Egyptian Natural Gas Co.
GASCO
Transmission Network Code

Approved by Gas Regulatory Authority

April 2020

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1. Glossary

Gas Reg.	The Egyptian Regulatory Authority for gas market activities established pursuant to article no. (2) of the gas law No. 196 of year 2017;
GASCO	The Egyptian Natural Gas Company or TSO in this document.
Residential consumer	Families using gas, at low pressure, for their own needs (cooking, water heating, space heating).
Industrial consumer	Industries using gas at medium and high pressure for industrial processes.
Commercial consumer	Non-residential and non-industrial consumer using gas at low and medium pressure for their own consumption.
Eligible Consumer	Eligible consumer means a consumer who is supplied by gas from a supplier of his own choice and at a price agreed upon between such consumer and such supplier.
Monthly Program or Nomination	Month
Non-Eligible Consumer	non-eligible consumer means a consumer supplied by natural gas in accordance with the price set by Ministerial decrees.
Asset Owner	A person/entity who owns the whole or part of the Gas Network defined in this code.
Final Consumer	Is a natural or legal person purchasing gas for his/her own use.
Standard /Reference Conditions	Pressure =1.01325 Bara & Temperature =15C° Or Pressure = 14.696 Psia & Temperature =60F°
BTU	British Thermal Unit. It is a measure of energy equal to about 1055.0559 Joules. It's the amount of energy needed to cool or heat one pound of water by one-degree Fahrenheit at a constant pressure of one atmosphere. In Egypt, the heat value (energy content) of fuels is expressed in BTUs.
Firm Capacity	Each year, subject to operational conditions and/or constraints of the gas system, the TSO may offer annual, multi-annual and/or infra-annual capacity differentiated in terms of delivery priority in case of gas shortage or shortfall..
Daily Program or Nominations	The transportation program provided by the Shippers to TSO for each Gas-day, containing the quantities to be injected and off-taken from the TSO network.
Capacity Charge	Payment made for reserving capacity in a Transmission network.
Commodity Charge	Payment made for each unit of gas transported. in heat units (MMBTU)

Entry Point	A point, which may comprise an aggregation of physical points, on the gas pipeline network at which the Shipper delivers gas to TSO and at which gas is measured.
Exit Point	A point of the gas pipeline network at which TSO re-delivers gas to the Shipper and at which gas is measured.
Gas-DAY	The period of 24 hours, starting from 06 am of each calendar day and ending at 06 am of the following calendar day.
Gas Producer	A company authorized by the Government to explore, drill and extract gas on-shore and/or offshore.
Gas Transmission	The transportation of natural gas throughout the Gas Transmission System, and its functionally related activities.
Gas Supplier	A licensed entity that sells gas to consumers. A Supplier may also be licensed as a Shipper
Network rules for the Transmission System or Transmission Network Code	A set of rules, approved by Gas Reg., which governs TSO´s transport of natural gas through the transmission system, from the entry points to the exit points. It forms the basis of the arrangements between TSO and the Shippers
Maintenance	Preventative maintenance, corrective maintenance (repair only) which does not include any change or upgrade in the gas network facilities, third party & vendor intervention, the use of any special tools or equipment.
Pipeline Capacity	The amount of gas that can be passed through a pipeline over a given period of time.
Shipper	A legal entity that carries out the activity of gas shipping under a license. A licensed Shipper can arrange with the TSO for gas to be introduced into, conveyed by means of and/or taken out of a pipeline system operated by the TSO. The purpose of the gas movement may be connected with the supply of gas to premises or not.
Gas Transmission System	The system formed by both the national transmission network, and its ancillary facilities, providing natural gas transmission throughout the country. The Gas Transmission System mainly contains high-pressure pipelines, other than an upstream pipeline network and other than the part of high-pressure pipelines primarily used in the context of local distribution of natural gas.
Transmission System Operator (TSO)	A legal entity that carries out the function of transmission of gas and is responsible for operating, ensuring the maintenance of and developing the gas transmission system in a given area or the entire territory of the Country and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of gas.
Distribution System Operator (DSO)	Any legal entity that is licensed to manage and operate a distribution system. In Egypt this activity is performed by several companies operating on a concession regime
Transportation Capacity	The maximum gas quantity that can be injected into the system or off-taken from the system, for a Gas day, at a specific Entry or Exit point.
Thermal Year	The period of twelve consecutive months, starting in Egypt from January 1 and ending on December 31.
Transportation Contract	The contract between the shipper and TSO

2. The Purpose of the Transmission Code

2.1. Foreword

The TSO, within the framework of its gas transmission activity, offers to Shippers the services described in this document.

Licensed Shippers are the only Gas undertakings allowed to have gas to be introduced into, conveyed by means of and/or taken out of the national Gas Transmission Network.

The Transmission Network Code is a live working document and it is the responsibility of the shipper to acquire the most up to date issue of the code, which can be downloaded from the TSO website: www.Gasco.com.eg

The Egyptian natural gas company (GASCO) is working as the national transmission system operator according to the license issued by the Egyptian Regulatory Authority for gas market activities issued on 1/1/2019

The network Code establishes the requirements, procedures, practices and standards that govern:

- How a shipper is connected to the Natural Gas Transmission System operated by GASCO; and
- The general terms and conditions for the provision of transmission services by GASCO

2.2. Introduction

The provisions of this document represent the set of rights and obligations of the parties, in relation to the gas transmission service on the Gas Transmission Network. The Gas Law and related executive regulations referred thereto as Network rules for the Transmission System or Transmission Network Code.

The Gas Law describes the roles, duties and rights of the TSO.

The purpose of the network Code is to ensure that the TSO (GASCO) provides fair, transparent, non-discriminatory, reliable, secure and efficient transmission of natural gas.

The provisions of Egyptian law shall be supplementary to the terms and conditions not explicitly stipulated in this document.

The Transmission System Operator (TSO) and the Shipper are mutually bound to respect these rights and obligations, and the subscription of the Transportation Contract. No party herein is authorized to address the other party with questions, requests and claims not mentioned in this document.

It is understood that the TSO reserves the right to inform Gas Reg. in case of non-compliance with the provisions of this Transmission Network Code (or Network Code).

In conformity with the definition of gas Transmission System as stated in the Gas Law and in this document, this TSO Code applies only to transmission activities within the Arab Republic of Egypt. Transmission activities regarding international pipelines are not subject to this TSO Network Code.

2.3. The objective of this Code is to:

- Promote the development of a competitive gas market by establishing uniform principles for owners and users of gas pipelines to allow transparent and non-discriminatory access to the natural gas transmission systems;
- Prevent abuse of power by the TSO;
- Provide the right of third party access to natural gas transmission systems on fair and reasonable basis for both Service Providers and Users; and
- Provide mechanism for the submission and resolve of grievances.

2.4. Ownership of Transported Gas

The delivery of gas to the TSO by the Shipper does not entail the transfer of ownership of such gas to the TSO, which holds the gas for the sole purpose of providing the service.

2.5. Unbundling Rules and Regulations

To ensure the transparent, non-discriminatory operation of Gas Transmission System and to prevent any conflict of interests that may rise between the gas market parties, the network owners, TSO and the Shippers shall comply with the legal, financial and functional unbundling rules and regulations set by the Gas Regulatory Authority.

3. Communication between the Parties

The nature of the activities performed by the TSO and the Shippers requires clear rules and procedures to exchange communications between the parties involved. For instance, in case of emergency, the TSO shall be able to communicate to Shippers and Consumers swiftly and successfully, in any time of the day, any day of the year.

3.1. Standard Communication Between the Parties

The standard communication tool between TSO and the Shipper should be **the fax and/or e-mail** and any other communication methods may be agreed upon between the parties such as written correspondence. The Shipper shall communicate to the TSO its capacity booking requests, its monthly and daily nominations by fax and it should receive an answer by TSO by the same method of communication.

TSO and the Shipper should communicate to each other the fax numbers at which they will exchange requests and messages.

For this purpose:

- The Fax number of the Shipper is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- E-mail of the Shipper is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- The Fax number of the Consumer is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- e-mail of the Consumer is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- The Fax number of TSO is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- e-mail of TSO is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

TSO and the Shipper will also exchange the list of people or offices in charge of communication. The Shipper will communicate the people available 24h/7days and their mobile number in case of urgent communication. The Shipper will also communicate to TSO the contacts of its Final Consumer that TSO may need to contact directly during emergencies.

- The contact person of the shipper is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ office/position_ _ _ _ _ _ _ telephone number_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- The fax number of the consumer is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ office/position_ _ _ _ _ _ telephone number_ _ _ _ _ _ _ _ _ _ _ _ _ _ _
- The fax number of TSO is_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ office/position_ _ _ _ _ _ _ _ _ _ _ telephone number_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

3.2. Communication Provisions Between the Parties during Emergencies

In cases of emergencies, the provisions described in Chapter 16“Emergency Procedures” apply.

3.3. The shipper’s rights and duties

3.3.1 The shipper shall use the services of transportation of gas in accordance with the principles specified in the gas Law, the TNC and the transportation contract.

3.3.1. The shipper is obliged to pay charges/tariffs specified in the tariff section to the TSO.

3.3.2. The shipper, as the user of the gas transmission service, is obliged to observe the provisions of the code, to:

- Introduce gas for transmission and off-take it from the system in quantities / requirements / quality specified in the approved proper nominations for the entry and exit points
- Not to exceed the contracted capacities specified in the transportation contract at entry or exit points,
- Not to exceed the imbalance limits at entry or exit points,
- Immediately notify the TSO of a change in the formal/legal and commercial conditions that constitute the grounds for concluding the transmission contract,
- Provide the ability of 24-hour contact with the shipper and his customers who are connected directly to the gas transmission system in the event of accident/s that affect the fulfilment of the transmission contract,
- Immediately obey the instructions of the TSO dispatcher services and assure fulfilment of such instructions by the entities receiving or supplying gas to or from the gas transmission system for the shipper.

4. Network Description

4.1. General Description of the Transportation System

The Gas Transmission Network in Egypt is considered as the largest and longest gas transmission pipelines network in Africa and the Middle East which plays a vital role as the link between the Gas Producers and Final Consume. The Gas Network has been extended to the South reaching the farthest point of the south valley in Aswan, moving along the Red Sea coast and extended east to Sinai, north to Jordan, Syria and Lebanon with the potential to reach further.

The transportation services of this network shall be provided in accordance with the terms of this Network Code. Besides the pipelines, the network includes compressor stations, pressure reduction stations, gas measurement plants, as well as auxiliary equipment required for gas transportation and dispatching

4.2. The Gas Transmission System

The gas Transmission System in Egypt includes the following elements:

4.2.1. Gas Pipelines

Gas pipelines are extended along the country to cover the increasing gas demand and to connect the consumers with the production centres. Accordingly, the pipeline transmission capacity has reached 240 million standard cubic meters per day (MMSCMD) by the end of year 2018 and about 7620 Km of Transmission pipelines

The network pressure is divided to 3 categories:

- The main network which is 25-70 bar;
- Sub network which is 25-45 bar;
- Another sub network, which is 14 bar.

4.2.2 Gas Entry and Exit Points

Entry Points to the Gas Transmission Network comprise:

- Entry Points connected to foreign importation pipelines;
- Entry Points connected to LNG regasification terminals;
- Entry Points from national production fields;

Exit Points comprise:

- Points of interconnection with exporting pipelines;
- Points of interconnection with local distribution networks;
- Points of conjunction with the premises of Final Consumers directly connected to the Gas Transmission Network;

A complete list of Entry and Exit Points and the relevant schematic maps are published on the TSO's website and regularly updated.

4.2.3 Pressure Reduction & Metering Stations

The current Gas Transmission System has about 150 main stations for filtering, reducing and metering to deliver gas to consumers of different sectors at contracted pressure, temperature and gas specifications.

4.2.4 DAHSHOUR Compressor Station

DAHSHOUR Compressor Station consists of the following: four turbo-driven compressor trains each has been designed for a capacity of 380,000 SCM/hr. Three trains can handle a station total capacity of 1,140,000 SCM/HR in addition to the fourth standby train.

The main components of the compressor stations are: -

- Compression units primarily constituted of centrifugal compressors operated by gas turbines and containing their own control systems.
- Pipelines and the associated process devices (filters, valves, air-coolers, etc).
- DCS Control systems for the turbo compressors and for the central process systems management.
- An appropriate electricity supply system.
- Supporting infrastructure (offices, warehouses, etc).

The station receives natural gas via two gas pipelines (El-AMERIA / DAHSHOUR 32" & El-Sadat/DAHSHOUR 42") with inlet pressure range 25:50 Bar that could be raised up to 70 Bar and to be delivered via DAHSHOUR/ ELWASTAA 36" and DAHSHOUR / KORIMAT 36" PL then to KORIMAT / BANI-SWIEF 30" in order to feed 32"/30" Upper Egypt Gas Pipeline to feed all south valley consumers with their needs from natural gas each under contracted requirement of pressure, temperature, gas quantity and gas specifications. Upper Egypt customers include sugar, paper and cement plants within the different governorates i.e. BENI-SWIEF, El Mania, ASSIOUT, SOHAG and QENA ending with KIMA plant of ASWAN.

4.2.5 National Advanced Transmission & Automation Centre (NATA)

NATA is the core and crux of our control over the Gas Network. It provides a 24-hour uninterrupted service, assures the network's operation in terms of security efficiency and effectiveness. TSO has built NATA from bricks to clicks to maintain utmost control of the Network through the use of the following technological systems and programs:

- Supervisory Control and Data Acquisition Systems (SCADA);
- Gas Network Analysis Software;
- Gas Network upgrading, maintenance and development supporting systems.

NATA will also be responsible for executing all Dispatching Centre related activities as detailed in Chapter 15 “Emergency Procedures”

4.3. Supervisory Control and Data Acquisition system (SCADA)

The SCADA system is a technologically highly advanced integrated system bringing the fields’ status and data to the field of vision while masterminding co-ordination and control of gas transmission & distribution via an advanced bundle of software applications making remote processes visible to everyone from control room operators to contingency management team, and decision support systems.

The operators in the control room are assisted by a sophisticated system of data acquisition and telemetry (SCADA). This system collates data from the peripheral units and supports the real time update of the display panel and data archiving.

The SCADA system allows the operators to monitor the state of the network and to apply operational adjustments.

The SCADA system monitors real time (instant) gas network, supports the optimization of network utilization, and provides the capability, via simulation, for preventive system actions, thereby enabling system operation in a secure and efficient manner.

The SCADA system comprises the following:

4.3.1 The SCADA main control centre

SCADA master terminal unit (Main Control Centre) is composed of hardware components and software components integrated together to comprise a full control and monitoring system. Hardware components include real time servers, historical servers, operator workstations, storage drives and media devices and computer networks.

Main SCADA Software applications will be responsible for the following:

- Gathering stations data
- Human machine interface (HMI) and supervisory Control
- Generating alarms after inspecting gathered data.
- Generating events
- Historical Database (events, timeline, trends)

- Reports
- Synchronization with the Emergency Back-Up Control Centre

4.3.2 The remote terminal units (RTUs)

The Remote Terminal Units that are responsible for collecting data from field devices existing at sites of the company, RTUs can also pass Control commands to GOVs i.e. to station inlet or pipelines' sectionalizing valves equipped with actuators and executing remote set points issued from the SCADA to control pressure/flow control valves at specific important sites.

4.3.3 Areas' Local Control and Monitoring Centres

The gas Network has been divided geographically into (**13**) sections each representing an administrative area supported with all resources needed to execute the operation, maintenance and administrative activities required. Besides, each area will have one Local Control Centre for monitoring and control sites relevant to that area.

There are QTY (13) Areas' Local Control Centres each equipped with two remote work stations each of quadruple head One work station will be used for monitoring the gas Network and also control functions could be enabled to the Area Local Control Centre but with authorities limited to sites relevant to the area. The other work station will be used for system maintenance purpose. Both of the two work stations will be connected to both control centres (Main & Emergency Back-up) via protected communication channels (Dedicated VPN and Shared VSAT).

4.3.4 Emergency Back-up Control Centre

The SCADA system is designed to be equipped with an Emergency Back-Up Control Centre that will be composed of hardware components and software components similar to those ones of the Main Control Centre integrated together in the same way as per the main control centre and doing the same functions.

Emergency Back-Up Control Centre will be synchronized all the time with the Main Control Centre to be able to smoothly take over all functions in case of Emergency failure of the Main Control Centre.

4.4. Telecommunication network

The system is supported by a robust telecommunication networks comprising Digital IP-VPN, Digital Microwave, VSAT, GPRS, Fibre Optics, and THURAYA Satellite Phone service.

The main connection is Digital IP-VPN (VPN over Wireless Digital Microwave & a backup of Leased Lines) that will be used to connect the main control centre at GASCO HQ with all GASCO offices in the different areas all over Egypt for serving transfer of voice, SCADA, data and Internet.

Digital Microwave network will be used as a backup for transferring voice, SCADA, data and Internet between main control centre and some of GASCO-areas' offices.

The digital satellite communication VSAT will be used as a second backup network for transferring SCADA data and voice between the main control centre and Local control centres.

For important customers of the Gas Network, like Electric Power Stations, VSAT will be the main telecommunication media that will be used for transferring SCADA data from remote sites to control centres.

GPRS will serve as a third backup for transferring SCADA data between some remote sites and control centres.

For some gas pipelines, Optical Fibre Networks are carrying SCADA Data and voice over the Gas Pipeline Network up to the end terminals where VPN or VSAT will be used to transfer it to control centres.

The Fourth Backup communication is the THURAYA Satellite Phone service that offers Voice Calls connecting NATA to the critical GASCO-areas' offices such as the Emergency Backup Control Centre, Suez, Red Sea and North Sinai.

4.5. Methodology for the Definition of the Network Performance

4.5.1. Capacity at the Entry Points of the Gas Transmission system.

The transportation capacity at the Entry Points from national production, import or regasification is the daily gas flow that the Gas Transmission System is capable of receiving and transporting to the Exit Points, on the basis of the technical verifications performed by the TSO

Since the transportation capacity at a point is strictly dependent on the capacity of contiguous injection and off-take points, it is not possible to define a unique value of maximum flow rate that characterizes each Entry Point from national production. This is even more the case for meshed networks.

The TSO will review an increase requested by Shippers, after a technical verification, to the transportation capacities at the Entry Points and follow the procedures of this document.

4.5.2. Capacity at the Exit Points of the Gas Transmission system

The transportation capacity at the Exit Points is the maximum capacity that can be made available to Shippers, for the Gas-day, for the firm transportation service.

The transportation exit capacity for the Off-take areas is defined as the sum of the capacities of the Exit Points within each Area.

4.5.3. Simulation programs

Gas transportation on the TSO's network is verified with hydraulic simulation programs developed for this purpose.

4.5.4. Technical, operational constraints and boundary conditions.

Generally, the gas quantity that may transit through a certain pipeline section in a unit of time depends not only from the maximum exercise pressure, entry and exit pressures, the diameter and length of the pipeline, the line-pack of the network, the transported gas quantities, the possible use of compression stations, but also on the off-takes and injections of gas along the section of the network.

5. Services Offered by The Transmission System Operator

5.1 Introduction

The Transmission System Operator (TSO), within the framework of its transportation and dispatching activities, offers to Shippers as described by the provisions of this document the services described below.

The principal (basic) service offered by the TSO and covered by the payment of a transportation tariff such as approved by Gas Reg. and published on the TSO's website, is the transportation of gas within its pipeline system.
The transportation service is currently available only on a firm basis.

5.2 Basic Service

The TSO offers a guaranteed firm transportation service (based on custody transfer measurements) provided as an integrated service from Entry to Exit Points.

The Shipper, who has booked firm transportation capacity, has the right to:

- Inject gas at the Entry Points of the TSO Network; and
- Off-take gas at the Exit Points

A daily quantity of gas (to be specified in min., max. pressure and max. hourly flow rate at entry / exit point) not greater than the daily capacity booked at any time of the Thermal Year.

The TSO guarantees continuity of service in all cases, except Force Majeure, emergency, and periods in which it plans and executes maintenance works that generate interruption / reduction of transportation capacity.

5.3 Ancillary Activities

The Transmission System Operator offers, within the framework of its natural gas transportation and dispatching operations, activities that are accessory to those mentioned above. The accessory activities are described below (this list is not exhaustive):

5.3.1 Capacity booking

This service is the subject of the chapter "Capacity booking".

5.3.2 Capacity transactions

Shippers can, upon authorization of TSO, can transfer capacity at the Entry and Exit Points of TSO Network as described in the chapter "Capacity transfer". The Shipper is not allowed to trade its capacity.

5.3.3 Physical balancing of the network

Physical balancing is the process by which TSO monitors / controls, in real time, all the relevant flow parameters, to guarantee that gas is moved efficiently and safely from Entry to Exit Points. The physical balancing operations, performed by TSO, are detailed in the chapter “Physical Balancing”.

5.3.4 Commercial balancing of the network

The TSO administers a charging system that incentives Shippers to balance inputs with off-takes. The objective of commercial balancing is therefore to minimize the size and frequency of imbalances. This service is described in the chapter “Commercial Balancing”.

5.3.5 Gas measurement

The TSO is responsible for as part of the gas measurement process to be custody transfer measurement besides, is responsible for measurement data acquisition and validation and for forwarding this data to Shipper and to the owner of the measurement plant, as described in the chapter “Gas measurement”.

5.3.6 Gas quality parameters

The TSO verifies and validates the parameters for the compliance with gas quality specifications, such as those necessary to calculate energy (Gross Heating Value) and those related to the control of chemical and physical characteristics of natural gas

5.3.7 Transportation network maintenance

To administer the pipeline network in a safe and efficient manner, the TSO performs periodic inspections, control and maintenance, which may cause interruption or reduction of transportation capacity. These activities can be planned or may become necessary during emergencies.

5.3.8 Gas shortage management

In accordance with chapter 13 “Balancing”, the TSO monitors and/or acts to address emergencies resulting from demand which cannot be covered by supply in order to restore normal system operations as quickly as possible.

5.3.9 Additional Services

Any additional services requested by any of the gas market parties shall be charged by the TSO including, but not limited to, works, services, studies or, any other requirements whatsoever

5.3.10 Invoicing

TSO invoices Shipper – as described in the chapter “Invoicing” – for all fees related to transportation services and the associated charges, in addition to other charges relating to transportation activities.

6. Capacity Booking

6.1 Scope of Capacity Booking

Firm Capacity, in MMSCFD and in MMBTU can be booked by the Shipper for gas transportation on the Gas Transmission Network.
The Shipper may require annual or multi-annual capacity, for a period up to five years.

Transportation capacity is requested and assigned at:

- Entry Points connected to each foreign import pipelines;
- Entry Points connected to each LNG regasification terminals;
- Entry Points from each national production fields;
- Exit Points of each interconnection with exporting pipelines;
- Exit Points of each interconnection with local distribution networks;
- Exit Point of each conjunction with the premises of Final Consumers directly connected to the Gas Transmission Network.

The shipper shall submit a table with the following data for each Entry/Exit:

- The yearly shipping / delivering gas quantities in MMSCF and MMBTU or MMSCM and MJ
- The daily shipping / delivering gas quantities in MMSCF and MMBTU or MMSCM and MJ
- The maximum daily shipping / delivering gas quantities in MMSCF and MMBTU or MMSCM and MJ

To be entitled to request capacity at each Entry Points, the Shipper must have the needed supporting documents to Valid shipper license.
The shipper must also prove the availability of gas at the same Entry Point where the shipper desires to book capacity.

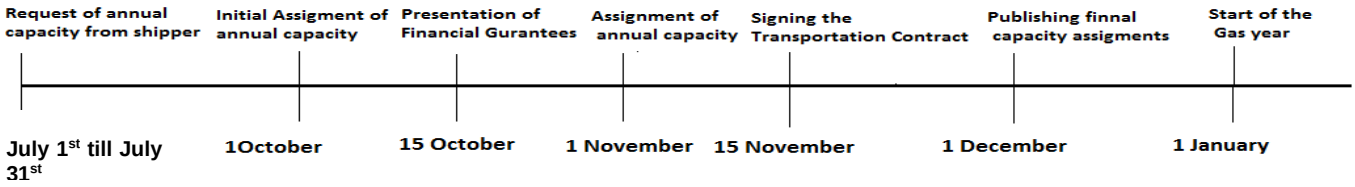
The shipper shall deliver quantities of natural gas to the TSO in accordance with the proper nomination up to and including the maximum daily quantities at the specified entry / exit points.

6.2 Booking Process

Every year, no later than July 1st till July 31st (if this date is a Friday or Saturday or public holiday, this is brought forward to the last working day prior to that date), the shippers shall send and/or confirm their request for transportation capacity at the Entry and Exit Points.

The requests must be sent via e-mail and/or fax by previously authorized staff of the Shipper, according to the corresponding procedure which will be published by the TSO on its official website.

The timeframe of the capacity booking is as follows: (This applies in case of using existing gas transmission system infrastructure)



6.3 Booking Criteria

The TSO assigns the transportation capacity requested to the requesting parties after preparing a technical study related to availability of capacity in the gas network and compliance of metering facilities to TSO specifications and Transmission network code. The requesting parties shall submit all the technical data to TSO with their capacity requests as described below.

If the available capacity is sufficient to satisfy all the requests received and measurement facilities comply with TSO specifications and Transmission network code, this capacity is assigned to the requesting party at the start of the thermal year.

Booking priorities, to be activated in case of shortage of capacity, are periodically set by the M.O.P. within the general strategy of the Gas sector and it is the responsibility of the Gas Regulatory Authority to regulate and monitor the implementation of such priorities.

If the available capacity is less than the amount requested, a pro-rata mechanism will be applied among shippers that have consumers with the same priority level.

E.G.

CASE 1:

At Entry Point “Shukna”

Shipper A requests 10 (scm/d) for annual capacity

Shipper B requests 10 (scm/d)

Available Capacity: 10

Capacity Allocation	
Shipper A	5
Shipper B	5

6.4 Booked but Unused Capacity

This principle aims to ensure that the capacity in Gas Transportation System is used efficiently and that a barrier to the development of effective competition does not arise through restricted or inadequate access to unused capacity.

If, at a given Entry Point, the capacity assigned to a Shipper is not utilized (according to the time specified in the transportation contract), the TSO can decide to sell the unused capacity in the gas market on a firm basis, and the shipper shall pay the capacity part of the transportation tariff for the unused booked capacity.

6.5 Requested Guarantees

The shipper shall pay the administration fees requested by the TSO before issuing Technical study related to the availability of gas network capacity and gas measurement system compliance.

Once a Shipper has been assigned capacity at Entry Points, the shipper has to provide guarantees on its ability to pay the charges (capacity and commodity) that the TSO will issue.

The shipper shall provide to TSO an unconditional and irrevocable letter of guarantee issued by an Egyptian bank and covering 2% of the total capacity charges with a maximum amount of 1,000,000 (only one million) US dollar. This guarantee shall be valid for, at least six months after the end of the thermal year covered by the contract /s referred to by the Transportation Contract and it should be cashable at first request.

- The shipper shall ensure that the value of letter of guarantee available to be drawn by TSO in case of
  - Non- performance of transportation contract obligations and any deficiencies thereof;
  - Any Unpaid of invoices with the amounts due regarding the assigned capacity according to the payment terms;
  - Tort, negligence or any kind of default may arise.

If TSO enforces the guarantee partially or in full, the Shipper shall restore it within 30 days, in addition TSO shall be entitled to apply the penalty of losing its booked capacity or early termination of the Transportation Contract.

6.6 The Shipper's Capacity booking obligation

Shipper shall pay the Capacity Charges on a regular basis every 3 month in advance for the capacity booked and finally assigned for the following 3 months.

6.7 The Transportation Contract

The licensed Shipper, to whom final capacity has been assigned, must sign the Transportation Contract by November 15, on an annual basis, to confirm the assigned capacity.
If the Shipper does not countersign the Transportation Contract with the specification of the booked capacity, shipper shall pay to TSO a penalty equal to the sum of 20% of the maximum annual charge for the capacity booked within the annual and multi-annual booking process.

If the Shipper countersigns the Transportation Contract with lower booked capacity levels than the confirmed, the shipper will incur a penalty equal to the product of the penalty for not countersigning the contract multiplied by the ratio between the confirmed and not countersigned capacities, and the sum of the confirmed capacities, for the whole period of assignment.

In case penalties are not paid by the Shipper, the TSO can execute the guarantees provided by the Shipper.

TSO shall not sign Transportation Contracts with requesting parties who have not, at the date of undersigning, paid the capacity fees for existing Transportation Contract, for amounts invoiced and with expired due date, higher than the value of the bank guarantee issued to cover the obligations deriving from the above-stated existing Transportation Contracts.

6.8 Infra Annual Capacity Booking

Shippers may request transportation capacity, after the start of the Thermal Year and for a maximum duration equal to the remainder of the same Thermal Year, in the following cases:

- If there is available unused capacity;
- For capacity increases at exit Points;
- For capacity increases at Entry Points;

The TSO must receive the capacity request within 7 working days from the publication of the available capacity; this publication will take place on the last working day of the month preceding the month to which these capacities refer.

If a Shipper requires transportation capacity within the Thermal Year, and this capacity is available, the request will be satisfied.

The capacity booking criteria are these adopted for the requests for annual capacity (paragraphs 6.4, 6.5 and 6.6).

6.8.1 Procedure for Booking of Available Capacity

TSO will inform each requesting parties of the outcome of the booking process within 14 working days from the publication date of the available capacities by assignment letter sent by fax/mail to the requesting Shipper.

The Shipper has to communicate, by the 20th of the month preceding the month in which the service is required to start, the capacity levels the shipper intends to book, within the capacity assigned by TSO, after providing the guarantees mentioned in paragraph 6.5.

6.8.2 The Transportation Contract

The Shipper, to whom preliminary capacity has been assigned, must sign the Transportation Contract by the 25th of the month preceding the month in which the service is required to start. If the Shipper does not countersign the Transportation Contract, he will incur a penalty equal to the sum of 20% of the maximum infra annual charge for the capacity booked within the infra annual booking process.

If the Shipper countersigns the Transportation Contract with lower booked capacity levels than those confirmed, he will incur a penalty equal to the product of the penalty for not countersigning the contract multiplied by the ratio between the confirmed and not countersigned capacities, and the sum of the confirmed capacities, for the whole period of assignment.

7. Capacity Transfer

7.1 Definition

A transaction by which the Incoming Shipper, who has activated a new supply to Eligible Consumer served previously by another Shipper (Outgoing Shipper), requires the transportation capacity needed to supply its new consumer at the Exit Point until the end of the Thermal Year.

7.2 Effects

If the Transaction is accepted by TSO upon a written consent from the TSO, the Transportation Contract of the Incoming Shipper and the Outgoing Shipper are arranged accordingly, to register the transfer of capacity from the Outgoing to the Incoming Shipper at the same Entry/Exit Point

The Incoming Shipper has the right to book equivalent capacity at Entry Point, while the Outgoing Shipper may require the partial or total reintegration of capacity transferred (if available).

7.3 Timing

The timing for the capacity transfer is as follows:

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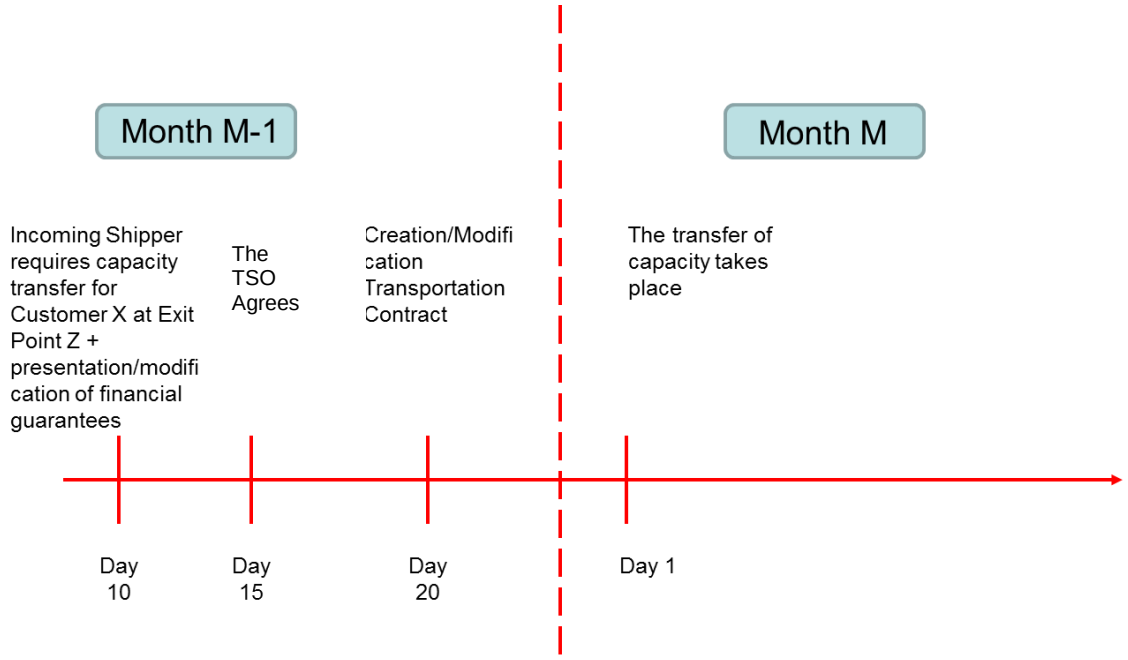


7.4 Roles, Rights and Responsibilities

The incoming shipper shall fulfil Gas network code and all relevant transportation contract terms between the TSO and the Outgoing shipper.

The incoming shipper will be obliged to pay for the capacity granted at the Exit point starting from the date of the transfer accordance with the methods laid down in paragraph 6.6 of chapter “Capacity Booking” and chapter 17 “Parties’ Liabilities”.

The incoming shipper must sign the Transportation Contract by Day 25 from Month M-1, to get the assignment confirmed.

The incoming shipper shall ensure that TSO has the possibility to fully use and access the measurement plant (at the relevant Entry & Exit points) at all times for the relevant activities according to 11.5 of chapter “Measurements” and 12.3 of chapter “Gas Quality Specification”.

8. Capacity Trading

8.1 Definition

A transaction by which a Shipper transfers the ownership of his transportation capacity at Entry and/or Exit points to another Shipper.

Capacity trading is currently not allowed under the terms of this Network Code.

9. Transportation Programs and Nominations

9.1 Introduction

To optimize the transportation service programming by the TSO, it is necessary that the Shippers communicate their transportation programs with the details and timescales described in the following paragraphs.

TSO and the Shipper agree that TSO will deliver at the Exit Point the same amount of energy that the Shipper has delivered at the Entry Point (pls. refer to item 12.3.1).

9.2 Annual Transportation Program

9.2.1 TSO's annual intervention plan

The TSO communicates to Shippers on in a period not less than 180 days before the beginning of the new thermal year (in the event that this date is a Friday or Saturday or public holiday this is brought forward to the last working day prior to that date) the list of planned intervention for the following Thermal Year that will cause a reduction of the transportation capacity on the Gas Transmission system in such a way not to violate the minimum contracted quantity (booked capacity).

9.2.2 Shipper' annual transportation program

Enough period not less than 180 days before the beginning of the new thermal year, the Shipper communicates to the TSO, via e-mail by previously authorized staff, the transportation program for the following Thermal Year, containing:

- Monthly gas quantities based on daily quantities, in energy units and for operational purposes in volume (calculated on basis of minimum heating value in the contract for both injected / delivered gas) the volume nomination is for operational purposes only not for accounting purposes, the volume for accounting purposes shall be calculated based on actual calorific value injected / delivered), to be delivered at each Entry Point of the Gas Transmission system for which the Shipper has been assigned capacity;
- A forecast value of Gross Calorific Value (GCV) at each of the aforementioned Entry Points;

The Shipper will also specify, at an aggregated monthly level based on daily quantities, the quantities, in energy units and for operational purposes in volume (calculated on basis of minimum heating value in the contract for both injected / delivered gas) the volume nomination is for operational purposes only not for accounting purposes, the volume for accounting purposes shall be calculated based on actual calorific value injected / delivered), forecast for redelivery at each of the Exit Points of the Gas Transmission system for which the Shipper has been assigned capacity.

The TSO shall reply to the shipper within 30 days from receiving the annual nomination objecting if the nominated annual quantities exceed the capacity booked or not complying with contract.

The TSO shall reply within 30 days from receiving the approved quantities otherwise the submitted quantities shall be considered approved.

9.3 Monthly Transportation Program

9.3.1 TSO's monthly intervention plan

The TSO communicates to Shipper the first day of each month (in the event that this date is a Friday or Saturday or public holiday this is brought forward to the last working day prior to that date) the list of planned intervention for the following month that will cause a reduction of the transportation capacity on the Gas Transmission system i provided that the reduced capacity is not less than the minimum contracted quantity (booked capacities).

9.3.2 Shipper's monthly transportation program

Prior of the requested month with a period not less than 90 days, the Shipper communicates to the TSO, via fax and /or e-mail or any other communication method such as written correspondence by previously authorized staff, the transportation program for the requested month, containing:

- daily gas quantities based on hourly basis, in energy units and for operational purposes in volume (calculated on basis of minimum heating value in the contract for both injected / delivered gas) the volume nomination is for operational purposes only not for accounting purposes, the volume for accounting purposes shall be calculated based on actual calorific value injected / delivered), to be delivered at each Entry Point of the Gas Transmission system for which the Shipper has been assigned capacity;
- A forecast value of Gross Calorific Value at each of the aforementioned Entry Points;

The Shipper will also specify, at a daily level based on hourly quantities, the quantities, in energy units and for operational purposes in volume (calculated on basis of minimum heating value in the contract for both injected / delivered gas) the volume nomination is for operational purposes only not for accounting purposes, the volume for accounting purposes shall be calculated based on actual calorific value injected / delivered), forecast for redelivery at each of the Exit Points of the Gas Transmission system for which the Shipper has been assigned capacity.

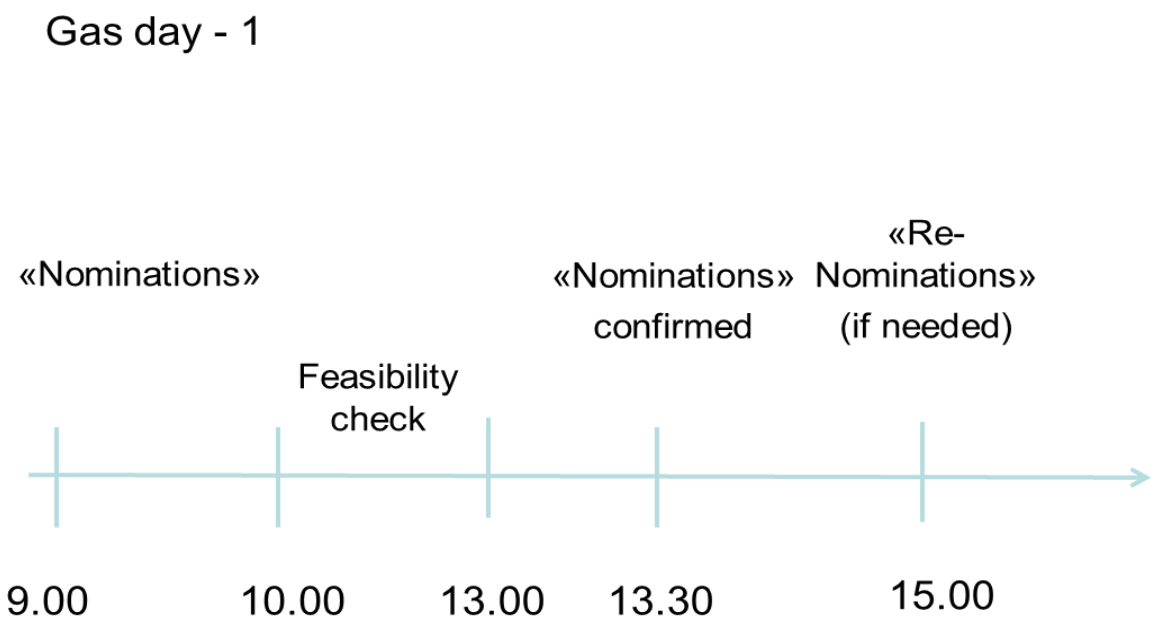
The TSO shall reply to the shipper within 15 days from receiving the monthly nomination objecting if the nominated monthly quantities exceed the capacity booked or not complying with contract.

The TSO will be considered approved on the submitted quantities from the shipper if he does not respond in 15 days.

9.4 Daily Transportation Program ("Nominations")

In alternative to weekly programming, the parties can commonly agree to proceed with daily nominations as follows:

The Shipper communicates to the TSO its daily transportation program (which will be on hourly basis, with the following timeframe:



The shipper shall nominate the TSO for the daily nomination in hours, for each relevant entry and exit points.

The nominations must be "balanced", to be accepted by the TSO, i.e. the quantities off-taken must be equal to those injected with certain percentage (with minus) (to be agreed in the contract) for operation manoeuvring and consumption / losses pls. refer to item 13.3.2.

If the Shipper does not communicate to the TSO its daily transportation program (for injected / redelivered gas), or this is incomplete or not compliant with the defined rules (stated in the contract), the TSO will adopt, for daily programming purposes, the values contained in the monthly program (dividing the total monthly values by the number of the days of the month).

The Shipper must also communicate a forecast of the Gross Calorific Value at each of the Entry Points for which the Shipper has been assigned capacity.

9.5 Updating Daily Nominations or "Re-nominations"

The contract defines the accepted timeframe within the shipper can change his nominations.

By 15.00 on Gas-day G-1, the Shipper may update its transportation program for the Gas-Day.

The TSO may reject within one hour the daily re-nomination in case this affects the proper working of the system and the supply of gas to any consumer not associated to such re-nomination.

9.6 Shipper's Imbalances

Imbalances are defined as relevant differences, over a defined period of time, between the gas quantity actually delivered by the Shipper at an Entry Point and uptake at the Exit Point and the scheduled quantities for that same period and the same points.

, Imbalances will be settled as follows:

TSO will calculate daily physical imbalances for the Shipper. Daily (Gas-Day G+1 by 14.00 pm) for daily imbalances.

In case these days happen in a non-working day, these calculations shall be done on the first possible working day.

Shippers will commit to solve the daily imbalance within the first day after the communication will have taken place (usually Gas-Day G+2),

TSO shall:

- Curtail withdrawn gas quantities at Exit Points (where applicable) in situation of a unique Shipper serving a Consumer directly connected to TSO Network, and having a daily imbalance due to gas withdrawn at the Exit Point greater than gas injected at Entry Point greater than 5% the scheduled quantity for that day.
- Reduce injected quantities at Entry Point (where applicable) in situation of a unique Shipper serving a Consumer directly connected to TSO Network, and having a daily imbalance due to gas injected at the Entry Point greater than gas withdrawn at the Exit Point greater than 5% the scheduled quantity for that day.
- The shipper will be charged with the gas price which was injected in the network from other shippers or imported to compensate shortage caused by the shipper in the network, this gas to be transported at the exit point, the shipper will be charged also with any penalties other than shortfall gas penalty due to providing gas from other sources.

9.6.1 Shortfall Gas

If the shipper fails to deliver or make available 95% of the nominated gas quantity on any gas day, due to reasons other than force majeure or off spec. gas or scheduled maintenance…etc.,The (" Shortfall Gas") shall be equal to95% of the accepted nominated quantity of Gas minus the actual quantity of gas delivered by the shipper.

The gas delivered by shipper or third party on behalf of the shipper at any If Entry Point is less than the confirmed Daily nomination (Shortfall Gas) as specified in the Transportation Contract and/ or this document in “Nomination” chapter, the Shipper remains responsible for the payment of the full capacity part of Transportation Tariff, and the commodity part for the quantity of Gas actually delivered in addition to any costs and charges borne or incurred by the TSO to manage the commercial and physical balancing of the Gas Network and/or to compensate the Shortfall Gas either through re-nomination or by availing Gas (for example by buying a hub, a Gas storage or an FSRU..etc) provided that any costs incurred by TSO or any other shipper shall be properly documented and in case a dispute rises with concerns to such costs, the parties shall refer to the Gas Regulatory Authority to identify a mechanism to calculate such costs.

9.6.2 Excess Gas

If the shipper’s client on any gas day takes more than 105% of the nominated gas quantity, then (“Excess Gas”) shall be equal to the difference between 105% of the nominated quantity and the quantity of natural gas actually taken by the shipper’s client.

At Exit Point

- If the gas withdrawn at any Exit Point exceeds the confirmed daily nominated quantity (Excess gas) specified by the Transportation Contract and/or approved “Nomination” chapter, the shipper remains responsible for the payment of the whole Transportation Tariff (capacity and commodity) in addition to the price of Excess gas, which shall be set by the Gas Regulatory Authority. In addition, the shipper shall be charged with any costs or charges borne or incurred by the TSO to manage the commercial and physical balancing of the Gas Network and/or to compensate the Excess Gas plus 10% or the total costs and charges incurred to manage the balancing of the Gas Network. In all cases, all costs incurred by TSO or any other shipper shall be properly documented ,and in case a dispute rises with concerns to such costs, the parties shall refer to the Gas Regulatory Authority to identify a mechanism to calculate such costs
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9.6.3 Gas Buyer Undertake

If the shipper’s client at any gas day fails to take less than a certain quantity of gas (95% of the daily nominated quantity) without any reason such as force majeure or off spec. gas or scheduled maintenance…etc. and the shipper, TSO made available all the nominated quantities then the daily buyer undertake quantity shall be calculated as the difference between agreed percentage (*95% of the nominated quantity) and the actual delivered quantity

The contract between the shipper and TSO shall organize the compensation of the buyer undertake

The compensation of buyer undertake shall be according to the provisions of the Transportation Contract.

All quantities shall be in energy.

9.6.4 Overruns gas

If the shipper exceeds by a certain percentage 105% of the nominated gas quantity on any gas day without TSO approval, the overrun gas quantity equals the actual delivered quantity by the shipper minus the quantity of natural gas, which is (105% of the accepted nominated quantity)

The compensation of this overrun gas shall be according to the provisions of the Transportation Contract.

All quantities shall be in energy.

10. Transportation Tariffs

10.1 Introduction

The gas transmission service offered by the TSO beside any other obligations referred to in this Network Code which has to be borne by the TSO shall be covered by the payment of transmission tariffs which is approved by the Gas Reg. and published on the TSO's website.

The tariff calculation exercise will be made by the TSO in accordance with the Gas Reg's setting methodology. As stated by the Gas Law, gas transmission tariffs and the procedures of collecting it are based on a transparent and non-discriminatory methodology which:

- Allow Third Party Access to the transmission network, at least for sale to eligible Consumers;
- Provide level playing field among shippers;
- Ensure that costs of the transmission operator, as recognized and allowed by the relevant regulation, are recovered
- Develop financial plan of the business and future investment.

The Tariff shall be expressed as an amount in United States Dollar per MMBTU or its equivalent in Egyptian pound according to the central bank of Egypt published exchange rate.

The transportation tariff shall be notified to shippers prior to the start of each gas year; and shall take effect from the start of the gas Year unless stated otherwise;

10.2 Tariff Structure

Gas Transmission tariffs are based on:

- A capacity charge term at the Entry and Exit points of the Gas Transmission Network;
- A commodity charge term associated to the gas quantities injected at the Entry Points of the TSO pipeline network

10.3 Tariff adjustments

TSO has the right to revise Transportation Tariff, after the approval of the GasReg, in case of:

- If a new Tax, Charge or Fee of general application is imposed or levied on TSO, or
- If an existing Tax, Charge or Fee is increased, Shipper must pay to TSO as an additional charge, the amount of Tax, Charge or Fee in relation to Services.
- Any unusual circumstances.

10.4 Special Tariff and charges

10.4.1 Special Tariff

TSO has the right to impose other special tariffs to Network user after the approval of GasReg., in case of, but not limited to, the conveyance of transit gas through the Gas Transmission Network, i.e. gas that transits across the territory of Egypt with a view to bring it abroad.

10.4.2 Additional charges

TSO has the right to impose additional charges to be paid by the shipper in case, but not limited to:

- Variance, when the actual quantity of gas transmitted at Entry point or withdrawn at the Exit point differs from variance stated at Entry/Exit points in the transportation contract (for example more than + 5% of nominated capacity).
- Any violation mentioned in that code or the transportation contract.
- Acts, omissions or failures attributable (Delivered Gas Quantity, Pressure and Quality) that affect other shippers or gas network pipeline facilities.

11. Measurements

11.1 Introduction

Measurement stations are where commercial transportations transaction takes place, the Custody Transfer measurement stations should be existed at all Entry Points, which belongs to all Shippers and local Gas Producers which deliver the gas to the TSO for further transportation to Exit Points. Also the Custody Transfer measurement stations should be existed at Exit Points where the TSO delivers gas at either the Final Consumers or at the inlet of a local distribution network.

Measurement data are usually used for the following:

- Calculation of the volumes & energy delivered at the Entry and Exit Points.
- Calculation of the “commodity” charges.
- Calculation of any overruns capacity (if the Shipper injects at the Entry Point more than its booked capacity) and imbalance charges (if withdrawals are higher than injections).
- Overall Transportation Network Gas Balance Calculation.

Therefore, the measurement methodologies adopted, and the accuracy and timing of the measured data are essential for the correct management of the Gas Transmission Network. As a consequence, the TSO, even if it is not the owner of the measurement stations, has the right to access the measurement plants subject to the approval of the owner to carry out all measurement activities – in the presence of the involved parties.
The same right applies to the Shipper and the Final Consumer if a measurement stations belongs to the TSO.

The parties commonly agree to visit and examine the measurement stations and agree that the measurement stations are fit for the purpose of the contract. If any written remark on the measurement stations is made prior to the start of the contract by any of the parties involved (Shipper, Consumer, TSO), the owner of the measurement station will reply to the remark before the (Commencement Date) of the contract and the parties shall commonly agree to any upgrading modification/change on the measurement station according to transportation contract (for the sake of improving the total uncertainty budget), including its calibration, monitoring, maintenance and operation before the start of the contract, and on the timings of such changes, their acceptance from the other parties, and any other relevant detail on the measurement stations, before the start of the contract.

The measurement stations at Exit and Entry point should be matched with the TSO specification and should be revised and accepted from the TSO.

11.2 Definition and Ownership of the Measurement Stations

The measurement station is an installation developed to perform custody transfer gas measurement and includes all the equipment installed (Filtering Section + Metering Section) between the entry and exit valves of the station (including the valves themselves). In case of measurement station is supplying a Final Consumer or any local gas distribution companies, the station may also include other equipment such as heaters, pressure regulating equipment… etc. to match Consumer's needs.

The overall uncertainty of the measurement system shall not exceed ±1% in any way.

The measuring policy shall ensure that systematic and unsystematic errors are actively reduced using agreed procedures regardless of the sign of deviation. When afterwards, a systematic error is found in the volume/energy determination over a period of time (e.g. caused by incorrect settings or deviations of instruments outside the agreed limit or problems due to design, operation and maintenance), the system shall be capable to deliver all the required data to calculate the deviating amount of energy (for the purpose to be presented to TSO and to be settled with the interested parties).

The required availability for the measuring installation is 100%. This can be managed by using redundancy in the systems (e.g. meter runs, gas analysing systems, no break power, redundant flow computers and transmitters). Gas shall only flow if the measuring installation is available and is functioning with agreed specifications. The responsibility of the interruption of gas flow in case of unavailability of the measuring installation will be beard by the responsible party for the correct working of the meter or by the subject that has caused its unavailability.

For volumes above a certain limit to be agreed upon, a double fitted flow measuring installation in series of different measuring principles shall be used. If in some locations the invoicing is in energy, double fitted gas chromatographs shall be used for the total measurement installation, including sample conditioning, carrier gas, calibration gas and reference gas.

The stations to measure gas input and off-take Volumes & Energies on the Gas Transmission System are owned by:

Entry points	
➢ Gas Producer	➢ Metering facilities will be owned and maintained by the Gas Producer. TSO has the right of remote SCADA monitoring, site access to the metering station and witness calibration and validation of the system and acquire any metering data every 6 month or as needed by TSO. ➢ TSO may have a check metering facility. ➢ The Gas Producer will be charged for connecting its SCADA port (the output SCADA port of the Gas producer metering station) to the TSO SCADA centre.
➢ Shippers	➢ Will be owned by the Shipper but the operation and / or maintenance for the measurement systems and gas network facilities could be the responsibility for of TSO against separate paid contract. ➢ TSO has the right of remote SCADA monitoring, site access to the metering station and witness the calibration and validation of the system and acquire any metering data. ➢ The shippers will be charged for connecting its SCADA port (the output SCADA port of the Shipper metering station) to the TSO SCADA centre. ➢ TSO may have a check metering facility.
Exit Points	
➢ Final Consumers	➢ Owned by Final Consumer while the operation / maintenance for the measurement system could be the responsibility of TSO against separate paid contract. ➢ TSO has the right of remote SCADA monitoring, site access to the metering station and witness the calibration and validation of the system and acquire any metering data. ➢ The Final Consumers will be charged for connecting their SCADA port (the output SCADA port of the Final Consumers metering station) to the TSO SCADA centre.
➢ Distribution Companies	➢ Owned by the distribution companies but the operation / maintenance of the measurement systems are the responsibility of the owners. ➢ TSO may have a check metering facility. ➢ TSO has the right of remote SCADA monitoring, site access to the metering station and witness the calibration and validation of the system and acquire any metering data. ➢ The Distribution Companies will be charged for connecting its SCADA port (the output SCADA port of the Distribution Companies metering system) to the TSO SCADA centre.

11.3 Gas Measurement Provisions

Various types of measurement stations have been constructed over the years. During these years, the measurement stations data collection and processing using electronic devices have been gradually upgraded starting from using "Local Volume Correctors" for the very old small consumers till using of “Metro-logically Approved Redundant Flow Computers Systems" which are used for most consumers. The most recent systems are also integrated within "Computer-Based Supervisory Systems" that provide some additional monitoring functions, historical data storage and easy reporting facilities.

All the technical information, requirements and standards that TSO requires for building, maintaining and operating a metering station are detailed in Annex 1.
The following list represents the International Standards mostly used in the design of the Gas Metering Systems (recent issues at the time of design must be followed unless otherwise specified):

- For Orifice plates – Based Metering Stations

Mainly, International Standard Organization's ISO 5167 must be followed and the American Gas Association's report no.AGA-3 could be used only in case of limited available space.

- For Turbine Meters – Based Metering Stations

American Gas Association's Report No.AGA-7 must be followed. Equivalent International Standard Organization's ISO may also be followed.

- For Ultra-Sonic Meters – Based Metering Stations

American Gas Association's Report No.AGA-9 or ISO 12765 must be followed.

- For Gas Density and Compressibility Calculations

American Gas Association's Report NO. AGA-8 Compressibility and Super compressibility for Natural Gas and Other Hydrocarbon Gases should be used.

- For Gas Heating Value and Volumes' Units & Reference Conditions

It is not allowed to mix between SI system and Imperial system in the same measurement system or to inject gas in the Gas Transmission Network by using SI or Imperial and redeliver it in another system unless previously approved as an exception using the correct and mutually approved conversion factors.

Imperial System	
Unit	Reference Conditions
SCF	Real Gas Tb = 60°F P_b = 14.696 psia
BTU/ SCF	Real Gas Gross (Superior) Heating Value 60°F /60°F combustion

11.4 Measurement Stations at Entry and Exit Points

Regardless of the owner of gas metering stations serving in the Entry and Exit Points, these stations shall be designed, manufactured, tested, installed and commissioned as per applicable international codes and standards, following the TSO rules, regulations, requirements and operation as well, maintenance and managing procedures.

Each of these metering stations shall include a data output in the form of raw &hard-wired signals, Ethernet and Serial port (with specific characteristics specified and approved by the TSO) for serving the TSO supervisory control and data acquisition (SCADA) as a connection with the measurement equipment.

So, these Measurement stations are designed, built and managed by following specific procedures that take into account their individual characteristics such as quantities of gas passing through, and that they are subject to commercial transactions involving numerous parties, such the TSO, the plant manager, the owner, gas purchasers and sellers.
The Shipper injecting gas at an Entry Point should inform the TSO with the energy quantity measured each hour daily to be able to create the TSO's physical balance. Shippers taking/ receiving gas from an Exit Point should inform the TSO the energy quantity measured each hour daily to be able to create the TSO's physical balance.

The reading values concerning the energy quantity measured is recorded by the involved parties each two weeks under their supervision and a bi-weekly authentication report shall be mutually signed between the TSO and the other involved party.

Any of the parties involved in a certain gas measurement which is done by metering system that is not operating under his direct control (operation), have the right to witness the periodic regular calibration checks done by the operator in the presence of other involved parties if any. Also the TSO has the right

to attend any calibration / validation required for metering system equipment based on the Maintenance plan presented from station owner for example (the annual / half validation and calibration procedures as a witness party, and ask for copy of all related documents which belongs to these measurement stations.

Third party (Expert) validation check may be agreed upon in case of presence of severe disputes or doubt or fixed difference over ±1%, (between the pay meter and the check meter if exist) on the energy delivered or received according to item 11.8. Requirement of meters high pressure flow calibration abroad will be specified on calendar or status basis as detailed in each individual contract. Costs for this type of meters' calibration will be charged to the owner and other involved parties have the right to witness at their own expenses.

All the measurement stations which are not compatible with the Custody Transfer measurement conditions, the owner of these stations should take all the necessary actions immediately to correct the measurement system and restore the original uncertainty agreed in transportation contract and Transmission network code and to submit schedule plan to the TSO for approval, this plan should contain the specifications & timing required for upgrading these stations to be compatible with the Custody Transfer measurement conditions

Back-up and redundant equipment – where available – is used to determine gas quantities when the main measurement system fails.

11.5 Roles, Rights and Responsibilities of the Parties

TSO and the Shipper, by adhering to the Network Code and transportation contract, expressly accept these roles, rights and responsibilities and undertakes to be bound by such rights and duties. .

TSO and the Shipper recognise that the plant owner is responsible for the construction, management and maintenance of the plant, in accordance with the relevant statutory laws and contractual obligations. Shippers, moreover, are responsible towards TSO for the accuracy and truthfulness of the measurement made at the plants belonging to the Final Consumer. Finally, the costs and charges regarding the legal metrology obligations fall under the remit of the owner of the measurement plants.

11.5.1 Shipper

The Shipper, being involved in the commercial transactions occurring at the plant, has the right to attend – upon formal request to TSO and in agreement with it to determine the operating methods – in the presence of the other parties involved (TSO and Final Consumer) all the operations carried out at

the plant which have an impact on the data recorded. The arrangements for such access must be agreed with and supervised by the TSO.

In case the metering station is owned or managed by the relevant Shipper, the Shipper undertakes the responsibility for:

- Communicating to the owner of the metering station the right of TSO to take part in the measurement activities that concern it.
- Assuring that TSO has the possibility to fully use and access the measurement plant at all times for the relevant activities subject to the approval of the respective Gas Producer (such approval is needed in case of existing entry point only). If TSO is not able to exercise this right, it will immediately communicate this fact to the relevant Shipper and, TSO can use the best available substitute.
- Communicating immediately with TSO in case:
  - The owner of the measurement station entrusts third parties with the responsibility for the management and maintenance of the station, to guarantee the continuous fulfilment of the related procedural aspects.
  - The plant's owner suggests modifications to the plant. These modifications must be agreed in advance between the parties involved in the measurement (TSO, Shipper, and Final Consumer), accepted by each one of them based on their responsibility and carried out and paid for by the owner.
- Providing TSO with assurance that the Final Consumer will meet its contractual obligations in relation to the operation and maintenance of the measurement plant.
- Providing TSO with assurance that the plant's owner will supply timely and accurate data and will promptly restore the plant in the case of breakdown. If the plant appears to be not functioning correctly, TSO will inform the Shipper accordingly.

All parties shall meet in good faith to agree on the ways and procedures to recover the metering system as soon as possible, agree on using the redundant metering system till the permanent one is in service and the ways to compensate this period if there is difference between pay and check metering system.

If the plant has not been repaired after 60 days have passed from this communication, TSO will reserve the right to charge the Shipper for the cost borne because of prolonged malfunctioning of the measuring system and supplying gas to this Exit Point may be stopped/interrupted

All parties shall agree what are the necessary procedures to be taken in cases of metering system failure partially/completely. These procedures shall begin from design phase (redundant metering

system), preventative maintenance and spare parts availability which help a lot in preventing metering system failure.

- Guaranteeing that during measurement operations for both new and existing plants appropriate rules, procedures and guidelines are adopted.
- Guaranteeing that in case within the scope of the operations performed to make the necessary modifications to the measuring system, different rules, procedures and guidelines are adopted from those issued by TSO - such rules, procedures and guidelines (having been subject to explicit prior acceptance by TSO) will provide an equivalent or superior quality of measurement data.

In case the metering stations owned or managed by the Shipper, and the Shipper ceases to be the relevant Shipper (e.g. due to capacity transfer),in addition to the corresponding obligations, The Shipper has the obligation to perform periodical metering readings and communicate them to the TSO, according to the relevant regulations issued by the Gas Regulator.

11.5.2 TSO

TSO measurement activities, independently or in the presence of the other parties involved, are designed to guarantee the highest level of data accuracy.

In this respect, TSO carries out:

- The acquisition of measurement data, via telemetry or direct measurement at the site in case of telemetry system failure.
- Validation refers to the verification and control processes undertaken by TSO to ensure the accuracy of measurement data for the transportation purposes. The data that TSO qualifies as usable for driving transportation balances and invoices is considered "validated".
- The access of Shippers to measurement data under control of TSO will be limited to the data related to the Exit Points served by each of the Shippers and will be accessible also to the owners of the measurement stations.

It is also the responsibility of TSO, in case of being the owner or the operator of the metering facilities, to maintain the necessary electronic or paper measurement records, in accordance with the relevant fiscal and administrative rules, which may be required to support the application of this document.

For Stations that are not under TSO control (operation), and subject to such Stations owner’s approval, TSO has the right to fully use/access monitoring, calibration, testing data at all reasonable times and witness any inspection to any measurement devices as being a party involved in the commercial transactions taking place at these plants, in the presence of the other parties involved, to all the operations that may have an impact on measurement data.

11.6 Adjustment of error

If any error in the owner's meters (volumetric & energy) is found to exceed the limits agreed in the contract, corrections to quantities contained in the monthly invoices and annual statement shall be made from the time at which the error occurred, or if this cannot be determined then the corrections shall be from the period of time elapsed between the error was detected and the last check done to the meters by involved parties.

11.7 Estimation of Measurement

If for any reason, the Shipper's, Producer's and Final consumer's meters are out of service or registering outside the limits agreed upon in the contract, so that the quantity of natural gas delivered cannot be ascertained or computed from the reading thereof, the natural gas delivered during the period such meters are out of service shall be determined upon the basis of the best data available, using the first of the following methods which is feasible:

11.7.1 By using the quantity recorded by check meters, if installed and accurately registering.

11.7.2 By adjusting for the error, if the extent of the error is ascertainable by calibration, test or mathematical calculation.

11.7.3 Expert determination of dispute quantities.

11.8 Measurement Dispute Resolution

If any measurement dispute arising under chapter 11 are not otherwise resolved within a period of sixty (60) days from the date of notification of such dispute, then the dispute shall be submitted to an Expert for determination at the request of either party

The qualification of the Expert to be determined in the transportation contract.

12. Gas Quality Specifications

12.1 Introduction

The Shipper must comply with the below quality specification to assure the integrity, safety of the transportation system (protecting the pipelines from corrosion) to allow the TSO to deliver the required gas specification at the Exit Point. Online Gas Analyzer System are commonly used to measure the gas specification parameters and calculate the heating value of the gas. The gas delivered shall be continuously computed by measuring instruments of custody transfer reasonably acceptable to both parties (total uncertainty for metering system not to exceed ±1%).If the parties cannot agree on measurement equipment, then the determination shall be made by an expert (determined by the TSO).

Due to the presence and participation of different actors in the process of measuring the gas quality specifications, it is deemed noteworthy to discuss first the roles and responsibilities of the parties involved, before specifying the gas quality specifications.

12.2 Ownership of the Gas Chromatograph

The gas chromatographs utilized to measure the gas specifications on the Gas Transmission Network are owned by:

At Entry Points:

- Gas Producers; or
- TSO; or
- Shippers;

At Exit Points:

- TSO; or
- Final Consumer.

A specific procedure issued by the TSO and published on its official website will govern the installation of gas chromatographs at new Entry and Exit points, as well as the respective obligations of the various parties involved.

12.3 Role and responsibilities of the parties

This paragraph describes the rules, rights and responsibilities of the parties involved in measuring the gas specification parameters. TSO and the Shipper, by adhering to this document, expressly accept these roles, rights and responsibilities and commit to respect them. In particular, TSO and the Shipper recognize that the gas chromatograph Online Gas Analyzer System (according to TSO specification and design rules) owner is responsible for the construction, management and maintenance of the plant

(as the Online Gas Analyzer System is part of the whole metering system), in accordance with the relevant statutory laws and contractual obligations. Shippers, moreover, are responsible towards TSO for the accuracy and truthfulness of the measurement made at the plants belonging to the Gas Producer or the Consumer with whom there is a contract in place.

If either party at any time desires a special test of any meter or computer used in the operation of this rule, all tests of such measuring equipment shall be made at Shipper expense except that the TSO shall bear Shipper's reasonable costs of tests made at the TSO request more often than once a month if the inaccuracy is found to be plus or minus 0.5%. In case of any dispute between Shipper and TSO on the accuracy of the equipment or the validity of tests or calibrations pursuant to this article, either party may refer the matter for expert determination (must be approved by the TSO).

If upon testing, the inaccuracy in the measurement of the quantity or the error in determination of the gross heating value of gas is found to be plus or minus 0.5% or as per ISO 10723 Natural gas – performance evaluation for on-line analytical systems, the previous recording shall be considered to be zero error otherwise the meter shall be calibrated to zero error and previous recording shall be corrected to zero error for any period which is known definitely to be in error.

The TSO shall have access to the metering station of Gas Producer's subject to his approval or Shipper’s metering station at all times providing adequate prior notice is given to Gas Producer and TSO is accompanied by a representative of the operating company.

Gas Density and Compressibility Calculations shall be computed based on American Gas Association's Report NO. AGA-8 and for Heating Value and for Base Density Calculations International Standard Organization's ISO 6976.

The gas chromatograph shall comply with ISO 10723 Natural gas – performance evaluation for on-line analytical systems.

The TSO and Gas Network owner(s) shall develop Gas Measurement Station development plan for the existing entry and exit points on the Gas Network which are not equipped with custody transfer metering systems and shall submit such plan to the Gas Regulatory Authority for review and approval. The Shipper undertakes to equip all new entry and exit points with custody transfer metering systems (including Gas chromatograph and online analyser) after the approval of this Network Code.

12.3.1 Shipper

The Shipper, being involved in the commercial transactions occurring at the plant, has the right to attend upon formal request to TSO and in agreement with it to determine the operating methods in the presence of the other parties involved (TSO and Gas Producer or Final Consumer) all the operations carried out at the plant which have an impact on the gas specifications recorded. The arrangements for such access must be agreed with TSO.

The Shipper is responsible, in case of gas chromatograph owned by the Gas Producer or the Final Consumer with whom a contract exists, for:

- Communicating to the owner of the gas chromatograph in case of Gas producer the request of TSO to take part in the measurement activities that concern it;
- Assuring that TSO has the possibility to fully use, access, monitoring, calibration, testing data at all reasonable times and witness any inspection to any measurement device as the gas chromatograph always for the relevant activities subject to the approval of the respective gas chromatograph's owner (such approval is needed in case of existing entry point only). If TSO is not able to exercise this right, it will immediately communicate this fact to the relevant Shipper and will assume no responsibility for the truthfulness and accuracy of the measurement data recorded by the gas chromatograph. TSO can use in this case the best available substitute data;
- Assuring that TSO has fully functional prepared /operating output port (in the form of raw & hard-wired signals, Ethernet and Serial port) that access all the measurement data (volume & energy) including the data related to the gas chromatograph (according to TSO SCADA specification) to be able to send the measured data to TSO's SCADA system.
- communicating immediately with TSO in case:
  - The owner of the gas chromatograph entrusts third parties with the responsibility for the management and maintenance of the device, to guarantee the continuous fulfilment of the related procedural aspects;
  - The owner of the gas chromatograph suggests modifications to the plant. These modifications must be agreed in advance between the parties involved in the gas specification measurement (TSO, Shipper, Gas Producer or Final Consumer), accepted by each one of them based on their responsibility and carried out and paid for by the owner. In case the modifications are proposed by the TSO for its own operational needs, the parties can define a different cost subdivision agreement for performing the modifications;
- Providing TSO with assurance that the Gas Producer or the Final Consumer will meet its contractual obligations in relation to the operation and maintenance of the gas chromatograph;

- Providing TSO with assurance that the owner of the gas chromatograph will supply timely and accurate data and will promptly restore the device in the case of breakdown. If the plant appears to be not functioning correctly, TSO will inform the Shipper accordingly. If the plant has not been repaired after 60 days (during this 60 day, all the gas analysis shall be done by Accredited Labs (ISO 17025) on the expenses of the Online Gas Analyzer System owner) have passed from this communication TSO will reserve the right to charge the Shipper for the cost borne because of prolonged malfunctioning of the gas specification measuring system;
- Guaranteeing that -during measurement operations for both new and existing plants- appropriate rules, procedures and guidelines are adopted, as specified by TSO.

12.3.2 TSO

TSO In measuring the gas specification parameters, TSO carries out:

- The acquisition of measurement data, via telemetry or direct measurement at the site in case of telemetry system failure.
- The validation of the measurement data. Validation refers to the verification and control processes undertaken by TSO to ensure the accuracy of gas quality data for transportation purposes. The data that TSO qualifies as usable for deriving transportation balances and invoices is considered "validated";
- The transmission of this gas quality data to Shippers (limited to the data related to the Entry Point served by the Shipper) and to the owner of the gas chromatograph at the Exit from the Gas Transmission Network TSO.

It is also the responsibility of TSO to maintain the necessary electronic or paper measurement records, in accordance with the relevant fiscal and administrative rules, which may be required to support the application of this document.

TSO, being a party involved in the commercial transactions taking place at the plant, subject to the plant owner’s approval, has the right of access, in the presence of the other parties involved, to all the operations that have an impact on gas quality data.

In respect of the contents of this document, TSO shall apply the latest national legislative, technical and meteorological regulations to correctly carry out the measurement transactions, as well as the latest international regulations if the aspect is question is not covered by the national ones. TSO will adopt new regulations in a timely manner and, if no specific terms apply, those that best suit the operating and engineering requirement of TSO.

12.4 Gas Specification

In order to assure the interconnection and interoperability of the gas systems, such as production, transportation, distribution, the chemical and physical characteristics of the natural gas input to the Gas Transmission Network shall at all times be commercially free from sand, dust, gums, synthetic oils, impurities, Liquid, water, glycols and any other non-conforming substances and shall comply with the following “Quality Specification”:

At Entry Points:

- Contain a maximum of zero decimal zero one-mole percent (0.01 %) of oxygen.
- Contain a maximum of three decimal zero mole percent (3.0%) of carbon dioxide.
- Contain a maximum of four (4) parts per million by the volume of hydrogen sulphide.
- Contain a maximum of thirty (30) milligrams of total sulphur per standard cubic meter with average mercaptans of seven (7) milligrams as sulphur per standard cubic meter.
- Have a water dew-point below zero degrees Celsius (0 °C) at a pressure of seventy (70) KG/CM2 gauge.
- Form no hydrocarbon condensates or hydrates above five degrees Celsius (5°C) at any pressure below the delivery pressure.
- Have a Gross Calorific Value of not less than nine-hundred and eighty (980) BTU per SCF.
- Contain a maximum of (6000) Nano-grams of mercury per normal cubic meter of gas.

At Exit Points:

- Contain a maximum of zero decimal zero one-mole percent (0.01%) of oxygen.
- Contain a maximum of three decimal zero mole percent (3.0%) of carbon dioxide.
- Contain a maximum of four (4) parts per million by the volume of hydrogen sulphide.
- Contain a maximum of one hundred fifty (150) milligrams of total sulphur per standard cubic meter with average mercaptans of fifteen (15) milligrams as sulphur per standard cubic meter.
- Have a water dew point below (0) degree Celsius at a pressure of seventy (70) KG/CM^2 gauge.
- Form no hydrocarbon condensates above five degrees Celsius (5^oC) at any pressure below the delivery pressure.
- Have a Gross Calorific Value of not less than nine-hundred and eighty (980) BTU per SCF
- Contain a maximum of (6000) Nano-grams of mercury per normal cubic meter of gas

12.5 Measuring the gas specification parameters

Any device and instruments used by the Shipper/Gas Producer/Final Consumer (such as gas chromatograph, any measurement device …. etc.) must follow the requirements, specifications,

characteristics and the procedure for installation used by the TSO, there is two type of calculation used for calculating the gas specification parameters at the Entry and Exit points.

12.5.1 Continuous calculation:

- The Shipper / the Gas Producer (with whom the Shipper has an agreement and contract) /Final Consumer should use gas chromatographs; the daily value is calculated as the average of the instruments' analyses during the day. These calculated values should be sent daily to the TSO.
- The final online calculated gas chromatograph values must be sent automatically to the TSO's SCADA system for operational wise.
- The data received from the gas chromatograph should be examined automatically by the Shipper / the Gas Producer (with whom the Shipper has an agreement and contract) /Final Consumer under the TSO's supervision where a calibration to the gas chromatograph should be conducted each 6 months in the presence of all concerned parties (in addition to Auto Daily / weekly Calibration) /Final Consumer under supervision and the confirmation of the TSO .The TSO shall have the right to request a calibration test from the Shipper / the Gas Producer (with whom the Shipper has an agreement and contract) /Final Consumer in case of receiving unreasonable measurement values.

12.5.2 Discontinuous sampling:

- At the Entry Point: The Shipper or the Gas Producer with whom the Shipper has an agreement/contract shall take samples from the pipeline at the Entry Point to be analysed in any Accredited lab (ISO 17025) (this lab must be approved by the TSO) (6) times /day and send these values at the end of the day to the TSO. Each one week the Shipper or the gas Producer with whom the Shipper has an agreement/contract should take a sample from the pipeline at the Entry Point to the lab under supervision of the TSO to confirm the average monthly Gross Calorific Value.
- At the Exit Point: The Final Consumer shall take samples from the pipeline at the Exit Point under supervision of the TSO to be analysed in Accredited lab (ISO 17025) (this lab must be approved by the TSO) four (4) times monthly and then send these values to the TSO to be approved.

12.6 Delivery Pressure

12.6.1 At Entry Points:

The delivery pressure of the delivered gas shall not be less than a value agreed upon with TSO at the exit point (this value should be stated in the contract between the Shipper and the TSO). However, this value will be applied unless the TSO expressly asked for or agreed to accept deliveries at lower pressure.

12.6.2 At the Exit Points:

The delivery pressure at each exit point shall be in the range of minimum operating and maximum according to the contract at the exit point depending on its technical characteristic and the network operation conditions, but in any case must not be too low to the degree that prevents the shipper/customer from being able to withdraw his nominated quantities (the value of the minimum &maximum pressure should be stated in the contract between the Shipper and the TSO).

12.7 Off Specification Natural gas

If at any time the gas delivered by the Shipper does not conform to specification provided for in article 12.4 (at the Entry Point) hereof, then the provisions defined in the paragraph “Shipper’s quality requirements” in the Chapter “Parties’ Liabilities” 17.2.3 will apply.

12.8 Gas quality Dispute Resolution

If any gas quality dispute arising under chapter 12 are not otherwise resolved within a period of sixty (60) days from the date of notification of such dispute, then the dispute shall be submitted to an Expert for determination at the request of either party

The qualification of the Expert to be determined in the transportation contract.

Notwithstanding the aforementioned above in chapter 12, The TSO and Gas Network owner(s) shall develop Gas Measurement Station development plan for the existing entry and exit points on the Gas Network which are not equipped with custody transfer metering systems and shall submit such plan to the Gas Regulatory Authority for review and approval. The Shipper undertakes to equip all new entry and exit points with custody transfer metering systems (including Gas chromatograph and online analyser) after the approval of this Network Code.

13. Balancing

This chapter describes the methods used to manage the balancing regime, which aims to ensure that the Transmission Network is operated in a safe and orderly manner and that costs are allocated correctly among Shippers.

13.1 General Principles of the Balancing System

Balancing is managed to reflect the real needs of the system considering the resources available to the TSO and it incentivises Shippers to balance the quantities of gas they inject into and withdraw from the network in an efficient manner.

Shippers are responsible for balancing the quantities of gas they inject into and withdraw from the network in order to minimize the balancing actions required to be taken by the TSO.

Balancing has a two-fold meaning:

- physical balancing of the system, meaning the series of activities by which the TSO, via its Dispatching Centre, controls in real time the transportation flow parameters (such as gas flow and pressure) to ensure that, at any moment, gas is moved from injection to withdrawal points, safely and efficiently;
- commercial balancing, meaning the set of actions by which Shippers balance the quantities of gas they inject into and withdraw from the network, as well as all the activities necessary for the correct accounting and allocating of transported gas, and the financial charging system that motivates Shippers to maintain the balance between the quantities of gas injected and withdrawn.

The Shipper is also responsible for providing its own and/or related Final Consumers with gas and the associated modulation they request and for the acquisition, from storage and transportation operators, of the capacity required to meet the demand of its own and/or related customer portfolio.

13.2 Physical Balancing

The TSO controls the gas flows and all ancillary services necessary for the operation of the pipeline system, including the physical balancing of the system.

The physical balancing process is designed to manage the overruns (occurring every Gas-day) between actual withdrawals from the network and the withdrawals nominated by Shippers on Gas-day G -1 for Gas-day G. The TSO monitors these overruns and acts promptly to deal with them, using the balancing instruments and priorities described in this section.

The instrument that the TSO uses primarily for physical balancing purposes is a system of selected and priority-ordered gas injection and/or delivery interruptions, based on transparent and non-

discriminatory criteria set up by the Ministry and the Gas Regulator and in accordance with this Network Code and in accordance with operation requirements; in fact:

- The TSO only makes limited use of line-pack, the use of which cannot be repeated for many consecutive days since it is principally used to manage hourly physical balancing;
- Local production typically has relatively fixed intake profiles, which are not suitable for the physical balancing of network;
- Import gas sources provide limited flexibility, for quantities different from those nominated by Shippers because of the long supply chain;
- Underground gas storage is currently not available.

Typically, two cases of physical balancing in emergency conditions may occur:

13.2.1 Gas excess situation

In the case where actual aggregate withdrawals are more than the corresponding aggregate nominations, the TSO, after having performed the following balancing operations:
making use of line-pack management in as far as this is consistent with the contractual commitments agreed and the safe operation of the system

will, insofar as the measures above are inadequate to deal with the oversupply situation, reduce the programmed quantities at one or more Entry Points interconnected with foreign import pipelines or LNG import facilities, selecting them on the basis of priority criteria. These are related to operational conditions like but not limited to pressures approaching values close to safety limits, within the area supplied by the same Entry Point: if the operational conditions are such that no priority criteria is dictated, the TSO will reduce proportionally all quantities programmed by Shippers, at all Entry Points interconnected with foreign import pipelines, with the exception of Shippers who withdraw natural gas only for transport across national territory in order to export it

13.2.2 Gas shortage situation

In the case of gas shortage emergency situations, which prejudice the safe operation of the gas transmission system, such as:

- plant or service emergencies (for example, total or partial unavailability of pipelines, compressor stations, or other auxiliary plants on network);
- General gas emergencies (for example, insufficient gas supply coverage as a result of failure of a supply source of the gas national system or severe weather conditions);

in accordance with this document, Shippers explicitly delegate to the TSO the actions described in the chapters entitled “Procedure for Service Emergency” and “Procedure for Shortage Emergency”, to restore normal system operations as quickly as possible.

If it is technically feasible, the abovementioned interruptions will be implemented according to the following list of priorities (in descending order of interruption):

- Consumers with priority of supply as established by the Ministry (with reference to final consumers)
- Eligible consumers
- Non-eligible consumers (not included in the priority list of the Ministry)

The TSO will annually set up transportation tariff for premium and conditional capacity, according to the criteria established by GasReg.

13.2.3 Responsibility

In view of the information given above, the TSO will not be held responsible, except for cases described in the chapter entitled “Parties" Liabilities”, for any possible technical and/or economic consequences borne by Shippers as a result of the physical balancing actions undertaken by the TSO within the pipelines, general and particular, described above.

13.3 Commercial Balancing

The accounting formula for transported gas and the methods for the treatment of imbalance quantities which are described below, allow the TSO to reconstruct the gas quantities corresponding to each Shipper in order to provide for the proper allocation and accounting of gas and the correct balancing costs among Shippers on the basis of actual use.

Listed below are the formula for the calculation of each Shipper’s imbalance terms.

13.3.1 Daily Network Balance

Every day the TSO calculates the “commercial” balance of the network

- **I + S = O + C + UNG**

Where

I = quantities injected/delivered by the Shipper at Entry Point;

S = quantities from the Storage (if exists);

O = Off-takes by the Shippers at Exit Points;

C = TSO consumption; (gas used for compressor station; pre-heating, etc..);

UNG = Unaccounted Gas. It is the result of the equation and includes losses & shrinkage (e.g. leakage, maintenance losses… etc.) and variation in the line-pack and that means 0.008 from any gas quantity injected inside the gas network.

From an accounting point of view, C and UNG are allocated proportionally to each Shipper.

All elements are expressed in units of energy (quantities Gross Calorific Value (GCV)).

13.3.2 Daily Shipper Balance

Every day the TSO calculates the “commercial” balance of each Shipper z

- **Iz + Sz = Oz + GSz + UBz**

Where

Iz = quantities injected/delivered by the Shipper z at Entry Point;

Sz = quantities from the Storage (if exists) for the Shipper z;

Oz = Off-takes by the Shipper z at Exit Points;

GSz= the share of unaccounted gas and TSO’s consumption assigned to the Shipper z;

UBz = Imbalance of the Shipper z; (if any).

All elements are expressed in units of energy (MMBTU).

If there are imbalances (the Shipper z off-takes more than it injected, including its share of UNG and L and C), the Shipper will be charged with imbalance charges, to be issued and paid according to the timing detailing in Chapter 10, “Invoicing”.

Losses are included in GSz (for the share assigned to Shipper z). Localized gas losses are not included in the Shipper Balance equation: except for the case of Force Majeure, the TSO shall restore at its own expenses all localized losses that happen.

13.4 Daily TSO Balance equation (in case of gas storage facilities)

The TSO’s balance equation, calculated daily, is:

- **IT + ST = C + L + ΔLP + UBT**

IT = the gas injected by the TSO;

ST = quantities from the Storage (if exists) for the TSO

C = TSO’s consumption; (gas used for compressor station; pre-heating, etc...);

L = losses & shrinkage and that means 0.008 from any gas quantity injected inside the gas network.

, which include

- Leakage due to operation activities;
- Losses happening during maintenance activities on the Gas Transmission Network: but that does not include any force majeure
- Localized gas losses:;

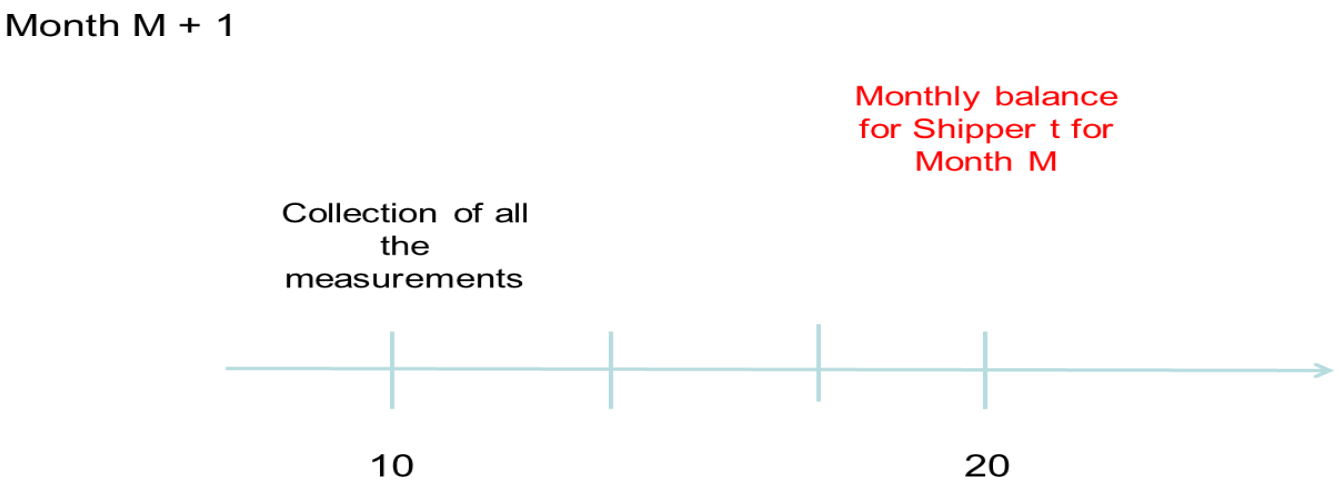
ΔLP = Variation in the Line-Pack; it is calculated and/or measured.

UBT = Imbalance of the TSO; (if any). It is the result of the TSO's balance equation. Any charges/incomes deriving from the economic adjustment of this term will be recovered/paid in accordance with the regulation defined by GasReg.

From an accounting point of view, C and UNG are allocated proportionally to each Shipper

13.5 Monthly Shipper Balance

At the month M+1, the TSO will send to the Shippers the monthly balance:



The Shipper has seven days to contest the elements (measurements, GCV, other elements) contained in the monthly balance. After that period, the monthly balance is considered accepted by the Shipper.

14. Quality of Service

TSO's constant objective is the adoption of a policy oriented toward the attainment and the maintenance of a high-quality standard of service in order to guarantee all shippers an adequate degree of reliability of the natural gas transportation system through the gas pipeline network located all over the Egyptian territory, with the best available technologies and in observance of security and environmental requirements.

TSO's' aim is to make known and guaranteed the right of Shippers to transportation and dispatch services compliant to the principles of efficiency, continuity and impartiality, by identifying the intervention areas related to the attainment and maintenance of service quality standards. Quality standards concern both technical quality – construction, management and maintenance of infrastructures – and commercial quality pertaining to the relationship with Shippers.

14.1 Basic Principles

The concept of "quality of service" considers some simple but fundamental principles, which are illustrated below.

14.1.1 Efficiency of service

This objective allows matching the natural gas transportation and dispatch services to market requirements and involves the identification of the most effective organizational, procedural and technological solutions.

14.1.2 Continuity

The TSO undertakes to provide a regular and continuous service to Shippers. In the event of service interruptions due to maintenance on the network, the TSO commits himself to limit the resulting inconveniences, to immediately inform Shippers and to adopt all the necessary measures to restore normal system operation as soon as possible.

14.1.3 Impartiality

The TSO's behaviour towards Shippers follows the principles of objectivity, neutrality, transparency and impartiality. In this context, the Network Code identifies the criteria for non-discriminatory access to the transportation service.

14.1.4 Security and environmental protection

Health and safety, as well as environmental protection are primary concerns for the TSO. These aspects are continuously under improvement.

To optimize the management of health, safety and environmental issues, the TSO will adopt specific management systems in line with international best practices.

14.1.5 Participation

There is a procedure for updating the Network Code that is open to the participation of Shippers who can propose modifications/additions to the document as established in the chapter “Update of the Network Code”.

14.1.6 Information

All Shippers can request information on their Transportation Contract, on their administrative/accounting situation and on other issues regarding the management of their relationship with the TSO.

14.2 “Quality of Service” Areas

To appraise the attainment of the above-mentioned objectives, some areas, within which it is possible to identify and monitor the parameters and indicators that adequately reflect technical and commercial quality standards, are indicated below. In order to identify such parameters, the TSO will refer not only to the relevant legal provisions, but also to international best practices in the gas transportation industry.

14.2.1 Commercial quality standards

Some of the main areas which are relevant for the definition of the quality level of the commercial service provided by the TSO can be grouped as follows:

- Procedures and time of response to shipper inquiries on:
  - access to the system;
  - billing;
  - allocations;
  - capacity allocation/transfers;
- Response to shipper complaints regarding transportation service bills.
- Compliance with the timing provided in Network Code.
- Evaluation of shipper satisfaction through specific interviews.

14.2.2 Technical quality standards

About technical quality, all areas for the definition of the quality of the service provided can be identified as follows:

- Days of service interruption – related to significant interventions on the network;
- Check of transported gas quality through reliable systems capable of monitoring the relevant parameters;
- For metering facilities owned by the TSO, the use of instruments that guarantee accuracy and reliability;
- Continuous monitoring of the transportation network, through both special peripheral structures and Dispatch Centre’s remote-control systems.

15. Invoicing

GASCO shall issue a fully itemized Invoice to each shipper incurring charges regarding each period as stated in the table below for the amount payable in respect of the transportation contract and this code, showing the amount payable.

On receipt of notice of any omission or error from any Shipper, the TSO shall use reasonable endeavours to correct it as soon as possible.

If the shipper for any kind of invoice failed to pay on the accurate dates, according to the table below, an interest rate is imposed on the unpaid amount.

15.1 Types and dead lines

Type	Issued	Payable
Entry and Exit capacity charges	35 days before the beginning of each quarter of the Thermal Year.	Within 10 working days following the issue date.
Variable charges("commodity")	By the 10th day of the month following the transportation month.	Within 10 working days following the issue date.
Non-fulfilment of contraction obligation charge (shortfall, excess gas, undertake gas, ...)	After the actual balance has been calculated.	Within 10 working days following the issue date.
Invoice for late payment interest	The interest for each day of delay is calculated at an interest rate equal to the LIBOR rate plus 3 percentage points.	At the same date of payment of the invoice subject to that delay.
Invoice for other items	After the calculation of the actual gas quantities	Within 10 working days following the issue date.

15.2 The Contents of Invoice related to the transportation system

- The identification data of the Shipper;
- The unique number of invoice to be easily identified;
- The type of invoice;
- The month to which the invoice relates;
- The period to which the invoice is related to;
- The description relating to each item of the invoice;
- The monthly quantity, expressed in the corresponding volume or energy unit of measurement, relating to each item of the invoice;
- The monthly amount, in USD, relating to each item of the invoice;
- The total amount invoiced, in USD;
- The exchange rate used;
- The monthly amount, in EGP, relating to each item of the invoice;
- The total amount invoiced, in EGP;
- The VAT (Value Added Tax) or other taxes, fees or levies associated with the amount invoiced;
- The TSO's Bank Name;
- The TSO's account number.

15.2.1 Dispute

If the Shipper disputes any amount payable by the Shipper pursuant to an Invoice or debit note or credit note, the Shipper shall notify the TSO with the dispute in writing, specifying:

- The date and number of the Invoice or debit note or credit note;
- The item(s) in the Invoice or debit note or credit note to which the dispute relates;
- An explanation of the basis on which the dispute is submitted; and
- The disputed amount.

The TSO and the Shipper shall use all reasonable efforts to settle such dispute within 5 working days of the date of the Shipper's notification.

If the Shipper and TSO are unable to resolve the dispute, the Shipper shall pay to the TSO the invoice amount in full and shall not make any set-off or deduction against any amounts and the dispute shall be referred and settled pursuant to the dispute resolution provisions of the Transportation Contract.

16. Emergency Procedures

Two types of emergencies are envisaged: service emergency and shortage emergency. The TSO has to develop its own emergency procedures to cope with the occurrence of extraordinary - unforeseen and temporary - situations, which may affect the normal operation of its pipeline network (or which may limit significantly its running) and may prejudice the safety of people and environment. These procedures will be contained in a document called “Procedures for Emergencies”, which, after approval of the Gas Regulator, will be published on the TSO’s official website. This document, which is integral part of the Transmission Network Code, defines the organisational and implementation criteria should the cases identified in the paragraph 16.1.2 occur. This chapter summarises the guidelines adopted by the TSO to manage the emergencies.

16.1 Procedure for Service Emergency

This procedure defines the terms and conditions of the activities to be carried out, as well as the appropriate responsible parties, in cases where cases listed in Chapter 16.1.2 (Types of Emergencies) occur.

16.1.1 Objectives of the procedure

The intervention parties shall establish, maintain, regularly test and update, emergency procedure.

The objective of the procedure shall be:

- To resolve, as quickly as possible, any cause which may endanger the safety of people, property and the environment;
- To minimize, as quickly as possible, the likelihood that the extent or consequences of the incident expand;
- To limit the impact on the transportation capacity of the network;
- To undertake, as quickly as possible, the actions required to restore the normal operation of the network;
- To determine a define roles and responsibilities for all parties intervene in case of emergency.

16.1.2 Types of emergency

Emergency means an event or circumstance or combination of events or circumstances which have occurred or are likely to occur and which in the opinion of the GASCO adversely affects, or is likely to have an adverse effect on the safety or operational integrity of the Gas Transmission system for natural gas or which results in or is likely to affect the safety of life, property or the environment and may refer to:

- Uncontrolled gas leakage;
- Total or partial unplanned unavailability of service of pipelines;
- Total or partial unplanned unavailability of compression stations;
- Total or partial unplanned unavailability of service of service line plants;
- Damage to pipelines for natural events (landslide, floods, earthquake, etc.).
- The event or circumstance which gives rise to the emergency;
- The safe conveyance of natural gas by the gas transmission system being significantly at risk;
- GASCO's inability to maintain safe pressures within the gas transmission system due to interruption or disruption to the gas transmission system or a connected system;
- Events or circumstances in a connected system either upstream or downstream of the gas transmission system;
- Any actual or potential failure of or damage to the gas transmission system.

16.1.3 Communication

The TSO ensures the effective communication with the Shippers and buyers involved in the reduction or interruption of the transportation service due to emergency, in order to define, if required, the best way to interrupt or suspend the transportation service.
Shippers and buyers must provide the TSO with a list of names, addresses and phone numbers of its relevant staff on call 24 hours a day, together with the same detail for their main consumers.

The TSO will inform the appropriate Authorities (police, fire department, etc.) where there could be specific danger for people, property or the environment.

16.1.4 Dispatching Centre

- Perform the all-necessary communications with all intervention parties.
- Defines the network organization and performs the operation on remote controlled systems ;
- Activate the staff on call:
- Collect relevant data from TSO's resources:
- Direct all needed aids towards the scene of emergency.

16.2 Procedure for Shortage Emergency

This procedure will be based on the principles and criteria stated in chapter 13.2.2 (Gas shortage situation).

The procedures define the terms and conditions of the activities to be carried out, as well as the appropriate responsible parties, in cases where interruption/reductions in the supply of gas for the national system occur.

17. Parties' Liabilities

17.1 Responsibilities

TSO is responsible for the correct technical operation of the network and for meeting the transportation requirements of the Shippers. TSO does not, however, own gas and does not control quantities made available by Shippers at Entry Points or off-taken by Shippers at exit Points.

17.2 Non-Fulfilment of Contractual Obligations

17.2.1 Consumer/shipper pressure requirement at Exit Point

If the gas made available by TSO at any Exit point does not comply with the minimum pressure values specified by the Transportation Contract and/or this document chapter « Gas Quality Specifications», the Shipper, in the absence of an immediate communication by TSO, should communicate the pressure value measured to the TSO immediately.

Without prejudice to the obligation to pay the Transportation Tariff, the Shipper has the right, supported by suitable documentation, to require TSO the pay of the costs and charges incurred because of the non-compliance supported by suitable documentations after the approval of the Gas Regulatory Authority (GASREG). Notwithstanding the cases where it is possible for the shipper/customer to operate with the non-compliance exit point gas pressure requirements.

17.2.2 Quality requirements

If the gas made available by TSO at any Exit point does not comply with the quality requirements specified by the Transportation Contract and/or this document chapter « Gas Quality Specifications »the Shipper, in the absence of an immediate communication by TSO, has to notify TSO of the extent of non-compliance and has the right to curtail the input of such gas.
Without prejudice to the obligation to pay the Transportation Tariff, the Shipper has the right, supported by suitable documentation within 30 days of the situation, to require TSO the pay of the all the costs and charges incurred as a consequence of the non-compliance supported by suitable documentations after the approval of the Gas Regulatory Authority (GASREG). But notwithstanding the cases where it is possible for the shipper/customer to operate with the non-compliance of gas quality specifications.

17.2.3 Non-performance of contractual obligations by TSO

- With the exception of the cases of Force Majeure, if TSO fails to carry out the gas transportation service specified by the Transportation Contract and, as a consequence, the Shipper cannot off-take gas, the Shipper, for the period of non-performance with the appropriate documentation provided to

be caused solely by TSO, will be relieved from its obligations to pay the Capacity Charges and will be entitled to require, supported by suitable documentation, the refund of the aforesaid Capacity Charges and charges incurred as a consequence of the non-performance. For the same period of the non-performance, the imbalance charges defined in this document chapter “Balancing" will not be applied.

- Under no circumstances whatsoever, shall the TSO be liable to any of the shippers for acts, omissions or failures attributable (Delivered GAS Quantity, Pressure and Quality) to other shippers.

  The defaulting shipper shall be obliged to pay all claims against TSO resulted from said shipper default after the approval of the Gas Regulatory Authority (GASREG).

17.2.4 TSO pressure requirement at Entry Point

If the gas delivered by the Shipper, or by a third party on behalf of the Shipper at an Entry Point does not comply for any reason with the minimum contractual pressure requirements, as specified by the Transportation Contract and/or this document chapter « Gas Quality Specifications », TSO, in the absence of an immediate communication by the Shipper, should communicate the pressure value measured to the TSO immediately.

In addition to being released from the obligation to transport the Shipper’s scheduled gas quantities, TSO has the right to curtail the gas input until the pressure values are restored up to the specified levels.

Any costs and charges, appropriately documented, incurred by TSO shall be charged to the relevant Shipper after the approval of the Gas Regulatory Authority (GASREG).

17.2.5 TSO quality requirements at Entry Points

If the gas delivered by the Shipper, or by a third party on behalf of the Shipper at an Entry Point does not comply for any reason with the other quality requirements, as specified by the Transportation Contract and/or by the In this document chapter « Gas Quality Specifications », TSO, in the absence of an immediate communication by the Shipper, will provide written communication.

TSO has the complete rights to stop receiving the non-confirming gas at the entry point (intercept the non-compliant gas) to keep the transmission network facilities & customers in a safe condition, notwithstanding the cases where it is possible to make the gas compatible with the quality specifications through suitable mixing.

Any confirmed costs, charges, appropriately documented, penalties and fines incurred ~~by~~ the TSO due to any direct / indirect damages to the grid (pipe lines, related facilities or consumers), as a result of the Shipper not complying with the delivered gas quality requirements, shall be Calculated by the TSO and charged completely to the relevant Shipper after the approval of the Gas Regulatory Authority (GASREG).

17.2.6 Management and maintenance of the measurement plants

If TSO is the owner or the operator of the measurement plant where the data is taken, it shall be responsible for the accuracy of the data used for the gas conformity check for the quality and pressure requirements.

If TSO is not the owner of the measurement plant where the data is taken, the Shipper must provide the relevant data to TSO, assuming responsibility for the timely communication, the correctness and completeness of the data.

TSO assumes no responsibility for the correct and regular management and maintenance of the measurements stations where these are not owned or operated by him.

By signing the Transportation Contract, the shipper should Assure that TSO has the possibility to fully use and access the measurement plant at all times for the relevant activities subject to the approval of the respective Gas Producer (approval needed in case of existing entry point only). If TSO is not able to exercise this right, it will immediately communicate this fact to the relevant Shipper and, TSO can use the best available substitute.

17.3 Limitations of Liabilities

Either TSO and shipper liability for all claims of any kind arising out of this Contract, tort or, any legal or equitable grounds shall not exceed in its entirety total transportation Contract value except in case of wilful misconduct or gross negligence.

17.3.1 Early termination of Transportation Contract

A party is not entitled to terminate the agreement if the reasons that constitute the grounds for its termination were because of force majeure.

If the force majeure or the elimination of the consequences of force majeure lasts longer than sixty days, either party is entitled to terminate the Gas Transportation contract with immediate effect. The Transportation Contract may also be terminated by written agreements of the parties.

17.3.1.1 Early termination by TSO

The Transportation Contract, other than for the reasons provided by the law, can also be early terminated by TSO, in the following cases:

- Shipper's loss of its license expiration, withdrawal or suspension of its license.
- Shipper's bankruptcy or insolvent placed into receivership or files a petition for bankruptcy or made an arrangement with or assignment in favour of its creditors, or agreed to perform the transportation contract under a committee of inspection of said creditors, or entered into liquidation or has an execution levied on its assets.
- Non-payment for of any of his financial obligations to the TSO a period of one month.
- the shipper fails to supplement the financial guarantees to the full amount in the form specified in the Gas Transmission Service
- Improper use of the information system for the communications between TSO and the Shippers (if in place)
- Failure to commence within the period specified in transportation Contract.
- The shipper breaches its obligations under this Code.

In the event of the termination of the contract based on the situations described before, shipper shall not be liable for any possible losses or compensation.

The TSO shall inform the Shipper in writing at least twenty working days in advance of the state on which the contract is to be terminated., copied the GasReg

17.3.1.2 Early Termination by the Shipper

Shipper has the right to terminate the contract if:

- GASCO fails to perform the gas transmission service for a successive 3 months in the gas year or
- Breaching material provisions of the transportation contract and fails to eliminate their consequences within the deadline agreed by the parties.
- TSO has abandoned the Transportation Contract unreasonably; or
- TSO has become bankrupt or has presented a petition in bankruptcy.

In the event of the termination of the contract based on the situations described before, GASCO shall not be liable for any possible losses or compensation.

In the event of the termination of the contract on the grounds of other reasons described before, GASCO shall be entitled to demand compensation which will be determined according to the situation by GASCO.

The shipper is authorized to terminate the agreement by providing a notice period of 30 working days

17.3.2 Payment due / Enforcement of guarantees

In all the cases of early termination, the Shipper concerned must in any case pay the TSO:

- The amounts (commodity charge) due until the termination date of the Transportation Contract.
- A sum equivalent of the estimated payment due for the Capacity Charges corresponding the transportation capacity allocated to the Shipper for the rest of the Thermal Year.

In the case of early termination and/or in the case of non-payment of the invoices issued, TSO will enforce the guarantees provided in relation to the unpaid amounts.

17.4 Force Majeure

17.4.1 Definition of Force Majeure

Force Majeure is any event or circumstance occurring on TSO's network not caused by the invoking party, which makes it impossible, totally or partially, for the party concerned to meet its obligations as specified by the Transportation Contract during the period of existence of the Force Majeure, and which it was not possible to avoid by the party concerned behaving as a reasonable and prudent operator,

For example, and not limited to, possible causes of Force Majeure are:

- War, terrorist action, sabotage, vandalism, revolution.
- Any natural phenomena such as Lighting, Earthquakes, landslide, fire and floods.
- Explosion, radiation and chemical contamination.
- Strikes, lockout and any other form of industrial unrest affecting TSO and the Shipper.
- Fault or breakdown of plants/pipelines/equipment, on TSO Gas network, which TSO could not have prevented using an adequate level of care

17.4.2 Effects of Force Majeure

The party concerned is relieved of all responsibilities of non-fulfilment of the obligations specified in the Transportation Contract, as well as for any other damage or loss borne by the other party, to the extent, and for the duration, that the party concerned is affected by Force Majeure

Whenever an event of Force Majeure occurs, the party so affected shall make reasonable effort to notify the other party immediately the occurrence of such event to limit the negative effects of the force majeure so there's possible time to recover its normal operation.

The inability of a party to comply with its payment obligations not considered an event of Force Majeure.

In the case of an event of Force Majeure, and for the corresponding period, the Shipper's Capacity Charges are waived in proportion to the effective reduction of the performance of the transportation service.

The party concerned must timely notify the other party (and GasReg.) of:

- The occurrence of an event of Force Majeure that prevent the fulfilment (total or partial) of its obligations defined by the Transportation Contract.
- Progress report of the event.
- The time at which the Force Majeure event ends.

18. Network Code Update

18.1 General Principles

The Network Code may be updated due to:

- Changes in the relevant legal and regulatory framework;
- Evolution of the gas market and technology;
- Material errors in the text of the document.
- Any Updates related to gas network operation.

The updating proposals are predisposed by TSO, undergo a phase of consultation with the subjects concerned and are subsequently sent to GasReg for approval.

The updating proposals may be predisposed by the TSO also following modification requests put forward by entitled entities according to what specified below.

18.2 Network Code Modification Requests

18.2.1 Entitled entities

- If the Gas Regulator deems so in consultation with the TSO
- Based on a request of the TSO, shipper or, any of the gas market parties provided that the request shall be submitted on the form prepared for this purpose accompanied by the supporting cases and documents.
- The gas reg. shall examine the modification request. In case the gas reg. accepts to study the request, the gas reg. shall consult the TSO regarding the proposed modifications. In case of its approval, the TSO shall introduce the new amendments to the network code and submit the amended network code to the gas reg. for the board of directors' decision thereon.
- In case of rejecting the modification request the gas reg. shall notify the applicant with the reasons of the modification rejection.

19. Annex 1: Functional Requirements of Gas Measuring Systems

19.1 Scope

The scope of this document specifies the functional requirements for the design; construction and commissioning of new gas measuring stations for custody transfer of natural gas

19.2 Introduction

Natural gas in EGYPT is transported between entry and exit points. At these points accountable measurements are needed for billing purposes. There is a set of minimum requirements that newly built or renovated connections to TSO network shall comply with, before the metering system can be used for the purposes of custody transfer of gas.

19.3 Physical Principles and General Requirements

19.3.1 Base Conditions

In EGYPT, the base conditions are 1.01325 bara and 15°C or 14.696 psia and 60° F for volume and calorific value determination.

19.3.2 Flow measurement

Several different primary elements / physical principles are used to measure gas flow. The most used commonly techniques are as per the following:

- Orifice meter: it is one of the oldest, rigid, reliable, simple and field proven primary elements, but now it is having other working competitors of new generations i.e. USM and turbine meter.
  Orifice-based measurement systems are required to be strictly designed and procured based on the guidelines and recommendations stated in the international standard ISO 5167 - 2003.
- Turbine meter: It is a primary element less preferred than the USM. However, the application and the operating conditions must be carefully studied to ensure its suitability to measure gas using turbine meter without any possible damage affecting the turbine meter especially over-speeding.
  Turbine-based measurement systems are required to be designed and procured based on the guidelines and recommendations stated in AGA Report No. (7) With upstream straight length of min. 10 D upstream the turbine meter and 5D downstream the turbine meter.
- Ultrasonic Meter: Considered one of the best most recent primary elements due to its many advantages; high accuracy, reliability, minimum pressure drop… etc.

USM-based measurement systems are required to be designed and procured based on the guidelines and recommendations stated in AGA Report No. (9) - 2007 with upstream straight length of min. 20 D upstream the USM and 10D downstream the USM.

It is the responsibility of the involved parties to ensure that the method used is traceable, reliable and satisfies the basic gas volume, and energy measurements like accuracy, safety as well as economic criteria.

All meters require both operating (line) density and base density to convert their primary output related to volumes at operating conditions to the corresponding volumes at base / reference conditions.

Operating (line) density and base density can be measured continuously or can be calculated from gas composition. Calculation of density also requires continuous measurement of temperature and pressure.

19.3.3 Calorific value measurement

The most commonly used techniques for measuring the calorific value of a mass or volume of gas are calorimeter (not previously used in the gas network) and gas chromatograph (used in gas network). Both techniques determine the calorific value of a mass or volume of gas at base conditions.

19.3.4 Energy measurement

The output of a measuring system might be in energy units. The energy is the product of a gas quantity and its corresponding calorific value.

19.3.5 Security of supply

Usually gas delivery is a continuous process.

An unintended cessation of gas flow can cause a safety hazard or operational problems. Therefore, the design shall be such that a failure of measuring system will not stop the gas flow. Extra equipment may be added to improve the security of supply.

All parties shall agree what are the necessary procedures to be taken in cases of metering system failure partially / completely. These procedures shall begin from design phase (redundant metering system), preventative maintenance and spare parts availability which helps a lot in preventing metering system failure.

19.3.6 Environmental conditions

19.3.6.1 General

Gas measuring stations shall be designed, constructed and located such that risk and nuisance to the environment of the station and its operation are kept within acceptable limits.

19.3.6.2 Environment noise levels

The operator shall ensure that the environmental noise levels during operation meet locally established

limits. In addition no design changes or modifications shall be undertaken which cause the established noise limits to be exceeded.

19.3.6.3 Ambient temperature

Certain types of equipment such as computers and other electronic devices can operate properly only within a limited temperature range. Where such equipment requires a temperature-controlled environment to maintain accuracy, the operator shall ensure that such requirements are met.

19.3.6.4 Ambient pressure

At certain measuring stations, particularly those where gas processing is undertaken, some buildings may require a positive internal pressure to prevent ingress of gas to the interior. The operator shall ensure that for such buildings these requirements are met.

19.3.6.5 Venting

The design and operation of the station shall be such that the venting of gas to the atmosphere is kept to a minimum. This shall be assessed during the design phase.

19.3.6.6 Safety

Safety is a management responsibility which implies that all personnel involved in construction, start-up, operation and maintenance of the measuring station shall be competent and have adequate safety training. Different areas of responsibility shall be defined.

19.4 Design and Construction

19.4.1 Design

19.4.1.1 General

- Measuring stations shall be designed such that the correct functioning is ensured for all specified pressure and temperature ranges (MOP, TOP, MIP, minimal pressure at station entrance, T_{min}, T_{max}, ambient temperature) as well as impurities, dust or condensate present in the gas.
- Measuring system may be installed as an independent installation or in a station together with other systems.
- The measuring station shall be designed such that it operates in a fail-safe manner even in the case of an accident. In case of emergency, it shall be possible to shut down the station safely.
- In general, the measuring system is preferably to be located in a building, a cabinet or a shelter.
- Locations where metering system exists, checking and calibration takes place shall have appropriate and stable environmental conditions and shall be free of vibration, so that measuring gas, checking and calibration may be carried out with the required accuracy.

- If there is any risk of undesirable reverse flow, the installation of a check valve or similar device to prevent incorrect registration of gas shall be considered.
- In natural gas network all the entry, exist and gas consumption points shall be equipped with means of gas measuring system fulfilling custody transfer requirements and the Consumer can be invoiced based on metering system calculations.
- The way of invoicing through the natural gas network shall be the same (i.e. based on either volume or energy gas measurements depending on contractual obligations) beginning from the gas shipper (Natural Gas fields, liquefied natural gas…,etc.) through large consumers till end users. Since nowadays most of the world sells the gas as energy, switching from volume-based measurements to energy-based ones must be considered carefully.
- The parties with connection to the gas Transmission System shall inform the TSO in the design of a newly built or renovated measuring installation by sending (on time agreed between parties) the P&ID's (piping and instrumentation diagrams), PFD's (Process flow diagrams), measurement System configuration, and measurement Functional Design Specification. TSO shall react on these documents within a period of time agreed between parties. Only after agreement with TSO the measurement system can be actually modified or built.
- The owner of the metering system has the responsibility to make the accountable measurement compliant with the applicable (legal) requirements and the latest international standards (ISO, AGA … etc).
- The overall uncertainty on volume and energy shall not exceed 1% in any way. And the owner of the metering system shall be considered responsible for proving this.
- The measuring policy shall ensure that systematic errors are actively reduced using agreed procedures regardless of the sign of deviation. When afterwards a systematic error is found in the volume / energy determination over a period of time (e.g. caused by incorrect settings or deviations of instruments outside the agreed limits) the system shall be capable to deliver all the required data to calculate the deviating amount of gas flow (for the purpose to be presented to TSO and to be settled with the interested parties).
- All parameters of the metering system shall be fully transparent to TSO.
- The degree of transparency on data, quality assurance and instrument maintenance shall be agreed upon and shall be established in a metering manual. this metering manual consist among others of:

  - The calibration procedures for P, T, flow meter, flow computer and gas chromatograph (if applicable) including tolerances and actions.

- The quality control, periodical and overall check, at which all instruments are calibrated using measuring references.
- Used (reference) materials.
- The data handling including verifications, corrections and final approval of the measuring data.
- The instruments shall be used within their calibrated range.

- It is recommended to maximize the availability of the measuring installation to the greatest possible extent. This can be managed by using redundancy in the measurement system (i.e. redundant one similar meter run, redundant flow computer, no break power, etc.). Gas shall only flow if the measuring installation is available and is functioning with agreed specifications.
- For large volumes (exact definition of "large" to be agreed between involved parties and depending on the price of natural gas) a double-fitted flow measuring installation in series of different measuring principles shall be used. If in some locations, the invoicing is in energy, double fitted gas chromatographs shall be used for the total measurement installation, including sample conditioning, carrier gas, calibration gas and reference gas.

19.4.1.2 Design Criteria

- The operator of local gas network shall put a code for the instrumentation of different sizes of measuring systems depending on flow rates (TSO requirements).
- The measuring system selected shall be sufficiently accurate to reduce random and systematic errors to such a level that contractual or legal obligations are fulfilled and that can be justified on technical and economic reasons.
- Care should be given to avoid pulsating flow and vibrations (resonance).
- If there is a meter run for series connection this shall tie into the main runs upstream and downstream of the required upstream and downstream straight length of the meter.
- It is necessary to insert at least one upstream isolating valve and one downstream isolating valve for each meter run.
- Depending on size and requirements of the measuring station and in order to increase the availability of the results of measurement the important instruments and / or measuring systems should be duplicated by instruments operating independently. The criteria for this shall be agreed upon between the involved parties.
- Use of odorants shall not affect the performance of the measuring system (if used).
- Any peripheral equipment connected to the measuring system shall be designed such that it does not interfere with the measuring process. Oscillations in gas pressure and flow caused by a flow (or

pressure) regulator or similar, which could affect the primary measuring instrument accuracy, should be minimized at the design stage.

19.4.1.3 Station equipment

According to needs, a measuring station is equipped with the following main components which shall fulfil TSO requirements in all cases as the TSO is part in the gas transaction process:

- Measurement equipment to determine the volume, mass and energy flow.
- Equipment to determine the gas properties (where considered necessary).
- Isolating valves.
- Monitoring systems, such as recorders, loggers and Supervisory computers.
- Pipework, thermal insulation, gaskets and joints.
- Filters and separators.
- Equipment for preheating the gas flow.
- Equipment to reduce the noise level.
  - Equipment for controlling the flow (flow control valve can be controlled and adjusted remotely from TSO SCADA system).
  - Change-over equipment to select the appropriate number of meters runs to meet the load of the station (if considered necessary).
- Equipment to prevent hydrate and ice formation.
- Pulsation and vibration damping equipment.
- Other components.

19.4.1.4 Station capacity

The design shall be based on the minimum and maximum values (20%extra value) for:

- Volume, mass or energy flow rate.
- Design pressure and operating pressure.
- Gas and ambient temperature.
- The gas components.

19.4.1.5 Measuring system

General

- Each measuring station shall be equipped with the instrumentation required for measuring/calculating the variables needed to meet the accuracy requirements.
- The measuring system consists of a gas meter and in general a conversion device (flow computer, volume corrector or any device complies with the custody transfer requirements) with sensors for the

various parameters needed for the determination of the delivered quantity. Depending on the components of the system the output can be: Volume - Mass – Energy.

- Design shall give possibilities by which field maintenance, checking and calibration can be carried out.
- An upstream flow conditioner shall be used; the same flow conditioner and in case of USM, the same upstream pipe of the flow meter shall be used during calibration. The distance between the flow conditioner and the gas meter shall be at least 10 Diameters. The manufacturer of the gas meter shall have documented evidence that the gas meter has a good performance with the flow conditioner at the chosen distance (if it is less than 10 D). If a flow conditioner is not used, the owner has to prove that there is no installation effect on the flow measurement.
- Guidelines and recommendations of the applicable international standards (stated under Item 3.2 above) relevant to each primary element which govern the metering stream layout and configuration must be followed. In case of conflict, the standard's recommendations should be given some preference over the manufacturers'.
- Flow meters shall be protected against internal pollution or dirt.
- In case of using an Ultrasonic meter, Active interpretation of online diagnostic data of a flow meter must be used if present, for example a continuous comparison of (calculated vs. measured) speed of sound (SOS)
- In case of using turbine meter or USM, a calibration curve correction shall be applied to minimize systematic error.
- Every primary meter shall have an individual calibration certificate and the calibration shall be performed complying to the following requirements:
  - In case of using turbine meter or USM, calibration of the flow meters will be performed at an internationally recognized calibration facility that is accredited by the national council of accreditation according to ISO 17025 (PTB, NMI-VSL and BNM). Owner / Supplier will inform TSO at which facility the flow meters will be calibrated (at least 1 month in advance).
  - Using natural gas and preferably under operational pressure (wet calibration).
  - Where applicable, the conditions at flow calibration shall resemble, as much as possible, the conditions during operation.

All parameters that may adversely affect the performance of the meter shall be considered: wall roughness (coating), temperature, diameter steps, protrusions, bends, flow conditioners, etc.

All generally-recognized differences between the conditions at flow calibration and conditions during operation shall be eliminated, if these differences result in a significant shift of (part of) the calibration curve, then the flow meter, the relevant upstream/downstream piping and the flow conditioner shall be calibrated as a package.

Gas Meters

Orifice meters shall comply with ISO 5167, Turbine meters shall comply with the requirements of AGA report no. 7 and Ultrasonic meters shall comply with AGA report no 9 or ISO 12765.

The meter shall be selected so that under foreseeable fault conditions within the installation, the maximum working pressure for which the meter has been designed and tested is not exceeded. The meter shall operate satisfactorily over all specified ranges of pressure, temperature and flow.

Conversion Devices

If the measurement is done under operating conditions a conversion device shall be fitted to the measuring system. The output of this device may be in volume, mass and energy units at base conditions.

Volumes at operational conditions shall be converted to volumes at standard or reference or base conditions (1.01325 bara and 15°Cor 14.696 psia and 60° F) and to energy.

Volume conversion shall be performed continuously by using live inputs of absolute pressure (P), temperature (T). Compressibility (Z) and Density shall be calculated by using AGA 8 with live inputs of P, T.

Gas composition may be entered into the flow computers as pre-set values based on manual offline sampling and lab analysis. The gas analysis entered into the flow computers is periodically updated. Frequency of update depends on rate of component change i.e. gas analysis stability. Energy conversion shall be performed by using live input of the calorific value.

Flow computer, pressure transmitter and temperature transmitter

Pressure shall be measured with an absolute pressure transmitter or with a gauge pressure transmitter and an atmospheric pressure transmitter. Ambient influences such as temperature, pressure, noise, moisture, pulsations, sunlight, etc. shall be minimized.

The volume conversion shall meet the following requirements:

- Application of Z calculation according to AGA 8.
- Full traceability of actions by electronic logging.
- Use of transparent logical decisions (alarm handling, low flow).
- It is preferable that the inputs shall be digital (serial) to eliminate additional uncertainty by transmission techniques (like analogue transmission).
- Measured volumes shall be registered by using non-volatile counters. Counters shall be volume at operational conditions, volume at standard conditions, mass and energy.

19.4.1.6 Construction of measuring stations

19.4.1.7 General

Meters and associated instrumentation are precision devices and such that they shall be handled with care. They should be stored in clean dry conditions, taking due regard manufacturer's recommendations on stacking and handling. The meter inlet and outlet connections shall be protected to prevent ingress of foreign materials and moisture and shall remain so prior to installation. The installation of instrumentation shall ensure proper readable indication. Metrological tapings shall not be used for any other purposes.

19.4.1.8 Gas meter installation

Gas meter pipework shall be installed and supported in such a manner to avoid undue stress being placed upon the gas meter connections e.g. by supporting them. Easy removal and replacement of the gas meter shall be possible. In general, temporary commissioning filters / sieves shall be positioned upstream of any straight lengths of pipe which precede the gas meter.

19.4.1.9 Corrosion protection

All components of the measuring station shall be resistant to or protected against corrosion. For this purpose, paint coating or any protection system may be used.

19.4.1.10 Temperature

- Any temperature sensor shall comply with API RP 550 Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control, Section 3: Temperature.
- Whenever a thermowell is installed, consideration shall be given to fit in a spare thermowell for use during calibration. If a spare is fitted for calibration, it should be at an angle to the primary thermowell.
- To ensure good temperature measurement, thermowells should protrude into the pipework to about one third of the nominal bore. However, on large diameter pipes (For thermowell lengths larger than 300 mm) where resonant vibrations of the thermowell are known to be a problem, the design of the thermowell can restrict the depth of insertion. In this case little accuracy will be lost provided the thermowells protrude at least 75 mm into the gas flow. This should be subject to detailed study from the manufacturer.
- Temperature transmitters shall be installed inside local field cabinets or in well-ventilated area to avoid ambient weather conditions effect on the measuring instrument.

19.4.1.11 Pressure and Differential pressure

- Any pressure sensor shall comply with API RP 550 Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control, Section 4: Pressure.

- To ensure accurate measuring care shall be given to the installation of pressure and differential pressure sensors. In case of a gas meter other than an orifice plate, the pressure shall be taken from the meter pressure tapping marked Pm.
- The mounting shall be according to ISO 2186 and the manufactures specifications and the mechanical stress shall be neither imported to the sensor by the installation nor by the sensing lines. Low points in the sensing lines to the sensors shall be avoided so that liquid or dirt cannot collect in them and cause false pressure reading. Pressure transmitters shall be installed inside local field cabinets or in well-ventilated area to avoid ambient weather conditions effect on the measuring instrument.
- The sensor shall be installed to be free from mechanical vibration.
- Field maintenance, checking and recalibration require, among others, the possibility to isolate the sensor from the line and to apply a reference test pressure. The pressure connections for differential pressure sensors may have common connections. To avoid errors in the pressure measurement, sensing lines and sampling lines shall not be combined. In all cases the pressure connection to the sensor shall incorporate a valve which will permit maintenance without the need to put down the whole installation. It should be capable of being sealed in the open position to prevent unauthorized isolation which could affect the overall accuracy.

19.4.1.12 Additional Equipment

- Components such as filters, heaters, valves, flow control valves …etc shall not impair the metrological operation of the measuring station.
- Meter Run isolating valves maybe fitted with a position indicators and also clear indication of the direction for opening or closing the valve should be given.
- If dust and/or fluids may influence the results of measurements, suitable filters and /or separators shall be installed upstream the measuring system.
- If pressure reduction or flow control cause hydrate or ice formation which might affect the operation of the measuring station, a heater or other suitable equipment shall be installed.

19.5 Calorific Value measurement

19.5.1 General

Various techniques can be used to get calorific values, both by indirect and direct measurement methods. Based on results of measurement, calorific values for billing purposes can also be calculated within a Network for places, where measurement is not economical.

The chosen technique shall deliver a calorific value with accuracy in line - at least - with legal requirements. The technique shall be sufficiently accurate to reduce random and systematic errors to

such a level that contractual obligations are fulfilled and can be justified on technical or economic considerations.

19.5.2 Measuring System

19.5.2.1 Description

A calorific value measuring system comprises the following components:

- A gas sampling system.
- Equipment for measurement and calculation (direct or indirect).
- A provision for calibration including a calibration standard
- A data storage and registration.

19.5.2.2 Sampling

A provision for conditioning shall be installed as a part of the sampling system.

Depending on the fluctuation of composition and gas properties, on-line measuring instruments may be used. On-line measuring instruments require continuous direct sampling.

With off-line measuring instruments the following sampling techniques may be used depending on the fluctuation of composition and properties:

- Periodical spot sampling.
- Incremental sampling, which accumulates gas samples into one composite sample.

Periodic spot samplers or incremental samplers can be used to get a single or accumulated sample of the gas to be measured. In case of incremental sampling, flow volume proportional sampling is preferred. These samples are periodically brought to a calorific value measuring instrument. These techniques may be used when on-line measurement cannot be justified, maybe for economic reasons.

When measuring continuously, the sample shall be designed to bring a representative of the composition of the gas flowing through the pipe work to the measuring instrument. To ensure this, the sampler shall take gas from a suitable point. Delay times between the sampling point and the analyser shall be kept short and at least shorter than the duration of the analytical cycle.

To achieve that objective, the gas shall be transported at reduced pressure though a narrow bore stainless tube.

There are several common concerns that shall be addressed to ensure that a representative sample of the natural gas is taken. It is of crucial importance for an accurate result of a measurement - as per "ASTM D 5503 Natural Gas Sample-Handling and Conditioning Systems for Pipeline Instrumentation" - the gas to be measured shall be conditioned to avoid solid, liquid and condensable components. The result of a measurement shall not be influenced by condition. The flow in the sampling line shall remain stable and be independent from other measurement process variations. To prevent any unnecessary

sample transport delay, pressure reductions shall occur close to the sampling point.

19.5.2.3 Indirect measurement

With composition derived measurement, the gas composition is measured. A technique often used is gas chromatography, which can be driven on line and off line. A gas chromatograph is an analyser which separates and measures particular individual or a composite group of components of natural gas. By comparing the detector signals with those from a well-defined and suitable calibration gas, the composition of natural gas can be calculated. Based on the composition, the calorific value and other physical properties can be calculated. The analysis should be done according to ISO 6974, ISO 6975 or ISO 6978, the computation shall be according to ISO 6976.

19.5.2.4 Gas Chromatograph

A gas chromatograph shall comply with the following requirements:

- Type approval by authorized body.
- Mounted according to relevant standards such as ISO 10723 Natural gas - Performance evaluation for on-line analytical systems.
- Minimization of ambient influences such as temperature, pressure, noise, moisture, pulsations, sunlight, etc.
- Authorized access only.
- The gas chromatograph GC shall be operated according to the following points:
  - The GC shall be used according to ISO 6974.
  - The calculation of physical components like calorific value, wobbe index, density and relative density shall be according ISO 6976.
  - A sampling system shall ensure that gas sample is representative to the gas in the gas station regarding composition and conditions and time.
  - The uncertainty of the GC shall be demonstrated according to the performance evaluation ISO 10723. From this evaluation a decision shall be made, in accordance to the expected gas composition range, if a multi-level calibration is necessarily.
  - The GC shall be periodically tested by analysing a certified natural gas, which resembles the process gas. Frequency will be agreed between the concerned parties
  - It shall be demonstrated that the GC will function within the stated uncertainty budget supplied by the GC vendor and confirmed by metrological authority. Also this can be checked in situ by certified reference gas bottle and certified calibration gas bottle. Frequency will be agreed between the concerned parties.

19.5.2.5 Calibration

The calorific value measuring system shall have a means of calibration including calibration standards. The calibration system normally consists of:

- A cylinder of gas of a traceable calorific value given also in a certificate and where a gas chromatograph is to be calibrated, a gas composition with a certificate.
- A dedicated pipeline connecting the cylinder to the measuring instrument including the necessary pressure reduction.
- Where necessary, heating to prevent condensation of components of the gas mixture.

19.5.2.6 Data storage and registration

All relevant data (i.e. measurement data, calibration factors, events) shall be stored on a suitable registration unit at intervals and for a period of time required by regulation or contract. They may be displayed and transferred to a remote station. Thus printers, computers, writing registration units,,etc. are in use. The calculation of the calorific value and other physical properties may be done by remote or by local systems.

19.5.3 Performance requirements

19.5.3.1 Measuring system

In general, the performance of a measuring system is characterized by the following:

- Its accuracy.
- Its repeatability.
- Its discrimination.
- Its sensitivity.
- Its stability.
- Its availability.

For gas chromatographs their ability to separate gas components is essential. Gas chromatographs may be set up to carry out analyses according to ISO 6974 and under operating conditions determined from the performance evaluation complying with ISO 10723.

The accuracy of the measuring system is depending on various factors, mainly from the measuring system being used. Additional factors are:

- Operating conditions.
- Maintenance gases.
- Calibration gases.
- Sampling / clean up.
- Gas quality changes.

- Ageing of measuring instruments.

19.5.3.2 Calibration Gas

The quality of the calibration gas is the key issue for the quality of the result of a measurement of a measuring system. The performance requirements of the calibration system shall be consistent with the requirements for the total uncertainty of the overall metering system.

The gas mixture to be used as a calibration standard shall have a composition which is stable under expected conditions of storage and use. The purity of single component gases, necessary for adequate calibration shall be defined.

19.6 References, Codes and Standards

NEN EN 1776 Gas supply systems - Natural Gas measuring stations functional requirements.

ISO 2186 Fluid flow in closed conduits - Connections for pressure signal transmission between primary and secondary elements.

ISO 5167 Measurement of fluid flow by means of pressure differential devices – Part 1: orifice plates, nozzles and venture tubes inserted in circular cross section conduits.

ISO 6141 Gas analysis – Calibration gas mixtures – certificate of mixture preparation.

ISO 6142 Gas analysis – Preparation of calibration gas mixtures – weighing methods.

ISO 6143 Gas analysis – Determination of composition of calibration gas mixtures – comparison methods.

ISO 6711 Gas analysis – checking of calibration gas mixtures by a comparison method.

ISO 6974 Natural gas – Determination of hydrogen, inert gases and hydrocarbon up to C8 – gas chromatographic method.

ISO 6975 Natural gas – Extended analysis – Gas Chromatographic method.

ISO 6976 Natural gas – Calculation of calorific values, density, relative density and wobbe index from composition.

ISO 10715 Natural gas – Sampling guidelines.

ISO 10723 Natural gas – performance evaluation for on-line analytical systems.

ISO 12765 Measurement of fluid flow in closed conduits – Methods using transit time ultrasonicflow meters.

AGA 7 AGA Report No. 7, Measurement of Natural Gas by Turbine Meter.

AGA 8 AGA Report No. 8, Compressibility Factor of Natural Gas and Related Hydrocarbon Gases.

AGA 9AGA Report No. 9, Measurement of Gas by Multipath Ultrasonic Meters.

AGA 11AGA Report No. 11, Measurement of Natural Gas by Coriolis Meter, Second Edition.

API RP 550 Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control, Section 4: Pressure.

API RP 550 Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control, Section 3: Temperature.

DIN 43760 Electrical temperature measuring instruments, calibration table of resistance thermometers.

19.7 Definitions

19.7.1 Measuring station:

An installation comprising all the equipment including the inlet and outlet pipe work as far as the isolating valves and any structure within which the equipment is housed, used for gas measurement in custody transfer.

19.7.2 Measuring system:

Complete set of measuring instruments and other equipment assembled to carry out specified measurements.

19.7.3 Measuring instrument:

Device intended to be used for measurements, alone or in conjunction with supplementary devices. For example, gas meter, pressure sensor.

19.7.4 Master or Reference meter:

Meter of known accuracy used only for comparison checks.

19.7.5 Installation effect:

Any difference in performance of a measuring instrument or of the measuring system between the calibration laboratory conditions and site conditions.

19.7.6 Accuracy:

The degree to which indicated value matches the actual value (or recognized reference value) of a measured value.

19.7.7 Confidence level:

The degree of confidence expressed as percent that the true value lays within the stated uncertainty. A proper uncertainty statement would read: “qm = 500 cfh+ 1.0 % at a 95 % level of confidence”. This means that 95 out of every 100 observations are between 495 and 505 cfh.

19.7.8 Discrete Error Value:

An estimate of error for an individual measurement, expressed in percent of reading’ or in engineering units.

19.7.9 Error:

The result of a measurement minus the true value of the measure.

19.7.10 Uncertainty:

An estimate of the interval bounding the measured value within which the true value lies.

19.7.11 Repeatability:

Closeness of the agreement between the results of successive measurements of the same measure carried out under the same conditions of measurement.

Notes:

- These conditions are called repeatability conditions.
- Repeatability conditions include:
    - The same measurement procedure.
    - The same observer
    - The same measuring instrument used under the same conditions
    - The same location
    - Repetition over a short period of time
- Repeatability may be expressed quantitatively in terms of the dispersion characteristic of the results.
- A valid statement of repeatability requires specifications of the conditions of measurement, such as pressure, temperature, and gas composition.

19.7.12 Reproducibility:

Closeness of the agreement between the results of measurements of the same measured carried out under changed conditions of measurement.

Notes:

- A valid statement of reproducibility requires specification of conditions changed.
- The changed conditions may include:
  - Principle of measurement.
  - Method of measurement.
  - Observer.
  - Measuring instrument.
  - Reference standard.
  - Location
  - Conditions of use
  - Time
- Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

19.7.13 Maximum permissible errors (of a measuring instrument):

Extreme values of an error permitted by specifications, regulations, etc. for a given measuring instrument.

19.7.14 Drift:

Slow change of a metrological characteristic of a measuring instrument.

19.7.15 Flow computer:

Flow calculating device, which indicates the flow rate as integrated volume or mass, or energy, etc. at base conditions.

19.7.16 Conversion device:

A device consisting of a flow computer and sensors used for converting the volume (flow rate) at operating conditions into a volume (flow rate) at base conditions or to mass (flow rate) or to energy (flow rate) at base conditions, based on either pressure, temperature and gas composition, or on density, or on calorific value.

19.7.17 Availability:

Probability, at any time that the measuring system, or a measuring instrument forming a part of the measuring system, is functioning according to specifications.

19.7.18 Stability:

Ability of a measuring system, or a measuring instrument, to perform its functions for a specified period.

19.7.19 Pressures

- Maximum operating pressure (MOP):

Maximum pressure at which the system can be operated continuously under normal operating conditions.

Note: normal conditions are: no fault in any device or stream.

- Temporary operating pressure (TOP):

  Pressure at which a system can be operated temporarily under control of a regulating device.

- Maximum incidental pressure (MIP):

  Maximum pressure which a system can experience during a short time, limited by safety devices.

- Design pressure: Pressure on which design calculations are based.

19.7.20 Temperatures

- Maximum operating temperature (T_{max}):

  Maximum temperature at which a system can be operated continuously under normal operating conditions.

  Note: normal conditions are: no fault in any device or stream.

- Minimum operating temperature (T_{min}):

  Minimum temperature at which a system can be operated.

19.7.21 Traceability (of a measuring system)

Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all have stated uncertainties.

19.7.22 Systematic error

Mean that would result from infinite number of measurements of the same measure and carried out under repeatability conditions minus a true value of the measurement.

19.7.23 Fail-safe

Characteristic of a device to go to a safe operating condition when a failure occurs.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