Regulatory Development for Gas Storage, Linepack and Restrictions Management

Final Report
CERI Project 205

CAP GEMINI ERNST & YOUNG

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Introduction

- The Energy and Gas Regulatory Commission ("CREG") has made progress in the regulatory development of the gas transportation activity. In doing so, the CREG has tried to facilitate the agents' free initiative in the management of the risks inherent in the activity and in the optimization of the use of the available transportation infrastructure. Despite the efforts made, there are additional activities that require the knowledge and expertise of developed gas industries which are considered necessary to be implemented in the country. The necessary activities conducive to a more efficient management of the transportation infrastructure include: gas storage, restrictions management and linepack
- Cap Gemini Ernst & Young ("CGE&Y") was retained to evaluate and provide input into developing draft regulations regarding restrictions management, linepack and gas storage.
- As part of the project, CGE&Y held meetings (via videoconference) with several key stakeholders in the Colombian gas industry, including:

CREG	Gas Natural	Cerro Matoso
MME	EPM	Texas
Promigas	Gas Caribe	Surtigas
Ecogas	Corelca	Ecopetrol

Colombian Gas Industry

Overview: Promigas and Ecogas are the two main pipeline operators in Colombia. Promigas operates the Atlantic coast pipeline and Ecogas operates the interior pipeline. Utilization for the various pipelines segments varies significantly, ranging from 47 to 91 percent. For 2000, gas throughput for the pipelines was approximately 220 mmcf/d for Ecogas and 359 mmcf/d for Promigas.

Due to the temperate climate, there is very little seasonal variation in gas consumption in Colombia. Primary use of natural gas is residential (cooking), thermal power plants, commercial and industrial. Majority of the contracts between the pipelines and shippers/consumers are firm and only a few consumers, primarily power plants, have dual fuel capability.

The major supply areas for natural gas are Guajira, Payoulha Salina, Provincia/Bonanza and Cusiana. There is an excess supply of gas from the upstream sector. However, the excess supply is not available in the short-term i.e. it takes about 6-8 hours to increase production to compensate for increased gas demand.

Colombian Gas Industry (cont.)

Issues: The natural gas industry in Colombia is faced with a number of issues, including:

- Disruptions Due to Public Disorder: In Colombia, disruptions due to public disorder are the major cause of curtailments in gas supply. Periodically, the guerrillas blow up gas transmission pipelines, gas distribution systems and production facilities resulting in curtailment of gas supply to the customers.
- Power Generation: Thermo-electric power generation accounts for about 30 percent of the power generated in Colombia. When there is a lack of rain (El Nino effect), the demand for thermo-electric power generation increases significantly. Also, when the transmission facilities are sabotaged by the guerrillas, the demand for thermo-electric power generation increases. This can result in a short-term demand and supply imbalance in the pipeline system.
- No Gas Storage Facility: Currently, there are no underground gas storage facilities in Colombia. As a result, the pipelines are restricted in their options to correct the short-term demand and supply imbalance.
- Lack of Duel Fuel Capability: Majority of industrial and commercial gas consumers, with the exception of the some power plants, do not have dual fuel capability. These consumers are solely dependent of the supply of natural gas.

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Decree on Restrictions Management

Review of Decree 1515 (Dated July 23rd, 2002): Decree 1515 outlines the priorities in the event of restrictions in the supply of natural gas. As per the decree, in the case of a gas supply curtailment, the following hierarchy of gas service will prevail:

1. Agents with firm contracts will be given first priority
2. Agents with gas storage and parking contracts will be given second priority
3. Agents with partial firm contracts will be given third priority
4. Agents with interruptable contracts will be given fourth priority

Following are some general observations related to the decree that CREG may want to consider:

1. The decree assumes that the gas storage facility will be operated by the gas transmission companies. Depending on several factors, gas storage facilities can be operated by LDCs, producers or pipeline companies. For example, historically in Alberta most of the storage was operated by LDCs. However, over the last decade, both producers and marketers have invested heavily in gas storage facilities. The main reason for this change was the new requirement for daily balancing in the Nova gas pipeline system (now part of TransCanada Pipelines).

Decree on Restrictions Management (cont.)

2. Similar to the pipeline contracts, most gas storage facilities provide a variety of contract options to their customers, i.e. firm, partial firm or interruptable. In the case of a curtailment, the decree does not address the priority hierarchy for the different gas storage contracts.

3. In the event of a gas supply curtailment, the decree only deals with the issue of gas withdrawal from gas storage. However, the decree does not address the issue of gas injections. For example, it is possible that some customers may be injecting gas in the storage during curtailment. In such a scenario, the decree does not empower the gas storage operator to divert the gas meant for injection and use it for the customers that are at risk of being curtailed.

Linepack

Gas pipelines are operate with a certain amount of inherent linepack to facilitate the movement of gas. The benefit of linepack is to have some stored gas (under pressure) available in the pipeline to allow for short-term variations in demand and supply due to disturbances in either upstream facilities or routine pipeline maintenance. The physical quantity of gas stored or available in the pipe at any given moment is called "linepack“.

By raising and lowering the pressure on any pipeline segment, a pipeline company can use the segment to store gas during periods when there is less demand at the end of the pipeline. Using linepack allows pipeline operators to efficiently handle short-term fluctuations in demand.

Gas pipeline companies use sophisticated real-time simulations to calculate the amount of linepack in their system. The operational flexibility is realized by operating the pipeline with a higher arrival pressure ("linepacking") than the minimum pressure specified in transportation contracts. Therefore, the actual system-survival time (i.e. ability of pipeline to function without affecting the supply of gas to customers) due to linepack varies from one pipeline to another. Typical values are 4 to 8 hours with no gas input and full delivery. For partial loss of input the survival time can be significantly longer.

Linepack (cont.)

Generally, the target linepack is a function of:

1. Maximum allowable operating pressure (“MAOP”)
2. Delivery pressure
3. Temperature
4. Distance
5. Size of the pipeline (length and diameter)
6. Pipeline throughput
7. Seasonal or short-term variation in throughput
8. Fuel Efficiency

As part of the project, CGE&Y met with TransCanada Pipelines and Alliance, the two major gas pipeline companies in Canada, to discuss their operational practices regarding linepack.

TransCanada Pipelines (“TC”): TC owns and operates a number of gas pipeline systems in North America. The two major systems are the Alberta System (used for gathering natural gas within the province of Alberta; gas delivery of between 12 to13 bcf/d) and the Canadian Mainline (used for transporting gas from Alberta to Eastern Canada and US; gas delivery of between 7 to 8 bcf/d).

Linepack (cont.)

Unlike Alliance Pipeline, TC does not have a system to calculate linepack on a real time basis. Linepack is calculated using the following methodology:

$LP = V_{seg} \text{ X } (P_{av}/P_b) \text{ X } (T_b/T_{av}) \text{ X } (C_f/Z_{av})$

Where,

LP	=	Average linepack in a pipeline segment
V_{seg}	=	Physical volume of the pipeline segment
P_{av}	=	$2/3 [P_{in} + P_{out} – ((P_{in} \text{ X } P_{out}) / (P_{in} + P_{out}))] + P_{atm}$
T_{av}	=	$T_{out} + 1/3 \text{ X } (T_{in} – T_{out}) + 273.15$
Z_{av}	=	Average gas compressibility factor
C_f	=	Correction factor (varies between 1.05 to 1.1)

TC maintains a linepack of between 14 to14.5 bcf in both of its systems. This translates to about 1.5 times the daily throughput of the total system.

Linepack (cont.)

Alliance Pipeline: Alliance is a 2,988 km long gas pipeline that was commissioned in 2001. The pipeline has a capacity to transport 1,325 mmcf/d of rich natural gas from the Canadian provinces of British Columbia and Alberta to the Chicago market.

Alliance uses a “State of the Art” SCADA system to calculate linepack on a real-time basis. Data is collected after every 20 miles on the pipeline system. The SCADA system also provides data related to leak detection and hydrocarbon dew point.

Since Alliance is a new pipeline, it can operate at a significantly higher pressure (around 1,740 psi). This allows it to maintain a linepack of about six times the daily throughput. Older pipelines in Canada maintain a linepack that is significantly lower (some maintain a linepack equal to the daily consumption). The linepack in the system is owned by Alliance and the cost of the linepack is recovered through its rate base.

The limit for the MAOP is defined by the technical limitations of the pipeline. The limit for the minimum operating pressure is defined by customer contracts.

Linepack (cont.)

Regulations: In North America, there are no regulations for the amount or quantity of linepack. The MAOP for the pipeline system defines the upper boundary for the amount of linepack. As a result, each pipeline operator sets its own target range of linepack based on the economics of maximising throughput and minimising fuel and carrying costs of the linepack. In the US, the Department of Transportation is responsible for approving the MAOP for pipelines.

Following are some general observations and regulations related to linepack that CREG may want to consider:

1. **General:** If the linepack is managed effectively, survival time for a pipeline system can vary from a few hours for full disruption to several days for partial disruption. From our discussions with the producers and pipeline companies, it would appear that it takes about six to eight hours to bring extra production on line. Therefore, if linepack is managed effectively, the pipeline system should be able to sustain the short-term imbalance before additional production is brought on line.

2. **Utilization**: In Colombia, the majority of the gas transmission systems are not fully utilized. System utilization varies from 47 percent for the Marquita-Cali system to 91 percent for the Ballena-Barrancabermeja system. In the short term, the possibility of using the underutilized pipeline capacity for gas storage should be explored. However, in case of a pipeline sabotage, this may not be very effective as the increased linepack may be lost.

Linepack (cont.)

3. **Linepack Gas**: As is the case in North America, the pipeline company should own the physical quantity of gas used for building linepack. Based on our discussions with the Colombian pipeline companies, it would appear that the ownership of the linepack was not clearly defined. The regulations should clarify the ownership of linepack and also allow the pipeline companies to recover (through the rate base) the cost of gas in the linepack.

   Suggested Modifications to Existing Regulations:

   (i) Resolution 001 of Jan. 20, 2000 – Article 2

   *Include the following definition of linepack in the list: "**the physical quantity of gas stored or available in the pipe at any moment**"*

   (ii) Resolution 001 of Jan. 20, 2000 – Section 3.2

   *Include "cost of linepack" to the list of existing investment: "operation related assets (gas lines, transport system compressors, **linepack**, accessories and other)*

   (iii) Resolution 057 of July 30, 1996

   Add Article 455 to specify that the pipeline company has ownership of the linepack.

Linepack (cont.)

4. **Capital Cost**: The amount of linepack in the pipeline can be increased by either increasing the pressure or by looping the pipeline (i.e. increasing length). Any capital investment required for increasing linepack, including compressors, pipeline, etc, should be justifiable from the perspective of benefits to the users (as per section 3.2.2. Resolution 001, Jan 20, 2000). Once the benefits and corresponding economic efficiency of the investment has been established, the pipelines should be allowed to recover these costs through the rate base.

   Suggested Modifications to Existing Regulations:

   Resolution 001 of Jan. 20, 2000 – Section 3.2.2

   > *Add "infrastructure required to increase linepack" in the bolded description: "operation related assets (gas lines, transport system compressors, **infrastructure required to increase linepack**, accessories and other)*

   .

5. **Operating Pressure**: The issue of increasing pipeline pressure should be explored. The factors that need to be considered include public safety (according to Promigas this is a significant issue), technical specifications of the pipeline (MOAP) and capital cost.

Operational Balancing Agreements - OBAs

As part of the project, CGE&Y reviewed the various OBAs pertaining to the gas transmission pipelines. In general, the OBAs were in compliance with acceptable industry standards. The nomination, scheduling and balancing procedures outlined in the OBAs and Resolution Number 071 of December 3rd, 1999 (RUT) are similar to the procedures followed in North America.

Following are some observations related to OBAs that CREG may want to consider:

1. It would appear that the penalties for gas imbalance outlined in the OBA (between the pipeline and customer) and the compensation matrix are different. For example, the OBA stipulates that, for all pipeline systems, the customer will be liable for the cost of gas, transportation and a 5% extra charge. Whereas, the compensation matrix defines the gas imbalance penalties as a function of:

    - Type of pipeline
    - Utilization of pipeline
    - Amount of imbalance
    - Customized factors -A1 to A9 (the value for these factors to be mutually defined by the pipelines and the customers)

    CREG needs to ensure that the penalty schedule for gas imbalance are the same in both the OBAs and the compensation matrix.

Operational Balancing Agreements - OBAs (cont.)

2. Typically, OBAs include a force majeure clause as part of the agreement. A sample wording for the force majeure clause is provided below:

   “*If either party is rendered unable, wholly or in part, by force majeure to carry out its obligations under this Agreement, the obligations of the Party, except payment for services, to the extent they are prevented by the force majeure, shall be suspended during the continuance of any inability but for no longer period. The Party claiming excuse by force majeure must take all reasonable efforts to cure the cause and shall give notice and full particulars of the force majeure in writing or by facsimile transmission to the other Party as soon as reasonably possible after the occurrence of the cause.”*

3. The OBA between the pipeline and the customer refers to the balancing of the thermal power plants [Four (b) – last line]. However, once the thermal plant is dispatched, the OBA does not specify the number of days that the thermal plant is obligated to balance itself. It would appear that, in the agreement, instead of “days” it should read “day”. This would give the thermal power plants a period of “24 hours” to balance their account.

Compensation Matrix

In case of an imbalance, FERC's Order No. 637 requires that the penalties imposed by a pipeline must adhere to the following three principles:

1. A pipeline must provide to customers, on a timely basis, as much information as possible about the imbalance and overrun status of each shipper and the imbalance of the pipeline's system as a whole.
2. A pipeline may include transportation penalties in its tariff only to the extent necessary to prevent the impairment of reliable service.
3. A pipeline must credit to customers all revenues from all penalties net of costs.

Following are some general observations related to the compensation matrix that CREG may want to consider:

1. In principle, we agree with Texaco's observation with regards to charging the customers actual costs incurred by the pipeline companies. This will be in agreement with the second principle of FERC's Order N0. 637 (see above). Punitive damages (i.e. penalties in excess of actual costs) should be considered for only those customers that cause frequent imbalances in the pipeline system.
2. In practice, it will be very difficult for the pipeline company to access the penalties based on actual costs for each gas output variation caused by the customer. Our recommendation would be to access penalties based on the compensation matrix. However, at the end of the year, the pipeline company should be required to credit to customers all revenues from total penalties net of actual costs (on a prorated basis).

Gas Storage

Introduction

Gas storage has been used in North America since 1915. In 2000, there were a total of 415 gas storage sites in the US with a total working gas capacity of 3,899 Bcf. The total deliverability from these storage sites was 77.73 Bcf/d. Gas storage sites are predominantly operated by interstate pipelines, LDCs and producers.

Gas storage is primarily used for:

1. Balancing both seasonal and short-term variations in demand and supply. (Note that in Colombia, due to the temperate climate, there is insignificant seasonal variation in gas demand and supply. Most of the imbalances are short term in nature. This subject is explored in further detail in Slides 22)
2. Deliverability Insurance (e.g. reliable gas supply for hospitals, schools)
3. Reducing capital outlay for pipelines i.e. with gas storage, pipeline capacity can be less than peak demand
4. Increasing firm transportation service on pipelines
5. Reducing capital outlay for gas wells (i.e. with gas storage, well deliverability capacity can be less than peak demand)
6. Hedging gas prices

Gas Storage (cont.)

Introduction (cont.)

For underground gas storage, the following three types of reservoirs are commonly used:

1. Depleted Pools: Because of their wide availability, most existing gas storage facilities in North America use depleted oil and gas reservoirs.
2. Salt Caverns: These storage pools are developed in thick salt formations by mining a cavern out of the salt using water. Because the gas is stored in a void, withdrawal rates per unit of gas are higher than depleted pools and aquifers which are adversely impacted by their porosity and permeability.
3. Aquifers: An aquifer is a porous and permeable formation that contains water under pressure. Gas is injected in the formation via wells and the injected gas displaces the water at the top of the formation.

Gas Storage (cont.)

Introduction (cont.)

The operating characteristics of the various types of gas storage facilities is shown below:

Attribute	Salt Dome	Depleted Reservoir or Aquifers
Number of Wells	1-3	10-100+
Deliverability per well	300-600	5-10
Working Gas (fraction of Total Gas)	65%	33-50%
Typical Withdrawal Time	10 days	100-150 days
Cycles per Year	6-12 (depends on compression horsepower)	1-2
Water Content	Negligible	Often Substantial

Gas Storage (cont.)

Introduction (cont.)

As depicted in the previous table, gas deliverability from a salt dome storage is significantly more than from a depleted reservoir storage. Typically, depleted reservoir storage is used for balancing seasonal changes in the gas consumption (i.e. in situations where there is a significant variation in winter and summer gas consumption).

In North America, most new power plants are gas-fired and have a load profile that varies significantly during the day. Their variation of gas consumption tends to be more short-term than seasonal. As a result, the storage facilities that cater to this market require high deliverability.

In the case of the Colombian gas market, there is very little seasonal variation in gas consumption. Most of the variation in gas consumption is short-term in nature (caused by the switch from hydro-electric to thermal-electric power generation). Hence, any potential gas storage facility will need to have multiple cycling capability and this requires both high deliverability and injectability.

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Gas Storage (cont.)

Regulations for Gas Storage in Canada

In Canada, there are no federal acts or regulations that govern gas storage (i.e. gas regulations are mandated at the provincial level). Most of Canadian underground storage is located in the the provinces of Alberta and Ontario and is operated by either LDCs or producers. The recovery of costs is either through negotiated/market-based pricing (as in the province of Alberta) or cost of service (as in the province of Ontario).

Alberta: Alberta accounts for approximately 40 percent of total Canadian storage capacity. The storage facilities are operated by both producers and utilities. In Alberta, unlike Ontario (Slide 25), only the technical operations related to gas storage are regulated. The rates for gas storage are negotiated and determined by demand and supply (Slide XX provides further explanation of the rates for gas storage). Gas storage operators have the flexibility in customizing the contract and rate for each individual customer. **Appendix A** provides a sample of a contract used by gas storage operators in Alberta.

Alberta's Department of Energy empowers a person under the Mines and Minerals Act to form a unit agreement (Gas Storage Unit Agreement, **Appendix B**) to represent the combining interests of parties utilizing a subsurface reservoir for the purpose of storing mineral substances. The Gas Storage Unit Agreement falls under the purview of the Alberta Energy and Utilities Board (AEUB) and refers to gas that does not have an outstanding royalty liability to the Crown. This agreement sets out the terms and conditions related to the development, operation and production of the zone to be unitized.

Gas Storage (cont.)

Regulations for Gas Storage in Canada (cont.)

In order to prevent waste, the Oil and Gas Conservation Act and corresponding regulations (excerpts from the regulations related to gas storage are provide in Slide 34) enable parties to inject natural gas into an underground reservoir for storage purposes. Although the Minister of Environment and the AEUB both play a role in regulating gas storage, there are very few legal instruments that govern natural gas storage within Alberta. The regulations stipulate that storage operators must file a monthly report with the AEUB that details the particulars of the gas received (source, quantity, price, inventory, delivery destinations, etc.).

Some of the requirements for a new underground storage scheme must include schematic and area details, gas analyses, reservoir calculations and pollution control for gas containing H_2S. The AEUB regulates gas storage operations to ensure that all gas conservation, equity, environment and safety issues are addressed and to maintain up-to-date estimates of provincial gas reserves and deliverability. Parties consult Guide 65 (**Appendix C**) in order to understand the necessary approvals needed when depleting a pool or portion of a pool. For example, Section 4.3 of the AEUB's Guide 65 provides more detail on the geological, environmental, and operational (pressure data, analysis of gas properties, deliverability and injectivity capabilities, etc.) requirements of underground storage schemes. These regulations are similar to those for production facilities

Gas Storage (cont.)

Regulations for Gas Storage in Canada (cont.)

Ontario: Ontario, the most populous province in Canada, contains approximately half of Canadian working gas capacity and has used gas storage to meet seasonal demand since 1915. Most of the storage in Ontario is operated by LDCs and is subjected to regulation.

Gas storage development is regulated by the Ontario Energy Board (OEB) under the OEB Act (**Appendix D**) and follows the regulatory framework of transportation. Two of the act's objectives are to:

- maintain just and reasonable rates for the transmission, distribution, and storage of gas
- facilitate rational development and safe operation of gas storage.

Part III of the OEB Act provides a person with the authority to inject, store, and withdraw gas from a designated gas storage area providing the person has an approved gas storage application on file with the OEB. Storage companies seek approval for their gas storage contracts with the OEB. The OEB reports its findings to the Ontario Minister of Natural Resources who in turn either grants or refuses approval.

Union Gas, an LDC, is the operator of the largest gas storage network in Canada. Unlike the gas storage operators in Alberta, Union Gas' storage rates are subject to OEB's regulations. A sample of Union Gas' contract is provided in **Appendix E**.

Gas Storage (cont.)

Regulations for Gas Storage in Canada (cont.)

The Canadian Standards Association (CSA) is a non-profit membership-based association serving business, industry, government and consumers in Canada. The mandate of the CSA is to develop standards related to public health and safety.

CSA standard CSA Z341-98 (**Appendix F**) relates to the storage of hydrocarbons in underground formations. This standard sets out the minimum requirements for design, construction, operation, abandonment, and safety of hydrocarbon storage in underground formations and associated equipment. The equipment considered includes all subsurface process equipment, the wellhead, and all safety equipment, including monitoring, control, and emergency shutdown systems, related to the storage facilities, wells, and wellheads.

Although the CSA Z341-98 is not part on the regulations in Canada, it is used by the provincial regulators as a baseline to evaluate applications for gas storage.

Gas Storage (cont.)

Regulations for Gas Storage in US

U.S. pipelines have owned storage facilities for operational and load-balancing purposes since the early 1900's. Gas storage is regulated by the Federal Energy Regulatory Commission (FERC or Commission) when the gas that is contained in storage is destined for interstate transportation. Because natural gas is commingled on a pipeline, any gas that originates in one state and is destined for another state is deemed as interstate transportation. In order to qualify as intrastate transportation, the gas must be produced and consumed within that state. Public Service Commissions are traditionally the regulatory authority governing intrastate transportation, including storage. **Appendix G** provides an example of regulations for gas storage on intrastate pipelines.

In its regulations, the FERC defines "transportation" to include storage. Storage facilities must offer contract storage service on an open-access, unbundled basis and are required to comply with the same rules and regulations as natural gas pipelines. For example, the terms and conditions of firm storage, capacity release of storage, allocation of storage costs among various services, title transfers, rate design and calculation, injection and withdrawal requirements are under the jurisdiction of the FERC.

Gas Storage (cont.)

Regulations for Gas Storage in US (cont.)

Prior to FERC's Order No. 636, pipelines were not required to make storage available on an open-access basis. Order No. 636, "restructuring rule", was issued by the FERC on April 8, 1992. It transformed the U.S. interstate natural gas pipeline industry and required, among other things, the unbundling of the sale of gas (merchant function) and the storage function from the transportation function. By restructuring the natural gas industry, the FERC sought to unbundle the sale from the transportation to open up competition. Although the sale of natural gas was competitive, transportation was not and therefore pipeline monopolies were able to control the price of the bundled service. However, Order No. 636, required pipelines to offer access to storage facilities on a firm and interruptible open-access contract basis. The rule accomplishes this by amending the definition of transportation to include storage, thereby making storage subject to non-discriminatory access and all other requirements of the rulemaking.

Recently, FERC has allowed some storage providers to charge market-based rates (Slide 32). Waiver of the FERC's regulations governing the submission of cost-based data is granted to a company to permit it to charge market-based rates.

Gas Storage (cont.)

Regulations for Gas Storage in US (cont.)

The Natural Gas Act is the governing act that the FERC enforces in combination with the regulations in Title 18 (Conservation of power and Water Resources). The regulations under the NGA set out the rate, terms, and reporting requirements that an interstate pipeline and storage facility must fulfill. Some of the regulations and precedents related to gas storage include:

1. General Provisions

- Filing of all rate schedules at the FERC for public access
- Separating costs related to pipeline transportation and storage
- Charging maximum rates for peak periods in the event that capacity rationing is required.
- Charging rates during off-peak periods which encourage capacity maximization
- Applying volumetric and distance-based rates to the commodity portion in order to recover variable costs based on projected volumes. (This would apply to both FT and IT customers)
- Complying with all environmental laws, including the National Environmental Protection Act (NEPA) and the provisions within an Environmental Impact Statement or Environmental Impact Assessment. Some of the requirements for building a pipeline or storage facility include, among other things, description of the facilities to be constructed or utilized, a current survey, erosion control procedures, maintenance, system alternatives, etc.
- Filing of a current and public customer index which details the maximum daily storage and withdrawal quantity for each customer
- Filing of the facilities' peak day storage capacity and marketing affiliate information

Gas Storage (cont.)

Regulations for Gas Storage in US (cont.)

2. Firm Shipper Provisions

- Filing at the FERC of all recorded volumes in MMBtu`s
- Offering of firm transportation which is separate from any sales service and which receives the same priority as any other class of firm service
- Allowing capacity release to the replacement customer offering the highest rate, with the releasing shipper's contract remaining in full force and effect
- Offering service on a non-discriminatory basis with no preference given to marketing affiliates or other customers regarding quality and duration of service, categories, prices, or volumes of natural gas to be transported or stored.
- Stating imposed but reasonable operating conditions within its tariff

3. Interruptible Shipper Provisions

- Ensuring that interruptible storage service is provided on a lower priority basis than firm storage
- Applying the same provisions of non-discriminatory access, reasonable operating conditions, and limitations previously identified under firm shippers.
- Not charging a reservation fee (IT service cannot have any minimum bill provision that has the effect of guaranteeing revenue.)
- Queuing and bumping procedures are normally outlined in a company's tariff.

Gas Storage (cont.)

Rates for Gas Storage

Regulated – Similar to a regulated pipeline, the rates for a regulated gas storage facility are based on the cost of service model. The rate of return is approved by the pertinent regulatory body (e.g. Ontario Energy Board in the province of Ontario and FERC in the US for gas storage on all interstate pipelines). Gas storage operators are allowed a certain rate of return on the amount of capital employed. Typically components of a regulated rate include:

- Operating and maintenance costs
- Depreciation
- Taxes
- Debt charges
- Rate of return on rate base

Gas Storage (cont.)

Rates for Gas Storage (cont.)

Market Based Rates – A relatively new development in gas storage is the emergence of market-based rates. In the US, the amount of gas storage capacity that is subjected to market based rates is very small. Under a market based rate, gas storage operators are free to set prices in an open and competitive market.

To be eligible to charge market-based rates, FERC requires the operator to demonstrate that it lacks market power in the market that it intends to serve. FERC defines market power as ". . . the ability of a seller to profitably maintain prices above competitive levels for a significant period of time." Thus, the critical element in a storage provider's application for market-based rates is its analysis of the market and its relative standing in that market.

In its review of market analysis, FERC has typically relied on two numeric measures: a facility's or company's market share, and a related measure, the Herfindahl-Hirschman Index ("HHI") of market concentration. The HHI is equal to the sum of the squares of each storage providers market share. For example, if there are two gas storage providers with market share of 0.6 and 0.4, the HHI for the market will be equal to 0.52 (i.e. $(0.6)^2 + (0.4)^2$). A high value of HHI is an indication of a monopolistic market.

In the province of Alberta, because of the large number of gas storage facilities, rates for gas storage are market based.

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Gas Storage (cont.)

Gas Storage in Colombia

Following are some general observations and suggested regulations related to gas storage that CREG may want to consider:

1. **Feasibility Study:** The CREG should commission a study on the feasibility of gas storage in Colombia. The study should focus on the location, infrastructure availability (i.e. gas reservoirs, salt caverns, aquifers, etc) and economics of gas storage. Also, the study should evaluate the ownership of gas storage i.e. who should own and operate the facility?. The following are some potential options for gas storage ownership:

   - Pipelines – Are in the best position to manage demand and supply. Also, operational (i.e. compressors) and balancing characteristics of a storage facility are akin to pipelines
   - Producers – The expertise of producers in managing gas reservoirs may be beneficial for operating an underground gas storage facility
   - Pipelines and Producers – A joint consortium of pipelines and producers to own and manage the gas storage facilities
   - LDCs – Given the current state of the gas market in Colombia, operation of gas storage by LDC's would likely not be feasible.

Gas Storage (cont.)

Gas Storage in Colombia (cont.)

2. **Technical Regulations:** As discussed earlier, in North America the technical aspects of operating an underground gas storage are generally covered in regulations (similar to regulations governing production of gas). For example, the oil and gas conservation regulations in the province of Alberta (Canada) states the following:

   15.060 An application under section 26, clause (b) of the Act for approval of a new scheme or a major modification to an existing scheme, for the underground storage of gas shall include, when applicable

   (a) maps showing

   i. the area included in the scheme,

   ii. the lessors and lessees within and adjoining the scheme area, and

   iii. the status of each well within and adjoining the area for each zone in which it is completed, and the gas gathering facilities including line size and operation pressures,

   (b) a figure showing the facilities for the measurement of all relevant streams within the scheme area,

   (c) a tabulation of the analyses of raw gas from each pool from which gas will be gathered or injected,

   (d) evidence, including reservoir calculations, illustrating that the storage of gas is consistent with sound conservation practices,

   (e) a discussion of the method proposed for the control of pollution which might result from the gathering or injection of gas containing hydrogen sulphide, and

   (f) a discussion of the future disposition of the stored gas. AR 151/71 s15.060;350/87

Gas Storage (cont.)

Gas Storage in Colombia (cont.)

In our research of the various gas storage jurisdictions in North America, we found the CSA Z341-98 (**Appendix F**) to be a fairly comprehensive technical standard for operating gas storage. The CSA Z341-98 deals with gas storage in aquifers, mined caverns, salt caverns and depleted oil and gas reservoirs. The standard was developed by a Technical Committee of various stakeholders in the Canadian gas industry and is widely used as a baseline for evaluating the applications for design, construction, operation, abandonment and safety of underground storage facilities.

The CSA Z341-98 meets or exceeds the operating and safety regulations for underground gas storage in Canada and is used as a reference guide by the regulatory boards for approving new applications for gas storage. In Alberta, with a few exceptions, the AEUB regulations are in compliance with the CSA Z341-98.

Suggested Modifications to Existing Regulations:

We recommend that the technical regulations for gas storage should be included in the "Code for Gas Pipeline Transportation System" (please note that we were not privy to these regulations). These regulations should follow the principle of the Alberta regulations (Slide 34) or the CSA Z341-98.

Resolution 071 of Dec. 03, 1999 – Section 2.3

> *Include a reference in this section that all gas storage facilities must adhere to the operating and technical regulations outlined in the "Code for Gas Pipeline Transportation System". Also, Commercialization should be redefined so that the gas storage operators are not precluded from charging regulated rates for their service.*

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Gas Storage (cont.)

Gas Storage in Colombia (cont.)

3. **Economic Regulations:** Depending on several factors (i.e. number of storage facilities, market share, function of gas storage, location, etc), rates for gas storage can be either regulated or market based.

Suggested Modifications to Existing Regulations:

Resolution 001 of Jan. 20, 2000 – Section 3.2 Basic Investment

> *Include a separate section (3.2.1.2) to segregate the investment for pipeline assets from the investment required for a gas storage system: " **3.2.1.2 Gas Storage Investment: Existing investment, to rate review date, in operation related assets (gas lines, gas storage compressors, accessories and other) cushion gas and other assets (buildings, land, furniture, and appliances, gas storage equipment, communication equipment, computers and other). Cushion gas is defined as the volume of gas intended as permanent inventory in a storage reservoir to maintain adequate pressure and deliverability rates.***

This investment would have it's own rate base and tariff, but be regulated by the same regulator. As explained in Slide 38, the preferred option would be to allocate cost of gas storage to customers that have either firm contracts with the pipeline company or storage/parking contracts with the gas storage operator.

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Gas Storage (cont.)

Gas Storage in Colombia (cont.)

The Colombian gas market is characterized by:

1. Regulated gas prices
2. Majority state ownership in the upstream sector
3. Only two major gas pipeline companies
4. No gas storage facilities
5. No market hubs for gas trading

In comparison to the North American gas market, the gas market in Colombia is less evolved. As discussed before, market driven rates are typical of markets with a large number of gas storage facilities and operators.

Therefore, at this stage, it will be prudent for CREG to regulate gas storage rates through a cost of service model (similar to gas pipelines). The regulations should allow the gas storage operator to recover all capital and operating costs for gas storage through the rate base.

Gas Storage (cont.)

Gas Storage in Colombia (cont.)

From the perspective of allocating the storage costs, the following customers categories need to be considered:

1. Customers with firm supply contracts with the pipelines
2. Customers with partial firm supply contracts with the pipelines
3. Customers with interruptable supply contracts with the pipelines
4. Customers that have specific storage or parking service contracts with the gas storage operator

In case of a gas supply curtailment, customers with firm and storage contracts have a higher priority than customers with partial firm or interruptable contracts. Therefore, the preferred option would be to allocate the storage costs to only customers with firm contracts with the pipeline company (Category 1) and storage/parking contracts (Category 4).

Parking

Introduction

Parking is defined as a service which allows a customer to hold (park) gas for short periods of time. The parked gas is transported for delivery at a later date.

Typically,

1. This service can be provided on interrupted on a short notice
2. Charges are rendered for this service. These charges can be based on:
    - negotiable rates between the parking service provider and the user
    - bidding for the parking service by the users
    - predetermined toll schedule
3. Similar to a gas pipeline, parking service is subject to a nomination process
4. Time period for parking is only a few days
5. Parking service allows for co-mingling of gas

Appendix H provides an example of the terms and conditions of a typical parking service.

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Parking (cont.)

Parking in Colombia

Parking service can be either provided on the underutilized portion of the existing pipelines or on future gas storage facilities.

Parking services is akin to short-term storage. It is typically offered for short-term and is available after longer term storage commitments for injection, withdrawal and storage capacity have been fulfilled.

Market Hub

A “market hub” is a place where either two or more pipelines interconnect or a single pipeline has a storage facility allowing physical and financial gas transactions to take place. A storage facility is usually a part of a market hub in order to provide a physical backup system for hub transactions. Market hubs can also be used as a designated delivery point for futures contracts and the exchange of futures for physicals (“EFP”). Similarly, many hub operators provide “price discovery” mechanisms for the cash and over-the-counter markets by collecting and aggregating actual transaction information and publishing price indices. Successful hubs require many suppliers and buyers transacting deals.

In addition to storage services, recognized hub services include “matching”, “supply pooling”, “swaps”, “title transfers”, “exchanges”, “wheeling”, “balancing”,“backhauling”, “imbalance trading” and “backstopping”. The benefit to the customer of contracting for Hub services include anonymity in certain transactions, reduction of administrative burden (since the Hub operator contracts for the respective transportation and submits the pipeline nominations), and the ability to access storage or transportation on a short term basis to take advantage of temporary opportunities.

Typically, a deregulated market and gas storage are essential for the evolution of a market hub. In the case of Colombia, majority of gas prices are regulated and there are no gas storage facilities. Based on the current state of the gas market, in our opinion, it is too early for CREG to explore the creation of a market hub in Colombia.

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