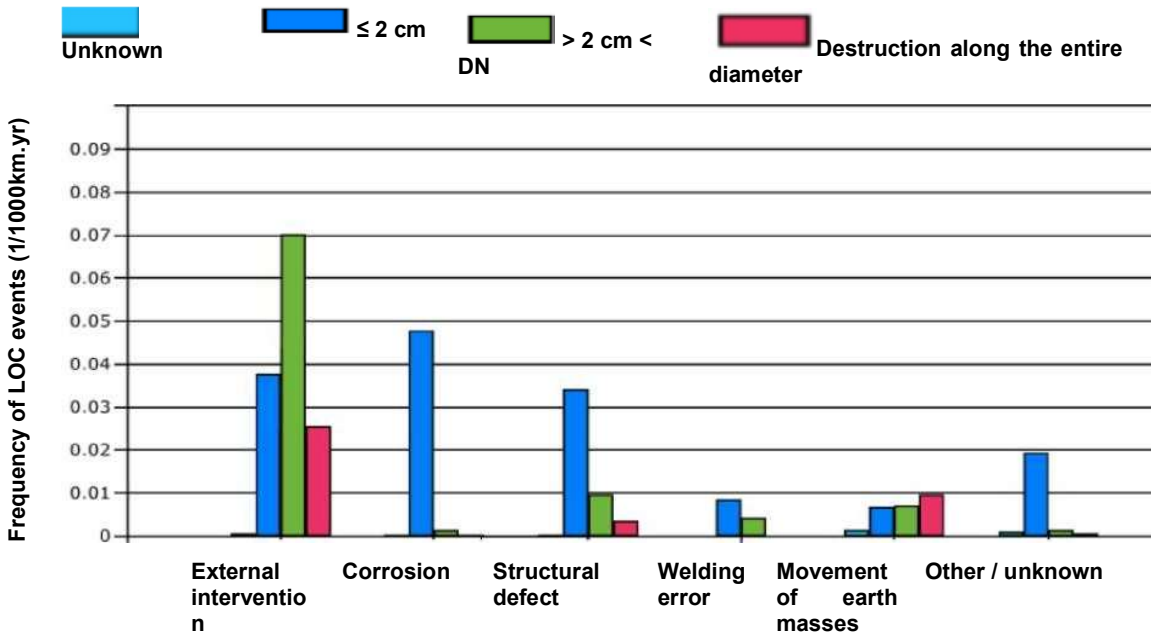


Figure II.3.1-1 Register of the reasons leading to a gas pipeline accident, causes and sizes of the ruptures, for the period 1970-2019 [11th Report of the European Gas Pipeline Incident Data Group]

The figure below shows the registered accident frequencies on gas transmission pipelines per year, for 1000 *km* of gas pipeline length, for the respective nominal diameter of the gas pipeline and the size/diameter of the rupture.

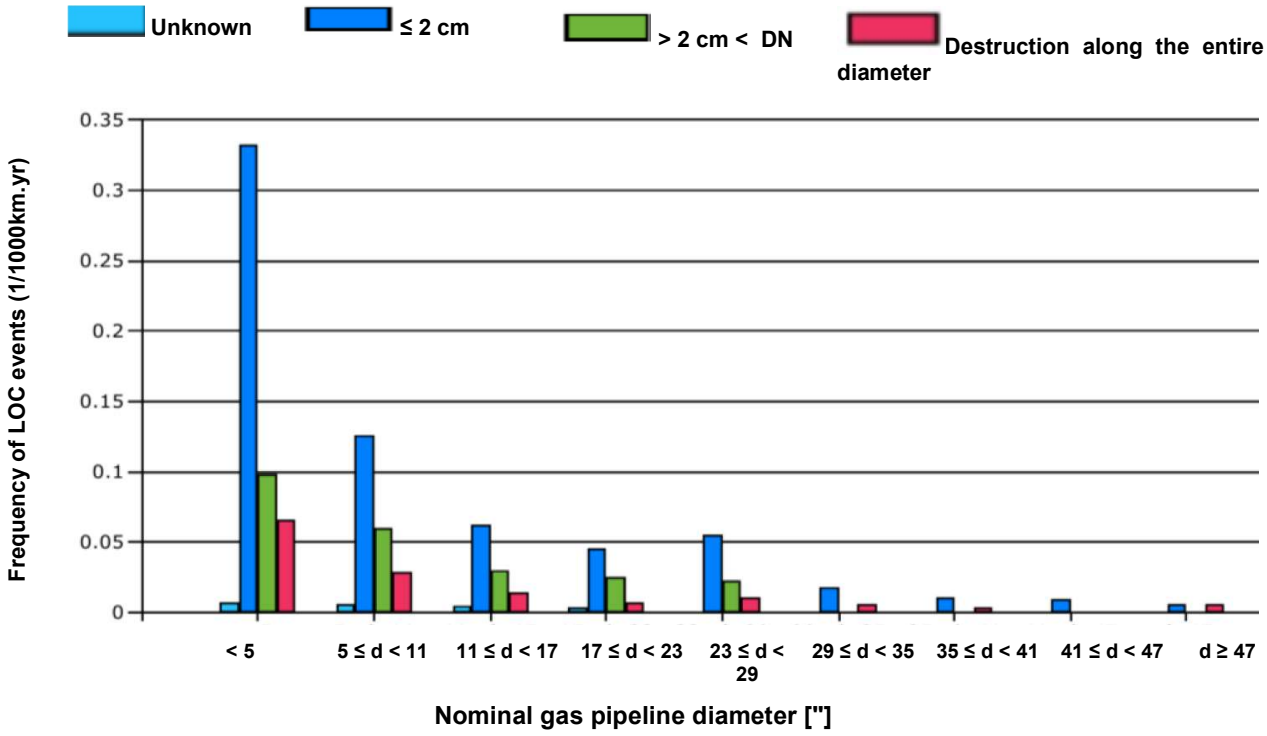


Figure II.3.1-2 Frequency of loss of containment (LOC) events depending on the diameter of the gas pipeline and the size of the opening for the period 2000-2019 [11th Report of the European Gas Pipeline Incident Data Group]

It is evident from **Figure II.3.1-2** that leakage events (LE) mainly occur in small diameter gas pipelines. Gas pipelines of various diameters are located on the site of Chiren UGS.

- ***in case of non-compliance with the technological discipline*** - in case of non-compliance with the technological discipline, it is possible to have situations in which there will be a leakage of natural gas with all the resulting consequences.

Occurrence of fires:

Fires can occur as a result of a combination of accidental or natural phenomena - rupture of a gas pipeline, leaks of natural gas from faucets of the production tree of wells and equipment, accompanied by the supply of an ignition spark that occurred as a result of technological processes (heated surfaces, electric arc or spark, electrostatic charge, mechanical friction or a spark from impact, optical, open flame, etc.), and also in the event of massive forest and field fires.

A fire can also occur as a result of non-compliance with the safety rules when carrying out fire works in temporary places *(for example cutting into gas pipelines, repair works, etc.),* unregulated use of an open flame, smoking, etc.

Most often, the fire is asymmetrical. It spreads downwind, from the low to the high part of a slope or elevation.

There are three main scenarios when natural gas leaks and ignites as a result of an accident or accident:

- formation of small diffusion gas flares (with a small amount of the escaping gas), the

burning of which stops immediately after stopping the gas flow;

- formation of large high-temperature diffusion gas flares, affecting the surrounding facilities through the emission of thermal radiation or through direct contact;

- formation of large gas-air clouds, the ignition of which may be accompanied by the occurrence of blast waves.

The risk of an explosion from an outdoor natural gas leak is minimal, but consideration should be given to possible natural or artificial barriers or specific climatic conditions that could temporarily limit the rapid dispersion of the gas into the atmosphere.

The development of an accident with the discharge of natural gas from a broken gas pipeline or technological equipment, as a rule, boils down to the following: as a result of the product leak, a combustible gas-air cloud is formed. The impingement of an ignition source in the cloud area with a combustible gas concentration above the lower and below the upper flammability limit leads to the ignition of the gas-air mixture. Depending on the flow mode of the combustible gas, the conditions for its mixing with air and the ignition conditions, the cloud combustion process can develop in a different way.

One of the most serious situations is the occurrence of a scattered flare, formed during the destruction of structures and congestion at the place of gas leakage. This flare is characterized by high resistance, a highly developed burning surface and a high degree of heat radiation.

A characteristic feature of flaring is its duration in time. At the same time, the surrounding facilities are in the zone of heat radiation, which can cause secondary fires, and also requires an extreme need to protect people and limit the time of their stay in the zone of increased heat radiation.

The expected damage to settlements, production sites, etc. as a result of emergency situations are minimized - the routes of the gas pipelines and the main facilities are located in undeveloped areas, and the required distances for safety – easement areas – are observed, according to the *Energy Act* and its regulations. The likelihood of causing secondary fires in agricultural and forest lands is greater.

II.3.1.2. External causes

- ***sabotage/terrorist act*** - committing a terrorist act on the facilities and installations would also lead to a major accident. In the event of a terrorist act, it is possible to rupture gas pipelines or installations and cause a subsequent fire:

- encroachment with the aim of sabotage of facilities, buildings and installations, which can lead to accidents with gas leakage and ignition, injured people, material losses, interruption of gas supply to consumers;

- cyber-attacks aimed at blocking the operation of computer systems or unauthorized access with the aim of extracting official information or blocking automation and information connectivity.

In the event of terrorist activity on the territory of the facilities operated by Bulgartransgaz EAD – Chiren UGS, the following consequences may occur:

1. The greatest danger can occur when an exploitation well is blown out. Suppression in such a case is long and difficult. Large amounts of natural gas will be lost from the underground gas storage.

2. Large losses can also occur in case of destruction - completely or partially - of the compressor department and/or GTCU.

3. In the above-mentioned accidents, there will be gassing of different territories (mostly in the case of well blow-outs) and forming an explosive mixture with all the dangerous

consequences.

4. In the event of a power outage, an emergency gas unit will activate, but in certain situations, a momentary interruption of production activity is possible during injection and withdrawal of natural gas.

5. The destruction of the dam wall, leakage of water, or failure of the pumping facility or water pipeline will result in a serious disruption of the production rhythm, including the shutdown of the facilities at the currently operating site. For the new GTCU, such a danger does not exist.

A major accident would also result from gross non-compliance with technological discipline.

- ***technogenic factors*** - The area around the establishment is arable agricultural land. There are no other businesses or facilities that could be a source of or increase the risk or consequences of a major accident.

- ***accident in neighbouring sites*** - The area around the establishment is arable agricultural land. The occurrence of a fire in the dry and hot period of the year constitutes a danger for the establishment. If it is not controlled and extinguished, then there is a danger of its expansion and its eventual transfer to the territory of the site with the resulting consequences.

- ***traffic accident*** - A traffic accident would pose a danger to the site in view of the possibility of a fire occurring in the warehouse facilities. Also, it is possible that the burning object will cause an explosion that will cause damage to nodes and equipment in the establishment, which in turn will cause the leakage of dangerous substances and possibly cause a fire and/or toxic dispersion and resulting consequences for the area.

It is important to note here that there are no roads with heavy vehicular traffic nearby. The local municipal road bordering the site connects the nearby settlements, incl. the site of Chiren UGS with second-class roads from the republican road network - Republican Road II- 15 *(at a distance of more than 9 km as the crow flies)* and Republican Road II- 13 *(at a distance of more than 5 km as the crow flies).*

II. 3.1.3. Natural causes

<u>In case of an earthquake:</u>

An earthquake is one of the most dangerous and unpredictable natural disasters. It arises as a result of underground shocks (thrusts) and displacements of the earth's surface, caused by the existing stresses in the Earth. Modern science divides these stresses into two types: stresses of all-round pressure, caused by the pressure of overlying layers and a system of stresses accompanied by a compressive force and perpendicular tensile forces. Under the influence of these stresses in the earth's interior, the layers bend and compressive energy accumulates in them, which is released, causing displacement of these layers.

The territory of Chiren UGS falls into a seismic zone of secondary importance, where the maximum earthquakes are expected to be up to the IV degree on the Richter scale. The buildings and facilities are structurally secured for earthquakes up to the ninth degree on the EM5-98 scale. At a higher degree, damage and destruction are expected. As a result of displacement of the earth's strata, deformation and rupture of gas pipelines is possible, which would lead to a time-limited leakage of natural gas into the atmosphere and the emergence of a danger of explosions and fires, possibly accompanied by human casualties. The power supply system will likely be disrupted. There will be damage to the communication system and disruption of technological and communication links.

In the event of an accident caused by an earthquake, it is possible (depending on the strength) that there will be destruction of the building stock, that the water supply and electricity supply of the site will be disrupted. During strong earthquakes, there may be rupture of gas pipelines.

Floods:

A flood is a temporary inundation of a significant part of the land with water. It is a natural disaster that is somewhat predictable. It can be caused both by the action of natural forces (heavy continuous rainfall, abundant snowmelt) and as a result of an accident in hydrotechnical facilities (dam walls, protective dykes).

The potential danger for the operation of the Chiren UGS is the rupture of the dam wall of the "Chiren - 3" dam, the industrial water pump room will fall into the flood zone, which will temporarily stop the injection process of the existing GMC. For the new GTCU, there is no such danger.

The likely consequences of a flood or impact of the water course in a place where there are facilities are: interruption of a gas pipeline, exposure of a section of the gas pipeline with damage to the protective coating of the pipe, disruption of communications and/or electrical power supply to facilities, breakdown of the facilities – interruption or limitation of the supply of natural gas to the gas transmission network, interruption of technological and communication links.

With regard to the 2016-2021 Flood Risk Management Plan (FRMP) for the Danube region, the site does not fall within the scope of a certain area with a significant potential risk of flooding (ASPRF) and there are no prohibitions and restrictions regarding the implementation of the planned activities.

Lightning in case of broken lightning protection:

The reason for this type of accident is irregular maintenance of the lightning protection. This reason could lead to a direct lightning strike and cause a fire on the premises of the establishment. *Prevention: annual inspection of the lightning protection installation.*

Hurricane wind, snowstorms, ice formation, icing

Hurricane wind significantly exceeding the design wind load is rare, but possible nonetheless. There is a possibility that, during the processes of running over the sheds, such a load will be exercised on them, which will significantly exceed the design one and they will be deformed or destroyed. In this case, a spill of dangerous substances can occur with the potential danger of a local fire, which, under the conditions of a stormy wind, can seriously grow.

The specificity of the continental climate is the basis of possible snowstorms, as a result of which large snowdrifts would be produced, which would make it difficult to communicate with the site, as well as to enter and exit it. This is most dangerous if an emergency situation occurs on the territory of the establishment, to overcome which external intervention will be necessary.

Ice formation and icing is a situation that can occur when the temperature drops sharply below 0° C, preceded by rain, snowfall and strong winds. This disaster does not directly affect the stability of the site, but indirectly affects the technical means and the organization of traffic. In the event of ice formation, traffic accidents could occur that would lead to accidents in the facilities of the site with all the resulting consequences.

In the event of ice formation and icing, there is a possibility of destruction of transmission lines and interruption of the power supply to the site with all the resulting consequences for its safe operation.

As a result of thermal impact from high temperature resulting from fires outside the territory of the site, but in dangerous proximity to it:

The presence of fires near the territory of the site would constitute a real danger, given the increase in temperature or their transfer to the territory of the establishment with all the resulting consequences.

II.3.2. An assessment of the size and severity of the consequences of identified major accidents, including maps, images or equivalent descriptions, where appropriate, showing the areas that will be affected by such accidents occurring at the establishment

II.3.2.1. Risk Assessment

Quantifying risk during the production, use, handling, storage and transport of hazardous materials is an important means of characterizing it. A good idea of the magnitude of the risk can be obtained on the basis of general statistical data on equipment depressurization caused by failures such as corrosion, construction defects, welding errors, valve and vent blockages, loading and unloading, and some specific to people, processes, materials and design errors.

The data cited below, the frequency of leakage through equipment failure, human error, storage, and instantaneous and delayed ignition probabilities, are taken from the Guideline for Quantitative Risk Assessment ('Purple Book').[1]

Below, the likelihood of the accident scenarios occurring on the territory of Bulgartransgaz EAD, for which there is statistical information in the Guideline for Quantitative Risk Assessment, is examined in detail. For the scenarios for which no statistical data are available, an expert assessment was made of the likelihood of occurrence of the relevant risk situation.

Leakage

Leakage can be slow with continuous release from small openings to almost instantaneous discharge of contents in large accidents. Examples of small openings are the cracks or holes in the walls of a tank, pipeline or vessel for carrying out physical processes.

- ***Leakage from stationary vessels***

Three leakage scenarios can be observed:

-G1 - instantaneous discharge of all contents

-G2 - continuous discharge of all contents for 10 minutes at a constant discharge rate;

-G3 - continuous discharge through an opening with an effective diameter of 10 mm

Table II.3.2-1 Frequencies of loss of content events (LCE) for stationary vessels

Installation	G1 instantly	G2 continuous, 10 min.	G3 Continuous, φ10 mm
Vessels for carrying out physical processes - gas drying installation	$5x10^{-6}$ $years^{-1}$	$5x10^{-6}$ $years^{-1}$	$1x10^{-4}$ $years^{-1}$

[1] Guideline for Quantitative Risk Assessment 'Purple Book' CPR 18E. Committee for the Prevention of Accidents and Disasters. First Edition, 1999

- ***Leakage from tanks***

The following tanks containing HCS falling within the scope of Annex 3 of the EPA are located on the site of the establishment:

- a methanol tank in a warehouse for flammable liquids, with a volume of 250 *m^3;*
- a tank for methanol at the collective manifold with a volume of 2 *m^3;*
- a tank for gas condensate in a warehouse for flammable liquids, with a volume of 525.5 *m^3;*
- an underground tank for gasoline at the company fuel station with a volume of 17.4 *m^3;*
- an underground tank for diesel fuel at the company fuel gas station with a volume of 5.2 *m^3.*

Only methanol and natural gas have the potential to cause major accidents.

Three leakage scenarios can be observed with the pressurised tanks:

- G1 - sudden discharge of all contents

a) direct discharge into the environment - in case of above-ground tanks;

b) from the primary container to the secondary container or the outer casing - for underground tanks;

- G2 - continuous discharge of all contents for 10 minutes at a constant discharge rate;

a) direct discharge into the environment - in case of above-ground tanks;

b) from the primary container to the secondary container or the outer casing - for underground tanks;

- G3 - continuous discharge from an opening with an effective diameter of 10 mm

a) direct discharge into the environment - in case of above-ground tanks;

b) from the primary container to the secondary container or the outer casing – applies to the underground tanks for gasoline, diesel fuel and to the new above-ground double-walled tank for methanol.

The frequency of leakage under these scenarios is given in the following table:

Table II.3.2-2 Frequency of leakage from pressurised tanks

Installation	**G1 Sudden discharge**		**G2 Continuous, 10 min.**		**G3 Continuous discharge from an opening with φ10 mm**	
	a	**b**	**a**	**b**	**a**	**b**
Single hull tank	$5x10^{-6}$ $years^{-1}$	-	$5x10^{-6}$ $years^{-1}$	-	$1x10^{-4}$ $years^{-1}$	-
Double wall tank	-	$5x10^{-6}$ $years^{-1}$	-	-	-	-

Leakage of HCS from a tank can occur due to corrosion, dynamic loads, design error, earthquake, operator errors, malicious acts, adjacent fire and cooling failure. It is possible to have an instantaneous release of:

- 250 *m^3 (197.5 t)* or 2 *m^3 (1.58 t)* or 30 *m^3 (23.7 t)* of methanol in the case of complete destruction or continuous discharge from the rupture with the formation of a casing spillage, puddle fire, toxic and thermal pollution of the environment, formation of a cloud of methanol vapours and dispersion in the ambient air;

- 30 *m^3 (23.7 t)* of methanol from the primary to the secondary container of the tank.

In the event of an accident of the gasoline and diesel storage tanks, a major accident is not expected.

- ***Leakage from pipes:***

Connecting pipelines between process units in an establishment can contribute significantly to the risk posed by the establishment as a whole due to their direct connection to different vessels. The considered LOC events cover all types of ground-based process pipelines. They are summarized in two cases:

- G1 - complete pipe rupture and leakage from both ends;

- G2 - pipe breakthrough - the leakage is through a breakthrough with an effective diameter of the opening of 10% of the nominal diameter of the pipe, but a maximum of 50 mm.

Pipe leakage frequency is given in the following table:

Table II.3.2-3 Frequency of leakage from pipes

Installation	G1 Complete pipe rupture	G2 Pipe breakthrough
Pipeline Nominal diameter <75 mm	$1x10^{-6}$ m^{-1} $years^{-1}$	$51x10^{-6}$ m^{-1} $years^{-1}$
Pipe 75 mm < d ≤ 150 mm	$3x10^{-7}$ m^{-1} $years^{-1}$	$2x10^{-6}$ m^{-1} $years^{-1}$
Pipe d > 150mm	$1x10^{-7}$ m^{-1} $years^{-1}$	$5x10^{-7}$ m^{-1} $years^{-1}$

The data given refer to pipes operating in an environment without corrosion, thermal stress or vibration. In the presence of such conditions, a correction factor of 3 to 10 is used, depending on the specific situation. Flange failures are included in those of the pipeline as a whole.

Emergency situations with pipelines at the site of the establishment may occur where they are connected to gas compression or drying installations.

- ***Leakage of natural gas from a collecting main:***

The collecting main is an underground pipeline connecting the relevant well with the site of Chiren UGS. The average depth of the collecting headers is 0.8 m, the outer diameter of the pipes is 133 *mm,* and the thickness of the pipes is 7 or 8 *mm.* When performing the analysis, the data of the European Gas Pipeline Incident Data Group (EGIG) have been taken into account.

Figure II.3.2-1 Frequency of accidents in gas pipelines by year (per 1000 km /year)

Regarding the reasons for the occurrence of incidents, 6 groups of reasons have been formed:

- External influences;
- Corrosion;
- Defects in construction and defects in material;
- Defects in the fittings of the gas pipeline;
- Other causes and unknown causes.

The damage that led to the loss of containment of the gas pipelines can be divided into three groups:

- Cracks and small openings;
- Openings (holes);
- Rupture of the gas pipeline.

Table II.3.2-4 Frequency of leakage from pipes

Type of damage	External influences	Defects in construction and material	Corrosion	Movement of earth layers	Defects in the fittings	Others unknown

Small openings and cracks	0.055	0.045	0.065	0.08	0.019	0.030
Holes	0.110	0.020	0.01	0.010	0.009	0.001
Ruptures	0.037	0.005	0.01	0.015	0.001	0.001

For pipelines of 5 to 10 inches *(127 to 254 mm*) in diameter, the frequencies of loss of containment are:

• Crack or small opening formation: 0.017 per 1000 *km/year.*

• Formation of an opening (hole): 0.016 per 1000 *km/year.*

• Full rupture: 0.011 per 1000 *km/year.*

• Total frequency of loss of containment: 0.044 per 1000 *km/year.*

- ***Road tanker leakage:***

Road tankers for filling tanks with methanol, gasoline or diesel fuel operate at atmospheric pressure. The frequencies of loss of containment (LOC) events are given in Table II. 3.2-5.

Leakage of HCS may occur due to faulty equipment, human error or terrorist act with potential fire, BLEVE *(boiling liquid expanding vapour explosion*), HCS spill, puddle fire hazard involved.

LOC events involving road tankers can be divided into:

- *LOC events relating to the failure of the means of transport as such;*

- *LOC events relating to loading (charging) and unloading (discharging) operations;*

- *LOC events relating to external impacts caused by accidents and fire.*

Table II.3.2-5 LOC events for tankers

	G.1: instant release	**G.2: continuously, the widest coupling connection**	**L.1a destruction along the whole diameter of the hose**	**L.2a leak, hose**
Tanker at atmospheric pressure	$1x10^{-5}$ $years^{-1}$	$5x10^{-7}$ $years^{-1}$	$4x10^{-6}$ h^{-1}	$4x10^{-5}$ h^{-1}

- ***Leakage from pumps:***

Pump failures can be expressed in:

- G1 - catastrophic failure, complete destruction of the connecting pipe;

- G2 - leak from a hole with a diameter of 10% of the nominal diameter of the largest connecting pipe, but not more than 50 mm.

The frequency of pump failures is given in the following table:

Table II.3.2-6 Frequency of pump failures

Installation	G_1 Catastrophic failure	G_2 Leakage
Pumps without additional protection	$1x10^{-4}$ years^{-1}	$5x10^{-4}$ years^{-1}
Pumps with forged steel casing	$5x10^{-5}$ years	$2.5x10^{-4}$ years^{-1}
Hermetically sealed pumps	$1x10^{-5}$ years^{-1}	$5x10^{-5}$ years^{-1}

- ***Leakage due to operator errors***

As operator errors, such actions are considered as incorrect connection, opening the wrong tap, or at the wrong time, spilling HCS when disconnecting or venting; according to the data, the frequency of errors is assumed to be $7.2x10^{-6}$ per load.

Occurrence of fire

- ***Direct ignition:***

Direct ignition is when an HCS vapour cloud is ignited at the beginning of its outflow.

The likelihood of direct ignition of stationary installations is given in **Table II.3.2-7,** and for vehicles in **Table II.3.2-8.**

Table II.3.2-7 Likelihood of direct ignition of stationary installations

Source of spillage		Likelihood of ignition of liquids
Continuous	Sudden	
< 10 kg/s 10 -100 kg/s > 100 kg/s	< 1000 kg 1000 - 10000 kg > 10000 kg	0.065

Table II.3.2-8 Likelihood of direct ignition of the means of transport on the site

Source of spillage	Likelihood of ignition
Road tanker – continuous	**0.1**
Road tanker - sudden	**0.4**

- ***Delayed ignition***

Delayed ignition is when a cloud of concentrated HCS vapours ignites after some time from the start of leakage.

To calculate the likelihood of delayed ignition, two methods are used - with a source on the site and off-site.

- calculation with a real source of ignition - for this purpose it is necessary to know or assume the location of the sources of ignition. Statistical data on the likelihood of ignition for some sources is presented in the following table:

Table II.3.2-9 Likelihood of ignition for a time interval of 1 minute for different sources

Source	Likelihood of ignition for 1 minute

From a point source	
Internal combustion engine	0.4
Furnace in a room	0.45
From people	
Workers	0.01 per person
From a linear source	
Road	0.041

- off-site calculation - if the cloud does not ignite at the site, it is assumed that it will do so at the location of maximum concentration from the projection of the cloud, made relative to 70% of the lower ignition concentration limit *(LICL).* If such a form line is not present outside the site, i.e. the spill is in the casing and ignition at the site has not occurred, it is assumed that delayed ignition will not occur.

- ***Fires and rising flare formation***

In a fire environment, unburned toxic substances and toxic products of combustion enter the ambient atmosphere. Due to the high temperature of the cloud, the latter tends to rise upwards.

In the case of outdoor fires, the immediate formation of a rising flare is assumed and the possibility of any fatal injuries from unburned gases is excluded.

Explosion

In the presence of a fire near process vessels or devices with a combustible gas, the heating of the gas resulting from the fire leads to a gradual increase in pressure in the vessel and to its depressurization and subsequent explosion.

The likelihood of BLEVE and a fireball (P_{BLEVE}) is assumed to be:

- *Stationary installations:* $P_{BLEVE}=0,7$
- *Vehicles in the establishment:* $P_{BLEVE}=1.0$

II. 3.2.2. Assessment of possible major accident scenarios

Quantifying risk in the storage and use of hazardous substances is an important tool for its characterization. A real idea of the magnitude of the risk can be obtained by considering emergency situations related to the loss of containment of facilities and equipment, loading and unloading operations, fires and some errors specific to people, processes, materials and projects.

Based on a study of the main methods of risk assessment, their advantages and disadvantages, it was found that the **CEL** or **3 F method (three factor method)** is suitable for use.

In this method, risk is assessed based on the following two factors:

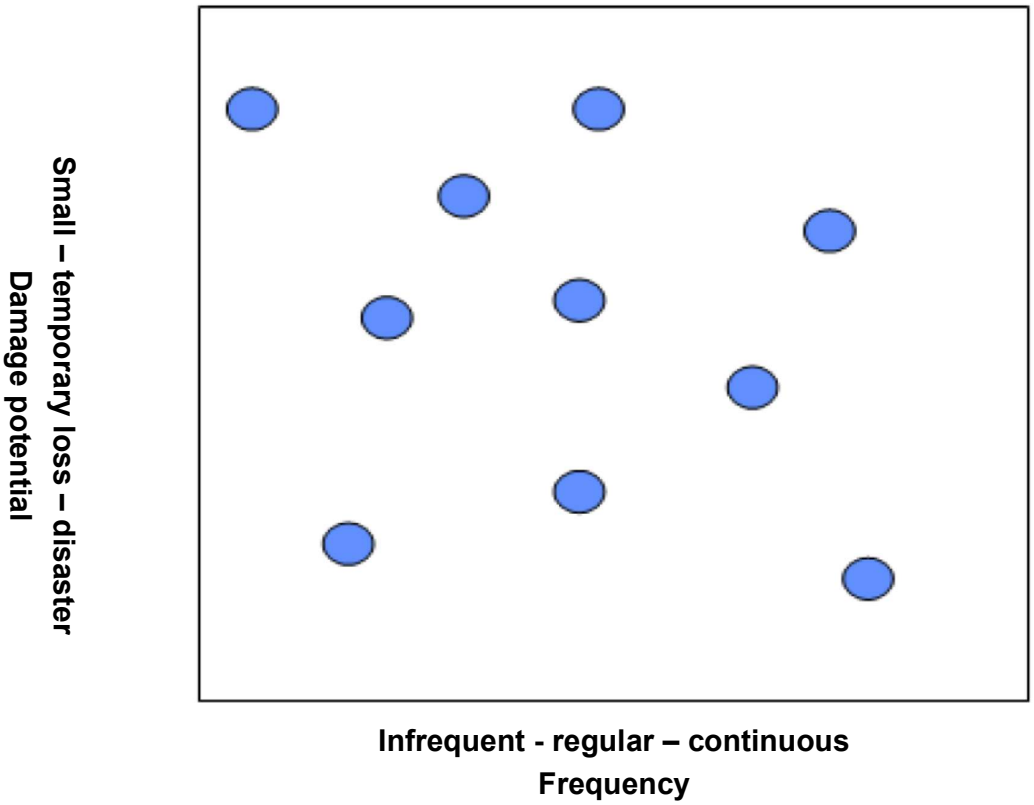
1. *The* ***likelihood*** that the adverse event will occur. This factor is also called ***"frequency".***
2. *The* ***type and extent*** of the damage for which the term ***"damage potential***" is used.

That is, the risk is determined simply by the formula:

Risk = frequency x potential to cause damage

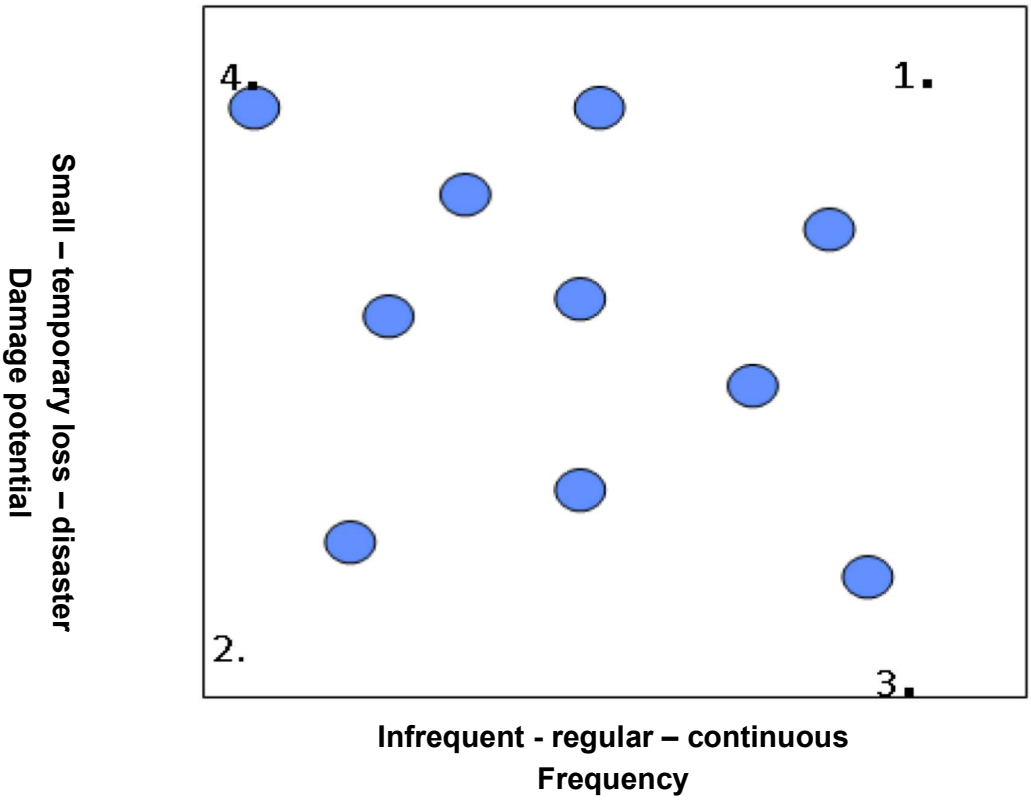
In the above equation, the two factors: ***frequency*** and ***damage potential*** are assessed as equally significant, i.e. it can be assumed that a frequently repeated minor accident carries the same risks as a rarely occurring serious accident.

To assess what the actual risk is, it is best to represent it graphically in the coordinate system: ***damage potential*** (plotted along the ordinate) and ***frequency*** (plotted along the abscissa). For the first factor, three levels will be introduced: small, temporary loss and a disaster, and for the second: infrequent, regular and continuous.

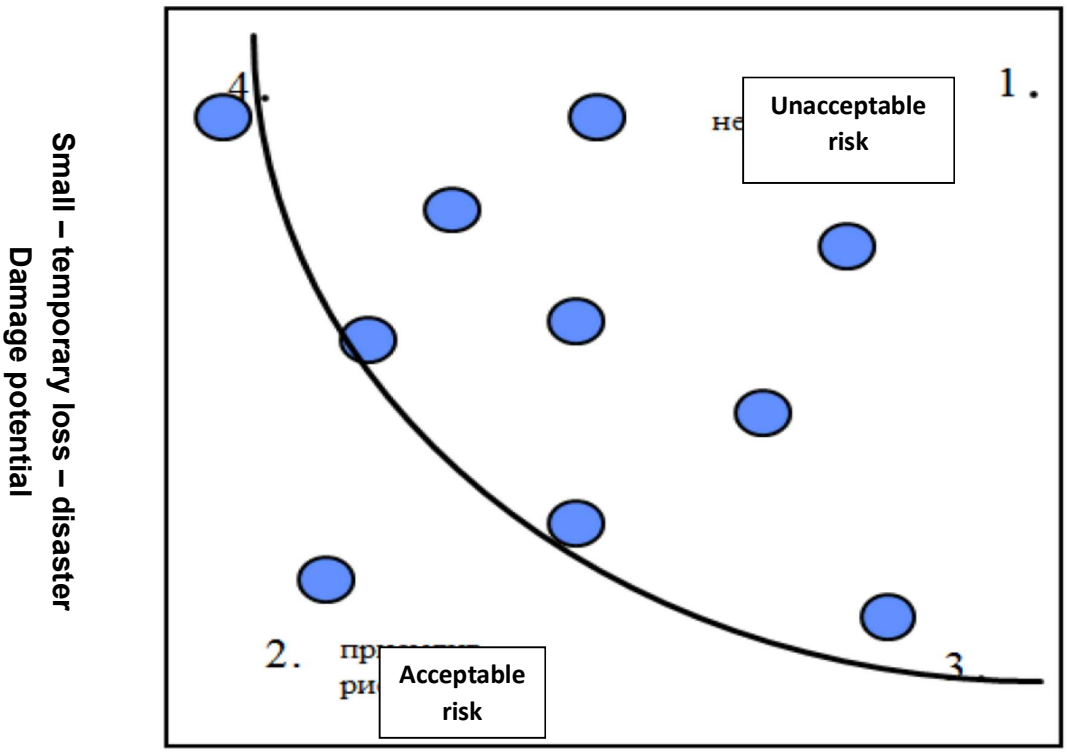


Four end states can be drawn on this graphical reproduction of the risk:

1. Continuous accidents (people killed, massive damage);
2. Infrequent minor damage;
3. Continuous small damage (daily damage);
4. Rare accident (natural disaster).

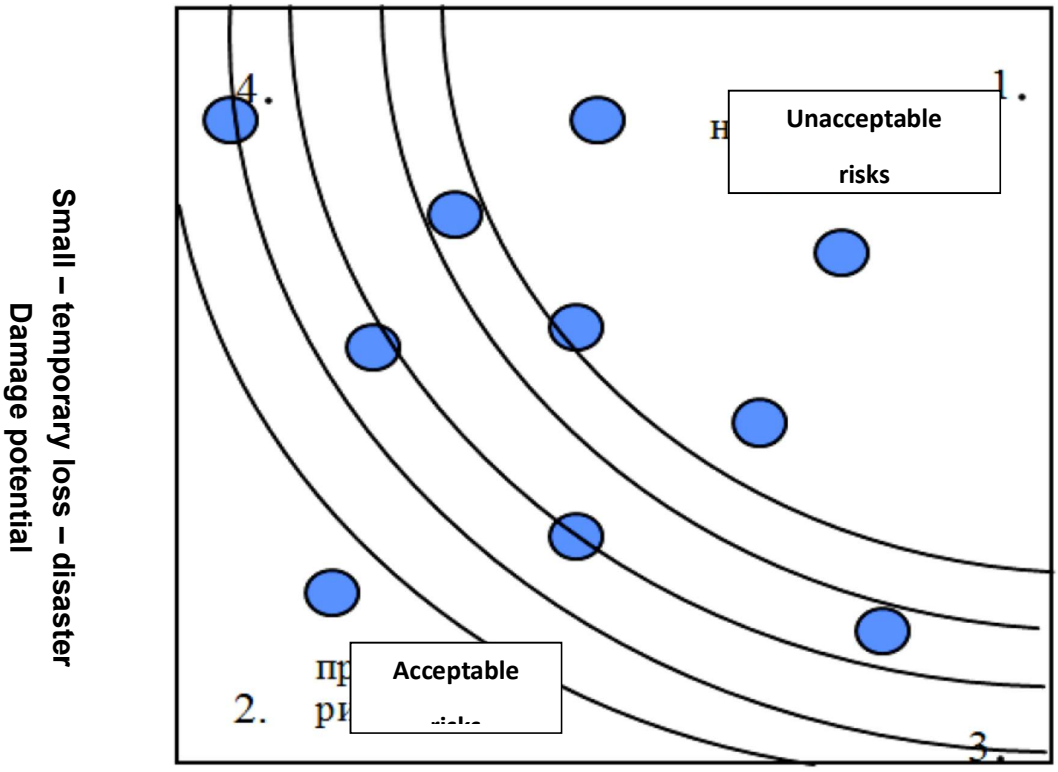


Based on these risk end states, the tasks of the health, safety and environmental protection management system can be identified. From the graph above, a curve can be drawn that separates acceptable and unacceptable risk. In this case, it is a curve of constant risk.



Infrequent - regular – continuous
Frequency

The health, safety and environmental protection management system may require the drawing of multiple constant risk curves as shown below:



Infrequent - regular – continuous
Frequency

The closer the curve passes to the origin of the coordinate system, the less risks the health, safety and environmental protection management system accepts.

The **CEL** or **3F method (the three factor method)** is a generally accepted method for analysing and quantifying specific risk. It rests on the examination of the risk presented above.

The three factors for risk analysis and assessment are:

- ***CONSEQUENCE*** (= ***THE CONSEQUENCES,*** the extent of the damage)
- ***EXPOSURE*** **(= *VULNERABILITY, the frequency*** with which the given system is exposed to certain hazards)
- ***LIKELIHOOD*** **(= *THE LIKELIHOOD*** of a certain consequence occurring)

"CONSEQUENCES" — ***C:*** represent the undesirable results of an event or a series of events. The following grades are used for their quantitative assessment:

1 = **minimal** consequences such as providing first aid or causing damage up to EUR 10,000;

3 = **significant** consequences such as serious injury, loss of working capacity or occurrence of damages in the amount of EUR 10,000 to 100,000;

7 = **serious** consequences such as causing permanent disability or causing damages in the amount of EUR 100,000 to 1,000,000;

15 = **very serious** consequences such as an accident involving a fatality, a serious illness or the occurrence of damages in the amount of EUR 1,000,000 to 2,000,000;

40 = **major damage:** several people killed or damage in the amount of EUR 2,000,000 to 20,000,000;

100 = **disaster:** many people killed and damage in excess of EUR 20,000,000;

"EXPOSURE" - E: shows how often a certain danger can occur, how often the system is threatened by accidents. For the quantitative assessment of this factor, the following grades are used:

0.5 = **very rare** (less than once a year);

1 = **rarely** (once a year);

2 = **sometimes** (once a month);

3 = **it happens** (once a week);

6 = **regular** (daily);

10 = **continuously;**

"LIKELIHOOD" - L: indicates how likely a given consequence is to occur. For the quantitative assessment of this factor, the following grades are used:

0.2 = **unimaginable;**

0.5 = almost impossible;

1 = improbable, but in the long run still possible;

3 = it would not be normal, but still possible;

6 = quite possible;

10 = almost certain.

The quantitative risk assessment is determined by the formula:

Risk = Consequence x Exposure x Likelihood or

R= C x E x L

In this way, we get the following risk zones:

< 20 = **minimal risk** – it should be checked whether measures need to be taken;

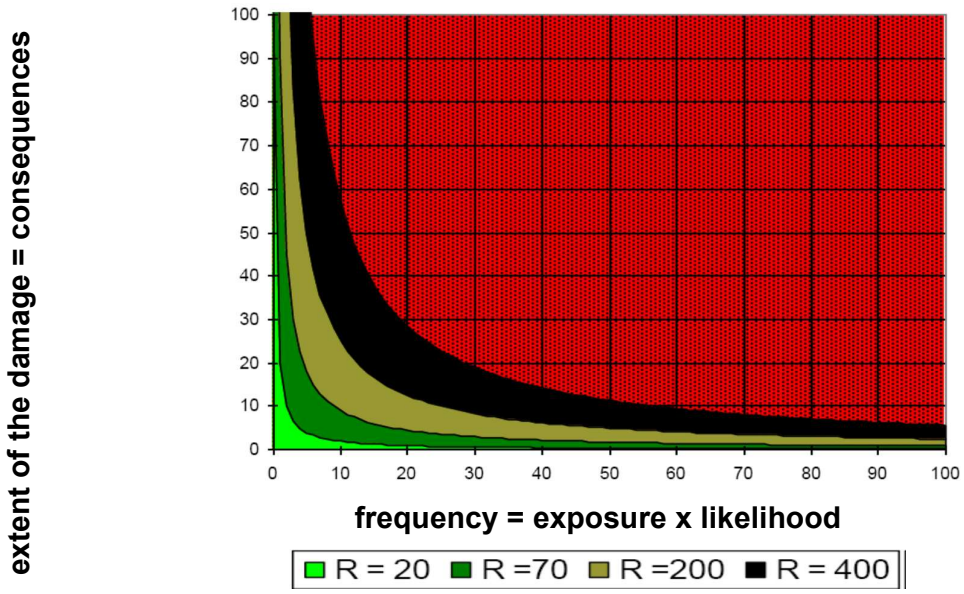
20 - 70 = **possible exposure** - measures must be taken;

70 - 200 = **high exposure** - measures must be taken to improve safety;

200 - 400 = **urgent action is required;**

> 400 = danger lurks - the corresponding activity must be stopped immediately

If these results are presented graphically, we will get the familiar curves of constant risk:



After the reasoning above, the results of the analysis according to the three factors can be represented by a Risk Matrix that takes the form shown below.

FREQUENCY = EXPOSURE x LIKELIHOOD

EXTENT OF THE DAMAGE CONSEQUENCES

	0,1÷10	18	30/36	60	100
1	<20	<20	20÷69	20÷69	70÷199
3	<20	20÷69	70÷199	70÷199	200÷399
7	<20	70÷199	200÷399	>400	>400
15	20-69	200÷399	>400	>400	>400
40		>400	>400	>400	>400
100		>400	>400	>400	>400

< 20	There is a minimum risk of the occurrence of an accident. An inspection is conducted whether measures need to be taken.
20÷69	Possible exposure. Measures must be taken.
70÷199	High exposure. Measures must be taken to improve safety.
200÷399	Urgent action is required.
> 400	Hazard – the activity must be stopped immediately.

Figure II.3.2-2 Risk matrix

Assessment of accident prevention measures, safety barriers and level of protection:

At the site of Bulgartransgaz EAD, there are HCS that pose a risk of fire or are

hazardous to health:

Flammable HCS - natural gas is present within the boundaries of the establishment in gas pipelines.

HCS hazardous to health are present in methanol tanks and pipelines.

In Bulgartransgaz EAD, procedures and tools have been adopted and implemented, which ensure the safe operation of the establishment, including the maintenance of the installation, the work process, the equipment and the temporary suspension of work.

The following emergency equipment is available at the site:

- Gas analyser systems - their inspection and maintenance is carried out by a licensed company and is subject to own monitoring.
- Fire hydrants - their inspection and maintenance is carried out by a licensed company.
- Industrial water pipeline, reservoirs and fire protection systems - the inspection and maintenance of the fire protection systems is carried out by a licensed company/or the operator.
- Fire alarm systems - their inspection and maintenance is carried out by a licensed company.
- Fire extinguishing systems - their inspection and maintenance is carried out by a licensed company.
- Internal fire hydrants - their inspection and maintenance is carried out by a licensed company.

Fire extinguishers are installed in all buildings on the site.

The preventive measures taken to prevent accidents with HCS are as follows:

- site security and control of persons and means of transport admitted to the establishment;
- performance of fire works in fire risk areas only after securing them and obtaining permission from an employee responsible for fire and emergency safety;
- compliance with the general fire safety rules;
- performance of periodic inspections of pipelines and storage facilities for HCS. Inspections are also carried out by contractor personnel during work;
- fire alarm system;
- fire extinguishing system;
- conducting training and drills for personnel to maintain emergency preparedness;
- provision of personal protective equipment for personnel protection.

The table below presents a summary assessment of the safety barriers and the level of protection:

Table II.3.2-10 Assessment of safety barriers and the level of protection

No	Description	Function	Description / Efficiency	Prevention	Protection	Technical	Organizational

1.	Provided fire alarm installation	Early notification of the danger of a major accident and mitigation of consequences.	Constant efficiency.	√	√	√	
2.	Provided fire extinguishing installation for an emergency gas unit	Elimination of accidents that may occur and mitigation of their consequences	Constant efficiency.		√	√	
3.	Formation and training of the Emergency Plan Performance Team and Emergency Group	Teams to eliminate possible accidents and mitigate their consequences	Constant efficiency		√		√
4.	Pipeline safety valves	To maintain and control the normal course of technological processes	Constant efficiency.	√	√	√	
5.	Provision of absorbent materials	Elimination of accidents that may occur and mitigation of their consequences	Constant efficiency	√	√	√	
6.	Sewage system built and disposal of polluted water	Preventing the occurrence of accidents with HCS hazardous to aquatic organisms	Constant efficiency	√	√	√	
7.	Concreted/ asphalted open production areas	Prevention of infiltration into soils and waters of potential HCS spills hazardous to aquatic organisms	Constant efficiency	√	√	√	
8.	Lightning rod	Avoiding the indirect effects of a lightning (protection of electrical networks, telecommunications, buildings and installations)	Equipment whose maintenance requires temporary decommissioning (less than 1% of the time) outside of risk periods. Constant efficiency.		√	√	
9.	Conducting training	Teams to eliminate	Constant efficiency	√			√

	and drills of personnel to maintain emergency preparedness	possible accidents and mitigate their consequences					
10.	Organization of work	Isolation of HCS storage compartments from external areas with potential risk (distance from main thoroughfares)	Passive safety device. Continuous efficiency, except for vehicles entering the site.	√			√
11.	Carrying out periodic inspections of pipelines, tanks, casings, warehouses	Identification of defective equipment, corrosion, wear and tear and timely replacement.	Constant efficiency	√		√	√
12.	Security of the establishment	Implementation of strict control over access to the territory of the establishment	Constant efficiency	√	√		√
13.	Construction regulations (party walls and firewalls)	Limiting the effects of a fire	Passive safety device. Lasting efficiency.		√	√	
14.	Safety instructions	Restricting access to warehouses of optional vehicles. Organization of site traffic. Limiting the risk of accidents	Almost systematic implementation (a human factor relating to the implementation by the operators, off-site: drivers...).	√			√
15.	Automatic fire detection system: Detection Transmission Response	Limiting the development and consequences of a fire	Detection: Instrumental safety system (sensors and measurement unit) whose maintenance requires temporary decommissioning (less than 1% of the time) during working hours (monitoring by staff). Transmission: Instrumental safety system (telephone transmitter) whose maintenance requires	√	√	√	

			temporary decommissioning (less than 1% of the time) during working hours. Response: intervention of a person on duty, even of external help services; instructions subject to safety recall exercises				
16.	Safety instructions (Fire Works Act, Gas Hazardous Works Order)	Strictly control any work that requires the introduction of hotspots	Systematically issued Fire Works Act and Gas Hazardous Works Order before the start of works and signed by the site manager, accompanied by safety information that must be complied with before, during and after the works. Systematic implementation.	√			√
17.	Safety instructions (no smoking...)	The introduction of a hotspot is prohibited	Instructions that are clearly stated on the site and distributed to operators. Systematic implementation	√			√
18.	Operating procedures, general safety instructions	Prevention against the occurrence of a major accident	Work procedures for the staff. Systematic implementation.	√			√
19.	Monitoring of the compliance of electrical installations	Protection against malfunction of electrical equipment. Grounding of installations	Passive safety device. Constant efficiency.	√			√

Presented below are all possible emergency situations that could occur on the territory of Bulgartransgaz EAD through the Risk Matrix based on a preliminary analysis using the method of the three factors:

Table II.3.2-11 Risk matrix

No	Risk situation	Extent of the damage / consequences	Frequency	Risk indicator
1.	Gas leakage	15	10	150
2.	Fire/explosion due to natural gas leakage	15	5	75
3.	Leakage of a flammable/toxic liquid from pipelines	1	10	10
4.	Leakage of a flammable/toxic liquid from pumps	1	10	10
5.	Leakage of a flammable/toxic liquid from a tank	3	10	30
6.	Accidental fire of a methanol tank with a capacity of 250 m^3	40	3	120
7.	Accidental fire of a methanol tank with a capacity of 30 m^3	15	3	45
8.	Occurrence of an accident as a result of a traffic accident	1	6	6
9.	Occurrence of an accident as a result of an earthquake	40	1.5	60
10.	Occurrence of an accident as a result of a lightning when the lightning protection is broken	1	0.5	0.5
11.	Occurrence of an accident as a result of thermal impact from high temperature released during fires outside the territory of the site, but in dangerous proximity to it	3	1.5	4.5
12.	Occurrence of an accident as a result of flooding	1	0.25	0.25
13.	Occurrence of an accident as a result of hurricane winds, snowfall, ice formation and icing	1	1	1
14.	Occurrence of an accident in the event of sabotage or terrorist act	40	2	80

The properties and quantities of hazardous chemical substances and mixtures and wastes stored on the territory of Bulgartransgaz EAD classify the establishment as one at risk of major accidents in the event of a fire or toxic effects on people. Natural gas alone and methanol in part meet the major accident reporting criteria according to Annex No 5 of the EPA - in relation to the possibility of an accident involving hazardous substances in quantities of not less than 5 percent of the threshold quantities according to Annex No 3, Part 1, column 3 or Part 2, column 3.

The preliminary analysis by the method of the three factors, expressed through the risk matrix, shows that the riskiest situations are:

- **Scenario 1:** a natural gas accident with the resulting consequences - explosion, flaring;
- **Scenario 2:** a methanol tank accident with the risk of toxic dispersion and/or a fire;

- **Scenario 3:** an accident occurring as a result of sabotage/terrorist attack. The worst possible scenario is also assumed here - destruction of a natural gas/methanol storage facility. And this scenario overlaps with the first two.

The riskiest scenarios are discussed in detail below in **point II.3.2.3.**

II. 3.2.3. Assessment of the consequences of a major accident

According to the quantitative risk assessment, a major accident involving natural gas or methanol may occur at the site of Bulgartransgaz EAD. The possible scenarios are as follows:

Scenario 1 – an accident involving natural gas:

- a drilling accident with the resulting consequences - explosion, flaring;
- an accident with a collecting main - flaring;
- an accident with gas connections of the compressors - explosion, flaring;
- an accident in a gas drying installation - explosion, flaring;

Scenario 2 – an accident involving methanol:

- a methanol tank rupture and toxic dispersion;
- a methanol tank rupture and a puddle fire;
- a methanol tank farm accident and a fireball.

SCENARIO 1 – ACCIDENT INVOLVING NATURAL GAS:

One of the prerequisites of emergency planning is identifying the areas that may be affected by the consequences of a potential major accident accompanied by a natural gas leak.

The most serious consequences arising from the emergency situation are:

1. Natural gas ignition and thermal effects on people in the area of the accident.
2. BLEVE - formation of a cloud with an explosive concentration and the occurrence of an explosion, accompanied by destruction from the blast shock wave.

- **Drilling accident:**

In all possible emergency situations, the gas will flow from the ground elements of the well. This part of the well has three main elements - a drilling wellhead, production tree and above-ground part of the collecting main. In the event of an accident related to the destruction of the drilling wellhead, gas leakage will take place from the pump-compressor pipes. The entire part of the above-ground drilling equipment is located on a reinforced concrete site and is surrounded by a non-combustible fence. In addition to the ones listed, the following elements are also located on the site: telemetry equipment; solar installation to power the telemetry equipment; lightning protection installation.

In the event of a drilling accident, an uncontrollable release of natural gas from the well may occur as a result of:

- Destroyed sealing elements of preventers and lubricator equipment;
- Unpacking of the operating lift during repair operations;
- Destruction of the production tree during a terrorist act.

It is necessary to note that all elements of the drilling equipment are designed to withstand a pressure significantly higher than the working one. However, depressurization of these elements is possible. The main immediate causes of drilling depressurization can be:

- Terrorist act;

- External mechanical impact, e.g. from a vehicle collision, a plane crash, etc.;
- Careless actions when carrying out repair works;
- Corrosion of pipes;
- Leaks in the flange gaskets;
- Possible landslide processes at the drilling site
- Strong earthquake, etc.

Methodology for determining the overpressure and the impulse of the blast wave generated in a physical explosion:

A basic hypothesis in determining the effect of the shock wave resulting from a physical explosion of a high-pressure vessel is the assumption that the vessel is fragile and breaks with the formation of a large number of fragments. This hypothesis makes it possible to ignore the effect of the resulting fragments on the shock wave, and the consideration of their influence is reduced to the reduction of the energy of the explosion by the value of the kinetic energy of the fragments. However, when predicting the consequences of the explosive impact, the influence of the kinetic energy of the fragments is also ignored and the parameters of the shock wave are determined by the theoretically maximum possible energy for the given temperature and pressure of the gas in the vessel. Studies conducted with fragile vessels have shown some features of physical explosions compared to explosions of high-energy explosives, namely the presence of a negative specific impulse close in absolute value to the positive specific impulse. With high-energy explosives, the negative specific impulse is negligibly small compared to the positive specific impulse.

Nowadays, the method of Harty's characteristics with Rankine–Hugoniot jump conditions is used to calculate spherical shock waves.

In this method, to determine the overpressure Δp and the impulse i in the shock wave, it is necessary to know the initial pressure p_1, the temperature T_1 and the adiabatic index k_1 of the gas contained in the vessel (gas pipeline). The data for these thermodynamic parameters are set by the technological regimes of natural gas transportation and storage, and the ratio of thermal capacities, expressed by the adiabatic index k_1, is determined with the *Thermofluid*s software product.

The second component that determines the characteristics of the shock wave is the medium of its propagation. In the case under consideration, it is the natural air environment of the Earth's atmosphere, which is characterized by the following parameters: pressure p_0= 0.101MPa, sound speed a_0= 324 m/s, and an adiabatic index k_0 = 1.4.

For high values of the ratio p_1/p_0 in the pressures of the natural gas and the air atmosphere, which is characteristic of the gas pipeline sections under consideration (from 55 to 150 times), the variation of the overpressure with distance is similar to the variation for the blast wave produced by a high-energy explosive. Therefore, at the basis of the modelling of explosive processes lies the principle of the "cube root", formulated by Hopkins and further developed by Krantz. According to this principle, Sachs defined the following dimensionless variables, which allow the use of experimentally obtained universal dependencies, expressed in graphical or tabular form, to determine the characteristics of various specific blast waves

Dimensionless pressure: $$\bar{P} = \frac{P}{p_0}$$

Dimensionless impulse: $$\bar{i} = \frac{ia_0}{E^{\frac{1}{3}} p_0^{\frac{2}{3}}}$$

Dimensionless distance: $$\bar{R} = \frac{R p_0^{\frac{1}{3}}}{E^{\frac{1}{3}}}$$

where P is the pressure in the shock wave front; p_0 - ambient pressure (in this case atmospheric pressure); i - shock wave pressure impulse; a_0 - the speed of sound in the environment (in this case, the speed of sound in air); E - the energy of the explosion; R - distance from the front of the shock wave to the centre of the explosion.

The energy of the explosion for high-pressure vessels is determined by the formula:

$$E = \frac{(p_1 - p_0)}{k - 1} V$$

where V is the volume of the vessel, for gas pipelines - the volume of the ruptured section. The most powerful shock wave occurs in a spherical explosion, due to the greatest concentration of energy per unit volume. All other stereometric shapes have smaller shock wave effects. Therefore, in safety calculations, all blast sources are reduced to a sphere of equal volume and the shock wave parameters for a spherical source are calculated.

At the moment of detonation of an idealized sphere, the pressure of the air behind the shock wave (which is the damaging factor in shock waves) is to the maximum at the surface of contact between the gas sphere and the air. Since at the initial moment the flow of the substance is strictly one-dimensional, the dependence between the gas pressure in the sphere and the pressure behind the shock wave can be determined by the transcendental equation for the decay of the compressibility buffet in a shock tube

$$\frac{p_1}{p_0} = \frac{p_{s0}}{p_0} \left\langle 1 - \frac{(k_1 - 1)\left(\frac{a_0}{a_1}\right)\left(\frac{p_{s0}}{p_0} - 1\right)}{\sqrt{2k_0\left[2k_0 + (k_0 + 1)\left(\frac{p_{s0}}{p_0} - 1\right)\right]}} \right\rangle^{-\frac{2k_1}{k_1 - 1}}$$

where

p_{s0}/p_0 - the dimensionless pressure in the air shock wave at the time of the explosion,

p_1/p_0 - the dimensionless pressure in the sphere,

a_0/a_1 - the dimensionless ratio of sound speeds in air and in the sphere.

Determination of the damaging factors in a physical explosion of the above-ground part of the collecting main

The damaging factors of the shock wave in a physical explosion (overpressure and impulse of the shock wave) are directly proportional to the volume of the ruptured section. Therefore, when determining these parameters, it is assumed that the above-ground part of the flow-line is ruptured at the location of the drilling, in which case the volume of the ruptured section will be larger compared to all other possible emergency situations.

The internal diameter of the above-ground part of the collecting main is 119 *mm (external diameter of 133 mm and a wall thickness of 7-8 mm).* The results of the calculations made for different lengths of the above-ground part of the pipeline are shown in the tables below.

Table II.3.2-12 Determination of the parameters of the air shock wave for a gas pipeline with a diameter of 119 mm and a pressure of 15 Mpa

Parameter	Symbol, dimension	Value				
Length of the torn section	L, m	10	20	30	40	50
Volume of the torn section	V, m^3	0.111	0.222	0.334	0.445	0.556
Radius of the sphere	R, m	0.298	0.376	0.430	0.474	0.510
Blast energy	E, MJ	2.437	4.874	7.311	9.748	12.185
Radius of the reduced spherical wave	r_0, m	0.298	0.376	0.430	0.474	0.510
Air shock wave front pressure	Ps, MPa	1.30				
Air shock wave front overpressure	ΔP, Mpa	1.20				
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000805	0.001015	0.001162	0.001278	0.001377
At a distance of 5 times the radius of the reduced spherical wave	$5r_0$, m	0.1492	1,879	2.151	2.368	2.551
Air shock wave front pressure	Ps, MPa	0.30				
Air shock wave front overpressure	ΔP, Mpa	0.20				
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000081	0.000101	0.000116	0.000128	0.000138
At a distance of 10 times the radius of the reduced spherical wave	$10r_0$, m	2.983	3.759	4.303	4.736	5.101

Air shock wave front pressure	Ps, MPa	0.15				
Air shock wave front overpressure	ΔP, Mpa	0.05				
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000045	0.000056	0.000065	0.000071	0.000077
At a distance of 15 times the radius of the reduced spherical wave	$15r_0$, m	4.475	5.633	6.454	7.104	7.652
Air shock wave front pressure	Ps, MPa	0.13				
Air shock wave front overpressure	ΔP, Mpa	0.03				
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000031	0.000039	0.000045	0.000050	0.000054
At a distance of 20 times the radius of the reduced spherical wave	$20r_0$, m	5.967	7.517	8.605	9.471	10.203
Air shock wave front pressure	Ps, MPa	0.12				
Air shock wave front overpressure	ΔP, Mpa	0.02				
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000027	0.000034	0.000039	0.000043	0.000046

Determining the consequences for adjacent facilities and people:

The length of the above-ground section of the collecting main at the drilling site does not exceed 10 *m.*

Therefore, to evaluate the consequences, the data from the above tables for a pipeline length of 10 *m* are used.

For greater clarity, the data on the value of the shock wave as a function of the distance from the epicentre of the physical explosion are shown in the following table.

Table II.3.2-13 Shock wave overpressure as a function of distance from the epicentre

Distance from the epicentre, *m*	0.3	1.5	3.0	4.5	6.0
SW overpressure, *kPa*	1200	200	50	30	20

The data from the table with sufficient accuracy for the purposes of the study is described by the equation:

$$\Delta P_{\phi} = 254.37.r^{-1.3895}$$

The radius of the danger zone around the wells is determined on the basis that the

minimum degree of damage to the neighbouring facilities is caused by an overpressure of the shock wave in the range of 10 to 5 *kPa.* In this interval, the glazing of the buildings and facilities breaks. The distance from the epicentre of the explosion at which the front overpressure will be 5 *kPa,* determined by the above equation, is 16.93 *m.*

There are no stationary facilities in a dangerous proximity to the collecting headers *(below 17 m).* There are no roads either with intense traffic of people and vehicles. Therefore, a physical explosion (rupture) at the well site will be dangerous only to the drilling facilities themselves. Given the small distance between these facilities and the relatively high pressure of the shock wave front *(about 200 kPa),* they will most likely be completely destroyed by the blast.

This will lead to depressurization of the production tree and leakage of natural gas into the surrounding space. The consequences for people of the overpressure action of the shock wave are given in Table II.3.2-14.

Table II.3.2-14 Radii of the areas of damage to people outdoors

Extent of damage	Overpressure, kPa
Fatal	>100
Heavy	60-100
Average	40-60
Minor	20-40
No damage	<10

The dangerous distance for people is determined on the basis of the fact that an overpressure of the shock wave below 10 *kPa* is completely safe for people. Such an overpressure will be realized at a distance from the drilling site equal to 10.28 *m.* Therefore, if there are people at a distance of less than 10 *m* away from the drilling site during the blast, they will suffer varying degrees of damage depending on their proximity to the epicentre.

These damages depend on the overpressure and are determined according to the following diagram:

- **Minor injuries** - $\Delta P\Phi$ = 20 - 40 *kPa.* They are characterized by rapidly passing disorders of body functions - dizziness, tinnitus, headache. Sprains and superficial injuries are possible;
- **Medium injuries** - $\Delta P\Phi$ = 40 - 60 *kPa.* They most often consist of sprained joints, brain concussion, damage to the hearing system, bleeding from the nose and ears;
- **Severe injuries** - $\Delta P\Phi \geq$ 60 *kPa.* This type of damage is characterized by severe contusions of the whole organism, loss of consciousness, broken bones, bleeding from the nose and ears, damage to internal organs is also possible;
- **Fatal injuries** - $\Delta P\Phi \geq$ 100 *kPa.* They are characterized by rupture of internal organs - liver, kidneys, spleen, lungs, etc., which usually lead to death.

Modelling of the process of gas leakage during well depressurization:

The dimensions of the pipes from which the leakage will take place are: 73 *mm;* 146 *mm;* 89 *mm*

For thermodynamic conditions of the outflow, the following are assumed:

- Natural gas pressure -*p*= 15 *MPa* and temperature - *T*= 318 K;
- Gas supply is practically unlimited.

The outflow conditions thus defined allow the theory of fluid outflow from an unbounded reservoir to be applied. Since the leakage takes place in the environment, which is at atmospheric pressure p_0=0.101 *MPa,* then the leakage mode will be above critical because the ratio p_0/p is much less than 0.489.

The purpose of the calculations when solving the problem of gas leakage from a tank is to determine: the mass flow per second and the parameters of the gas when leaving the leakage section - temperature, pressure, density and leakage speed.

Since the gas escape will be the result of an accident, it will not form an expanding part at the rupture place and no Laval nozzle effect will occur. Therefore, the thermodynamic parameters of the gas at its outflow will acquire values equal to the critical values of the outflow, and the maximum diameter of the critical section will be equal to the diameter of the gas pipeline. According to the general theory of isentropic flow, the listed gas parameters are determined by the ratios:

$$T_{\text{кр}} = \frac{2}{K+1} T;$$

$$p_{\text{кр}} = \left(\frac{2}{K+1}\right)^{\frac{k}{k-1}} p;$$

$$\rho_{\text{кр}} = \left(\frac{2}{K+1}\right)^{\frac{1}{k-1}};$$

$$w_{\text{кр}} = \sqrt{k \frac{p}{\rho}};$$

$$M = f_{\text{кр}} \Gamma(\text{к}) \sqrt{p\rho},$$

where: *T, p, ρ* are the temperature, pressure and density of the gas in the pipeline;

$W_{кр}$ - the critical outflow speed (equal to the speed of sound in the gas in the critical section);

M – the second mass flow rate

$f_{\text{кр}} = \pi \frac{d^2}{4}$ cross-sectional area of the gas pipeline

d - diameter of the gas pipeline

Γ*(k)* - function of k characterizing the outflow;

k - adiabatic index.

It is clear from the given ratios that as far as the pressures and temperatures of the gas in all wells are practically the same, then the parameters of the gas when it flows out of these wells will also be equal. There will be a difference only in the second mass flow rate, which is limited by the cross-sectional area (diameter) of the gas pipeline.

The values of the density *ρ* and the adiabatic index *k* are determined using the *Thermofluids* software product based on the known temperature *T* and pressure *p* of

the gas in the gas pipeline. They are: for the density - ρ = 105.28 *kg/m* ^{3} and for the adiabatic index - k =1.65.

The table below shows the results of the calculations for the various drilling works.

Table II.3.2-15 Leakage parameters in the event of depressurization of a well

$f_{kp,}$ m^2	$T_{kp,}$ K	$p_{kp,}$ MPa	$\rho_{kp,}$ kg/m ^{3}	$W_{kp,}$ m/s	M, kg/s
0.00419÷0.01674	239.74	7.336	68.301	421.357	120.45÷481.81

Likely sources of ignition

As already noted, any heat source with a temperature above 530^0 C, which is the self-ignition temperature of the mixture of natural gas and air, can act as an ignition source in case of natural gas leakage. This relatively high self-ignition temperature of natural gas greatly limits the number of possible ignition sources.

As the most likely sources of ignition in case of leakage of natural gas from the wells, the following are accepted:

- Carrying out fire works in the vicinity of the well;
- A discharge of atmospheric electricity;
- Sparks emitted during the operation of vehicles used in the performance of repair and other activities;
- Use of spark-hazardous tools when carrying out repair works;
- Setting grass vegetation around the drilling site on fire, etc.

The preventive measures that should be taken to prevent the occurrence of ignition sources are:

- Compliance with fire safety rules when performing fire works;
- Maintenance of the lightning protection installations of the drilling sites;
- Use of spark arrestors for vehicle exhausts.
- Use of spark-proof tools and clothing made of natural materials for workers;
- Regular clearing of vegetation from the safety strips around the drilling sites.

The fact should be taken into account that the coincidence of the two events - the depressurization of the well and the occurrence of an ignition source - is unlikely. This means that the occurrence of gas combustion is also unlikely.

Flaring of the gas at the point of leakage

It has been experimentally proven that after the transition of the gas leakage combustion from laminar to turbulent, the height of the flame depends practically only on the diameter of the pipeline. At outflow velocities above 20% of the speed of sound, the height of the flare remains constant and does not depend on the pressure in the pipeline and the outflow velocity, but only on its diameter. This height is approximately equal to 118 times the diameter of the pipeline.

$$H_{\phi} = 118.d_{\mathrm{TP}}$$

The shape of the flare resembles the shape of a cylinder, with combustion taking place

in a thin layer at the boundary of contact of the gas with the surrounding air. The diameter of the flare in its widest part is determined by the equation:

$$D_{\text{ф}} = 0.15.H_{\text{ф}}$$

The radiation intensity of the flare (Qφ) as a function of the distance from the flare (r) is determined by the equation:

$$Q_{\text{ф}} = \frac{f.Q_{\text{П}}}{4.\pi.r^2}$$

In this equation, f is the radiation coefficient of the flare, taking into account the part of the heat dissipated in the surrounding space by radiation *(for methane, f takes a value of 0.2, for ethane - 0.33, for other hydrocarbons -0.4).*

The heat released from the flame (Qn) is determined by the equation:

$$Q_{\text{П}} = \beta.Q_{\text{Д}}.V_{\Phi}$$

where:

ß - coefficient of incomplete combustion, assuming a value of 0.8;

$Q_{\text{д}}$ - heat of combustion (lower working calorific value) of natural gas equal to 36E+06 *J/m³;*

Vφ - relative flow of gas through the opening [m^3 /h].

$$V_{\text{ф}} = 16.7.H_{\Phi}^{2.5}$$

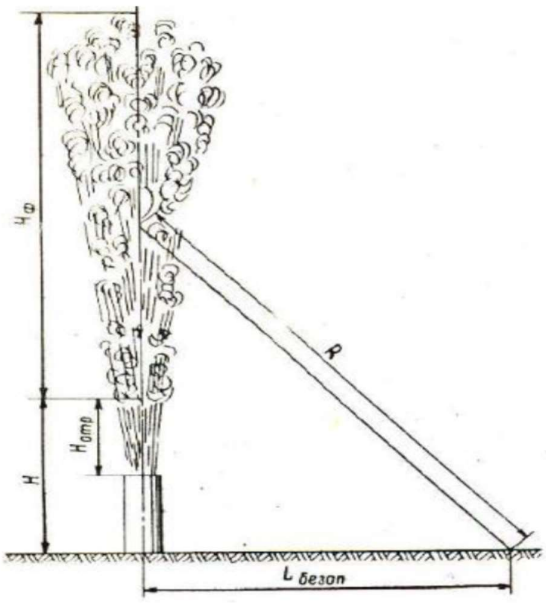


Figure II.3.2-3 Calculation scheme for determining the safe distance for people from the point of leakage in case of gas flaring

The density of the heat flux emitted by the flare, as a function of distance, allows to determine the safe distance for people, at which they can stay for an unlimited time without special protective equipment. The calculation scheme for determining the safe distance is shown in Figure II.3.2-3.

The equations for determining the distances shown in the figure have the form:

$$R = 1.32.H_{\Phi}^{1.25}$$

$$L_{\text{БЕЗОП}} = \left[175.H_{\Phi}^{2.5} - \left(H_{\text{СТР}} + \frac{H_{\Phi}}{2}\right)^2\right]^{0.5}$$

$$H_{\text{СТР}} = 5.d_{TP}$$

The above equations are derived on the basis of the experimentally proven fact that without protective means a person can withstand a heat load of 5.6E+6 *J/m².h* for an unlimited time.

In the event of a sudden ignition of the escaping gas, the time for reaction of the people nearby is around 5 s. That's how much time a person needs to realize what's happening and take self-defence actions (hiding behind a barrier, moving away from the danger zone, etc.). If the heat flux density during these 5 *s* is above 19.5E+06 *J/m².h,* a person feels pain and may get various degrees of burns. This fact makes it possible to determine the dangerous distance for people from the place of leakage in case of ignition of the gas.

Another dangerous distance is the distance from the point of leakage, at which the heat flow emitted by the flare can ignite the dry grass vegetation.

This distance is determined on the basis of the critical density of the heat flow in relation to the ignition of the vegetation, the value of which is 39E+06 *J/m².h.*

According to the methodology described above, the dimensions of the flare and the dangerous and safe distances from the point of leakage in the event of flare burning in the wells were determined.

The results of the calculations for the drilling sites in the area of Chiren UGS are indicated in the following table.

Table II.3.2-16 Flare dimensions and safety distances

$d_{тр}$, mm	Hφ, m	Dφ, m	$L_{безоп}$ (for people), m	$L_{оп}$ (for people), m	$L_{оп}$ (for vegetation), m
73÷146	8.61÷17.23	1.3÷2.58	18.9÷33.8	9.1÷21.95	6.5÷15.5

Due to the sufficient amount of oxygen in the surrounding air for complete combustion to occur, the products of combustion will not contain highly toxic substances. This means that there is no danger of poisoning the people nearby when burning natural gas outdoors.

The calculations made regarding the safe distances in the event of flaring at the location of the drilling sites give reason to draw the following conclusions:

1. If the gas escape occurs at a height of approximately 1 *m* above the ground surface, the height of the flare together with the height of the jet will be from 10 to 19 m.

2. The people engaged in containment operations should be equipped with special protective equipment for the heat of the flare. People without protective equipment for the heat radiation must be kept away from the drilling site at a distance of at least 34 *m.*

3. There is a serious hazard in the event of ignition of the flare for people less than 22 m away.

4. The dangerous distance from the point of view of vegetation ignition is from 6.5 to 15.5 m. This distance significantly exceeds the width of the existing strips of about 2 m.

5. There is no danger of poisoning people in the event of natural gas flaring.

Summary Assessment of Consequences of Drilling Accidents

The modelling of the course and consequences of a possible accident related to the depressurization of a drilling site allows the following summary to be made:

- In the event of an explosive rupture of the above-ground part of the collecting main at the drilling site, the zone of 17 m around the site of the explosion is dangerous. There are no fixed facilities or roads with heavy traffic of people and vehicles in this zone. A physical explosion (blast) at the drilling site will only be dangerous to the drilling equipment itself. Given the small distance between these facilities and the relatively high pressure of the shock wave front *(about 200 kPa),* most likely they will be completely destroyed by the explosion. This will lead to depressurization of the production tree and leakage of natural gas into the surrounding space.

- If people are less than 10 m away from the drilling site during the blast, they will suffer various injuries depending on their proximity to the epicentre.

- The most likely ignition sources for natural gas leaks from wells are:

- Carrying out fire works in the vicinity of the well;
- A discharge of atmospheric electricity;
- Sparks emitted during the operation of vehicles used in the performance of repair and other activities;
- Use of spark-hazardous tools when carrying out repair works;
- Discharge of static electricity accumulated in the clothes of the service personnel (if the clothes are made of an artificial material);
- Setting the grass vegetation around the drilling site on fire, etc.

The calculations made regarding the safe distances in the event of flaring at the drilling sites give reason to draw the following conclusions:

- If the gas escape occurs at a height of approximately 1 *m* above the ground surface, the height of the flare together with the height of the jet will be from 10 to 19 m;
- There is a serious danger in the event of ignition of the flare to people less than 22 m away;
- The dangerous distance from the point of view of vegetation ignition is from 6.5 to 15.5 m.
- There is no danger of poisoning people in the event of natural gas flaring.

Conclusions:

1. An emergency situation involving drilling does not pose a danger to the nearby facilities or to the people in them;
2. In case of explosive rupture of an above-ground part of a borehole, the shock wave will not cause dangerous consequences for the buildings and facilities around it.
3. The resulting flare may also cause a fire on the field vegetation around the accident site. This fire can be contained with good organization;

No people are expected to be in the affected areas. It is not expected to have consequences on the life and health of people and on the infrastructure in the area of the establishment.

- **Accident involving a collecting main:**

The collecting main pipeline is an underground one with a depth of embedding h = 0.8 m. This means that the determination of the danger from the impact of the various damaging factors in the event of a rupture of the gas pipeline should be carried out on the basis of the theory of underground explosions. The primary impact factors of a pipeline rupture will be the impact of the shock wave and the fragmentation action of the primary and secondary fragments. The impact of the shock wave is the result of the impact of the products of the explosion on the surrounding air atmosphere. In order to obtain a shock wave, it is necessary that the products of the explosion spread at a speed higher than the speed of sound in air, which under normal conditions is about a = 340 m/s.

Primary fragments are understood as the elements from the fragmentation of the blast shell; in this particular case, pieces of the steel pipe of the gas pipeline. Since steels with high toughness, strength and coefficient of linear expansion are used to make gas pipelines, it is practically impossible to realize the shortness of rupture, characteristic of brittle materials. This delayed rupture significantly reduces the power of the destructive action. Since the gas pipeline is underground, the danger of primary fragments should immediately be rejected, since their kinetic energy will be absorbed by the earth mass accumulated on the gas pipeline.

Modelling the process of gas leakage in the event of loss of containment of a collecting main:

Although the transported gas contains small quantities of gases with a density greater than that of air, due to the homogeneity of the mixture of gases, the transported gas will behave as an individual gas with a density corresponding to the average density of its constituent gases. The most unfavourable from the point of view of leakage is the case when the rupture is complete and the place of the rupture is somewhere in the middle of the gas pipeline.

For thermodynamic conditions of the outflow, the following are assumed:

- Natural gas pressure - p = 15 *MPa* and temperature - T = 318K;
- Gas supply is virtually unlimited;
- No Laval nozzle forms at the rupture point.

Thus defined, the outflow conditions allow the theory of fluid outflow from an unconfined reservoir to be applied. Since the leakage occurs in the environment, which has an atmospheric pressure p 0=0.101 *MPa,* the leakage regime will be supercritical because the ratio p_0/p is much less than 0.489.

According to the general theory, the isentropic gas flow parameters are determined by the ratios presented in the point above for well depressurization. The results of the calculations for a pipeline with d = 0.119 *mm* are presented in the table below:

Table II.3.2-17 Parameters of the isentropic outflow of gas from a collecting main

Initial conditions of the outflow	Pressure	15.0 *MPa*
	Temperature	318.0 *K*
	Density	105.3 kg/m^3
	Adiabatic index	1.65
Parameters of the effluent gas	Pressure	7.34 *MPa*
	Temperature	240.0 *K*
	Density	68.3 kg/m^3
	Mass second consumption	320.0 *kg/s*
	Leakage rate	421.2 *m/s*

Likely sources of ignition

As already noted, any heat source with a temperature above 530° C can play the role of an ignition source in case of natural gas leakage. The most likely sources of ignition for a natural gas leak due to loss of containment of a collecting main are much the same as for gas leaks from wells, namely:

- Fire works when carrying out repair works;
- A discharge of atmospheric electricity;
- Sparks released during the operation of vehicles used in repair works;
- Use of spark-hazardous tools when carrying out repair works;
- A discharge of static electricity accumulated in workers' clothing (if their clothing is made of a synthetic material);

- Setting the grass vegetation around the depressurization site on fire, etc.

Preventive measures are also similar to those when drilling:

- Compliance with fire safety rules when performing fire works;
- Use of spark arrestors for vehicle exhausts.
- Use of spark-proof tools and clothing from natural materials for workers.

Flaring of the gas at the point of leakage:

To determine the damaging factors in the event of flaring resulting from a loss of containment of a collecting main, the same methodology used to assess the drilling accident scenario described earlier in the report will be used.

The internal diameter of the pipelines of collecting mains is 119 *mm.* At this diameter, the flare parameters will be:

• Height of the flare - $H_Ф = 118.d_{TP} = 118.0,119 = 14$ m;

• Diameter of the flare - $D_Ф = 0,15. H_Ф = 0,15.10,5 = 2,1$ m;

• Height of the jet from the place of gas outflow to the lower end of the flare - $H_{CTP} = 5.d_{TP} = 5.0,119 = 0,6$ *m.*

It can be seen that the height of the jet is commensurate with the depth of embedding of the gas pipeline, which means that the flare will start approximately at a height equal to the level of the terrain;

- Gas consumption - $V_Ф = 16,7. H_Ф^{2.5} = 16,7.14^{2.5} = 12\ 247$ *m^3/h;*
- Amount of heat released from the flame - $Q_П = ßQд.V_Ф = 0,8.36.10^6.12247 = 3.53E+11$ *J/h.*

At $Q_Ф$ = 19.5E+06 *$J/m^2.h$* (the value dangerous for humans) - r = 16,8 m.

At $Q_Ф$ = 39E+6 *$J/m^2.h$* (the value dangerous for vegetation) - r = 12,4 *m.*

The safe distance for people with unlimited time of stay will be 35 *m.*

The calculations made regarding the safe distances for flaring at the drilling site give reason to draw the following conclusions:

1. The flare, formed by the outflow of gas from a ruptured collecting main, will start approximately at the earth's surface and be about 14 *m* high.

2. People engaged in containment operations must be equipped with special protective equipment for the heat of the flare. People without protective equipment for heat radiation must be kept away from the borehole at a distance of at least 35 *m.*

3. There is a serious danger at the time of ignition of the flare to people less than 17 m away.

4. The dangerous distance from the point of view of vegetation ignition from the point of leakage is about 12.5 *m.*

Assessment of the consequences of accidents involving collecting mains:

The analysis of the likely reasons for the loss of containment of collecting mains allows the following conclusions to be drawn:

The rupture of the underground part of collecting mains cannot lead to the occurrence of a shock wave, as well as to the ejection of fragments from the pipeline or the ground cover located above it. Gas consumption at the time of loss of containment will be 320 *kg/s.*

In the event of flaring at the depressurization location:

- The torch will start approximately from the earth's surface and will have a height of

about 14 m;

- There is a serious danger at the time of ignition of the flare to people at a distance of less than 17 m;

Conclusions:

1. The very process of loss of containment of the underground part of a collecting main cannot pose a danger both to nearby facilities and to the people there;

2. A shock wave cannot form when a collecting main breaks.

3. The resulting flare may also cause a fire on the field vegetation around the accident site. This fire can be contained with good organization;

4. The seismic impact caused by an underground collecting main rupture is not dangerous for buildings and facilities around it.

No people are expected to be in the affected areas. It is not expected to have consequences on the life and health of people and on the infrastructure in the area of the establishment.

- **Accident caused by the gas connections of compressors:**

If the gas connections of compressors are broken, it is possible to get an uncontrolled gas leak with a possible explosion, if the gas ignites. The maximum amount of gas that could leak is about 160,000 *Nm^3/h.* This gas flow can be stopped within up to 10 minutes.

The most likely causes that could lead to depressurization of the gas connections of compressors and gas leakage are:

- Pressure increase above the permissible one due to violation of the material balance of gas compression;
- Defects in pipe material or welds;
- Occurrence of high temperature stresses in the compressor connections;
- Corrosion of the connection pipes (e.g. in the presence of active impurities in the gas);
- Vibrations caused by the operation of compressors;
- External mechanical impact (e.g. when working with the overhead crane), etc.

Action of the shock wave at the time of a physical explosion in an existing CD:

An emergency situation is considered, in which one of the compressor connections breaks completely and the resulting physical explosion leads to the formation of a shock wave, affecting the structure of the building of the compressor department and endangering the life and health of people in the department.

The overpressure value of the shock wave generated during the explosion depends on the pressure in the connection and on the length of the ruptured section. Obviously, a higher value of overpressure will be obtained when the second compressor connections are ruptured, because with the same dimensions as the first ones, the pressure in them is higher.

To determine the overpressure of the shock wave formed when these two connections are ruptured, the methodology described above for a drilling accident was used.

Table II.3.2-18 Parameters of the air shock wave for II-nd connection II-nd degree

Diameter of the gas pipeline	D_gpr. m	0.5
Length of the ruptured section	L, m	2

Volume of the ruptured area	V, m^3	0.393
Radius of the sphere with a volume equal to the volume of the ruptured section	R, m	0.454
Blast energy	E, MJ	8.605
AIR SHOCK WAVE PARAMETERS		
Radius of the reduced spherical wave	r_0, m	0.454
Air shock wave front pressure	Ps, MPa	0.75
Air shock wave front overpressure	Δp, Mpa	0.65
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.001226
At a distance of 5 times the radius of the reduced spherical wave	$5r_0$, m	2.271
Air shock wave front pressure	Ps, MPa	0.25
Air shock wave front overpressure	Δp, Mpa	0.15
Pressure pulse at the front of the air shock wave	i, Mpa.s	0.000195
At a distance of 10 times the radius of the reduced spherical wave	$10r_0$, m	4.543
Air shock wave front pressure	Ps, MPa	0.14
Air shock wave front overpressure	Δp, Mpa	0.04
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000042
At a distance of 15 times the radius of the reduced spherical wave	$15r_0$, m	6.814
Air shock wave front pressure	Ps, MPa	0.12
Air shock wave front overpressure	Δp, Mpa	0.02
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000038
At a distance of 20 times the radius of the reduced spherical wave	$20r_0$, m	9.086
Air shock wave front pressure	Ps, MPa	0.12
Air shock wave front overpressure	Δp, Mpa	0.01
Pressure pulse at the front of the air shock wave	i, Mpa.s	0.000027

Table II.3.2-19 SW overpressure as a function of the distance from the epicentre

II-nd connection I-st degree		II-nd connection II-nd degree	
Distance from epicentre [m]	SW overpressure [kPa]	Distance from epicentre [m]	SW overpressure [kPa]
0.52	600	0.45	650

2.6	120	2.27	150
5.2	40	4.54	40
7.8	20	6.81	20
10.4	10	9.09	10

The data in the table show that the values of the overpressure of the shock wave formed when each of the connections is broken are approximately the same. This is due to the fact that the generated energy of the explosion in one and the other emergency situations is approximately equal - 8.229 compared to 8.605 *MJ.*

Based on the generally accepted criteria for assessing the impact of shock waves on building structures and technological equipment, the following conclusions can be drawn about the consequences of a possible rupture of the gas connections of some of the compressors:

- Construction structures and equipment located in the immediate vicinity of the connections *(below 2.5 m)* will be destroyed by the blast;

- Structures and equipment located within a radius of 5 m from the epicentre of the explosion will be severely damaged;

- Within a radius of 10 m from the epicentre, the glazing of the compressor department will be destroyed;

- An explosion caused by the rupture of one of the compressor connections will not cause damage outside the department;

- The dangerous overpressure of 10 *kPa* will occur at a distance of 10.5 m from the epicentre of the explosion.

After the potential rupture of any of the gas connections, there will be an uncontrolled gas leak from the connected pipelines.

Action of the shock wave at the time of a physical explosion in the premises of the new compressors (GTCU):

By analogy to the analysis for the existing department, the consequences of a possible rupture of the gas connections of any of the new compressors will be as follows:

- Construction structures and equipment located in the immediate vicinity of the connections *(below 2.5 m)* will be destroyed by the blast;

- Structures and equipment located within a radius of 5 m from the epicentre of the explosion will be severely damaged;

- The dangerous overpressure of 10 *kPa* will occur at a distance of 10.5 m from the epicentre of the explosion.

After the potential rupture of any of the gas connections, there will be an uncontrolled gas leak from the connected pipelines.

Modelling the gas leakage process:

If one of the compressor connections breaks, gas will begin to leak from the connected pipelines. Given the high pressure of the gas, it will leak out at critical mode, i.e. at a speed equal to the speed of sound in natural gas. Given that the diameter of the connected pipelines is one and the same *(219 mm),* the amount of gas leaked will depend only on the pressure in the pipeline. For these reasons, the most serious emergency situation from the point of view of the amount of gas entering the room will

take place in the case of rupture of the second connection of the second degree of the compressors. The gas pressure in that pipeline is the highest - a maximum of 15 *MPa* and a temperature of 367 K. Under these conditions, the density of natural gas will be 84.01 *kg/m*^{3} and the adiabatic index - 1.505.

The incoming volume of natural gas in one second, aligned to normal m^3, is determined by the formula:

$$V = M\frac{V_\mu}{\mu}$$

where:

V - the second volumetric income of gases, aligned to *Nm*^{3}*;*

$M = f_{kp}\Gamma(k)\sqrt{p\rho}$ - the mass flow per second in the case of supercritical flow from a pipeline;

$V\mu = 22.36\ m^3/kmol$ - is the molar volume of natural gas under normal conditions;

$\mu = 26.04\ kg/kmol$ - is the molar mass of natural gas.

Therefore, as a result of the calculations, we get:

f_{kp}, m^2	M, kg/s	V, Nm^3/s
0.038	1977.83	1308.33

The calculations show that in the given emergency situation, 1308.33 *Nm*^{3} of natural gas will flow out every second.

Likely sources of ignition

The analysis of the situation immediately after the rupture of the gas connections gives reason to claim that the most likely source of ignition of the gas leaking from the pipelines will be the short circuits in the electrical installations damaged by the physical explosion.

It is also possible for other sources of ignition to occur, for example, frictional sparks from the impact of fragments produced in the explosion on technological machines and building structures, but the likelihood of their occurrence is significantly lower than the likelihood of the occurrence of short circuits.

Explosion of a gas-air mixture in an existing compressor department:

Immediately after the rupture of the connection, the leaking natural gas, being lighter than air, will rise in height and collect under the ceiling of the working room. This will cause the gas detectors to activate and automatically switch on the emergency ventilation.

15 fans with a total flow rate of 91 373 *m*^{3}*/h* are installed in the upper part of the compressor room. This makes 25.4 *m* ^{3}*/s.* In the calculations above, it has been determined that, in the emergency situation under consideration, 1308.33 *m*^{3}*/s* of natural gas will leak into the work room. Due to the accumulation of gas in the area of the fans, they will expel almost pure gas from the room. This means that 1283 *m*^{3} of gas

will accumulate in the compressor room every second.

The compressor room has a volume of 11040 m^3. It is assumed that 20% of the volume of production premises is occupied by technological equipment. Then, the free volume of the room will be 8832 m^3. In the analysis above, a stoichiometric concentration of natural gas combustion of 9.42 % vol. has been determined. To form a concentration equal to the stoichiometric one, there must be 8832.9,42/100 = 832 m^3 of gas in the compressor room.

This amount will accumulate in the room in 832/1283 = 0.65 s.

With a ratio of uneven distribution of gas in the volume of the room equal to 0.5, the time for the formation of a concentration equal to the stoichiometric one will increase by 2 times, i.e. for about 1 s. after the accident, the average volume concentration of gas in the compressor room will be equal to the stoichiometric concentration.

Detonation combustion, although of lesser consequences, will occur whenever the gas concentration is between the lower and upper detonation limits of the gas.

The values of these limits determined in the above calculations are:

• Lower detonation limit: 5.33 [%vol.];

• Upper detonation limit: 14.73 [%vol.].

A concentration equal to the lower limit in the compressor room will be created after 0.74 s, and a concentration equal to the upper limit – 2 s after the start of the leakage.

Therefore, in the considered emergency situation, the period up to the 2nd second after the start of the leakage is dangerous from the point of view of occurrence of detonation combustion in the compressor room. If a source of ignition appears in the room during this period, an explosion caused by the detonation combustion of the combustible mixture will follow. At a gas concentration equal to the stoichiometric one, the overpressure created as a result of the explosion can be determined by the equation:

$$\Delta P = 100 \frac{(P_{\text{ВЗР}} - P_0) m_{\text{ГВ}}}{V_{CB} \rho_{\text{ГВ}} C_{\text{СТЕХ}}} Z \frac{1}{K_{\text{ХЕР}}}$$

where:

- ΔP - overpressure in the room, *MPa;*
- $P_{ВЗР}$ - maximum explosion pressure of the explosive mixture, equal to 0.72 *MPa;*
- P_0 - atmospheric pressure, which for the UGS region at an altitude of 269 *m* is about 0.098 MPa;
- $m_{ГВ}$ - mass of the combustible substance, *kg;*
- $V_{св}$ - free volume of the room, equal to 8832 m^3;
- ρгв - gas density equal to 0.7371 kg/m^3;
- $C_{СТЕХ}$ - stoichiometric concentration of natural gas combustion, equal to 9.42 % vol.;
- Z - coefficient of gas participation in the combustion process, which for combustible gases is assumed to be equal to 0.5;
- $K_{ХЕР}$ - coefficient of leak tightness of the room, which for glazed working rooms has a value of 5.

The mass of the combustible substance is a product of the volume of gas needed to create a stoichiometric concentration in the working room *(832 m^3)* and its density -

832.0,7371 = 613,3 *kg.* Then the resulting overpressure in the room will be 0.104 MPa or 104 *kPa.*

In order to protect the structure of the compressor room from destruction in the event of a gas-air mixture explosion, the building is equipped with blast openings - glazing on the two long walls. The area of the blast openings of the compressor room meets the regulatory requirements.

It is obvious that the overpressure generated during a natural gas explosion in the compressor room will lead to the destruction of the non-bearing structures and part of the technological machines, apparatuses and pipelines. After the accident, the room will have to be restored. The consequences for people can be assessed on the basis of the generally accepted criteria, namely:

- Minor injuries: ΔP_{Φ} = 20 - 40 *kPa.* They are characterized by rapidly passing disorders of the body functions - dizziness, tinnitus, headache. Sprains and superficial injuries are possible.

- Medium injuries: ΔP_{Φ} = 40 - 60 *kPa.* These most often consist of sprained joints, brain concussion, damage to the hearing system, bleeding from the nose and ears.

- Severe injuries: $\Delta P_{\Phi} \geq 60$ *kPa.* This type of damage is characterized by severe contusions of the entire organism, loss of consciousness, broken bones, bleeding from the nose and ears, damage to internal organs is possible.

- Fatal injuries: $\Delta P_{\Phi} \geq 100$ *kPa.* These are characterized by rupture of internal organs - liver, kidneys, spleen, lungs, etc., which usually lead to death.

The conclusion is that the people in the compressor room will most likely die. Moreover, the explosion will occur practically immediately after the connection is ruptured, and people will not be able to evacuate in such a short time.

Explosion of a gas-air mixture during gas leakage as a result of an accident involving the gas connections of the new compressors:

Immediately after the connection is ruptured, the escaping natural gas, being lighter than air, will rise in height and dissipate into the atmospheric air. After the gas sensors activate, the automatic cut-offs will stop the flow of natural gas to the compressors.

The new GTCU will be located outdoors, therefore blast wave calculations in the compressor room are not applicable. For the purposes of this assessment, the software product ALOHA *(Aerial Location Of Hazardous Atmosphere - version 5.4.7),* developed by the Environmental Protection Agency of the USA, will be used. The program allows the simulation of blast waves in the case of direct release of natural gas.

In accordance with the accident analyses for the existing compressor room and the capabilities of the ALOHA software product, the consequences for people have been recalculated from *kPa* to *psi (lbf/in^2):*

- Minor injuries: ΔP_{Φ} = 2.9 - *5.8 psi;*

- Medium injuries: ΔP_{Φ} = 5.8 - 8.7 *psi;*

- Severe injuries: $\Delta P_{\Phi} \geq$ 8.7 *psi;*

- Fatal injuries: $\Delta P_{\Phi} \geq$ 14.5 *psi.*

A rupture of a gas connection with a new compressor unit is examined, as a result of which 916 *t/s (1308.33 Nm^3/s)* of natural gas are released into the environment - under open field conditions.

A summary of the input data used in the simulation and the results obtained are presented below:

SITE DATA:
Location: BULGARIA, CHIREN
Building Air Exchanges Per Hour: 0.36 (unsheltered single storied
Time: November 5, 2021 1637 hours ST (using computer's clock)
CHEMICAL DATA
Chemical Name: METHANE
CAS Number: 74-82-8 Molecular Weight: 16.04 g/mol
PAC-1: 65000 ppm PAC-2: 230000 ppm PAC-3 : 400000 ppm
LEL: 50000 ppm UEL: 150000 pp
Ambient Boiling Point: -161.9° C
Vapour Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%
ATMOSPHERIC DATA: (MANUAL INPUT OF DATA
Wind: 2 meters/second from W at 10 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 20° C Stability Class: B
No Inversion Height Relative Humidity: 50%
SOURCE STRENGTH:
Direct Source: 916 tonnes/sec Source Height: 0
Release Duration: 10 minutes
Release Rate: 49,900,000 kilograms/min
Total Amount Released: 4.99e+008 kilograms
Note: This chemical may flash boil and/or result in two phase flow.
Use both dispersion modules to investigate its potential behaviour.
THREAT ZONE:
Threat Modelled: Overpressure (blast force) from vapour cloud explosion
Type of Ignition: ignited by spark or flame
Level of Congestion: uncongested
Model Run: Gaussian
Red: LOC was never exceeded — (8.7 psi)
Orange: LOC was never exceeded — (5.8 psi)
Yellow: LOC was never exceeded — (2.9 psi)

The simulation shows that in the event of a gas connection accident of the new compressor units, which will be located outdoors, there are no conditions for an explosion of the natural gas released into the environment.

Flaring of the gas at the point of leakage:

The occurrence of flaring at the place of the accident is very likely, because the presence of sources of ignition *(primarily the already mentioned short circuits)* will lead to the ignition of the gas leaking from the destroyed pipelines. Flaring may occur in several places if gas pipelines other than those of the connection are also destroyed during the explosion. The largest parameters of the flare will be when the gas flowing from the pipeline feeding the compressors is ignited. The impact factors of the flare are determined according to the methodology described above for drilling.

At Q_{Φ} = 19.5E+06 *J/m².h* (the value dangerous for humans) - r = 36.3 m.
The safe distance for people with an unlimited time of stay will be 56.4 *m.*

Figure II.3.2-4 Flaring hazard zone in an existing compressor room

Figure II.3.2-5 Flaring hazard zone in the area of new compressors

Summary assessment of the consequences of rupture of the gas connections of

the compressors:

The numerical modelling of the emergency situation involving the rupture of the gas connections of the compressors allows the following summary assessment of its consequences to be made:

The most likely causes that could lead to depressurization of the compressor gas connections and gas leakage are:

- A pressure increase above the permissible one due to violation of the material balance of gas compression;
- Defects in pipe material or welds;
- Occurrence of high temperature stresses in the places of the compressor connections;
- Corrosion of the connection pipes (e.g. in the presence of active impurities in the gas);
- Vibrations caused by the operation of compressors;
- External mechanical impact (e.g. when working with the overhead crane), etc.

The consequences of a potential rupture of the gas connections of some of the compressors will be:

- Construction structures and equipment located in the immediate vicinity of the connections *(below 2.5 m)* will be destroyed by the blast;
- Structures and equipment located within a radius of 5 m from the epicentre of the explosion will be severely damaged.
- In a radius of 10 m from the epicentre, the glazing of the compressor room will be destroyed;
- The explosion caused by the rupture of one of the compressor connections will not lead to damage outside the room *(in the case of an accident at the existing site)* or to other installations near the new compressor units *(in the case of an accident with the new GTCU on the territory of the extension of the production site).*

After the eventual rupture of one of the gas connections, there will be an uncontrolled gas leak in the compressor room *(in the event of an accident in an existing CR)* or in the environment (*in the event of an accident in the area of the new compressors)* from the connected pipelines.

In the given emergency situation, 1308.33 Nm^3 of natural gas will leak every second in the working room of the compressor department or in the environment.

The most likely source of ignition of the gas leaking from the pipelines will be the short circuits in the electrical installations damaged by the physical explosion.

The area of the glazing of the compressor room is sufficient to preserve the integrity of the main supporting structures of the building in the event of a natural gas explosion in it. The resulting overpressure during a natural gas explosion in the compressor room will lead to the destruction of the non-bearing structures and part of the technological machines, apparatuses and pipelines. After the accident, the room will have to be restored. Most likely, the people present at the time of the explosion in the compressor department will die. Moreover, the explosion will occur practically immediately after the connection is ruptured, and people will not be able to evacuate in such a short time.

In the event of an explosion in the area of the new compressors, it is possible that there will be damage to the life and health of people who are outdoors in the vicinity of the accident.

In the event of flaring in the compressor department, caused by a gas leak as a result of the rupture of the connections of one of the compressors, all combustible elements

of the building and compressor department equipment located at a distance of less than 22 m from the flare will self-ignite under the action of thermal radiation for 15 minutes. In this accident, it is possible that the shift workers in the compressor department - up to 4 people – will die.

In the event of flaring in the area of the new compressors, which will be located outdoors, the safe distance for people is 56.4 m. If there are people working outdoors within a radius of 36.3 m from the damaged compressor, it is possible that there will be a fatal outcome for the people exposed to the thermal radiation.

- **Accident in the gas drying installation:**

Accidents that are identical both for the existing site and for the extension, after the implementation of the IP, will be examined below:

Analysis of the causes of loss of containment of the gas drying installation

The reasons that can lead to loss of containment of the gas drying installation are relatively few. The most likely of them are:

- Sabotage;
- External mechanical impact;
- Internal corrosion of equipment, etc.

With the high pressure and temperature in the column, not only corrosion from the interaction of moisture with the material of the column and pipelines, but also hydrogen corrosion from the interaction of methane with the steel is possible.

Action of the shock wave in the event of a physical explosion:

An emergency situation is examined, in which the pipeline for removing the gas from the absorption column is ruptured. A rupture of the 10 m long pipeline is assumed. Given the high pressure in the pipeline (55 bar), the rupture will proceed as a physical explosion.

Table II.3.2-20 Parameters of the air shock wave in the event of rupture of the natural gas extraction pipeline

Diameter of the gas pipeline	D_gpr. m	0.5
Length of the ruptured section	L, m	10
Volume of the ruptured area	V, m^3	1.964
Radius of the sphere with a volume equal to the volume of the ruptured section	R, m	0.777
Blast energy	E, MJ	15.593
AIR SHOCK WAVE PARAMETERS		
Radius of the reduced spherical wave	r_0, m	0.777
Air shock wave front pressure	Ps, MPa	0.60
Air shock wave front overpressure	Δp, Mpa	0.50
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.001495
At a distance of 5 times the radius of the reduced spherical wave	$5r_0$, m	3,884

Air shock wave front pressure	Ps, MPa	0.19
Air shock wave front overpressure	Δp, Mpa	0.09
Pressure pulse at the front of the air shock wave	i, Mpa.s	0.000208
At a distance of 10 times the radius of the reduced spherical wave	$10r_{0,}$ m	7.768
Air shock wave front pressure	Ps, MPa	0.13
Air shock wave front overpressure	Δp, Mpa	0.03
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000053
At a distance of 15 times the radius of the reduced spherical wave	$15r_0$, m	11.652
Air shock wave front pressure	Ps, MPa	0.12
Air shock wave front overpressure	Δp, Mpa	0.02
Pressure impulse at the front of the air shock wave	i, Mpa.s	0.000037
At a distance of 20 times the radius of the reduced spherical wave	$20r_{0,}$ m	15.536
Air shock wave front pressure	Ps, MPa	0.11
Air shock wave front overpressure	Δp, Mpa	0.01
Pressure pulse at the front of the air shock wave	i, Mpa.s	0.000030

Table II.3.2-21 SW overpressure as a function of distance from the epicentre

Distance from the epicentre [m]	0.78	3.88	7.77	11.65	15.54
SW overpressure [kPa]	500	70	30	20	10

The data from the table are described by the equation: $\Delta P\Phi = 378{,}3.r^{-1.2585}$

The table below shows the distances from the ruptured pipeline to the neighbouring facilities and buildings, as well as the value of the overpressure of the shock wave when it reaches the corresponding object, calculated by the above equation. Damage to other buildings and facilities around the gas drying installation is not considered, because the overpressure of the shock wave when it reaches these objects will be below 10 *kPa,* which would at most result in breakage of the buildings' glazing.

Table II.3.2-22 Distance to adjacent facilities at the existing site and SW overpressure

Adjacent facility	Distance from the epicentre m	SW overpressure kPa
Operational absorption column	2	158.1

Non-operational absorption column	4	66.1
Overhead pipeline with a length of 5 m	7	32.7
Metering and Checking Equipment and Automation (MCEA) Building	11	18.5
Triethylene glycol (TEG) regeneration installation	14	13.7
Furnace of the TEG regeneration installation	17	10.7

Table II.3.2-23 Distance to adjacent facilities at the new site and SW overpressure

Adjacent facility	Distance from the epicentre m	SW overpressure kPa
TEG regeneration installation	7	32.7
General separation	7	32.7
Emergency diesel generator	18	10
Separation of layered fluids	35	4.3
Production energy unit	37	4
Gas heating installation	45	3.1
New GTCU	70	1.8
Above-ground methanol tank	160	0.6

Table II.3.2-24 Resistance of technological equipment and facilities to the SW action

Name of the equipment or facility	Shock wave overpressure [kPa]				
	Full destruction	Strong damage	Medium damage	Weak damage	Failures
Vertical column apparatus	>80	80-60	60-30	30-10	<10
Compressors	>70	70-50	50-30	30-20	<20

Technological pipelines	>60	60-40	40-30	30-20	<20
Upper-header pipelines with a height of 4-5 m	>60	60-35	35-25	25-20	<20
Gas burning torch	>55	55-40	40-30	30-15	<15
Horizontal overhead cylindrical apparatus	>80	80-60	60-30	30-10	<10

Table II.3.2-25 Radii of the damage zones for people outdoors

Degree of damage	Overpressure kPa	Distance from the epicentre m
Deadly	>100	2.87
Heavy	60-100	2.87-4.32
Medium	40-60	4.32-5.97
Minor	20-40	5.97-10.36
No damage	<10	>18

It can be concluded that people located less than 18 m away from the epicentre of the blast will receive different degrees of damage according to the data for the distances from the epicentre of the blast given in the table.

Comparing the data from Table II.3.2-22 to Table II.3.2-24 above allows to estimate the degrees of destruction that will be received by the adjacent apparatuses and pipelines:

In the event of an accident at the existing site:

- The operational absorption column will suffer complete destruction.
- It is most likely that it will be depressurized and even thrown away by the blast. In this case, it is possible that hot triethylene glycol will be dispersed at large distances away from the site of the accident;
- The non-operational column (at the old site) will suffer damage on the borderline between the medium and strong degree. They will most likely consist in the deformation of the column and its associated pipelines;
- Deformation and even depressurization of the 5 m long overhead pipeline is possible;
- The TEG regeneration installation and its associated furnace will suffer slight destruction, consisting in the destruction of the thermal insulation and damage to the metering and checking and automation equipment.

A mathematical analysis has been carried out on the resistance of the control room of the installation to the action of the shock wave, on the basis of which it has been determined that, as a result of the physical explosion in the event of the extraction pipeline rupture, the control room of the natural gas drying installation would suffer damage, consisting in broken glazing, dented door and window frames, cracks in the plaster and damage to the roof. People inside the building may suffer minor injuries and lacerations from the broken glass.

In the event of an accident at the production site extension:

- the TEG regeneration and general separation installation will be subjected to a medium

degree of destruction;

- the other installations in the area may be damaged, without danger of destruction.

The danger to people in the open air during the explosion has been determined according to the methodology described above for a drilling accident. The consequences for people of the action of the overpressure of the shock wave are given in the following table:

Modelling of the gas leakage process:

The flow from a gas pipeline with the following technological characteristics: diameter – d = 500 *mm,* natural gas pressure -*p* = 5.5 *MPa,* and natural gas temperature – T = 293 K, also obeys the dependencies described for an isentropic flow. For these conditions, using the *ThermoFluids* software product, the gas density in the gas pipeline has been determined p = 40.095 kg/m^3 and the adiabatic index *k* = 1.362.

The determination of the parameters of the leaking natural gas is in accordance with the formulas presented above - *Modelling of the process of gas leakage during well depressurization.* The thermodynamic parameters of natural gas when it flows out of a gas pipeline with a diameter of 500 *mm,* a pressure of 5.5 *MPa* and a temperature of 293 K are presented in Table II.3.2-26.

Table II.3.2-26 Thermodynamic parameters of the gas

f_{kp}, m^2	T_{kp}, K	p_{kp}, MPa	ρ_{kp}, kg/m^3	W_{kp}, m/s	M, kg/s
0.196	248.04	2.941	25.323	397.8	1977.83

Likely sources of ignition:

The most likely source of ignition of the natural gas released in the accident is the triethylene glycol regeneration furnace. It is located near the place of the accident, and in the presence of wind in the direction of the furnace, the leaking gas may ignite. Both the burner of the furnace and its components heated to a high temperature can act as a source of ignition. To the extent that the escaping gas will rise in height, a short circuit in a lighting fixture destroyed by the explosion on the electric mast located near the absorption column may also act as a source of ignition. The remaining sources of ignition are more or less accidental in nature - carrying out fire works at the time of the accident, using spark-hazardous tools when trying to stop the leakage, static electricity on the body and clothing of service personnel, etc.

Flaring of the gas at the point of leakage

The methodology for a drilling accident described above will also be used to determine the damaging factors in a flaring event resulting from the loss of containment of the natural gas pipeline to the absorption column.

The inner diameter of the pipeline is 500 *mm.* With this diameter, the flaring parameters will be:

- Flaring height - $H\Phi = 118.d_{TP} = 118x0.5 = 59$ m;

- Flaring diameter - $D\Phi = 0,15. H\Phi = 0.15x59 = 8.85$ m;

- Height of the jet from the place of gas outflow to the lower end of the flare - $H_{CTR} = 5. d_{TP} = 5x0.5 = 2.5$ *m.*

If the rupture is at the height of the flange, this means that the flare will start at a height of about 5 - 6 m above the ground level.

Gas consumption will be:

$$V_{\text{ф}} = 16.7.H_{\Phi}^{2.5} = 16.7\,.59^{2.5} = 446526\ m^3/h$$

The amount of heat given off by the flame will be:

$$Q_{\text{П}} = \beta.Q_{\text{Д}}.V_{\Phi} = 0.8\text{x}36\text{x}10^6\text{x}446525 = 1.29\text{E+}13\ J/h.$$

At Q_{Φ} = 19.5E+06 *J/m².h (the value dangerous for humans)* → r = 102 m.

At Q_{Φ} = 55E+06 *J/m².h (the value dangerous for combustible plastics)* → r = 60.8 m.

The safe distance for people with an unlimited time of stay will be 214 m.

The calculations made regarding the safe distances for flaring in the case of gas leakage from the pipeline in the gas drying installation give reason to draw the following conclusions:

- The flare, formed by gas leakage from the ruptured pipeline, will start at approximately 5 m above the ground and will be about 59 m high;
- People engaged in actions to stop the leak must be equipped with special protective equipment for the heat of the flare;
- People without protective equipment for the thermal radiation must be kept away from the pipeline at a distance of at least 215 m;
- A serious hazard from the thermal radiation of the flare exists for people at a distance of less than 102 m;
- The dangerous distance as regards the ignition of combustible materials from the point of leakage is about 61 m.

Figure II.3.2-6 Flaring hazard zone in an existing gas drying installation

Summary assessment of the consequences:

The reasons that can lead to the loss of containment of the gas drying installation are relatively few. The most likely of them are:

- Sabotage;
- External mechanical impact;

- Internal corrosion of equipment, etc.

In the event of a physical explosion resulting from the rupture of the pipeline for removing the gas from the absorption column, the adjacent equipment and pipelines and the people nearby will suffer the following damages:

In the event of an accident at the existing site:

- The operational absorption column will suffer complete destruction.
- It is most likely that it will be depressurized and even thrown away by the blast. In this case, it is possible that hot triethylene glycol will be dispersed at large distances away from the site of the accident;
- The non-operational column will suffer damage on the borderline between the medium and strong degree. They will most likely consist in the deformation of the column and its associated pipelines;
- Deformation and even depressurization of the 5 m long overhead pipeline is possible;
- The TEG regeneration installation and its associated furnace will suffer slight destruction, consisting in the destruction of the thermal insulation and damage to the metering and checking and automation equipment.
- The associated building of the installation will suffer damage, consisting in broken glazing, dented door and window frames, cracks in the plaster and damage to the roof;
- People inside the building may suffer minor injuries and lacerations from the broken glazing;
- People in the open air less than 18 m away from the epicentre of the blast will suffer various injuries, and those less than 3 m away will die.

In the event of an accident at the production site extension:

- the TEG regeneration and general separation installation will be subjected to a medium degree of destruction;
- the other installations in the area may be damaged, without danger of destruction.
- people in the open air less than 18 m away from the epicentre of the blast will suffer various injuries, and those less than 3 m away will die.

Gas will flow out of the depressurized pipeline with a flow rate of 1978 *kg/s.* The most likely source of ignition of the natural gas released in the accident is the triethylene glycol regeneration furnace. It is located near the site of the accident *(applies to the new and existing site)* and in the presence of wind in the direction of the furnace, the leaking gas may ignite.

The parameters of the possible flaring and its consequences will be the following:

- The flare, formed by gas leakage from the ruptured pipeline, will start at approximately 5 m above the ground and will be about 59 m high;
- People engaged in actions to stop the leak must be equipped with special protective equipment for the heat of the flare;
- People without protective equipment for the thermal radiation must be kept away from the pipeline at a distance of at least 215 m;
- A serious hazard from the thermal radiation of the flare exists for people at a distance of less than 102 m;
- The dangerous distance as regards the ignition of combustible materials from the point of leakage is about 61 m.

Figure II.3.2-7 Flaring hazard zone in the new gas drying installation

SCENARIO 2 – ACCIDENT INVOLVING THE METHANOL TANK:

In an emergency situation involving a tank storing flammable HCS, the following results may occur due to the leakage of the substance:

- Exposure to harmful substances;
- Environmental pollution;
- Puddle fire – in the event of ignition of the substance that has leaked into the casing;
- Fireball/ BLEVE cloud formation with explosive concentration and ignition.

The most severe accident scenarios will be examined below:

- rupture of a methanol tank at the existing site – FL warehouse with a volume of 250 m^3 with a subsequent puddle fire;
- rupture of the two containers of the new methanol tank located at the extension of the production site, with a volume of 30 m^3 with a subsequent puddle fire *(only in the event of sabotage/intentional rupture of the double-walled tank);*
- a fireball of 100% of the substance stored in a methanol tank.

➢ **Puddle fire:**

Accident analyses will be performed using the ALOHA *(Aerial Location Of Hazardous Atmosphere - version 5.4.7)* software product developed by the Environmental Protection Agency of the USA.

The mapping of the emergency zones on a satellite image of the area has been made using the Aloha emergency situation mapping option in the Google Earth program.

Rupture of a methanol tank with a capacity of 250 m^3 (197.5 t) and a puddle fire – FL warehouse:

A rupture of a tank (*a standard opening – 10 cm*) is considered, as a result of which methanol leaks into the casing with the burning liquid.

A summary of the input data used in the simulation and the results obtained are as follows:

SITE DATA:

Location: BULGARIA, CHIREN
Building Air Exchanges Per Hour: 0.36 (unsheltered single storied)
Time: October 31, 2021 1636 hours ST (using computer's clock)
CHEMICAL DATA:
Chemical Name: METHANOL
CAS Number: 67-56-1 Molecular Weight: 32.04 g/mol
AEGL-1 (60 min): 530 ppm AEGL-2 (60 min): 2100 ppm AEGL-3 (60 min): 7200 ppm
IDLH: 6000 ppm LEL: 71800 ppm UEL: 365000 ppm
Ambient Boiling Point: 63.7° C
Vapour Pressure at Ambient Temperature: 0.13 atm
Ambient Saturation Concentration: 131,272 ppm or 13.1%
ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 2 meters/second from W at 10 meters
Ground Roughness: open country Cloud Cover: 5 tenth
Air Temperature: 20° C Stability Class: B
No Inversion Height Relative Humidity: 50%
SOURCE STRENGTH:
Leak from a hole in a vertical cylindrical tank
Flammable chemical is burning as it escapes from the tank
Tank Diameter: 7.1 meters Tank Length: 6.3 meters
Tank volume: 249 cubic meters
Tank contains liquid Internal Temperature: 20° C
Chemical Mass in Tank: 197.5 tonnes Tank is 91% full
Circular Opening Diameter: 10 centimetres
Opening is 0 meters from tank bottom
Max Flame Length: 11 meters
Burn Duration: ALOHA limited the duration to 1 hour
Max Burn Rate: 365 kilograms/min
Total Amount Burned: 20,475 kilograms
Note: The chemical escaped as a liquid and formed a burning puddle.
The puddle spread to a diameter of 22 meters.
THREAT ZONE:
Threat Modelled: Thermal radiation from a pool fire
Red: 19 meters — (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: 25 meters — (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: 37 meters — (2.0 kW/(sq m) = pain within 60 sec)

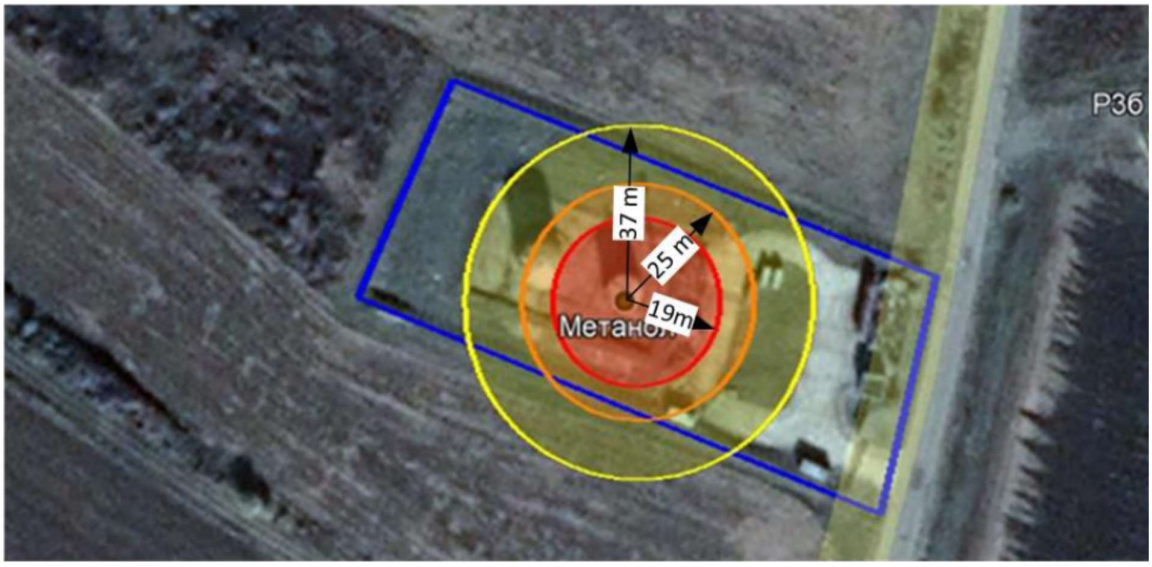


Figure II.3.2-8 Puddle fire in a tank storing 197.5 t of methanol

In the event of a puddle fire, the damage zones affect only the site of Bulgartransgaz EAD.

Rupture of a methanol tank with a capacity of 30 m^3 (23.7 t) and a puddle fire – the production site extension:

A rupture of the double-walled tank *(a standard opening - 10 cm)* during sabotage is considered, as a result of which methanol leaks onto the burning liquid area.

A summary of the input data used in the simulation and the results obtained are as follows:

SOURCE STRENGTH:

Leak from a hole in a horizontal cylindrical tank

Flammable chemical is burning as it escapes from the tank

Tank Diameter: 2.5 meters Tank Length: 6.68 meters

Tank Volume: 32.8 cubic meters

Tank contains liquid Internal Temperature: 20° C

Chemical Mass in Tank: 23.7 tonnes Tank is 83% full

Circular Opening Diameter: 10 centimetres

Opening is 0 meters from tank bottom

Max Flame Length: 11 meters

Burn Duration: ALOHA limited the duration to 1 hour

Max Burn Rate: 365 kilograms/min

Total Amount Burned: 20,475 kilograms

Note: The chemical escaped as a liquid and formed a burning puddle.

The puddle spread to a diameter of 22 meters.

THREAT ZONE:

Threat Modelled: Thermal radiation from a pool fire

Red: 18 meters — (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 25 meters — (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: 37 meters — (2.0 kW/(sq m) = pain within 60 sec)

Figure II.3.2-9 Puddle fire in a tank storing 23.7 t of methanol

In the event of a puddle fire, the damage zones affect only the site of Bulgartransgaz EAD.

- **BLEVE/Boiling Methanol Fuel Vapour Explosion/Fireball:**

Fireball of a methanol tank with a capacity of 250 m^3 *(197.5 t):*

An emergency situation involving a tank with 197.5 tonnes of methanol accompanied by a fireball is considered.

Presented below are the input and output data from the ALOHA software product for the modelling of a fireball in the event of a tank accident:

SOURCE STRENGTH:

BLEVE of a flammable liquid in a vertical cylindrical tank

Tank Diameter: 7.1 meters Tank Length: 6.3 meter

Tank volume: 249 cubic meters

Tank contains a liquid

Internal Storage Temperature: 20° C

Chemical Mass in Tank: 197.5 tonnes Tank is 91% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 327 meters Burn Duration: 19 seconds

THREAT ZONE:

Threat Modelled: Thermal radiation from a fireball

Red: 463 meters — (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 670 meters — (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 1.1 kilometres — (2.0 kW/ (sq m) = pain within 60 sec)

From the data, it can be seen that the fireball will have a height of 327 m, and its duration will be 19 seconds.

It is important to note here that the damage zones are for 60-second exposure cases, resulting in the need to recalculate the thermal radiation values to a 19-second exposure.

For the purposes of recalculations, the following source of information was used: "Methods of approximation and determination of human vulnerability for offshore major accident hazard assessment", developed by the Health and Safety Executive - http://www.hse.gov.uk/aboutus/ index.htm. The following effects on humans are assumed depending on the dose of thermal exposure expressed in: [(kW/m ^{2}) $^{4/3}$ seconds]:

Table II-27 Ranges of thermal effects

Parameters	Effects of thermal impact		
	II degree burns	III degree burns	50% mortality rate
Average dose of thermal impact [(kW/m^2)$^{4/3}$ seconds]	815	1505	3100
Thermal impact at 19-second exposure [kW/m^2]	16.5	27	45.5

The recalculated radiation emission values *(in kW/m^2)* depending on the dose of thermal impact, for a 19-second exposure, are as follows:

- at 16.5 kW/m ^{2} and exposure duration of 19 seconds – it causes second degree burns;
- at 27 kW/m^2 – it causes third degree burns;
- at 45.5 kW/m^2 - 50% likelihood of death.

The areas in which consequences for the life and health of humans can be expected: second and third degree burns, at the BLEVE of a tank with 197.5 tonnes of methanol, at 19 seconds of exposure, are as follows:

SOURCE STRENGTH:

BLEVE of a flammable liquid in a vertical cylindrical tank

Tank Diameter: 7.1 meters Tank Length: 6.3 meters

Tank Volume: 249 cubic meters

Tank contains a liquid

Internal Storage Temperature: 20° C

Chemical Mass in Tank: 197.5 tonnes Tank is 91% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 327 meters Burn Duration: 19 seconds

THREAT ZONE:

Threat Modelled: Thermal radiation from a fireball

Red: 242 meters — (27 kW/(sq m))

Orange: 344 meters — (16.5 kW/(sq m))

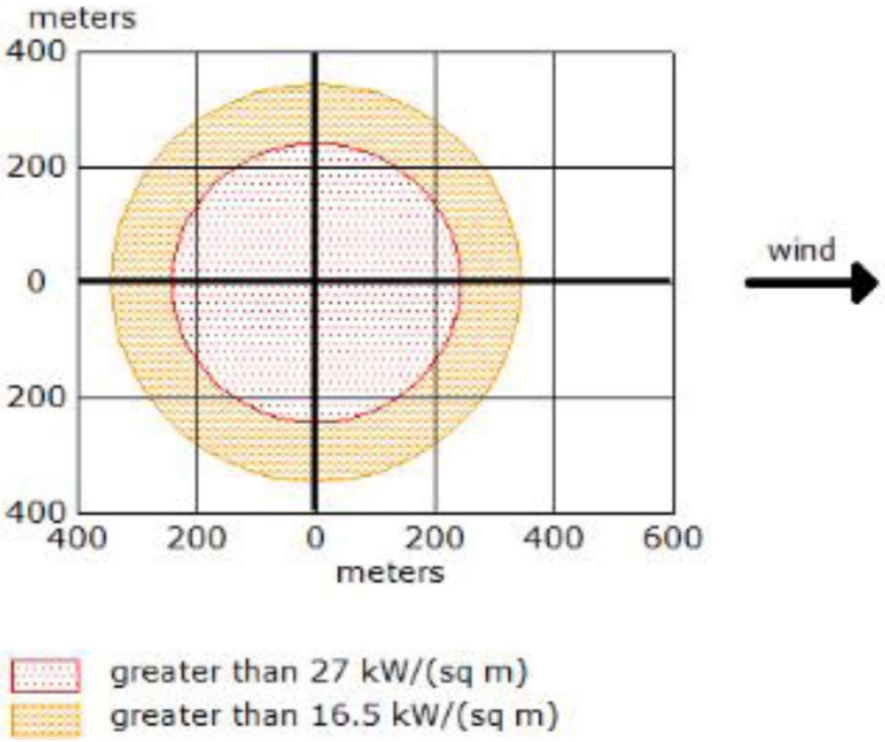


Figure II.3.2-10 ALOHA simulation of a fireball involving 197.5 t of methanol at thermal doses recalculated for a 19-second exposure

The program does not allow calculation of the first zone - a zone with thermal radiation above 45.5 kW/m^2, where 50% mortality can be expected.

Presented below are the zones in which permanent damage to the life and health of people in the open air is expected - the first one in the form of a circle with a radius of 242 m *(the zone in which third degree burns are expected - the red circle in **Figure II.3.2-11***), the second one with a radius of 344 m *(the zone with second degree burns - the orange circle in **Figure II.3.2-11**)*

Figure II.3.2-11 Fireball damage zones involving 197.5 t of methanol - FL warehouse

The damage zones extend beyond the boundaries of the establishment. The zones include the following facilities:

- zone 1 includes a section of the third-class road connecting the villages of Chiren and Devene and wells: P3, P3a, P3b and E73, and a small part of the site of the existing production site

- zone 2 includes part of the facilities falling within zone 1.

No outsiders are expected to be present in the damage zones. Sensitive public buildings and facilities are not affected.

Internal domino effects are not expected - 27 *kw/m²* of thermal radiation lasting 19 seconds is not likely to cause a critical increase in temperature in adjacent installations with HCS available.

Fireball in a methanol tank with a capacity of 30 m³ (23.7 t):

Presented below are the input and output data from the ALOHA software product for the modelling of a fireball in the event of a tank accident:

SOURCE STRENGTH:

BLEVE of a flammable liquid in a horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 6.68 meters

Tank Volume: 32.8 cubic meters

Tank contains a liquid

Internal Storage Temperature: 20° C

Chemical Mass in Tank: 23.7 tonnes Tank is 83% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 161 meters Burn Duration: 11 seconds

THREAT ZONE:

Threat Modelled: Thermal radiation from a fireball

Red: 237 meters — (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 342 meters — (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 540 meters — (2.0 kW/(sq m) = pain within 60 sec)

From the data, it can be seen that the fireball will have a height of 161 m, and its duration will be 11 seconds.

By analogy to the above scenario, below is a recalculation of the thermal radiation values to an 11-second exposure.

The recalculated values of the radiation emission *(in kW/m²)* depending on the dose of thermal impact, for an 11-second exposure, are as follows:

- at 20 *kW/m²* and exposure duration of 11 seconds – it causes second degree burns;

- at 31.5 *kW/m²* – it causes third degree burns;

- at 54 *kW/m²* - 50% likelihood of death.

The areas in which consequences for human life and health can be expected – second and third degree burns – in the event of a BLEVE of a tank with 23.7 *t* of methanol, at an 11-second exposure, are:

SOURCE STRENGTH:

BLEVE of a flammable liquid in a horizontal cylindrical tank
Tank Diameter: 2.5 meters Tank Length: 6.68 meters
Tank Volume: 32.8 cubic meters
Tank contains a liquid
Internal Storage Temperature: 20° C
Chemical Mass in Tank: 23.7 tonnes Tank is 83% full
Percentage of Tank Mass in Fireball: 100
Fireball Diameter: 161 meters Burn Duration: 11 seconds

THREAT ZONE:
Threat Modelled: Thermal radiation from a fireball
Red: 110 meters — (31.5 kW/(sq m))
Orange: 156 meters — (20 kW/(sq m))

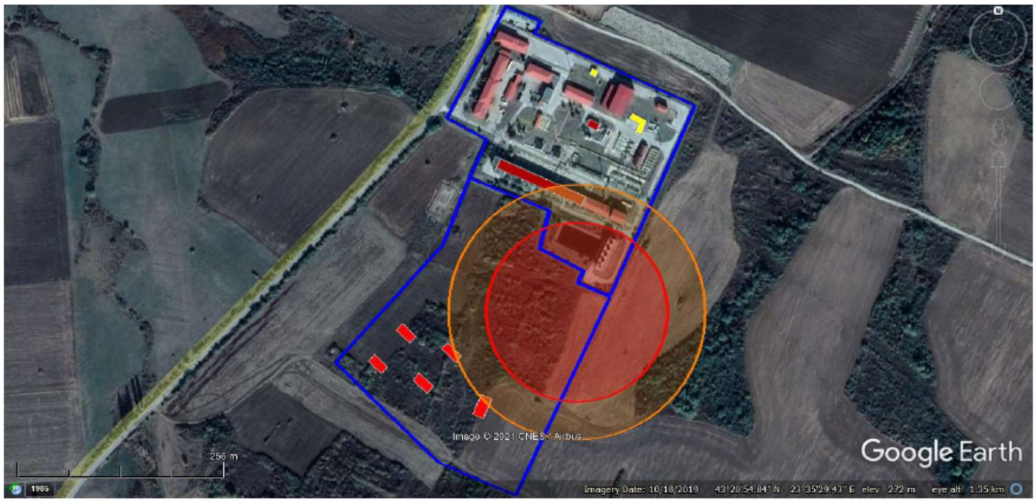


Figure II.3.2-12 Fireball damage zones involving 23.7 t of methanol - production site extension

The program does not allow calculation of the first zone - a zone with thermal radiation above 54 kW/m^2, where 50% mortality can be expected.

The damage zones include part of the site of Bulgartransgaz EAD and adjacent undeveloped land. No outsiders are expected to be present in the damage zones. Sensitive public buildings and facilities are not affected. If there are people outdoors, within a radius of 110 m of the tank, third-degree burns are expected, and within 110-156 m, second-degree burns.

Internal domino effects are not expected - 20 *kw/m^2* of thermal radiation lasting 11 seconds is not likely to cause a critical increase in temperature in adjacent installations with HCS available.

Scenario 3 - Toxic dispersion in the event of a methanol tank accident:

The worst possible scenarios will be considered:

- a loss of content event in an existing FL tank with a capacity of 250 *m^3 (197.5 t at a methanol density of 0.79 g/cm^3)* containing methanol that is toxic by inhalation *(acute toxicity, hazard category 3);*

- a loss of content event in a new methanol tank with a capacity of 30 *m^3 (23.7 t)* that will be available at the new production site.

For the purposes of calculating the safe limits in the event of a methanol accident, the emergency situation accompanied by toxic dispersion will be analysed using an established methodology.

It is most appropriate to use the *Methodology for rapid assessment of possible damages from a major accident involving hazardous chemical substances,* which was developed for the Italian Ministry of Civil Protection, 1994. The Methodology makes it possible to calculate the damage zones in the event of release of 197.5 *t* or 23.7 *t* of a toxic liquid regardless of exposure time.

For the purposes of the analysis, methanol is first classified into a specific hazard class according to Table 1 of the methodology. In the table, toxic liquids are classified into four separate hazard classes:

- low-toxic liquid;
- toxic liquid;
- highly toxic liquid;
- very highly toxic liquid.

As a criterion for classifying the toxicity of substances, the study of THO[2] is used.

To determine the toxicity of a given substance, the following parameters are determined:

- toxicity class
- volatility class

The toxicity index is based on the LC50 value *(concentration at which 50% of the exposed population dies within a certain period of time)* for a population of rats after a four-hour exposure. In accordance with the information from Pubchem *(https://pubchem.ncbi.nlm.nih.gov),* LC50 = 64000 *ppm* for rats, at a 4 hour exposure, toxicity class K_T = 2, respectively.

The second aspect to be analysed is the volatility of the substance, as this parameter gives information on the ability of the substance to be transmitted through the air *(to form a toxic cloud).*

Methanol is a liquid with a vapour pressure of 12.9 *kPa* or 0.129 bars at 20° C [3] *(volatility class Кл=2).*

Then K_T + Кл = 2 + 2 = 4 or methanol is classified into the low toxicity class *("Low-toxic liquid").*

According to the analysis above, methanol is classified as a ***"Low-toxic liquid"*** with a numerical code 16 *(toxic liquid - storage/tanks)* according to Table 1 and Table 2 of the Methodology for rapid assessment of possible damages from a major accident involving hazardous chemical substances. For the emergency situation involving less than 200 tonnes of methanol, according to Table 3 and Table 4 of the methodology, there are no designated emergency planning zones - it is considered that the damage zones are

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[2] *Guide for hazardous industrial activities* - THO study for the Ministry of the Interior of the Province of South Holland

[3] *Methodology for rapid assessment of possible damages from a major accident involving hazardous chemical substances. Italian Ministry of Civil Protection, 1994.*

negligibly small due to the small amount of the low-toxic liquid involved in the accident.

Domino effect:

From the scenarios considered above and the relevant impact zones, it can be concluded that there are no conditions for the occurrence of a "domino effect". Only in the event of an accident with flammable HCS and, more specifically, a BLEVE of a tank and a fireball, facilities containing HCS are reached but 20 *kw/m*^{2} of thermal radiation lasting 11 seconds is not likely to cause a critical increase in temperature in adjacent installations.

It is important to note here that the simulations above concern the theoretically worst case: a BLEVE and a fireball of 100% of the substance in the tank. Such an accident scenario is not realistic, as several conditions are necessary for a BLEVE to occur:

- a temperature above the flash point for the substance;

- presence of vapours of the flammable substance, which suggests that the accident is a consequence of a prolonged fire of the substance, which has led to boiling and concentration in a small volume of the vapours of the boiling fuel.

Realistically, a BLEVE and a fireball will involve significantly less than 100% of the fuel in the tank, but due to the lack of prediction methodology, accidents are represented in this way.

II. 3.2.4. Assessment of the severity of the consequences of a major accident

From the calculations of the worst case scenarios for accidents on the territory of Bulgartransgaz EAD, it can be concluded that no residential areas, sensitive public buildings, entertainment and recreational areas, important transport routes, protected territories or cultural and historical heritage sites will not be affected.

The territorial scope of the accident scenario under consideration is visualized on a map in point II.3.2.3.

In the event of an accident at the site of Bulgartransgaz EAD, only the life and health of employees of the company, who at the time of the accident are within the damage zone – up to 10 m – may be affected. Up to four employees may be within the damage zones.

In the event of an accident at the site of Bulgartransgaz EAD, no loss of human life, injuries or other consequences for the health are expected outside the territory of the site. The outer limits of the safe zone around the establishment do not affect other buildings *(residential, industrial, public, etc..),* installations and facilities of other operators.

In **point II.3.2.2,** the measures for preventing the occurrence of major accidents are presented. **In Section II. 4** the measures for limiting the consequences of possible accidents are described.

II.3.2.5. Preventive measures

Detailed information on the preventive measures that have been taken against the occurrence of emergency situations on the territory of the establishment is presented in **point II.3.2.2.**

According to the definition in item 29d, § 1 of the Supplementary Provisions of the EPA, ***the necessary measures for preventing major accidents*** are the technical, organizational and management measures necessary for the safe operation of the establishment. Based on this, in order to prevent, control and limit the consequences of a major accident on human health and the environment, Bulgartransgaz EAD implements the following measures:

1. Preventive activities to increase, improve and enhance the technological and

technical condition of the site, in order to prevent accidents.

2. Identification and assessment of hazards, assessment of the risk of major accidents and assessment of the consequences of accidents on people, facilities and the environment.

3. Ensuring compliance with all internal company rules, instructions and other documents in the operation and maintenance of the establishment.

4. Ensuring security and timely disclosure by the management in the event of emergency situations.

5. Staff training how to act in the event of disasters, accidents and catastrophes. [3]

6. Encouraging the staff to strictly observe the measures aimed at ensuring the safe operation of the facilities.

7. Staff training, briefings and drills for adequate and effective actions in emergency situations and elimination of the consequences of accidents. [3]

8. Implementation of strict control of all risky activities.

9. Control of the movement of motor vehicles in the area of the site of the establishment.

10. Implementation of a strict access regime by the site's security. [10]

11. Carrying out annual control measurements of the impedance of the phase - protective conductor loop. [8]

12. Carrying out annual measurements and maintaining the lightning protection grounding system. [8]

13. Carrying out periodic inspections of the serviceability of the fire-fighting equipment located on the territory of the establishment. [8]

14. Carrying out periodic inspections of the fire alarm installation. [8]

15. Carrying out periodic inspections of explosion-proof ventilation. [8]

16. Carrying out periodic controls of HCS tanks. [8]

17. Checks and controls of high-risk facilities (HRF)

and many others.

Periodically, different emergency situations are played out, in accordance with the emergency plan scenario, after which an analysis is made and, if necessary, improvement measures are taken. [3]

The following instructions have been drawn up and are followed, which ensures the maximum safety of the work process in the establishment: [4]

• <u>Fire safety instructions:</u>

- Instruction for ensuring fire safety in Bulgartransgaz EAD;

- Fire safety instruction for the maintenance of electrical, heating and ventilation installations;

- Instructions for control and maintenance of portable and transportable fire extinguishers

- Rules and norms for ensuring fire safety when performing fire and electric welding works with burners and other devices using flammable gases (FG) and flammable liquids (FL);

• <u>Instructions for the safe storage of HCS:</u>

- Instruction for the safe storage of fuels and lubricants;
- Instruction for the safe handling of methanol;
- Instruction for the safe handling of triethylene glycol;
- Instruction for the safe storage of hazardous chemical substances and mixtures on the territory of Chiren UGS;
- Instruction for the safe handling of gas condensate and protection of the environment against pollution;
- Instruction for the safe handling of natural gas;
• Instructions for safety and health at work:
- Instruction for ensuring fire safety (FS) on the territory of Bulgartransgaz EAD.

Annex 4 lists the instructions that are applied in the establishment.

II.3.3. Assessment of past accidents and incidents involving the same hazardous substances and processes, taking into account the lessons learned from them and making explicit reference to specific measures taken to prevent such accidents

In Bulgartransgaz EAD, there has been no emergency situation that has led to a "major accident" with severe consequences for people, facilities and the environment.

The European Commission's major accident reporting system (eMARS) has registered two incidents involving the release of natural gas from an underground storage..

Table II.3.3-1 Historical report on past accidents in underground natural gas storage facilities outside Bulgartransgaz EAD

Date and place	Activity	Circumstances	Reasons for the accident	Consequences and follow-up action
25.09.1989 Place: n. d.	Storage and wholesale and retail distribution of natural gas	During the replacement of a water filter of the gas injection system for underground storage of natural gas, control over the facility was lost. The gas pressure pushed the borehole interlock to 25 m and subsequently natural gas began to leak (without ignition) from the central zone of the system, initially at a flow rate of 100,000-150,000 m^3/h at 100-120 bars. Following the activation of internal and external emergency plans, the release was stopped with the assistance of a specialist contractor called by the	The reasons for the accident were not clarified.	No one died as a result of the accident.

		manufacturer. After covering the natural gas release source with sediment, the contractor returned the interlock to its original position by increasing the load on it.		
07.05.2003		A gas explosion followed by a fire and damage to equipment located above an underground natural gas storage facility. The explosion occurred in an room with electrical equipment located outside the gas zone, containing an automatic transfer collector control system. The explosion occurred during the extraction of gas from the storage facility. Employees equipped with self-contained breathing apparatuses quickly brought the fire under control with CO2 fire extinguishing equipment	An investigation revealed a gas leak in a dead-end line (DN50) connected to a DN150 branch and part of the purge circuit, which was partially dismantled in 1987. The gas probably reached the electrical equipment room via the cable wires. It is not known exactly for how long there has been a natural gas leak: the leak may have started long before the accident.	No one died as a result of the accident. Measures were introduced to improve the gas tightness of electrical equipment rooms. The incident led to the installation of a servo system that shuts down the electrical supply in the event of gas detection.

II.3.4. Description of the technical parameters and equipment used for the safe operation of facilities

The facilities that are important for the safe operation of the establishment are as follows:

- fire extinguishing/fire alarm installation
- gas signalling system for natural gas;
- control signalling devices in production installations;
- safety valves and fire barriers of natural gas facilities;
- lightning protection grounding system;
- sewerage system with a local domestic wastewater treatment plant (DWWTP) and 5 oil and sediment separators.

In the design of buildings, facilities and installations, the seismic characteristics of the area have been taken into account.

All facilities and installations on the territory of Chiren UGS are designed and built in

such a way as to comply with the requirements of the "Regulation on the structure and safe operation of gas transmission and distribution pipelines, facilities, installations and appliances for natural gas". In the dispatch centre, where 24-hour duty is ensured, the dispatcher on duty monitors the operation of all facilities and installations by means of the specially built and implemented information system. It is integrated with the WPS 32 information system in place in Bulgartransgaz EAD, which enables the dispatchers in the company's central dispatching office (CDO-Sofia) to also monitor the operation of the facilities and installations in Chiren UGS.

All facilities and installations on the UGS territory are equipped with safety fittings. Gas pipelines are designed and built in such a way as to ensure safe operation and controlled gas release during repairs. The pipes have a wall thickness sufficient to accommodate the internal gas pressures and the expected external pressures and loads to which the pipeline will be subjected during its operation. Gas pipelines, depending on the operating conditions, are checked for accommodating: internal pressure; anchoring or backfilling; pressure during the gas pipeline test and load from the mass of water; subsidence; soil swelling due to frost; load from landslide processes; seismic load for the relevant area; thermal expansion; soil erosion, etc.

The steel pipes of the gas pipelines, their chemical composition and mechanical characteristics, the initial determination of the wall thickness of the pipes, the design pressure and the maximum design coefficient for internal pressure are determined according to BDS EN 1594.

In 2004, well E-70 was put into operation, in 2008 - well E-71, and by the end of 2017, two more wells were put into operation: E-72 and E-73. The structure of inclined-directed boreholes is characterised by a new type of production and underground equipment, ensuring interruption of the gas flow in case of fire. An underground safety valve is included in the composition of the operating lift, which stops the flow of gas to the surface in case of destruction of the wellhead in emergency situations.

In 2003, the existing substation (built and equipped in the early 1980s as 20 kV switchgear) was completely reconstructed. 20 kV and 0.4 kV kiosk substations were built, with Merlin Gerin equipment. The equipment, as well as the installed transformers, do not contain polychlorinated biphenyls (PCB).

20 kV and 0.4 kV ALT (automatic load transfer) was built. The bus system from the transformers to the 0.4 kV substation is of a closed type. Software, electrical and mechanical interlocks are installed to prevent unauthorized switching, thus ensuring the safety of the service personnel. Switching from working to backup power takes about 4 seconds. In the 0.4 kV substation, a programmed automatic switch-on of an emergency gas unit is provided in the event that the power supply from the two transmission lines fails.

The emergency gas unit was put into operation at the beginning of 2010. The unit is designed to provide the necessary electricity to the existing installations in the event of emergency situations in which the voltage to the site of Chiren UGS fails.

The tests of the personal protective equipment, the measurements of the lightning protection and protective grounding system, the phase - protective conductor loop are carried out by an accredited laboratory, which is certified by the relevant inspection certificates.

The maintenance of electrical equipment is carried out in strict compliance with the requirements of:

1. "Rules for safety and health when working on electrical equipment with a voltage of

up to 1000 V" (Promulgated, SG No 21 of 11.03.2005).

2. "Rules for safety and health when working on electrical systems of electrical and heating plants and on electrical networks", (Promulgated, SG No 34 of 27.04.2004, in force from 28.08.2004).

Explosion-proof emergency lighting has been installed in the compressor department. An installation with 24V EX sockets has been built for explosion-proof mobile lamps used during machine inspections and repairs. New lighting and power installations have been designed and built in the administrative building and garages. All outlets are connected to current circuits with fault current protection set for a current of up to 30 *mA.* In this way, the danger of an accident in the event of damage to electrical cables connected to the power supply is significantly reduced.

All equipment, installations and gas pipelines are permanently marked (registration numbers, working pressure, pressure at which the safety fittings activate, etc.). The drilling sites, lifting units, unattended repeater sections (URS), CS are surrounded by fences to prevent encroachment, with warning and information signs being placed on the fences.

A fire-fighting ring of high density polyethylene pipes is in place. 9 self-draining hydrants are also installed so that the use of the fire-fighting ring does not depend on the ambient temperature. One operating and one backup pump with flow rates of 180 m^3/h automatically maintain a pressure of at least 0.4 *MPa* in the ring.

At the site of Chiren UGS, automatic systems with sensors for combustion, smoke and gas detectors at the places of potential sources of ignition and gassing, which are connected to notification systems, are in place.

Fire alarm and fire extinguishing systems on the existing site:

The fire alarm system is designed for early detection of a fire, indicating the exact location of the event by the address of the triggered detector. The use of modern technological solutions ensures high reliability and precision in fire protection.

A fire alarm system has been built on the territory of Chiren UGS with the aim of early detection of ignitions and fires in the Chiren UGS building stock and providing the relevant alarm. The fire alarm system is built on the basis of IRIS addressable panels, automatic addressable fire detectors and addressable manual buttons and covers all rooms except the wet ones (toilets, bathrooms, etc.). Security of the attic spaces is also implemented by means of optical smoke detectors located above the electrical cables and installed above the first ceiling.

The IRIS fire alarm system has a maximum coverage of 96 zones connected to 1 to 4 circuits. System status information is visualized on a sensitive graphic display with separate LED indication for zones and problems. The panel has a built-in real-time clock and the ability to program a day/night operating mode. False alarms are minimized by applying a special working algorithm called "Two levels of alarm status". Depending on the type of devices used, the IRIS panel supports operation with two communication protocols: System Sensor series (IRIS SS loop expander) and Teletek Electronics (IRIS TTE loop expander). In the IRIS panel configuration, both loop expanders can be connected at the same time.

The system constructed offer ample opportunity for set-up, testing and analysis. The control panel monitors the states (normal, fire, failure) of the address points and displays them on the LED indicator and liquid crystal display.

Control, programming and signalling is carried out on the front panel of the system, equipped with a LED indicator, liquid crystal display and touch keyboard.

The fire alarm installation in place is in accordance with the principles for early detection of ignitions and fires. Control of the condition and operability of all technical equipment and systems of the installation is foreseen at any time of the day. The technical implementation is in accordance with: the specific working conditions in the premises, the class of explosion protection, the degree of fire hazard, the environmental conditions and the presence of factors disturbing the operation of the installation, as well as the configuration and location of the facilities and the communications between them. Alarm is raised by means of internal and external sound and light signalling.

The fire alarm systems (FAS) are installed in the Dispatch Hall and the administrative building. A FAS repeater has been installed in the premises of the crossing point (CP) in order to ensure constant monitoring of the FAS.

The personnel on duty in the Dispatch Hall and CP carry out constant, round-the-clock monitoring of the fire alarm system.

Description of the fire alarm system of the building stock and command rooms at the existing site of Chiren UGS

Description	Type	Quantity (it.)
Fire control panel	IRIS	2
Panel repeater	IRIS RPT	1
Addressable optical smoke detector	SensoIRIS S130ISO	167
Addressable thermal detector	SensoIRIS T110ISO	13
Conventional thermal detector	Senso MAG R20	31
Conventional optical smoke detector	SensoMAG S30	16
Linear beam smoke detector	DOP6001	4
Reflector for a linear beam smoke detector	E39-R8	4
Addressable conventional zone module	SensoIRIS MC-Z	31
Addressable module with a potential outlet for conventional sirens	SensoIRIS MOUT	17
(IR3) detector	Spectrex 20/20I	4
Flame explosion-proof conventional detector	LITES Liberec MHG581	5
Flame explosion-proof conventional detector	Polon Alfa DUR 40-Ex	2
Thermal explosion-proof conventional detector	LITES Liberec MHG381	6
Thermal explosion-proof conventional detector	Polon Alfa TUN-38Ex	1
Addressable manual call point	MCP150	37
Sounder with built-in isolator module	SensoIRIS WSOU	4

	IS	
Outdoor siren with a LED flash light	SF300	20
Power supply unit	1.0A@24V PS 2410	20
Battery	SB 18-12 12 V/18Ah	3
Battery	SB 7-12 12 V/7Ah	20
Zener-diode barrier	MTL7787+	4
Explosion-proof manual call point	DMN700E - is	7
Explosion-proof manual call point	LITES Liberec	3

Chiren UGS fire alarm system
Schematic diagram

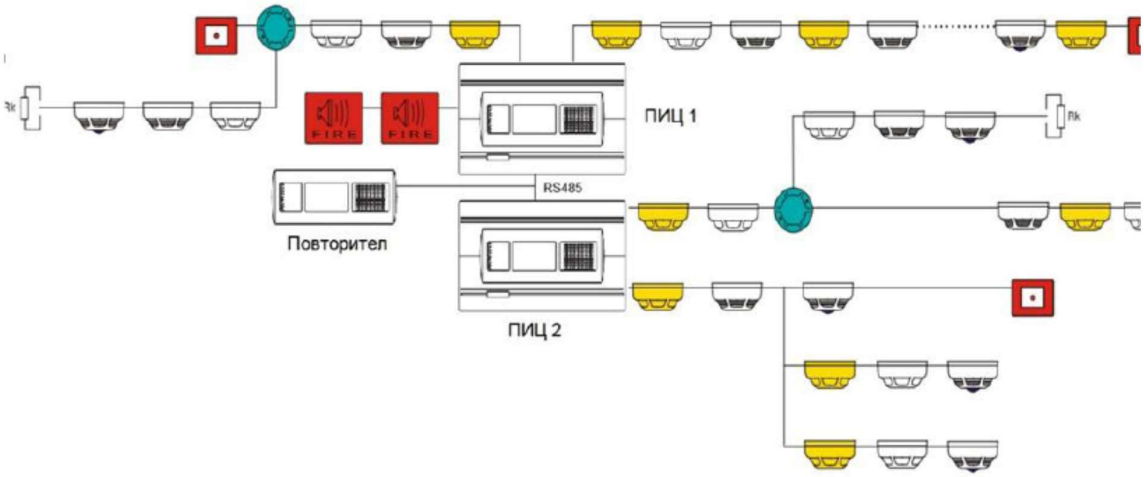

Figure II.3.4-1 Schematic diagram of the fire alarm system at the existing site of Chiren UGS

To ensure fire protection of the existing emergency gas unit, there is an automatic fire alarm and powder fire-extinguishing system equipped with a "**Sigma XT**" type control panel. The fire alarm system protects the room with two fire alarm beams using thermal fire detectors. The system can be switched into manual or automatic mode of operation. Fires are extinguished by automatic or manual spraying of BC 60 kg powder and nitrogen as a displacement agent. The system is under continuous control by the personnel on duty.

Description of the fire extinguishing system of the existing emergency gas-powered electric generator at Chiren UGS

Description	Quantity (pcs.)
Sigma XT K1 1031M2 fire alarm control panel	1
Thermal sensors	4

JBA-1EX zener-diode barrier, kit	2
MBF-6EV fire alarm bell	1
ROSHNI fire alarm sounder	1
SL-401 flash light	1
KS-02 "On/Off" switch for BC powder bottles	1
Fire extinguishing installation with ABC powder 60 kg and nitrogen as a displacement agent	1

Description of the available fire hydrants, fire cocks, portable and transportable fire extinguishers at the existing site of Chiren UGS:

1. **Description of the available extinguishing and cooling system in the FL warehouse.**

Description	Quantity (pcs.)
Stable generator for air-mechanical foam PGSV 120	1
Fire hydrants with couplings	4
Carriage nozzles	6

2. Description of the available portable and transportable fire extinguishers, fire cocks and fire hydrants at the existing site of Chiren UGS

Description	Type	Quantity (pcs.)
Fire extinguisher	Powder 1 kg	10
Fire extinguisher	Powder 2 kg	9
Fire extinguisher	Powder 6 kg	47
Fire extinguisher	Powder 12 kg	29
Transportable fire extinguisher	Powder 25 kg	6
Transportable fire extinguisher	Powder 50 kg	1
Fire extinguisher	CO2 - 3.5 kg	1
Fire extinguisher	CO2 - 5 kg	36
Transportable fire extinguisher	CO2 -17.5 kg	2
Transportable fire extinguisher	CO2 - 25 kg	2
Water-based fire extinguisher 9l.	for class B fires	23
Fire cock	flat hose	15

Fire hydrant	-	9

Activities during the periodic servicing of fire alarm system (FAS), fire extinguishing system (FES), fire cocks, fire hydrants and portable and transportable fire extinguishers by an external licensed company at the existing site of Chiren UGS.

The scope of activities that the contractor carries out during periodic servicing is in accordance with the operating instructions of each specific FAS and FES, fire cocks, fire hydrants, portable and transportable fire extinguishers and includes at least the following:

1. Checking the condition and operability of the FAS, FAS repeaters, sensors and connection lines between the sensors and the secondary devices. Cleaning of the sensors from layers of dust, moisture, etc.
2. Checking the condition and operability of the FES, the connection lines between the command devices.
3. Simulative actuation of each sensor with a device for controlled setting of the necessary parameter of the FAS.
4. Performing all the necessary settings of the FAS and FES.
5. Checking the condition and serviceability of fire cocks (fire hoses) and hydrants.
6. Checking the condition, serviceability and suitability of portable and transportable fire extinguishers. Provision of re-circulating fire extinguishers for the time of inspection and testing, according to the schedule.
7. For the performed inspection, bilateral reports are drawn up for each inspected facility (FAS and FES), fire cocks, fire hydrants, portable and transportable fire extinguishers. In each report, the activities performed, the specific values for the activation threshold of each channel, the detected failures, the repairs performed, adjustments, inserted spare parts, etc. are described and a conclusion is given on the suitability of each FAS, FES, fire cocks, fire hydrants, portable and transportable fire extinguishers.

Fire alarm and fire extinguishing systems of the extension of the production site:

In order to ensure the supply of the site's fire-fighting water pipes with water quantities with the required flow rate and a sufficient amount of water, a fire-fighting reserve is provided, which is stored in a fire-fighting tank.

The fire-fighting tank is a two-chamber, reinforced concrete, monolithic tank, dug into the ground, rectangular in form, with inlet hatches, inflow and overflow system, and ventilation of each chamber.

A new fire water pumping station, a new fire water tank and a new water pipe ring will be built on the new site.

Supply is ensured by means of a branch line of an existing fresh water supply system on the site. When the maximum level in the fire water tank drops to a certain level, topping up will be carried out automatically by the opening of electromagnetic valves.

Corresponding passive and active measures are foreseen to ensure fire safety.

The **passive measures** include providing and securing: the required degree of fire resistance of buildings; fire resistance of structural elements; evacuation conditions; anti-corrosion and fire protection; explosion protection; fire barriers, fire sectors; roads

and sidewalks on the site, incl. for fire-extinguishing and emergency-rescue activities and an external motor road; ladders for fire-fighting and emergency-rescue activities; the necessary distances to buildings and facilities; the required category of power supply security, power supply protection; external and on-site water pipes and many others.

The **active measures** include:

- the construction of fire extinguishing installations - fire protection of the equipment located inside the container is envisaged for the GTCU. An automatic CO2 fire extinguishing system is provided.
- fire alarm installations – these will be built in electrical and automation equipment buildings, GMS and fuel gas preparation units (FGPU). An addressable FAS system will be used to secure the premises. A local fire alarm and gas alarm system in the containers, including sensors, wiring, etc., is also envisaged for GTCU 1-4. The control panel of the alarm systems will be connected to the UCS and subsequently to the station management system. The fire alarm system is a complex electronic system that consists of different types of automatic fire detectors, responding to various signs of fire before an open fire breaks out. The FAS system meets the following requirements:

- reliability of the entire FAS
- appropriate combination of detectors to prevent false alarms
- minimum maintenance
- appropriate location of detectors
- safety of detectors performance
- clarification of the location of the fire hazard

An addressable FDS system will be used to secure the premises. The FDS system will consist of a control panel, collective automatic detectors, addressable automatic detectors, addressable call point detectors located in guarded areas and sound and light signalling.

The remote transmission of fire signals, FDS malfunctions, etc. will lead to the stationary control system (SCS).

- Gas detection installations - a gas detection system has been designed to detect flammable gases and vapours in selected buildings *(electrical and automation equipment buildings, GMS and FGPU).*
- Portable appliances and equipment for initial fire extinguishing:

Site No	Sub-site	Fire extinguisher:				Fire extinguishing blanket of the heavy type
		ABC powder 6 kg	BC powder 6 kg	CO2 5 kg	Water 9 dm ^{3}	
1. PEU	Transformer cells		1	1		
	Switchgear equipment			2		
	Laboratory		1	1		1
	Gas boiler room		2			1

	HCS warehouse	1			1	
	Operator and metering and checking equipment (MCE) room			2		
	Administrative premises	1		1	1	
2. GMS	GMS hall		3			
	Warehouse for reference methane bottles		1			1
	Chromatograph room		1			1
	Gas boiler room		2			1
	Instrumentation and MCE room			1		
	Electrical machine room			2		
3. FGPU	Compressor room		4			1
	FGPU room		3			
	Boiler room		3			1
	Electrical and MCE room			2		
4. Pumping station	Building			1		
5. Crossing point	Boiler room		2			1
	Administrative unit	1		1	1	
6. Electrical and automation equipment buildings	EAE building 28.5.6.7			2		
	Battery room			2		
	Electric switchgear room			2		

II.4. Protection measures and ways of limiting the consequences of major accidents

II.4.1. Description of the equipment installed at the establishment to limit the consequences of a major accident on human health and the environment

A detailed description of the equipment is presented in **point II.3.4.**

II.4.2. Organization and description of the warning, alarm and information measures in the event of an accident, as well as the measures for locating and limiting the consequences, including detection/protection systems, technical equipment for limiting the quantities accidentally released, including by water jet spraying, vapour screens, emergency capture or collection vessels, shut-off valves; inertisation systems; capture and collection of water released during a fire

The effectiveness of the measures to prevent and limit the consequences of an accident largely depends on: the timely alarm, warning, good information to the personnel in the establishment, to the neighbouring sites and potentially endangered population and to

the competent authorities and specialized divisions.

After receiving a positive decision on the EIA, approval of the design documentation and construction of the site, on the basis of the design documentation, a local automated notification system (LANS) will be built, according to the requirements of Art. 35, para. 3, item 5 of the Disaster Protection Act, which will be integrated with the National Early Warning and Notification System, in accordance with the requirements of the *Regulation on the terms and conditions for the operation of the national early warning and notification system for the executive authorities and the population in the event of disasters and for air hazard alarm.*

Work instructions have been developed and implemented in the establishment, which ensure the safe management of the technological process and the safe operation of all facilities and installations. The instructions describe the procedure for safe work and the provision of fire safety on the territory of Bulgartransgaz EAD.

Permanent places for fire *(welding and soldering)* works and a place for smoking have been designated.

II.4.3. Description of the available forces and means (inside and outside the establishment) necessary to carry out rescue and urgent emergency restoration works, including to provide warning and intervention

Forces

Chiren UGS has qualified specialists who are able to secure the area of the accident and take quick measures to eliminate it. In a special room, equipment and tools necessary for the work in the event of accidents are stored.

Chiren UGS has the necessary equipment located on the site. The vehicle fleet consists of light, cargo and specialized motor vehicles - including: a mobile steam plant, an auto-cementing unit, a tanker truck, a truck crane, an excavator. All vehicles are equipped with the appropriate fire-fighting devices. For the specialized machines (MSP, CU-320 and the truck crane), there is qualified personnel, developed and approved instructions for safe operation.

All motor vehicles undergo a periodic technical inspection. Daily, periodic and emergency safety briefings are carried out. Autumn-winter preparation takes place every year.

The mechanical department has nine machines and four welding apparatuses. The staff is competent and equipped with personal protective equipment (goggles, gloves and masks). Fire extinguishers and instructions for using them are placed in appropriate places.

Periodic briefings are held regularly in accordance with the established rules and instructions. If necessary, specialists from other structural units of Bulgartransgaz EAD can be dispatched to quickly eliminate an accident that has occurred.

In the event of emergency situations, assistance will be sought from the **Regional Directorate for Fire Safety and Protection of the Population - Vratsa,** its emergency vehicles and fire-fighters. Although it has a well-functioning fire extinguishing system, the UGS needs the intervention of professionally trained specialists to deal with accidents involving chemical substances.

In case of drilling accidents, help can also be sought from the *Oil and Gas Exploration and Extraction* company.

Means

Bulgartransgaz EAD has and maintains in working order and readiness for action the following basic firefighting and emergency equipment and means:

- means for initial fire extinguishing;
- firefighting equipment;
- air insulating apparatusec;
- other means of protection and rescue;
- mobile electric power generators;
- gas detectors;
- fire extinguishing system for the emergency gas unit;
- foaming system for the condensate tank;
- carriage nozzles;
- emergency mobile fire pumps;
- firefighting pumping stations (and corresponding reservoirs);
- cooling installation (irrigation system) for the condensate tank;
- fire alarm installations;
- fire hydrants;
- hoses on duty at the installations;
- firefighting blankets;
- the individual personal protective equipment is stored in a storage room in accordance with the requirements;
- a reserve of the foaming agent is stored in the fire depot.

In **Annex 7,** a list of protective work clothing and personal protective equipment for the staff of Bulgartransgaz EAD is presented.

In the event of an accident at the site of Bulgartransgaz EAD, no loss of human life, injuries or other health consequences outside the territory of the site are expected. The outer limits of the safe zone around the establishment do not affect other buildings *(residential, industrial, public, etc..),* installations and equipment of other operators. The establishment is provided with local notification and fire extinguishing systems.

In point II. 3.4 above, detailed information on the firefighting equipment at the existing and the new site is presented.

II.4.4. Description of all technical and non-technical measures relevant to limiting the consequences of a major accident

1. Not allowing or preventing accidents by conducting preventive activities to increase, improve and enhance the technological and technical condition of the site;
2. Identification and assessment of hazards, assessment of the risk of major accidents and assessment of the consequences of the accident on people, facilities and the environment;
3. Ensuring compliance with all internal company regulations, instructions and other regulatory documents in the operation and maintenance of the establishment;
4. Development of an emergency plan that limits the consequences of an accident for people, facilities, neighbouring sites and the environment to the lowest level;
5. Management guaranteeing security and prompt notification in the event of extreme situations;
6. Training of personnel for actions in the event of disasters, accidents and

catastrophes;

7. Encouraging the staff to strictly comply with the measures to ensure the safe operation of the facilities and involve in the overall policy for the prevention of major accidents;

8. Keeping the means of protection in working order - fire extinguishers, fire alarm system, etc. Provision of material and technical workers with the necessary means, individual protective equipment and other special equipment.

9. Implementation of strict access regime and minimization of external malicious intervention in the process of work.

10. Strict compliance with the working instructions, adequate management and implementation of technological processes and constant supervision of the condition of the facilities and checking and metering devices.

11. High qualification, knowledge and conscientious performance of the duties of all management personnel and service personnel.

12. Strict compliance with technical safety rules, use of personal protective equipment and appropriate equipment.

13. Strict compliance with the rules and norms for fire safety during the operation of the sites.

14. Annual training of employees in fire safety, according to the annual training schedule.

15. Practical drills for emergency situations at dangerous areas and workplaces, not less than 1 time per year.

16. Control of high-risk facilities

II.4.5. Summary of the information under items 4.1, 4.2 and 4.3, necessary for the preparation of an emergency plan of the establishment

In section II.4.1 above, information is presented on the equipment installed in the establishment to limit the consequences of a major accident for human health and the environment.

The forces necessary to carry out rescue and urgent emergency recovery works are the personnel of the establishment and, more specifically, the people making up the Emergency Plan Implementation Staff, Monitoring and Reporting Group, Sanitary Post, Group for Receiving and Distributing Individual Protective Equipment, Group for Maintenance and Operation of Collective Protective Equipment, Fire Protection Group.

The means necessary for carrying out rescue and urgent emergency recovery works are the firefighting equipment of the establishment and the individual means of protection of the personnel - see **point II.4.3.**

III. INFORMATION ON THE ORGANIZATION ESTABLISHED FOR COMPLIANCE WITH THE RULES AND NORMS FOR FIRE AND EMERGENCY SAFETY

The following orders, instructions, plans and procedures have been prepared for the site, with which compliance with the rules and norms for fire and emergency safety is achieved:

- Internal emergency plan;

• Fire safety instructions:

- Instruction for ensuring fire safety in Bulgartransgaz EAD;
- Fire safety instruction for maintenance of electrical, heating and ventilation installations;
- Instruction for control and technical maintenance of portable and transportable fire extinguishers;
- Rules and norms for ensuring fire safety when performing fire and electric welding works with burners and other devices using FG and FL;
- Instruction for the safe storage of fuels and lubricants;
- Instruction for the safe handling of methanol;
- Instruction for the safe handling of triethylene glycol;
- Instruction for the safe storage of hazardous chemical substances and mixtures on the territory of Chiren UGS;
- Instruction for the safe handling of gas condensate and protection of the environment against pollution;
- Instruction for the safe handling of natural gas;
- Instruction for safe work when using portable ladders;
- Instruction for measuring the factors of the working environment in sites of Bulgartransgaz EAD;
- Orders and reports for conducted trainings;
- Order for determining the procedure for training and preparation of the personnel to ensure fire safety at the site;
- Order regarding the assignment of fire safety activities;
- Order for determining the procedure for carrying out fire works;
- Order for the use of heating and hot appliances and equipment;
- Order for establishing the prohibited places for smoking and use of open fire;
- Order for determining the procedure for use of electrical appliances and equipment, including disconnection of the electrical supply after the end of working hours;
- Order for establishing the rules for fire safety during non-working hours;
- Order for establishing the procedure for control, technical maintenance, recharging and hydrostatic pressure resistance testing of portable and transportable fire extinguishers and for maintenance and service of FAS, FES, VNS, fire hydrants and smoke and heat management systems;
- Order for the appointment of an official with the relevant competence to coordinate the activity of ensuring fire safety in Bulgartransgaz EAD;
- Order regarding the periodicity of cleaning of the building structures, technological and electrical equipment, heating elements and installations from explosive and fire-hazardous dust and other combustible materials;

- Order on the procedure for collecting and removing combustible waste, as well as residual products from solid fuel stoves.
- Procedure P-BTG - Management of human resources;
- Procedure P-BTG - Assessment of risks and possibilities;
- Procedure P-BTG - Operational management of health and safety at work
- Procedure P-BTG - Investigation of occupational health and safety incidents and non-conformities
- Procedure P-BTG – Entry control and warehousing
- Procedure P-BTG - Preparedness for emergency situations and ability to react
- Procedure P-BTG - Internal audits

IV. INFORMATION ABOUT THE INDIVIDUALS INVOLVED IN THE PREPARATION OF THE SAFETY REPORT

Name, surname	**Position**	**Phone**	**e-mail**
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Mag. Ivailo Prediov	ecologist	0885248527	ivailo.prediov@gmail.com

ANNEXES

1. General plan of Bulgartransgaz EAD
2. Organizational chart and job descriptions of Bulgartransgaz EAD
3. Order for the conduct of briefings; Annual staff training program; Logbook for monitoring of the trainings; Reports of IAP drills; Reports of conducted trainings of the Emergency Team.
4. Instructions and rules for ensuring safe working conditions
5. Orders and plans for ensuring fire safety at the site
6. Safety data sheets
7. Fire Action Plan; Evacuation Plan; Evacuation Schemes; List of protective work clothing and personal protective equipment for the staff of Bulgartransgaz EAD
8. Reports of performed on-site control
9. Procedures:
10. Contract for providing security at the site
11. **List of PPE and work clothing kept in reserve; Positions and workplaces where PPE and work clothing are used; Order for the storage of PPE, separate from that provided to workers pursuant to Art. 5 of Regulation No 3 of 19.04.2001 on the minimum requirements for safety and health protection of workers when using PPE at the workplace; Order regarding the inspection of the suitability, expiration dates of PPE, work clothing and documentation of the inspection results**

I, the undersigned Ivan Kolachev, hereby certify the genuineness of the present translation from Bulgarian into English language of the document attached hereto. The translation consists of 194 pages.

Translator: Ivan Kolachev