

Seminar and Study Tour on Safety, Reliability and Integrity of Transmission Systems

AHEF GE 37 REPORT
08 -12 September 2014
Tbilisi, Kazbegi /Georgia

**INOGATE Technical Secretariat (ITS) and Integrated Programme in support of the
Baku Initiative and the Eastern Partnership energy objectives**

Contract No 2011/278827

A project within the INOGATE Programme

Implemented by:

Ramboll Denmark A/S (lead partner)

EIR Development Partners Ltd.

The British Standards Institution

LDK Consultants S.A.

MVV decon GmbH

ICF InternationalStatistics Denmark

Energy Institute Hrvoje Požar

Document title	Seminar and study tour on Safety, Reliability and Integrity of Transmission Systems
Prepared by	Achilleas Gekas, Rusudan Nonikashvili
Check by	Nikos Tsakalidis, Mark Allington
Date	January 2015

Contents

Executive summary	7
DESCRIPTION OF THE SEMINARS AND THE STUDY TOUR	7
Findings 8	
1 Introduction	9
2 Preparation of the seminars/study tour.....	10
3 Seminars and study tour.....	10
3.1 COMBINED EVENT/STUDY TOUR OVERVIEW	10
3.2 THE PARTICIPANTS	12
3.3 THE RESULTS FROM THE SEMINAR AND THE STUDY TOUR	12
4 Evaluation of the Event	13
4.1 OVERALL ORGANISATION EVALUATION	13
4.1.1 <i>Overall evaluation</i>	14
4.1.2 <i>Evaluation results tables</i>	15
4.2 SPECIFIC COMMENTS AND MAIN ISSUES ADDRESSED	17
4.2.1 <i>Trainers Comments and Feedback</i>	17
4.2.2 <i>Presentation of Georgian Gas Pipeline Network and Georgian Legislation for Safety Zones</i>	18
4.2.3 <i>Various topics discussed during the seminar:</i>	20
5 Conclusions	21
5.1 THE CONCLUSIONS OF THE SEMINAR WERE:.....	21
5.2 SPECIFIC OUTCOME FROM THE SEMINARS	21
6 Annexes	22
6.1 AGENDA.....	22
6.2 LIST OF PARTICIPANTS	22
6.3 PRESENTATIONS	22
6.4 QUESTIONNAIRES	22
6.5 EVALUATION RESULTS.....	22
6.6 PHOTOS & MEDIA MATERIAL	22
6.7 THANK YOU LETTER	22

List of Figures

Figure 1 Overall Organisation..... 14

Figure 2 INOGATE Seminar Sessions..... 14

Figure 3 Achievements of INOGATE Seminar’s Objectives 15

List of Tables

Table 1 How would you rate your knowledge and understanding of General Risk Management and the terms used within? 15

Table 2 Please indicate your knowledge and understanding of Risk Identification Methodologies..... 16

Table 3 How you would rate your knowledge on the Consequences Assessment by:..... 16

Table 4 How would you rate your personal potential to contribute to the Quantitative Risk Assessment of your company’s pipeline systems?..... 17

Abbreviations List

AGRI	Azerbaijan-Georgia-Romania Interconnector
ALARP	As Low As Reasonably Practicable. Risk assessment methodology to identify the acceptable by society risk.
BLEVE	Boiling Liquid Expanding Vapour Explosion. Type of fire accident.
CH ₄	Methane
CO ₂ e	Carbon dioxide equivalent
DI&M	Directed inspection and maintenance
DN	Normal diameter
EC	European commission
EPA	Environmental Protection Agency (USA)
EU	European Union
FTA	Fault Tree Analysis
GIS	Geographic information system
GHG	Greenhouse gas
GGTC	Georgian Gas Transportation Company
GOGC	Georgian Oil and Gas Company
HAZID	Hazardous Identification
HAZOP	Hazardous Operability
IPCC	Intergovernmental panel on climate change
IR	Infrared
IRR	Internal rate of return
km	Kilometres
LDAR	Leak detection and repair
LNG	Liquefied Natural Gas
NO _x	Nitrogen oxides
OVA	Organic vapour analyser
PC	Partner country
PID	Piping and Instrument Diagrams
PIMS	Pipeline integrated management system
ppm	Parts per million
QRA	Quantitative Risk Assessment
RTU	Remote terminal unit
SCP	South Caucasus Pipeline
SCADA	Supervisory control and data acquisition



ENERGY COOPERATION BETWEEN THE EU, THE LITTORAL STATES OF THE BLACK & CASPIAN SEAS AND THEIR NEIGHBOURING COUNTRIES



SWOT	Strengths, Weakness, Opportunities and Threats Analysis
TANAP	Trans Anatolian gas Pipeline
TAP	Trans Adriatic gas Pipeline
TOC	Total organic compounds
U.S. EPA	U.S. Environmental Protection Agency
UV	Ultraviolet

Executive summary

Description of the seminars and the study tour

Georgia is a crossroads for oil and gas, coming from north and east and headed mostly south. At the end of the 19th century the Rothschild banking family built a railway across Georgia and in 1904 the famous Nobel brothers completed the first, biggest on the continent, oil pipeline connecting Baku to Batumi.

New gas resources found in Azerbaijan will lead to construction of more pipelines to bring the gas to market in Europe and elsewhere via Georgia. A second pipeline alongside the existing South Caucasus Pipeline (SCP)¹ will be constructed to connect Baku with the proposed Trans Anatolian Natural Gas Pipeline (TANAP)² and the Trans-Adriatic Pipeline (TAP)³ and thereby to feed Europe with Azeri gas, decreasing European dependence to Russian gas.

Training of the Georgian Oil and Gas Corporation (GOGC) in issues related to the safety and security of the gas pipelines is an urgent and very important task.

Georgian legislation on the safety zones of gas pipelines needs to be improved in preparation for new pipeline construction projects.

The one week seminar on “Safety, Reliability and Integrity of Transmission Systems” addressed these needs of the two organisations GOGC and GGTC which own and operate the Georgian gas transportation network.

The INOGATE Technical Secretariat organised the event in collaboration with experienced engineers of Ramboll: Axel Sporon-Fiedler and Daniel Lundberg. The presence of the senior advisor of GOGC, Professor Gochitashvili was a key factor for the successful conduct of the seminar and study tour.

The duration of the seminar and Study Tour was five days, undertaken from September 8th to September 12th 2014. In the first three days, trainers presented the risk assessment methodology, examples of incidents, hazard identification and quantitative estimation of frequency and consequence risk assessment. Theory presentations were illustrated with case studies. On the afternoon of the third day, the study tour started. The trainers and trainees visited two pipeline sites, where data were collected in situ and the trainees calculated the probability of accidents and their consequences. The group returned to Tbilisi the following day and the seminar concluded the fifth day with the discussion of findings during the study tour and a wrap up of the theoretical sessions.

¹ The South Caucasus Pipeline (SCP - also known as the Baku-Tbilisi-Erzurum (BTE) pipeline is a 692km long, 1.07m diameter, natural gas pipeline from the Shah Deniz gas field in the Azeri part of the Caspian Sea to Turkey. The initial capacity when opened in 2006 was 8.8 bn cubic metres/year, with scope to expand to 25 bn cubic metres/year. It runs parallel to the Baku-Tbilisi-Ceyhan pipeline.

² The Trans Anatolian Natural Gas Pipeline (TANAP) is intended to transport gas from the Shah Deniz 2 field in the Azeri part of the Caspian Sea via Georgia through Turkey to Europe.

³ The Trans Adriatic Pipeline (TAP) is a pipeline project to transport natural gas from the Caspian Sea starting from Greece via Albania and the Adriatic Sea to Italy and then further to western Europe.

Findings

This AHEF assignment strengthened the capacity of the GOGC engineering department on the preparation of risk assessment studies, relating to appropriate areas along the existing and future transmission pipeline network in Georgia. The engineers who attended were trained in the methodology of these studies and learned where to find statistical data for the risk assessment. They also learned about existing software packages, which are necessary tools both for assessing the probability of a risk occurring, and for quantifying the consequences if the risk actually occurs..

During the training courses but mainly during the study tour, specific actions were identified to optimise GOGC and GGTC safety and security operations:

- In the decade 2000-2010, utilising European standards, three zones have been specified along the pipelines with different risk probability and with special restrictions for buildings and other installations in each zone. Risk assessment is one of the methods used for zone definitions. Applying this method especially to high pressure pipelines, allows definition of new ways of construction resulting in reduction of risk and consequently decreasing the width of safety zones. The engineering department of GOGC has already started preparing risk assessment studies for new pipelines. GOGC also plans to introduce a decree, based on the conclusions of the seminar, with quantitative criteria for the approval of risk assessment studies by the Georgian authorities.
- During the visits to pipeline sites, it was observed that there are not continuous marking signs along the pipelines routes as is specified in European Standards. The trainers pointed out that this increases dramatically the probability of accidents and GOGC should install these signs, especially in areas that are accessible by third parties.
- In areas that are accessible, or close to residential areas, where either the risk probability is high or the consequent damages high, it is recommended that shut off valves should be installed, with remote controlled motor drives. Such valves would ensure that, if an accident happens, the quantity of released gas would be very small and the consequences relatively minor.
- Both of the sites that were used as case studies in the study tour (Gudauri and Kazbegi), are close to residential areas that are, for certain months of the year, heavily populated (as ski resorts during winter time). In both cases, taking advantage of the presences of experienced Ramboll engineers, the GOGC engineers collected the necessary initial data and performed preliminary calculations to identify risks and estimate the consequential damages. The risk assessment of these installations needs to be finalised and measures for risk mitigation to be decided and implemented. Some probable mitigation measures were identified and discussed: hydro-testing of old pipes and replacement of certain sections with new ones, installing cathodic protection against corrosion along the route, marking signs, and installing remote motor driven shut off valves.
- Close to the sites that the team visited for the case studies, the previously collapsed transmission pipeline (site Devrodaki, few kilometres far from Russian borders) was under construction. GOGC invited the trainers to visit the place and to discuss with the designers of GOGC details for the improvements to the location of the new route and the special construction details introduced to decrease the risk of repetition of the accident.

1 Introduction

This Final Report describes the seminar and study tour to support the GOGC and GGTC organisations (responsible for gas supply and transportation in Georgia) to establish a methodology and procedures for risk assessment of transmission gas pipelines, based on European and International standards. The lessons learned would enable GOGC and GGTC to determine new safety zones for their pipelines.

Currently, risk assessment of safety and operational zones of gas pipelines is governed according to a Technical Regulation issued by Presidential Decree in Georgia. This regulation is in line with the standards inherited from the Soviet era. This means that, although the construction of new gas pipelines in Georgia is performed according to international gas industry standards, the regulation does not allow the undertaking of a risk assessment to comparable standards or an appropriate decision to be made about each specific case. GOGC (Georgian Gas and Oil Corporation) and GGTC (Georgian Gas Transportation Company) after the completion of the seminar are preparing revisions on the existing Decree in order to be in line with the EU practice. These proposals will be presented discussed and finally adopted by the Georgian Governmental Authorities.

At time of writing, based on the old Soviet standards along the gas pipelines, a safety zone of 200 m is required and cannot be used for other purposes. In accordance with the international standards, depending on the pressure of the gas, the material of the pipeline, the method of construction and the surrounding environmental conditions the “risk assessment study” determines the safe and secure area along the pipeline and the nearest point that can be used for any other activity. That means that the safety zone is determined specifically and allows better utilization of the area round the pipeline.

Previous workshops conducted in 2011 by USAID (two day workshop) and the Millennium Challenge Fund Georgia (MCG) (1 day workshop) for GOGC and GGTC on gas risk assessment introduced the international concept but did not train the organisations on how to implement these studies for specific projects.

This seminar was designed to provide theoretical and practical knowledge of implementation risk assessment studies. The training was a mixture of presentation of the theories and formulas applied and actual calculations of risk on cases studies from trainers’ experience. For one day and a half, the trainers and trainees visited two specific sites, where the natural gas pipelines (coming from Russia of 700 and 1200 mm diameter and 25 and 35 bars operating pressure, cross areas of tourist interest. Data were collected and trainees calculated risks and safety zones for each case.

The technical assistance of INOGATE in risk assessment will help GOGC and GGTC to determine the optimal safety zones around the gas pipelines, within which safe construction is allowed. Hence, some quantity of the land that is currently captive within a safety zone due to the old Soviet standards could be released and used for other economic activities. GOGC/GGTC will follow the European directives to implement Risk Assessment and HAZOP (Hazardous Operability) studies before the start of any construction activity.

The selection criteria for the trainers took into account the substantial global experience of Ramboll in risk assessment and environmental impact studies, in conjunction with the experience of the specific trainers. The actual data base of the organisation has been used for the presentation of the more suitable case studies.

On the first day, Professor T. Gochitashvili presented the Georgian Gas Transportation Network, present and future. The actual safety zones and the existing legislation, the new challenges and the necessity of GOGC to comply with European Standards were discussed. Then the two trainers presented the risk assessment methodology, examples of incidents, the hazardous identification and the quantitative estimation of frequency and consequence assessment. The theoretical part was completed with case studies involving trainees.

On the afternoon of the third day, the study tour started visiting two pipelines, where data were collected in situ and the probability of incident and the consequences were calculated. The group returned the following day and the seminar concluded on the fifth day with the discussion of findings during the study tour.

Within two months following the seminar, the engineering department of GOGC has started applying the European methodology of risk assessment in the new pipelines that are under detailed design and construction.

2 Preparation of the seminars/study tour

The preparation of the seminar/study tour consisted of the following tasks:

- Development of the concept note, thematic agenda and selection of Ramboll experts to implement the seminar and study tour.
- Preparation of the detailed agenda with the trainers, review and agreement with the GOGC senior advisor, Professor Gochitashvili.
- Collection of the actual legislation in Georgia regarding the safety and security of the natural gas network of GOGC/GGTC along with relevant technical data.
- Selection of the pipeline sites to be visited as case studies: Gudauri and Kasbegi.
- Organisation of logistics for the seminar (interpreter, equipment for simultaneous translation, etc.) and the accommodation of trainees and trainers during the study tour. The beneficiary provided the facilities for the seminar and the transport for the study tour.
- Development of ex-ante and ex-post questionnaires.
- Translation of the seminar and study tour material.
- Development and updating of the seminar agenda.
- Development and editing of the materials which would be provided to the participants.
- Distribution of ex-ante and ex-post evaluation questionnaires.
- Preparation of the evaluation reports and review of the seminar conclusions.

The specific objectives of the seminar and the study tour were to support GGTC and GOGC:

- To establish within GGTC and GOGC, international standards and methodologies for risk assessment of pipelines, including the necessary procedures.
- To build-up the capacity of the staff of these organisations to use the standards and methodologies to prepare risk assessment studies for various existing pipelines and all new pipelines.
- To comply with the safety and environmental requirements of the Energy Community, in the area of Gas Transportation.

3 Seminars and study tour

3.1 Combined Event/Study Tour Overview

Location: Four day seminar in Tbilisi, Georgia. One day on pipeline sites in Gudauri and Kasbegi in Georgia.

Dates: 8 to 12 September 2014.

The overall objective of this assignment was to support GGTC, Gas System Operator of the Georgian Transportation Network and GOGC, Georgian Oil and Gas Company, to:

- Establish a methodology and procedures for the risk assessment of transmission pipelines based on European and International standards, which will assist GGTC and GOGC in determining new safety zones for their pipelines.

With the new methodology, GGTC and GOGC will be able to determine the optimal safety zones around the gas pipeline within which a safe construction is allowed. Some quantity of the land that is currently captive as a safety zone due to the old Soviet standards could be released and used for other economic activities. In addition, the quantity of land that needs to be purchased to establish the safety zones for new pipelines could be reduced, saving GGTC and GOGC financial resources.

It is imperative for any project in the oil and gas industry including pipelines, that Risk Assessment and HAZOP (Hazardous Operability) studies are implemented before the start of any construction activity. This intervention's objective was to train GGTC and GOGC how to implement these studies before starting the design of new pipelines and gradually to complete the studies for the existing network.

The seminar began with a presentation by the senior advisor of GOGC, professor T.Gochitashvili who presented the Georgian Gas Transportation Network, along with future plans for natural gas in Georgia. He also presented the actual safety zones along the gas pipelines and the relative legislation and concluded with the new challenges presented by the (June 2014) agreement signed between European Union and Georgia.

The main topics presented by the two Ramboll trainers were:

- General risk methodology (purpose, risk types, methodology, tools)
- Establishment of basic data (definitions of pipeline system, surroundings, environmental conditions)
- Examples of pipeline and compressor systems incidents.
- Hazard Identification. Short cut calculations and rules of thumb. Use of hazid log.
- Risk acceptance criteria. Rules and regulations
- Frequency assessment, release frequencies and ignition probabilities
- Consequence assessment. Description of gas dispersion-fire-explosion
- Examples of fire and explosion (video session with comments from trainers).
- Software for consequence modeling (hand calculations, free and commercial software).
- Risk assessment (tools for the calculation of risk, examples of risk assessment and typical risk results for pipeline systems).
- ALARP (As Low As Reasonably Practicable): philosophy and assessment-register.
- Risk reducing measures.
- Case Study 1: Ghislenghien, Belgium-Pipeline Accident, July 30, 2004. In this case study the conditions of the accident were analyzed; the existing risk, before the accident, was identified; and the human mistakes or negligence were evaluated.
- Case Study 2: Transmission pipeline to Underground Gas Storage of Georgia.

The trainer presented the case and gave all technical data and assumptions to the trainees in order to identify, evaluate and estimate:

- Risk identification
- Risk evaluation
- Frequency assessment
- Consequence assessment
- Risk reducing measures
- Risk Consideration
- Risk identification in life-time extension.

Trainees worked in groups and later the results were discussed together.

In the study tour the team (trainers and trainees) visited three sites:

Site 1: GUDAURI

There are two pipelines from Russian borders to the direction to Tbilisi, the technical characteristics of the pipelines are:

- 1) Dia: 720mm, width: 8mm, Design Pressure: 54 bar, Maximum Operating Pressure: 25 bar
- 2) Dia: 1220 mm, width: 19 mm, Design Pressure: 54 bar, Maximum Operating Pressure: 35 bar

The pipelines run parallel through a ski resort in operation with buildings (restaurant, café, and restaurant) in distances of 60-70 metres.

Site 2: KAZBEGI

The same pipelines run close to the village Stepantsminda. The nearest hotel to the two pipelines is 220 and 140m distant. An investment interest has been expressed for the construction of a ski resort in this area.

Site 3: DEVRODAKI

This site is a few kilometres from Russian borders. Landslides, after heavy rainfall had destroyed the smaller of the two pipelines. GOGC re-designed the destroyed section taking into consideration the characteristics of the soil and the morphology, decreasing the risk of damage in the future. The project was at the final stage of construction, at the time of the visit.

3.2 The participants

A list of the participants attending the Seminar may be found in Appendix 6.3

3.3 The results from the seminar and the study tour

As Professor Gochitashvili mentioned in his presentation and in the wrap up of the seminar:

- The GOGC is involved with the safety assessment of the systems of main pipelines that exist in parallel or under construction on the territory of Georgia. The activities include route selection, right-of-way and **establishment of safety zones** which, in some cases, are regulated by other specific normative requirements. This fact substantially complicates the activities of operational maintenance and construction organisations respectively.

- The restricted space conditions of Georgia (e.g. mountainous terrain) create competition for usable land. Hence, while planning industrial or service facilities, it often becomes necessary to make special design decisions including the application of risk assessment methodology, in order to establish safety zones for individual sections of pipelines.
- Practical application of the methodology is hindered by the complexity of the relevant criteria and the use of a calculation model, also by the insufficient experience of the personnel.
- Therefore, the main achievement of the seminar was to secure the communication of the safety zone calculation model, guidelines, examples of practical cases and the knowledge transfer from highly-qualified experts to the local engineering personnel.
- The main result of the seminar was also to present the adjusted version of the methodology that is based on the international, oil industry-tested risk assessment approach. The knowledge gained at the seminar, will be integrated with knowledge of the existing and/or accepted norms and will be included into the regulatory documents that govern the main pipeline safety zone establishment criteria.

Beyond the general achievements of the seminar, the work on the two sites during the study tour gave the opportunity to the engineering department of GOGC to establish the basic data and principles for implementation of risk assessment studies in these two cases.

4 Evaluation of the Event

The evaluation of the event and its impact has been assessed using the questionnaires (see appendix 6.4) which were completed by the participants before and after the event. The evaluation was aimed at:

- The assessment of the overall organisation of the event (presentations, logistics, hotel, etc.), along with the utility and quality of each session.
- A self-assessment by participants on the knowledge gained and an evaluation covering the priority needs of the participants based upon their contributions during the event.

Additionally in the second part of this chapter, specific comments remarks and conclusions are included as have been presented by the trainers and the participants. Finally, a brief reference is given of the topics that discussed during the case studies and the study tour. The wide range of the topics discussed and specific details on subjects of interest to beneficiaries showed that the event achieved its objectives and was of value to the organizations in addressing some of their needs.

4.1 Overall organisation evaluation

An evaluation of the overall organisation of the event included the following components:

- 1) Organisational Aspects
 - Overall organisation
 - Travel and visa support
 - On-site organisation
 - Quality of the hotel

- Selection of the topics and presentations
- 2) Quality of Sessions (selection of topics)
 - 3) Achievement of the INOGATE seminar’s objectives

The summary of the evaluation results for all above mentioned components is presented in Appendix 6.5

The tables below illustrate the difference of the level of understanding of a set of questions that participants have answered before and after the event:

4.1.1 Overall evaluation

As it can be seen on the evaluation tables the participants have recorded the highest scores for the organisation part of the event.

Figure 1 Overall Organisation

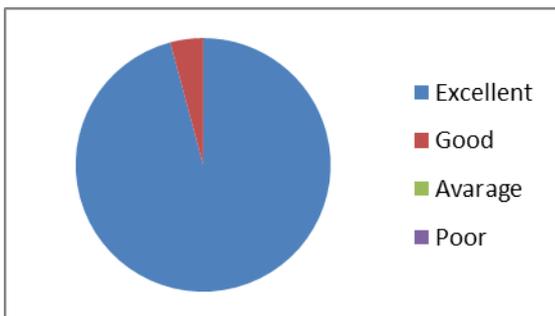


Figure 2 INOGATE Seminar Sessions

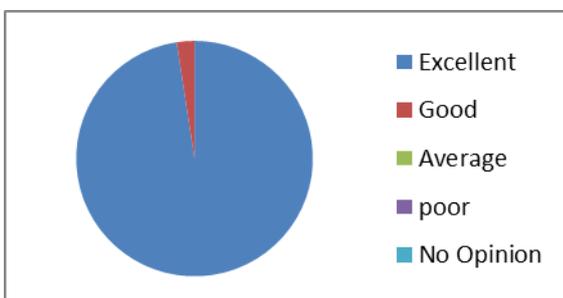
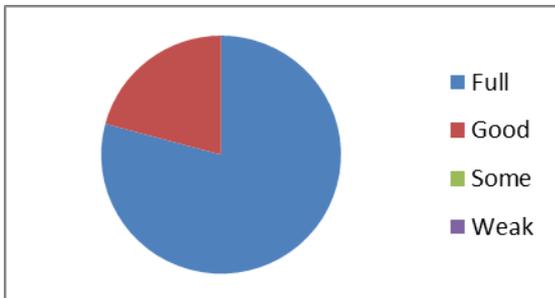


Figure 3 Achievements of INOGATE Seminar’s Objectives



4.1.2 Evaluation results tables

The following comparative tables show the difference in level of understanding of participants before and after the event, on the main objectives of the seminar. The tables of all answers to the questionnaires are in the Attachment 6.5:

General and specific knowledge gained and priority needs evaluation

Table 1 How would you rate your knowledge and understanding of General Risk Management and the terms used within?

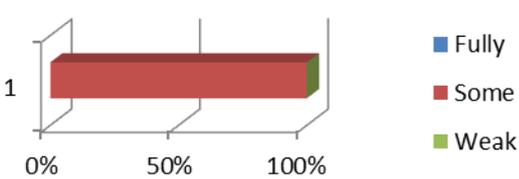
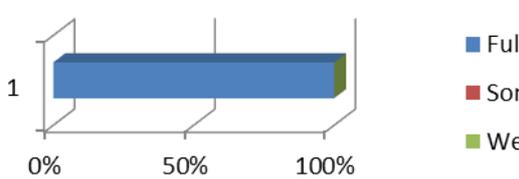
Before event			After the event		
Fully	Some	Weak	Fully	Some	Weak
0%	100%	0%	100%	0%	0%
					

Table 2 Please indicate your knowledge and understanding of Risk Identification Methodologies.

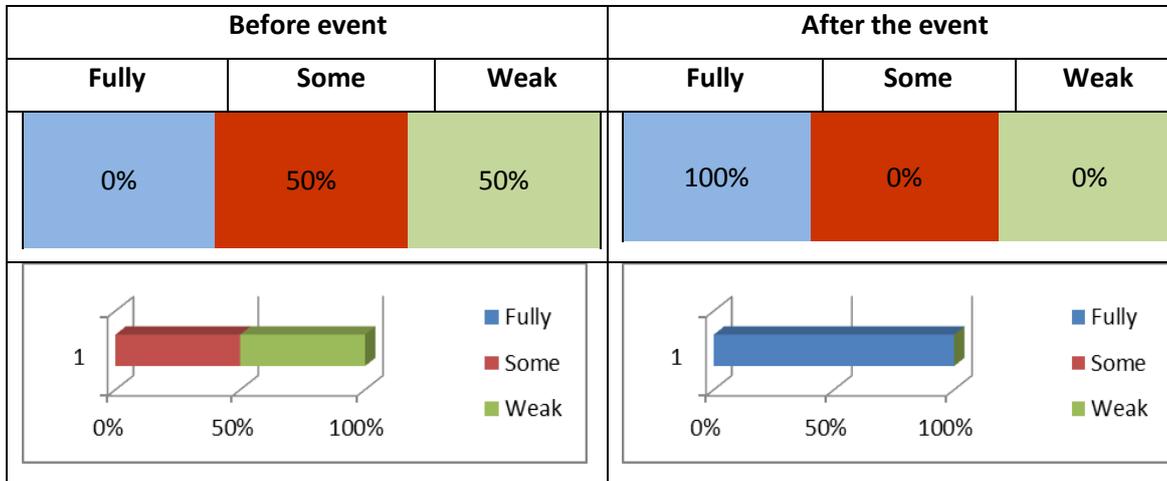


Table 3 How you would rate your knowledge on the Consequences Assessment by:

- Gas dispersion
- Fire
- Explosion.

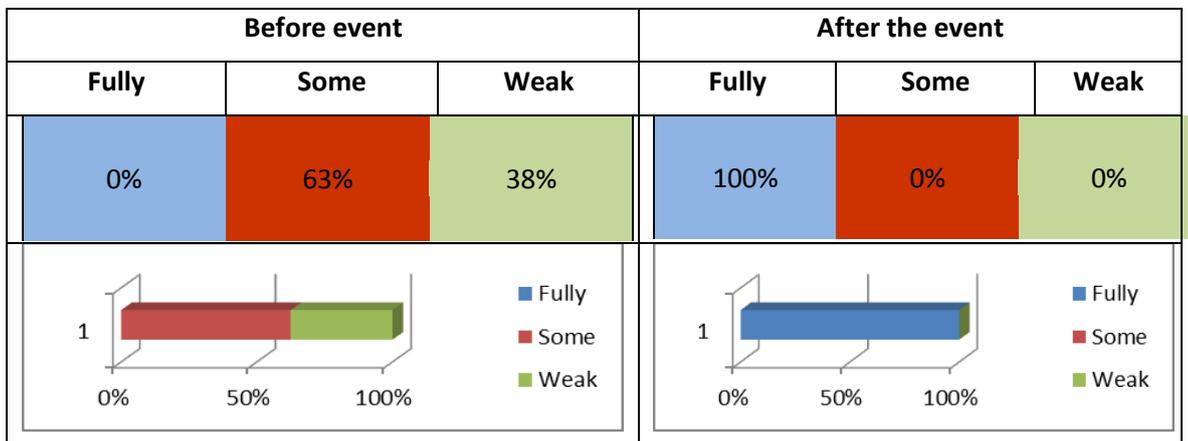
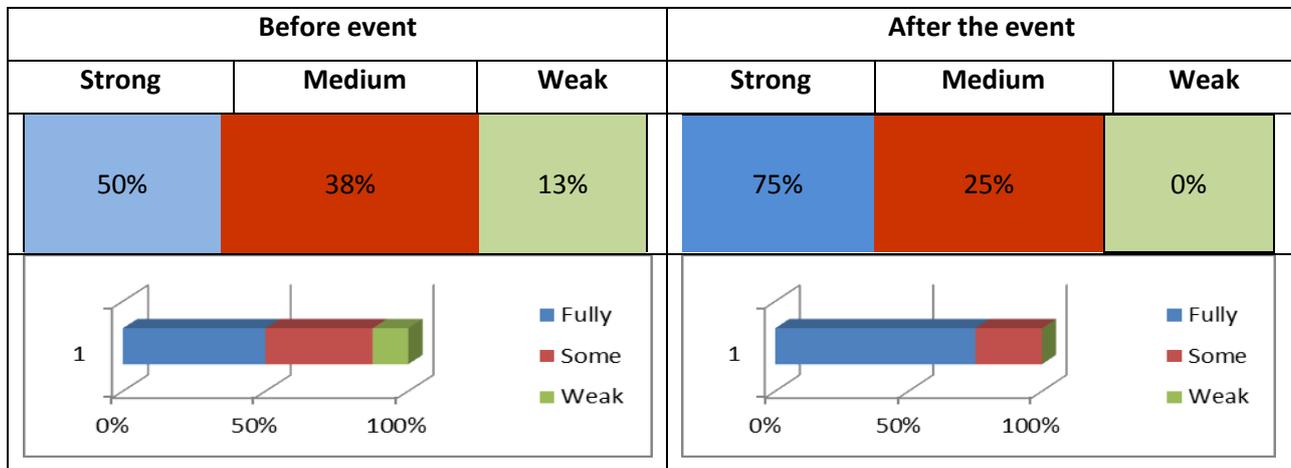


Table 4 How would you rate your personal potential to contribute to the Quantitative Risk Assessment of your company’s pipeline systems?



The answers on the questions concerning the main objective of the seminar show that the seminar material, the case studies and the approach taken by the trainers were sufficient to provide full knowledge of risk assessment on transmission pipelines to participants, however that was not enough for all of them to feel self-confident to conduct a study by themselves. The 25% of the participants answered that they don’t feel “quite strong to contribute to the Quantitative Risk Assessment of their company’s pipeline systems”. It is suggested to the organizations that for the first study, they will implement, to do it with the support of a third party specialist experienced in risk assessment studies to give them the necessary confidence to undertake a proper implementation.

4.2 Specific Comments and Main issues addressed

4.2.1 Trainers Comments and Feedback

Days 1 and 2 were an introduction to the subject matter in terms of methodology, practical examples and presentation of incidents and accidents.

The previously planned sequence of the presentation programme was re-arranged to a minor degree to enhance the understanding of the topics presented.

On day 3, the presentations were concluded and a site visit was conducted in Gudauri close to a planned expansion of a ski-resort (Site 1).

On day 4, site visits were conducted during the morning to Kazbegi at the site of a pipeline rupture of a 700 mm pipeline, caused by plastic debris flowing in a river close to the Russian border.

On the way back to Kazbegi a relatively new metering station was visited (ZWELETTI). Finally, a pipeline river crossing close to the Rooms Hotel in Kazbegi was visited, where the pipeline route came close to the hotel. Plans exist for a ski-resort development close to the hotel (Site 2).

The planned ski resorts at the sites visited are creating risk management challenges for GOGC, because of the possible large number of people being close to a potential lethal leak or rupture of a pipeline of substantial size.

The afternoon of day 4 was used to present a case study and conduct calculations of consequence and risk on the sites visited, based on the methodology presented during the previous days.

The last day was conducted in Tbilisi and was a wrap-up of the entire Seminar.

Conclusion:

Overall, the seminar fulfilled its intentions, with all of the attendees confirming that the substantial benefits they received from participating and that they are now independently capable of conducting an initial, basic risk assessments for their projects.

We would also like to state that INOGATE did a very good job regarding all aspects of the arrangement in terms of facilities, translation and other arrangements.

It has been a gratifying experience for both of us presenters to be in Georgia for this Seminar.

Copenhagen, September 15th 2014.

Axel Sporon-Fiedler and Daniel Lundberg

Presenters/Instructors

4.2.2 Presentation of Georgian Gas Pipeline Network and Georgian Legislation for Safety Zones

Professor Gochitashvili started his presentation on the Georgian Gas Pipeline Network by describing the importance of Georgian pipelines in the oil and gas supply to Europe from the Countries littoral to the Caspian Sea. The Georgian Gas Pipeline Network consists of the Main Gas Pipeline System (MGPS) that belongs to GOGC and is operated by GGTC, and the South Caucasian Pipeline (SCP) that belongs to the consortium of SCP Co and is operated by BP. The network has more than 2000km of main gas pipeline (diameter $D=200-1200\text{mm}$ pressure $P(d)=55\text{barg}$) and around 150 regulation and distribution stations.

The SCP transfers gas from the Shah Deniz field in Azerbaijan to Georgia and to Turkey (Erzerum). The MGPS has two main branches, the North/South branch that transfers gas from Russia to Georgia and to Armenia and the East/West branch that transfers Gas from Azerbaijan (occasionally from Iran and Iraq) to Georgia up to Puti and Batumi, which are ports on the Black Sea.

The new gas field that is under exploration in Baku and the efforts for decreasing the European dependence on Russian gas supply provide the opportunity to Georgia to increase its interconnection role in the area. A second line is already under final stages of engineering, which will run along the existing SCP to be connected with TANAP and TAP and feed Europe with Azeri gas, decreasing the European dependence on Russian gas. Rehabilitation of the East/West pipelines and further expansion to cover the needs of Georgia and of the AGRI LNG project, the Azerbaijan-Georgia-Romania-Interconnector, is being considered. AGRI is a proposed project to transport Azerbaijani natural gas to Romania and further to Central Europe. Natural gas would be

transported by the pipeline from Sangachal Terminal in Azerbaijan to the Kulevi Terminal at the Black Sea coast of Georgia. In Kulevi, the liquefied natural gas export terminal (LNG plant) would be built. Liquefied natural gas will be transported by LNG tankers to the Constanta terminal in Romania. After regasification natural gas will be delivered through the existing gas grid to Romania and other European countries. An alternative to the transportation of liquefied natural gas is transportation of compressed natural gas⁴.

The training of GOGC in gas pipeline safety and security issues is an urgent and very important task.

The improvement of Georgian legislation on safety zones of gas pipelines is a challenge for new pipeline construction projects.

Pipelines in Georgia have been built under varying conditions during different political regimes, realities and economies. This has impacted the design/construction and operational parameters and the procedures of establishment of safety zones of the facilities.

The application of the Soviet-recommended generic protection and safety zones without considering the specific design/construction conditions is not appropriate, especially on the territory of Georgia which is a land-poor country where the substantial part of its land is under private ownership. The use of the Soviet-era method significantly complicates the construction or rehabilitation of main pipelines as well as increasing their costs.

The definition of Safety zones were based on GOST Standards. Later, in 2000, technical regulatory documents that are accepted in EU, OECD member-countries and Georgia's Main Trade Partner-countries were admitted as a technical regulation and declared as permitted for use. According to these standards, three zones are specified along the pipelines with different risk probability and with special restrictions for buildings and other installations in each zone. Additionally, these new standards consider risk assessment as one of the methods of zones definition. Applying this method especially in pipelines with high pressure, new ways of construction can be defined, resulting in reduction of risk and consequently decreasing the width of safety zones. The need to have a practical methodology is often an issue in Georgia while constructing new industrial and social facilities under the restricted conditions that are characteristic of the country (e.g. the gorges of the Terek and Aragvi Rivers, the industrial region of Gardabani-Rustavi-Tbilisi).

The demand for the seminar was as a result of the request for knowledge and experience to help develop amendments that would be implemented in Georgia's regulatory framework. These amendments would directly permit the practical application of a risk assessment-based methodology that would reduce the burden of safety (protection) zones. In addition, the appendix of the regulation decree would contain the proper calculation model for practical use and the guidelines to be complied with.

⁴ Liquefied Natural Gas (LNG) is natural gas that has been converted to liquid form for ease of storage and transport. It occupies around 0.17% of the volume of natural gas in its normal state; Compressed Natural Gas (CNG) is gas that has been compressed to less than 1% of the volume it would normally fill at standard atmospheric pressure. It is stored and transported in cylindrical vessels at around 20-25MPa pressure and can be used as a gasoline substitute. LNG achieves around 2.4 times higher energy density than CNG, which makes LNG more cost effective to transport over long distances where pipelines do not exist.

4.2.3 Various topics discussed during the seminar:

- For the definition of risk management, a distinction between ‘incident’ and ‘accident’ (which is one of relative severity) was made. Incidents comprise 70 to 90% of the events while the accidents comprise 30 to 10%. Incidents are not important and usually have negligible consequences, however if an organisation is tracking any incident that happens to their installations and takes measures to protect the installation from the causes of incidents, this helps avoid accidents, which are more severe.
- Risk identification is a subjective task and needs a group of experienced engineers to brainstorm and also use check lists in order to identify potential risks.
- Trainers suggested the site NGTSB.GOV, where there are a lot of detailed descriptions of accidents. They give ideas for the most common risks and mitigation measures.
- In critical areas of gas pipelines (high risk), shut off valves are installed in short distances. If an accident happens, the released quantity of the gas is relatively small and hence the consequences are smaller.
- HAZID and HAZOP studies. HAZID is used to define the potential risks and HAZOP the consequences and mitigation measures.
- Published HAZID guidelines exist. Ramboll has developed “guidelines” that it uses in all projects.
- The importance of **real** “as built” drawings for the mitigation of pipeline risks was discussed in detail. Incorrect “as built” drawings are the main cause of accidents. The example of the pipeline accident in Ghislenghien, Belgium, July 30 2004, demonstrated this. The explosion happened because the excavation works considered the depth of the pipeline as 6 m instead of the **real** 1.5 m!
- The calculation of risk probability is based upon published statistics which help determine the frequency of accidents of various types. Discussion concentrated on the assumptions that should be taken into consideration for these statistics. Trainers gave the example of accidents in installations. It is assumed that the installations were constructed in accordance with international standards, hence if the installation under evaluation has been constructed with “lower standards” the statistical frequency figure will be increased.
- For the identification of the Risk Assessment Criteria, trainers clarified that, when they evaluate a system, they estimate the frequency of failure for each equipment separately and the total probability for system failure is the summary of all individual frequencies.

5 Conclusions

5.1 The conclusions of the seminar were:

This AHEF assignment strengthened the capacity of the GOGC and GGTC participants to implement, review and approve “risk assessment studies” in areas of the transportation network that are close to industrial and residential areas or tourist resorts. Most of the participants were from the engineering department of GOGC, they received information about the methodologies of risk assessment, data sources for the necessary statistical analysis, existing software packages that are used internationally as tools for risk quantification and the estimation of consequences if an accident happens. Finally, in discussing the case studies with trainers, the delegates received several examples of risk mitigation measures. The theoretical case studies in the class and the actual ones on the study tour provided them with capacity to apply this knowledge. Already the engineering department of GOGC has utilised the seminar material and knowledge to implement risk assessment studies.

5.2 Specific outcome from the seminars

During the training courses, but mainly during the study tour, specific actions were identified that could optimise GOGC and GGTC safety and security operations:

- During 2000 to 2010, utilising European standards, three zones have been specified along the pipelines with different risk probability profiles and with special restrictions for buildings and other installations in each zone. Risk assessment is one of the methods used for zone definitions. Applying this method especially to high pressure pipelines, permits the definition of new ways of construction resulting in reduction of risk and consequently decreasing the width of safety zones. The engineering department of GOGC has already started preparing risk assessment studies for new pipelines. GOGC also plans to introduce a decree, based on the conclusions of the seminar, with quantitative criteria for the approval of risk assessment studies by the Georgian authorities.
- During the visits to pipeline sites, it was observed that there are not continuous marking signs along the pipelines routes as is specified in European Standards. The trainers pointed out that this increases dramatically the probability of accidents and GOGC should install these signs, especially in areas that are accessible by third parties.
- In areas that are accessible, or close to residential areas, where either the risk probability is high or the consequential damages high, it is recommended that shut off valves should be installed, with remote controlled motor drives. Such valves would ensure that, if an accident happens, the quantity of released gas would be very small and the consequences relatively minor.
- Both of the sites that were used as case studies in the study tour (Gudauri and Kazbegi), are close to residential areas that are, for certain months of the year, heavily populated (as ski resorts during winter time). For both cases, taking advantage of the presences of experienced Ramboll engineers, the GOGC engineers collected the necessary initial data and performed preliminary calculations to identify risks and estimate the consequent damages. The risk assessment of these installations needs to be finalised and a decision taken on measures for risk mitigation that can be implemented. Possible mitigation measures were identified and discussed. These included: hydro-testing of old pipes and replacement of certain sections with new ones, installing cathodic protection against corrosion along the route, marking signs, and installing remote motor driven shut off valves.

6 Annexes

6.1 Agenda

The Agenda of the seminars/study tour can be found at the following link of the INOGATE web portal)

<http://web.inogate.org/activities/384?lang=en#2>

6.2 List of participants

The List of Participants of the seminars/study tour can be seen in the following link of the INOGATE web portal

<http://web.inogate.org/activities/384?lang=en#2>

6.3 Presentations

The main presentations of the seminars/study tour can be seen in the following link of the INOGATE web portal <http://web.inogate.org/activities/384?lang=en#2>

6.4 Questionnaires

See Attachment 1 Questionnaires (before and after)

6.5 Evaluation results

See Attachment 2 Evaluations

6.6 Photos & media material

The relevant material can be found at the following link of the INOGATE web portal:

<http://web.inogate.org/activities/384?lang=en#2>

6.7 Thank you letter

See Attachment 3