

OVERVIEW OF FISCAL MEASUREMENT BEST PRACTICES FOR CUSTODY TRANSFER BETWEEN SELLER AND BUYER UNDER GAS SALES CONTRACTS(GSCs)

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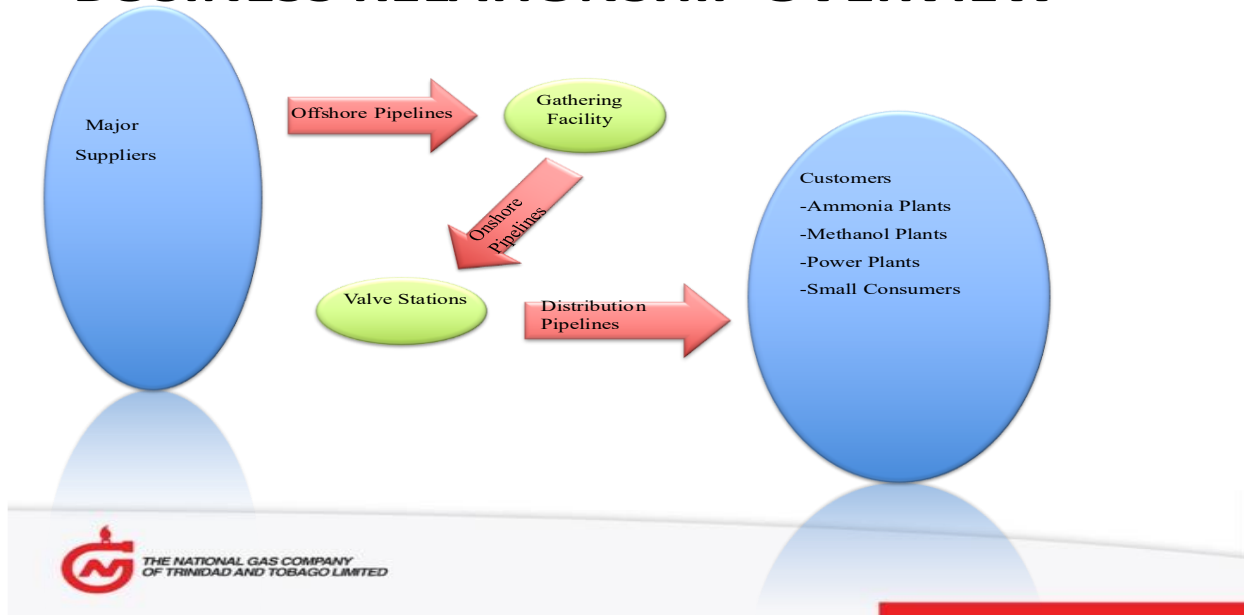
Introduction:

The National Gas Company of Trinidad and Tobago Limited (NGC) is a state-owned company fully owned by the Government of the Republic of Trinidad and Tobago, with its core business to PURCHASE, TRANSPORT, AGGREGATOR, MERCHANT, and SALE of Natural Gas to the Local Downstream PETCHEM. The gas is transported via an extensive network of approximately 1000km of both Offshore & Onshore pipelines with a current overall maximum installed transportation capacity of 4.4 Bcf/d on the Domestic and Gas export Market.

NGC being a gas monopoly within Trinidad and Tobago and being 100% state owned and its major shareholder being the Ministry of Finance, it is paramount to ensure that all business transactions undertaken by NGC is in alignment with energy policies and procedures. This would mean all Natural Gas purchased by NGC (Buyer) from the major Suppliers (Sellers) and then Sold by NGC (Seller) to the Local Downstream Petrochemical plants (Buyers) are done under custody transfer best practices discussed in Measurement Articles and Clauses pursuant to **GAS PURCHASES & SALES CONTRACTS** and adopts relevant Codes and Standards according to American Gas Association (AGA), American Petroleum Institute(API) Manual of Petroleum Manual Standards (MPMS), Gas Processors Association (GPA) and American Society for Testing and Materials (ASTM).

The diagram below shows the flow path linkage between major Suppliers and NGC's offshore/onshore transmission and distribution pipelines to major customers.

BUSINESS RELATIONSHIP OVERVIEW



Background:

Prior to the custody transferring of the natural gas between the Seller and Buyer on an offshore or any facility, the Seller is held responsible under the contract for the fiscal measurement of the gas using mainly senior orifice fittings with an Electronic Flow Meter (EFM) for volume computations and a Gas Chromatograph (GC) for determining gas quality and energy determination. It is highly recommended for the Buyer to have an independent measurement system to be procured, installed, and commissioned that is of similar make and design to Seller's system which meets and exceeds the required AGA, API MPMS and GPA Codes and Standards. This approach has become highly necessary and mandatory for both Seller and Buyer in the Upstream Oil and Gas Industry:

- For independent calculations as per contractual obligations and tolerances therein set out.
- Perform a comparative analysis between Seller and Buyer data.
- Use Buyer EFM as primary data if the Seller's EFM is out of service, reading inaccurate without any alternate.
- To mitigate against potential mismeasurements between Seller and Buyer leading to financial, commercial, and legal implications.
- To maximize molecular optimization through minimum "Loss and Unaccounted for" (LUAF) for e.g. Selling less but physically delivering more molecules at the Delivery Point to Buyer and on the other hand paying for more molecules but not physically being delivered into the Buyer's pipeline.

Key Drivers:

Pursuant to the respective GSC's it is very critical for the Seller when invoicing the Buyer not to exceed a 1% tolerance of the volume(mscf) and energy (MMBtu). If the tolerance is greater than 1% through various bad measurement practices by the Seller, that can impact the Seller's financial profitability and as well the Buyer's revenue stream leading to a loss in confidence of Seller. Important to note that the Seller not using an accurate and scientific method of accounting for its molecules sold to the Buyer between the wells and the fiscal measurement system, can quickly translate into a "Loss and Unaccounted For" (LUAF) situation requiring an expert determination worse case to manage same.

To ensure the LUAF is minimum and allows for a better balance between what is purchased and sold between the Seller and Buyer, Buyer shall also reserve its right to perform calculations with its independent measurement check system and compare same to the Seller's to meet the acceptable 1% tolerance between both sets of data points. Some major best practices to be implemented by the Seller to achieve the above and close performance gaps are:

- Full alignment between Seller/Buyer primary, secondary, and tertiary element of the measurement system
- Good flow profiling system such as flow conditioner, tap locations etc.
- Accurate wake frequency calculations for sizing the sample probes.
- Using EOS calculations to calculate properties and phase conditions of hydrocarbon mixtures for better technology selection.
- Using a GC as the leading indicator instead of a composite sampler which is a lagging indicator for accurate fiscal measurement.

Verification and Auditing of the Seller/Buyer Measurement Data:

The verification and auditing of the Seller's/Buyer's data is contingent on the role NGC plays. This is data can be from the independent fiscal and or check measurement devices but are carried out by a back-office team comprising of measurement analysts. The final data is then compared to the Seller's/Buyer's data for meeting contractual tolerances under the contract. The verification/auditing of the data is done by a Flow Cal Measurement software to confirm any anomalies and variances captured from the EFMs, whereby highlighting any performance gap(s) between the Seller and Buyer independent measurement system if installed and functioning properly.

The measurement software has a data base set up to allow remote data mapping between Flow Cal Measurement software and the EFM's through a SCADA interface via automatic polling of data from autosol and the downloading of gas quality data calculated in the GC to be recalculated in the EFM prior to being verified and audited in the Flow Cal measurement software. In Appendix 1, a very key parameter that is monitored closely to determine accuracy of volume and energy received from EFM is the Volume Correction Factor (VCF) that should be circa 1. If the VCF is equal to 1, then volumes and energy values computed from the EFM is acceptable. If the VCF is greater than 1, there must be quality checks of data coming. This process helps with further investigation in determining the root cause of the problem and helps with rectifying same.

Appendix 1 - Volume Correction Factor

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In Appendix 2 the above investigation for understanding the root cause can be done by analyzing the findings as seen in the exception resolver field in the Flow Cal measurement software, where there is an effective error description captured for the error acknowledgement and or troubleshooting in bring resolve to the problem at hand. This has become a best practice under the contractual arrangement between Seller and Buyer it creates an environment that strives to achieve transparency, mutual trust and adherence to the appropriate processes utilized by both Seller and Buyer in carrying out its overarching business.

Appendix 2 - Exception Resolver

Exception Resolver

RESET

EXL

5

System:

ENTERPRISE

Object Type:

List

Date Selector:

None

Effective Date

Generated Date

First Date:

4/1/2024 00:00:00

Last Date:

5/17/2024 16:11:57

Status Filter:

Acknowledged

Pending

Resolved by Late Data

Unresolved

Resolved by User

LC_PCS_GC | LC_PCS_GC

+ Show Quality Source Object Selector

Refresh

Object Explorer

Device Number	Device Name	Effective Date	Description	Exception Count	Field Value	Alarm Limit	Status	Type	Severity	Except
FX20-0551	PCS 01 WEST A	05/17/2024 10:00:00	SRV - High volume as compared to previous day 1821.500 -> 1017.215 1821.500 -> 1017.215 1821.500 ->		1821.50037	420.510010	Unresolved	Meter	1	
FX84-1703	COVE SALES	05/17/2024 11:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX84-1707	COVE BYPASS	05/17/2024 11:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX20-0550	PCS- 01 EAST	05/17/2024 11:00:00	SRV - High volume as compared to previous day 1912.134 -> 982.713 1912.134 -> 982.713 1912.134 -> 9		1912.13433	432.229004	Unresolved	Meter	1	
FX20-0551	PCS 01 WEST A	05/17/2024 11:00:00	SRV - High volume as compared to previous day 1993.825 -> 1021.149 1993.825 -> 1021.149 1993.825 ->		1993.82486	420.510010	Unresolved	Meter	1	
FX84-1703	COVE SALES	05/17/2024 12:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX84-1707	COVE BYPASS	05/17/2024 12:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX20-0550	PCS- 01 EAST	05/17/2024 12:00:00	SRV - High volume as compared to previous day 2098.731 -> 981.733 2098.731 -> 981.733 2098.731 -> 9		2098.73129	432.229004	Unresolved	Meter	1	
FX20-0551	PCS 01 WEST A	05/17/2024 12:00:00	SRV - High volume as compared to previous day 2190.504 -> 1021.438 2190.504 -> 1021.438 2190.504 ->		2190.50449	420.510010	Unresolved	Meter	1	
FX43-0551	PLNL	05/17/2024 12:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	
FX69-0552	Atlas Methanol Central	05/17/2024 12:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	
FX26-0554	P'GEN PT.LISAS NEW EAST	05/17/2024 12:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	
FX84-1703	COVE SALES	05/17/2024 13:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX84-1707	COVE BYPASS	05/17/2024 13:00:00	Missing analysis(GQ Apply Anl)		E		Unresolved	Meter	1	
FX20-0550	PCS- 01 EAST	05/17/2024 13:00:00	SRV - High volume as compared to previous day 2147.778 -> 981.107 2147.778 -> 981.107 2147.778 -> 9		2147.77800	432.229004	Unresolved	Meter	1	
FX20-0551	PCS 01 WEST A	05/17/2024 13:00:00	SRV - High volume as compared to previous day 2241.765 -> 1023.414 2241.765 -> 1023.414 2241.765 ->		2241.76472	420.510010	Unresolved	Meter	1	
FX17-0550	TCL	05/17/2024 13:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	
FX17-0550	TCL	05/17/2024 13:00:00	CV - Viscosity too high		0.01027	4E-5.000000	Unresolved	Meter	1	
FX84-1703	COVE SALES	05/17/2024 14:00:00	Missing analysis(GQ Apply Anl)				Unresolved	Meter	1	
FX84-1707	COVE BYPASS	05/17/2024 14:00:00	Missing analysis(GQ Apply Anl)				Unresolved	Meter	1	
FX72-0551	P' gen Pt Lisas Exp	05/17/2024 14:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	
FX62-0551	Trinity Power	05/17/2024 14:00:00	FPC - Low flow time		100.00000	86400.000000	Unresolved	Meter	1	

Count = 110

Count = 110

Effective Maintenance of Measurement System:

To achieve accurate verification and carry out effective auditing, it will mean both the Seller and Buyer execute a very robust maintenance strategy on the various elements of the measurement system inclusive of performing calibrations checks and evaluation on the other elements of the system. In accordance with the GSCs, based on the findings relevant adjustments shall be made where necessary for at least and up to a maximum of fifteen (15) days prior to the date of calibration or half the month. When a measuring technology aligns with an AGA 3 standard, it employs the primary element known as the senior orifice fittings with an orifice plate installed to create a differential pressure which plays an integral role in accurately calculating the flow rate of the gas inclusive of other key parameters used in the overall calculations.

With effective auditing best practices in place for carrying out independent physical assessments and evaluation of the senior orifice fittings. The orifice plate used is a common linkage to both Seller's fiscal measurement and Buyer's

check measurement system. Therefore, the undermentioned are crucial to ensure optimum performance of an entire measurement system in accordance with the best industry standards and practices:

Requirement criteria's for ensuring accurate data are computed for invoicing purposes using an Orifice plate are as follows:

- Accurate sizing of orifice plate.
- Accurate beta ratio.
- Proper inspection of the orifice plate to ensure no nicks, pits and weep holes, surface flatness, plate thickness etc.
- Good Seal Condition.
- Managing liquids in the pipeline.
- Using correct calculation method and configuration characteristics in the Flow Cal measurement software.
- Using proper manual override when inspecting orifice plate.
- Correct configuration data in the EFM and Flow Cal measurement software for effective data mapping.

The above best practices carried out accurately and in a timely manner shall maintain accuracy, precision, and repeatability of the measurement system. Considering this approach there is great benefits for both the Seller and Buyer, ensuring maximum value for money, return on investment, maintain good relations and partnerships with confidence in the way business is executed under the contract.

Conclusions:

Verification and auditing of Seller and Buyer fiscal measurement and check measurement system to carry out custody transfer of natural gas is accurate using best practices in accordance with relevant codes and standards such AGA, API MPMS, GPA and ASTM is a priority in the energy value chain. The Flow Cal measurement software used for performing verification and auditing of the volume and energy derived from the Seller and Buyer EFM's are critical especially for capturing anomalies, variances which has the potential of becoming mismeasurements and leading to "Loss and Unaccounted For" (LAUF).

In Appendix 3 the fiscal measurement data that the Flow Cal measurement software produces known as a Gas Volume Statement (GVS) which is then validated and audited by the measurement analyst(s) are quite valuable and has a direct impact on a company's financial profitability/sustenance for remaining in business, gaining and sustain competitive advantage and maximizing value for the shareholders. Important to acknowledge that all measurement and analysis of natural gas executed timely, accurately with an effective maintenance strategy using best in class technology shall yield greater opportunities for building and creating a better energy ecosystem Globally.

Appendix 3 - Gas Volume Statement

Day	Differential (In. H2O)	Pressure (psia)	Temp. (°F)	Flow Time (hrs)	Relative Density	Plate (inches)	Volume (Mcf)	Heating Value (Btu/scf)	Energy (MMBtu)
1	91.98	1128.26	77.35	24.00	0.5663	7.0000	126,411	1007.58	127,369
2	94.24	1111.01	77.41	24.00	0.5663	7.0000	126,841	1007.58	127,802
3	95.94	1092.14	76.99	24.00	0.5663	7.0000	126,829	1007.58	127,790
4	96.03	1089.03	77.12	24.00	0.5663	7.0000	126,665	1007.58	127,624
5	97.11	1075.88	77.03	24.00	0.5663	7.0000	126,519	1007.58	127,477
6	97.04	1084.89	77.13	24.00	0.5663	7.0000	127,049	1007.58	128,011
7	94.02	1119.00	77.74	24.00	0.5663	7.0000	127,137	1007.58	128,100
8	93.62	1121.57	77.75	24.00	0.5663	7.0000	127,028	1007.58	127,991
9	94.08	1115.46	77.84	24.00	0.5663	7.0000	126,937	1007.58	127,898
10	93.81	1117.22	79.98	24.00	0.5663	7.0000	126,469	1007.58	127,427
11	93.91	1116.37	78.11	24.00	0.5663	7.0000	126,830	1007.58	127,791
12	93.51	1119.33	78.41	24.00	0.5663	7.0000	126,690	1007.58	127,650
13	93.49	1118.18	78.56	24.00	0.5663	7.0000	126,575	1007.58	127,534
14	96.60	1100.15	78.40	24.00	0.5663	7.0000	127,522	1007.58	128,488
15	97.32	1090.41	78.00	24.00	0.5663	7.0000	127,430	1007.58	128,396
16	95.06	1109.98	77.68	24.00	0.5663	7.0000	127,273	1007.58	128,237
17	95.57	1102.66	77.38	24.00	0.5663	7.0000	127,193	1007.58	128,157
18	95.74	1108.93	77.10	24.00	0.5663	7.0000	127,765	1007.58	128,733
19	95.64	1108.40	76.95	24.00	0.5663	7.0000	127,693	1007.58	128,660
20	95.80	1105.07	76.79	24.00	0.5663	7.0000	127,610	1007.58	128,577
21	96.25	1101.05	76.69	24.00	0.5663	7.0000	127,671	1007.58	128,638
22	95.53	1107.16	76.62	24.00	0.5663	7.0000	127,602	1007.58	128,569
23	93.76	1130.61	77.19	24.00	0.5663	7.0000	127,807	1007.58	128,775
24	96.27	1104.86	77.04	24.00	0.5663	7.0000	127,867	1007.58	128,835
25	96.48	1099.77	76.96	24.00	0.5663	7.0000	127,688	1007.58	128,655
26	90.41	1137.51	77.79	24.00	0.5663	7.0000	125,824	1007.58	126,778
27	94.18	1122.53	77.70	24.00	0.5663	7.0000	127,477	1007.58	128,443
28	91.60	1116.44	78.31	24.00	0.5663	7.0000	125,232	1007.58	126,180
29	87.97	1102.81	78.35	24.00	0.5663	7.0000	121,886	1007.58	122,809
Total	94.60	1108.85	77.60	696.00	0.5663		3,679,520		3,707,394