POTENTIAL METHANE EMISSIONS REDUCTIONS AND CARBON OFFSET OPPORTUNITIES IN RUSSIA

Venugopal, S., TransCanada PipeLines Ltd.

ABSTRACT

TransCanada embarked upon a project with Gazprom[1] of Russia that uitlized its expertise in methane emissions management, to study the potential methane emissions reductions that can be achieved through joint implementation. In 2001, a field measurement and mitigation campaign was conducted at two of Gazprom's compressors stations on the Nizhny Novgorod transmission system. The field campaign consisted of several components, training and technology transfer, baseline measurements, implementing mitigation actions, and verification measurements. The result was a 173,800 tonne CO_2E reduction in methane emissions and a potential 4.3 million tonne CO_2E reduction over the life of the project. This paper will discuss this project and how the methane emission reductions were achieved. It will also estimate the potential methane emissions that can be reduced from the Gazprom system based on information collected during the field campaign.

1.0 INTRODUCTION

TransCanada has invested significant resources to mitigate greenhouse gas emissions (GHG) emissions (mainly methane), as this has been most cost-effective means for direct greenhouse gas emissions reductions. Even with these efforts, TransCanada is still one of Canada's single largest greenhouse gas emitter. This is due the emissions of carbon dioxide and nitrous oxide that result from combustion process from facilities operations. Reducing carbon dioxide is currently both a technological and economical challenge for TransCanada. Therefore TransCanada has considered carbon offset projects as a potential management option for GHG emissions. In the Kyoto Protocol, flexible mechanisms have been included to facilitate this process. Joint implementation is a means by which emission reduction projects occur between signatories of the Kyoto Protocol and benefits are shared in accordance to the contractual agreement set in place between the parties. Joint implementation potentially offers cost effective emissions reductions and thereby, meeting both environmental objectives of reducing global greenhouse gas emissions and also business objectives by seeking cost effective means of managing GHG gas emissions.

2.0 PROJECT DESCRIPTION

TransCanada has developed expertise in measuring methane and mitigating methane emissions from natural gas pipeline systems. A project called The Rusagas Carbon Offset Project (Rusagas Project) was undertaken by TransCanada and Gazprom that measured fugitive[2] methane losses from two natural gas compression facilities (Pochinki and Torbeevo) in Russia, trained personnel in mitigation techniques, conducted mitigation and verified reductions.

3.0 METHODOLOGIES

The reduction of fugitive methane emissions and the generation of carbon offsets from both Pochinki and Torbeevo followed the process presented in Figure 1. The baseline work began with the acquisition of operational data and was coordinated with compressors station staff. Calibration of equipment preceded the leak detection and measurement campaign. Independent third party consultants performed leak detection, baseline measurements and verification of emissions reductions.[3]

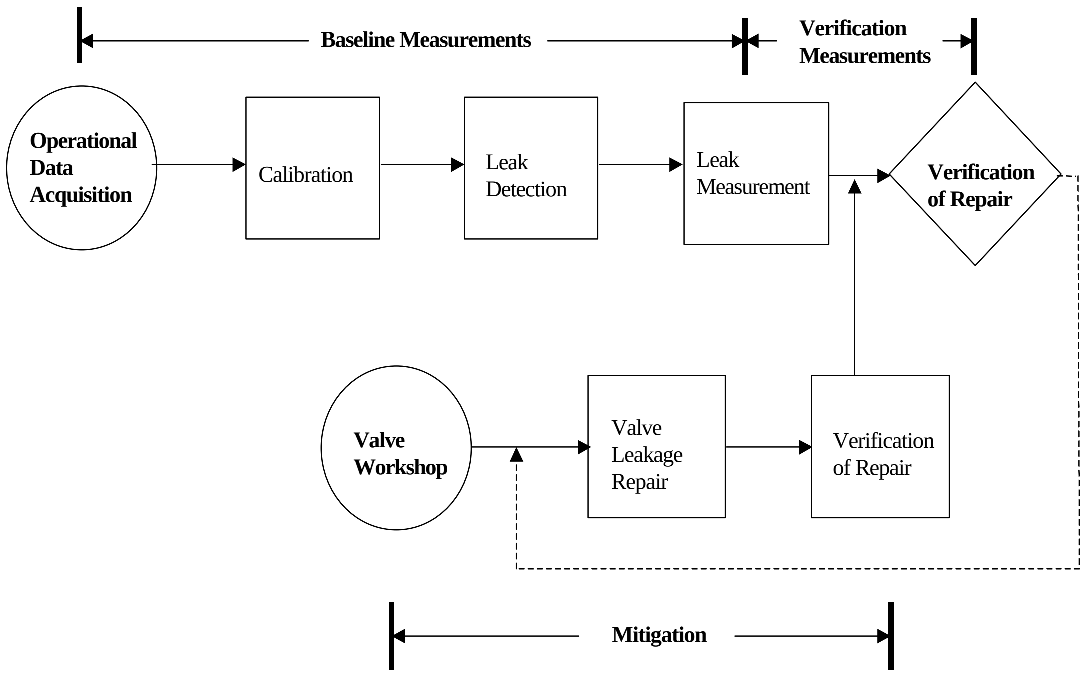

Figure 1: The process of reducing fugitive methane emissions. There are two parallel streams of activity in process: i) baseline measurements and verification and ii) mitigation.

The second stream of work began with a valve maintenance program. A process of conducting the repairs was mutually agreed upon by the TransCanada team and the compressor stations' engineers and technicians. The results of the screening and measurement work were recorded and analyzed on a daily basis and presented to the valve maintenance team. The valve leakage repairs commenced once the leaks were prioritized for repair. As the valve leakage was repaired, the valve maintenance team conducted their own verifications of the repairs to benchmark the progress of the valve maintenance. When a valve leak was repaired to a satisfactory level, an independent verification was performed and the reduction in methane emissions recorded. If during the independent verification process the leakage rate increased to an unacceptable level, the valve leakage repair process was again undertaken. This was repeated until the leakage was contained to an acceptable level.

3.1 LEAK DETECTION

Leak detection is the first step in the measurement campaign. Its purpose was to identify fugitive emissions arising from valve leakage and record relevant information on the leak source. There are two specific methods utilized in the leak detection, soap and water solution screening and gas analyzer screening (US EPA, 1993). First, the method of leak detection is chosen and applied to identify the leaking source. An iterative process of leak detection is applied until a leaking component is found. Once a leak component is found it is tagged with an identification tag and appropriate information on the leak source documented. The process again commences at the next potential leak souce.

3.3 LEAK MEASUREMENT

Leakages were quantified using one of three techniques: high flow (or high volume) sampling, vane anemometer measurement or positive displacement meter measurements. For the majority of the leaks, the high flow sampler was used for measurements (Figure 2). For leak rates that exceeded the high flow sampler's upper quantifiable limit (350 l/min), the vane anemometer or positive displacement meter were used. The volumetric leak rates were recorded on the appropriate field forms. Both the screening and leak rate data were captured on an electronic spreadsheet that calculated the mass flow rate and the uncertainty in the measurement.

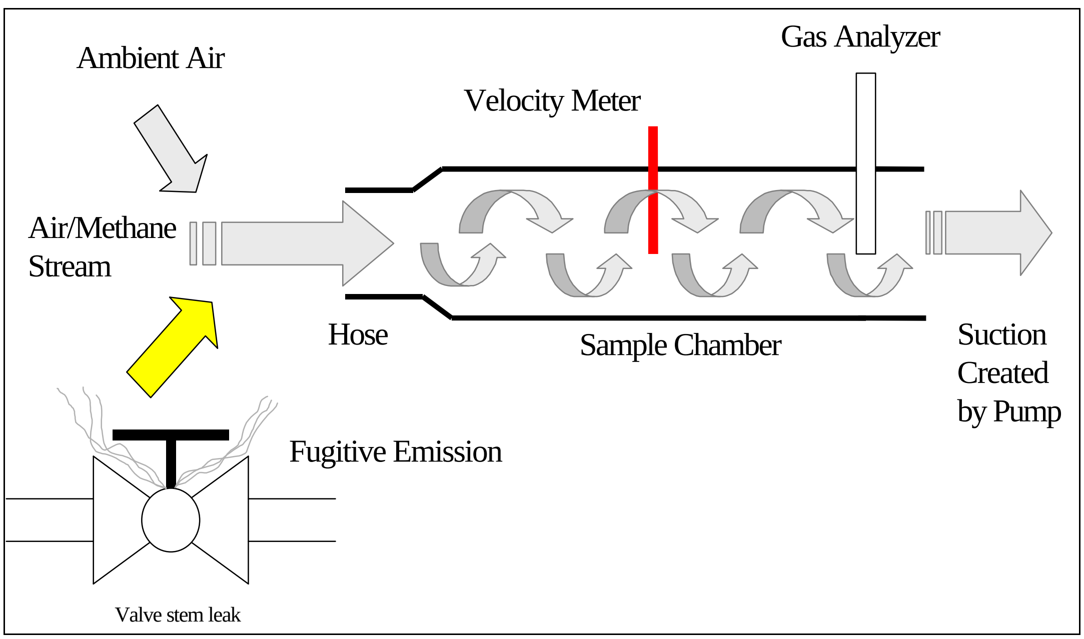

Figure 2: Principles of high volume sampling. The high flow sampler uses an air pump to draw both methane from the leaking component and ambient air into its sample chamber. The velocity and gas concentration is measured in the sample chamber to determine the mass flow rate of the leak.

3.4 LEAK MITIGATION

The mitigation program started off with a workshop on valve maintenance for compressor station directors and engineers. This portion of the mitigation program identified the procedures that would be used to mitigate the fugitive emissions. The actual mitigation work was also an opportunity for training and capacity building.

The mitigation of fugitive emissions begins with an inspection of the leakage source. The inspection is an exterior examination and it involves finding the leak source, a survey of the valve for physical outer characteristics, obtaining design documents, installation dates and verbal discussions with technicians to obtain a history of the valve. Following the external inspection, a root cause analysis is performed using certain techniques to evaluate the internal conditions of the valve. Acoustic techniques, cycling of the valve seat to find the sweet spot, the point of minimal leakage, and the use of an orifice flow tester are the main techniques used in the assessment. Once the assessment is completed, a repair strategy is outlined and carried out. This process flow is illustrated in Figure 3. Once a repair is conducted, verification measurements are taken. If measurements indicate that the repair is not satisfactory then the process of root cause analysis and repair is once again undertaken. This becomes an iterative cycle until the repair and emissions reductions are satisfactory.

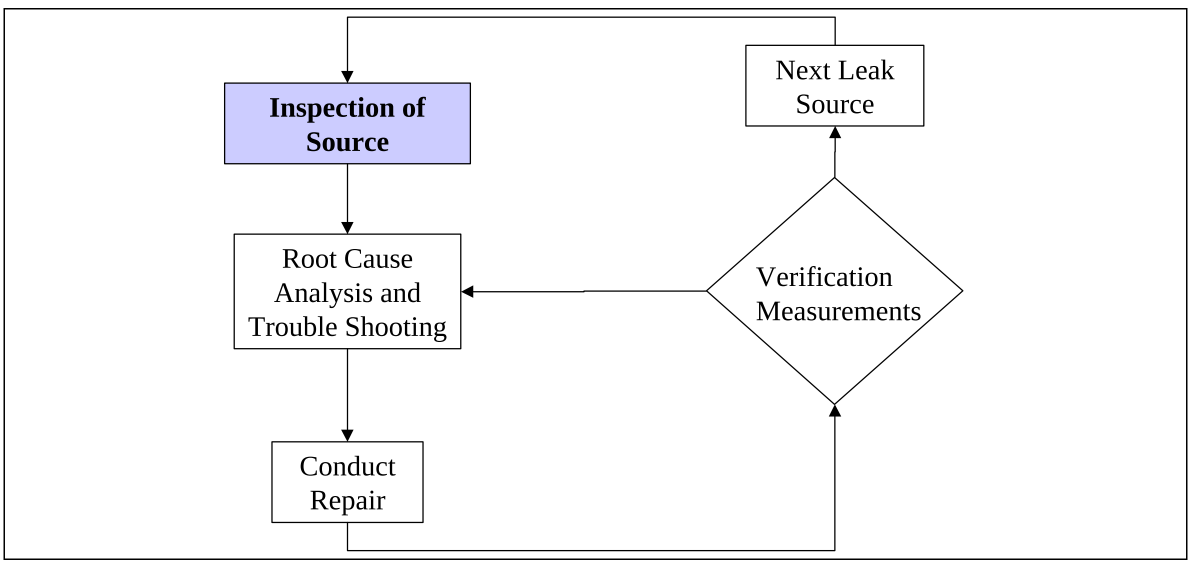

Figure 3: Process of mitigating fugitive emissions. The iterative process of leak inspection, root cause analysis, repair and verification measurement is shown in this figure.

3.5 VERIFICATION OF REPAIRS AND EMISSIONS REDUCTION

The verification of repairs were conducted using both the screening and measurement techniques. When the valve repair was 100 per cent effective in stopping the leakage, screening was sufficient for the verification. When the valve repair was not 100 per cent effective, the leak rate was quantified to determine the leak rate after repair. The verification of measurements were conducted by independent third party consultants for the project. The reduction in emissions is calculated by subtracting the verification emissions rate from the baseline emissions rate.

4.0 RESULTS

There is over 1000 MW of combined compression capacity at Torbeevo and Pochinki compressor stations. Both gas turbines and electric drives are used to drive the 71 compressor units at both stations. The baseline screening revealed over 1,500 leaking sources at both stations. The quantification of the leak rates found that 21.5 million m^3/year of methane or 352 thousand tonnes CO_2E/year was being lost to atmosphere from valve leakage at both stations. Table 1 and 2 summarize operational data and leak rate data from both Pochinki and Torbeevo. The verification measurements found that 10.6 million m^3/year or 174 thousand tonnes CO_2E/year were reduced from the mitigation efforts. This represents a 50 per cent decrease in fugitive emissions. There is a potential of reducing emissions by 266 million m^3 or 4.4 million tonnes CO_2E over the anticipated 25 year life of the project.

An estimate of the potential fugitive losses from the entire Gazprom system can be estimated based on the total installed compression. Presently Gazprom has 40,000 MW of installed compression. Using this emission factor, 21,364 m^3/MW/yr, it is estimated that 854 million m^3/year methane or 14 million tonnes CO_2E/year is released to atmosphere from the entire Gazprom system (Table 4). Based on the mitigation results from Pochinki and Torbeevo, it is estimated that a minimum of 422 million m^3/year of methane or 7 million tonnes CO_2E/year is a manageable reduction. This is summarized in Table 4.

The estimates are based on the average leak rates calculated for both compressor stations. An upper and lower boundary for the estimates cannot be assessed at this time. This is because the uncertainty in the estimate included more than the intrinsic measurement error. The following are assumptions made in development of these estimates and the uncertainty is tied to these as well: i) similar compressor station designs and valve configuration for the entire Gazprom system, ii) similar maintenance programs are implemented and practiced throughout the Gazprom system, iii) similar leak sources are found throughout the Gazprom system, and iv) similar efforts required to mitigate and reduce emissions across the Gazprom system.

Table 1: Summary of Emissions and Reductions from Both Pochinki and Torbeevo

	Baseline			After Repairs		
	m^3/yr	t CH_4/yr	t CO_2E/yr	m^3/yr	t CH_4/yr	t CO_2E/yr
Pochinki Compressor Station	12,995,730	9,227	212,220	6,388,660	4,536	104,327
Torbeevo Compressor Station	8,544,893	6,067	139,538	4,505,757	3,199	73,579
Total	21,540,623	15,294	351,758	10,894,417	7,735	177,906
	Reduction - Annual			**Reduction - 25 Years**		
	m^3/yr	t CH_4/yr	t CO_2E/yr	m^3	t CH_4	t CO_2E
Pochinki Compressor Station	6,607,070	4,691	107,893	165,176,755	117,275	2,697,336
Torbeevo Compressor Station	4,039,136	2,868	65,959	100,978,408	71,695	1,648,977
Total	10,646,207	7,559	173,853	266,155,163	188,970	4,346,314

Table 2: Summary of Compressor Train Emissions for Both Pochinki and Torbeevo

					Leak Rate		
Compressor Train	**Number of Units**	**MW per Unit**	**MW Installed**	**MW-hr/yr**	m^3/yr	t CH_4/yr	t CO_2E/yr
Urengoi - Uzhgorod	6	25	150	328,500	3,552,241	2,522	58,008
Urengoi - Centre 1	13	15	198	473,040	7,508,136	5,331	122,608
Urengoi - Centre 2	10	19	188	328,500	3,748,604	2,662	61,215
Yamburg - Yelets 1	14	11	158	435,372	2,326,825	1,652	37,997
Yamburg - Yelets 2	14	11	158	435,372	3,475,398	2,468	56,753
Yamburg - West Boundary	14	11	158	349,524	929,419	660	15,177
Total	**71**		**1008**	**2,350,308**	**21,540,623**	**15,294**	**351,758**
Average	**12**	**15**	**168**		**3,590,104**	**2,549**	**58,626**

Table 3: Summary of Emission Factors for Both Pochinki and Torbeevo Compressor Stations

Emission Factors	**Leak Rate Factor**		
Compressor Train	**m^3/MW/yr**	**tCH_4/MW/yr**	**t CO_2E/MW/yr**
Urengoi - Uzhgorod	23,682	16.8	387
Urengoi - Centre 1	37,872	26.9	618
Urengoi - Centre 2	19,993	14.2	326
Yamburg - Yelets 1	14,773	10.5	241
Yamburg - Yelets 2	22,066	15.7	360
Yamburg - West Boundary	5,901	4.2	96
Emission Factor	**21,364**	**15.2**	**349**

Table 4: Estimate of Fugitive Emissions and Reductions from the Gazprom System

Estimate of Fugitive Emissions From Compressor Station Valve Leakage				
Gazprom	**Capacity (MW)**	**m^3/yr**	**t CH_4/yr**	**t CO_2E/yr**
Fugitive Emissions	40,000	854,574,679	606,748	13,955,205
Potential Reductions		422,363,754	299,878	6,897,200
25 Year Project Life		**m^3**	**t CH_4**	**t CO_2E**
Fugitive Emissions		21,364,366,972	15,168,701	348,880,113
Potential Reductions		10,559,093,839	7,496,957	172,430,002

5.0 CONCLUSIONS

The Rusagas Project proves that tangible reductions of GHG emissions can be obtained from Russia. This is demonstrated by the reductions in fugitive losses achieved by the project. The Rusagas Project was successful in transferring new methane emissions measurement and mitigation technology to the Russian Federation. The success was based on capacity building that was executed in the form of valve maintenance workshops and during the field leak mitigation campaign that reduced fugitive emissions. The estimated fugitive methane emissions released from valve leakage at Gazprom compressor stations is 855 million m^3/year or 14 million tonnes CO_2E/year. The total potential reductions in fugitive emissions is estimated at 422 million m^3/year or 6.9 million tonnes CO_2E/year.

6.0 REFERNCECS

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[1] Gazprom is the world's largest natural gas company that operates a pipelines system that is over 140,000 km long and with nearly 40,000 MW of compression power at their compressors stations.

[2] Fugitive emissions are losses of natural gas though equipment leakage, such as leaks past valve seats and flanges.

[3] The consultants were Clearstone Engineering from Calgary, Canada and two scientists from Moscow State University. Using an independent third party for this work is very important, as it will facilitate the transfer of greenhouse gas emissions credits at the end of the project.