

# City Gas Distribution Gas Flow & Measurement



**Presented By -**

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# Introduction – City Gas Distribution Business Segments



**Domestic**



**CNG**



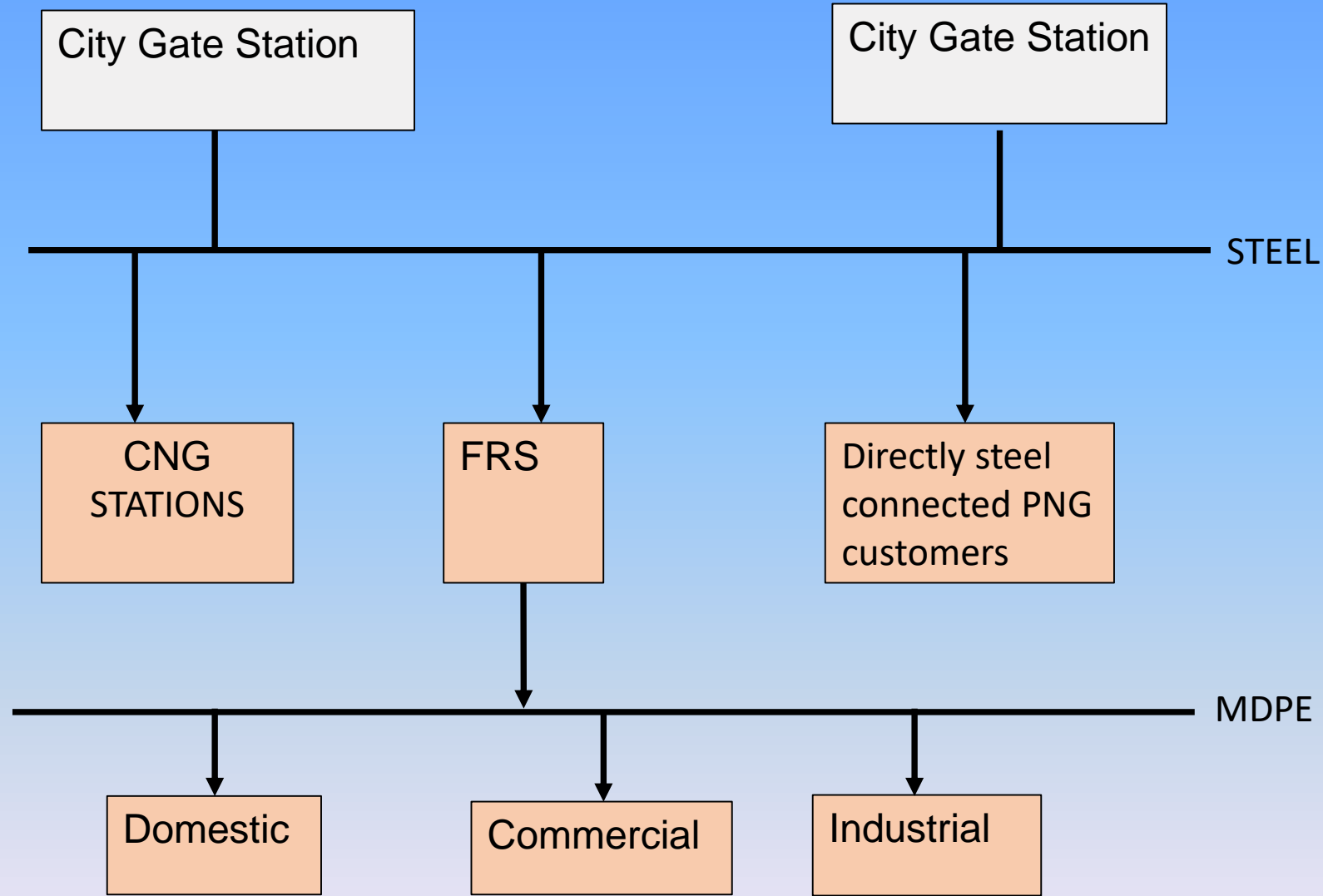
**Commercials**



**Industries**



# City Gas Distribution Network



# CITY GATE STATION(CGS)

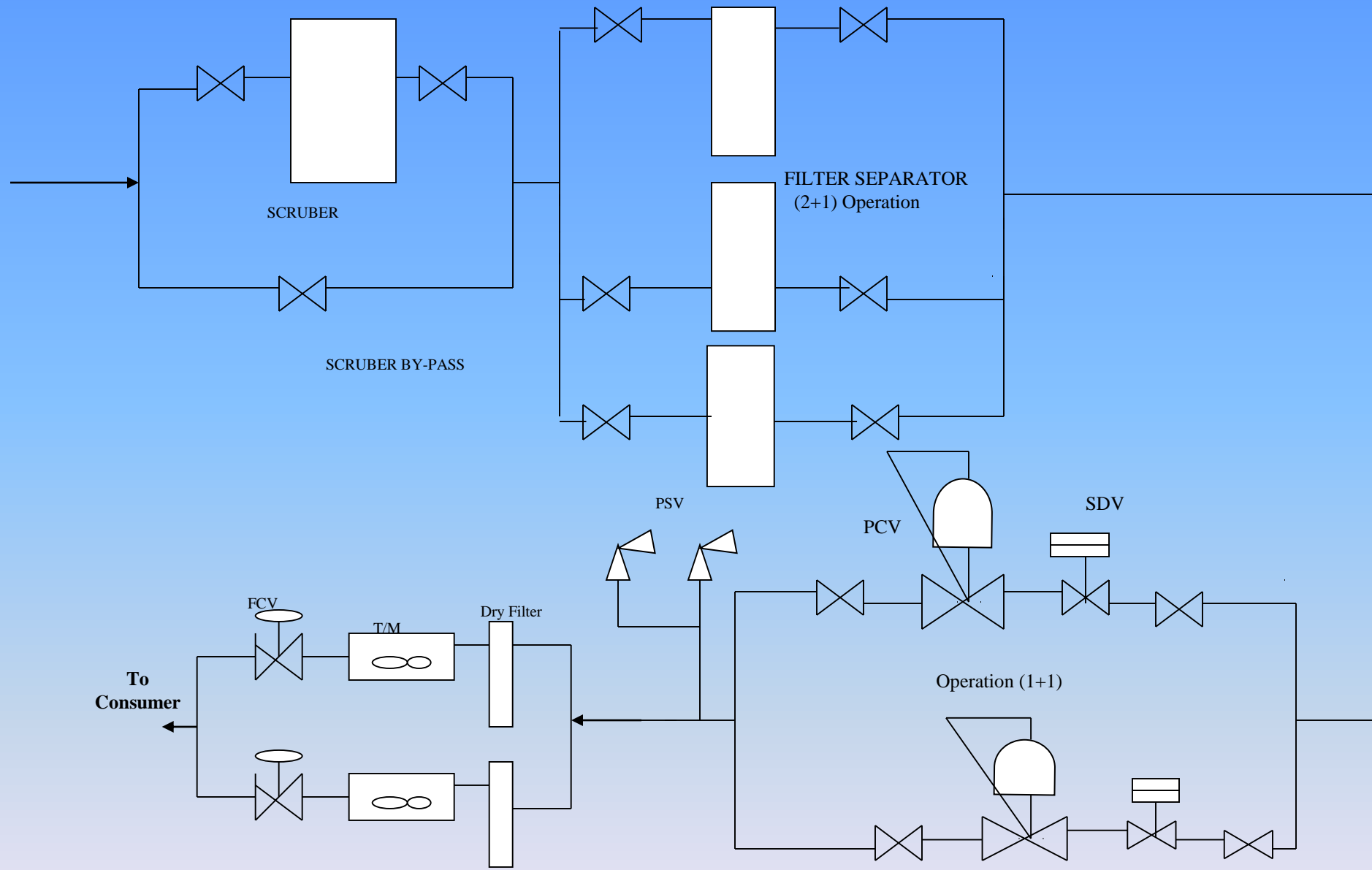
It is inlet point of the pipeline from which natural gas enters in to the City Gas Distribution network

## BASIC FUNCTIONS OF CGS

- a) REMOVAL OF CONDENSATE , DUST AND OIL FROM THE NATURAL GAS .
- b) MEASUREMENT OF SULPHUR CONTENT IN THE GAS
- c) MEASUREMENT OF HYDROCARBON DEW POINT
- d) MEASUREMENT OF MOISTURE IN THE GAS
- e) ANALYSIS OF NATURAL GAS.
- f) CONTROL OF PRESSURE OF NATURAL GAS SUPPLIED TO CONSUMER.
- g) MEASUREMENT OF THE NATURAL GAS SUPPLIED.
- h) FLOW CONTROL .
- i) SAFETY AGAINST HIGH PRESSURE

## MAIN EQUIPMENTS IN CGS

- ISOLATION VALVES
- SCRUBBER
- FILTER SEPARATOR
- SULPHUR CONTENT ANALYSER
- HYDROCARBON DEW POINT ANALY.
- MOISTURE DEW POINT ANALYSER
- GAS CHROMATOGRAPH
- GAS HEATER
- PRESSURE REDUCTION SKID
- PRESSURE SAFETY VALVES
- FLOW MEASUREMENT SYSTEM
- FLOW CONTROL SYSTEM



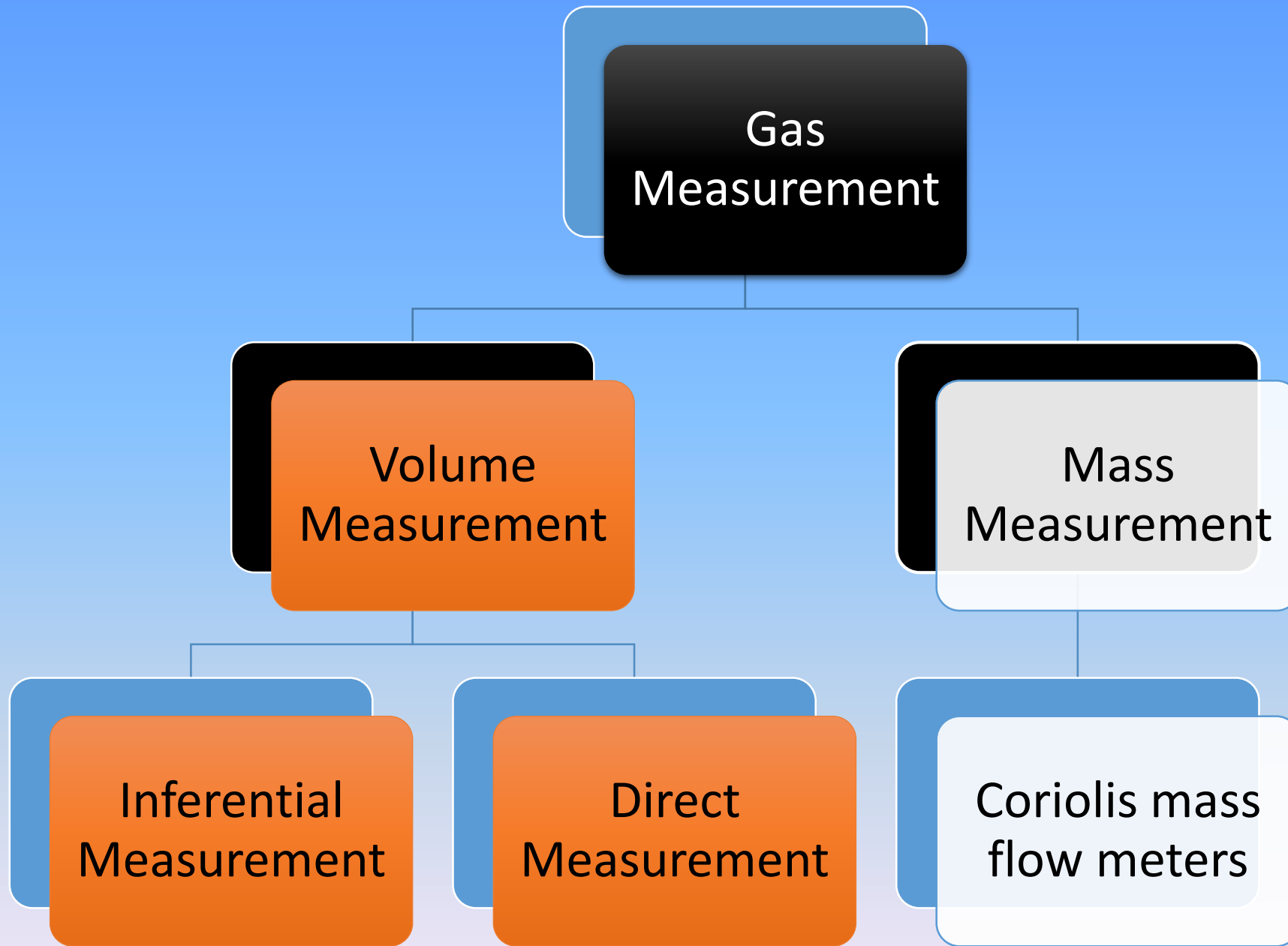
# SCHEMATICS OF CITY GATE STATIONS

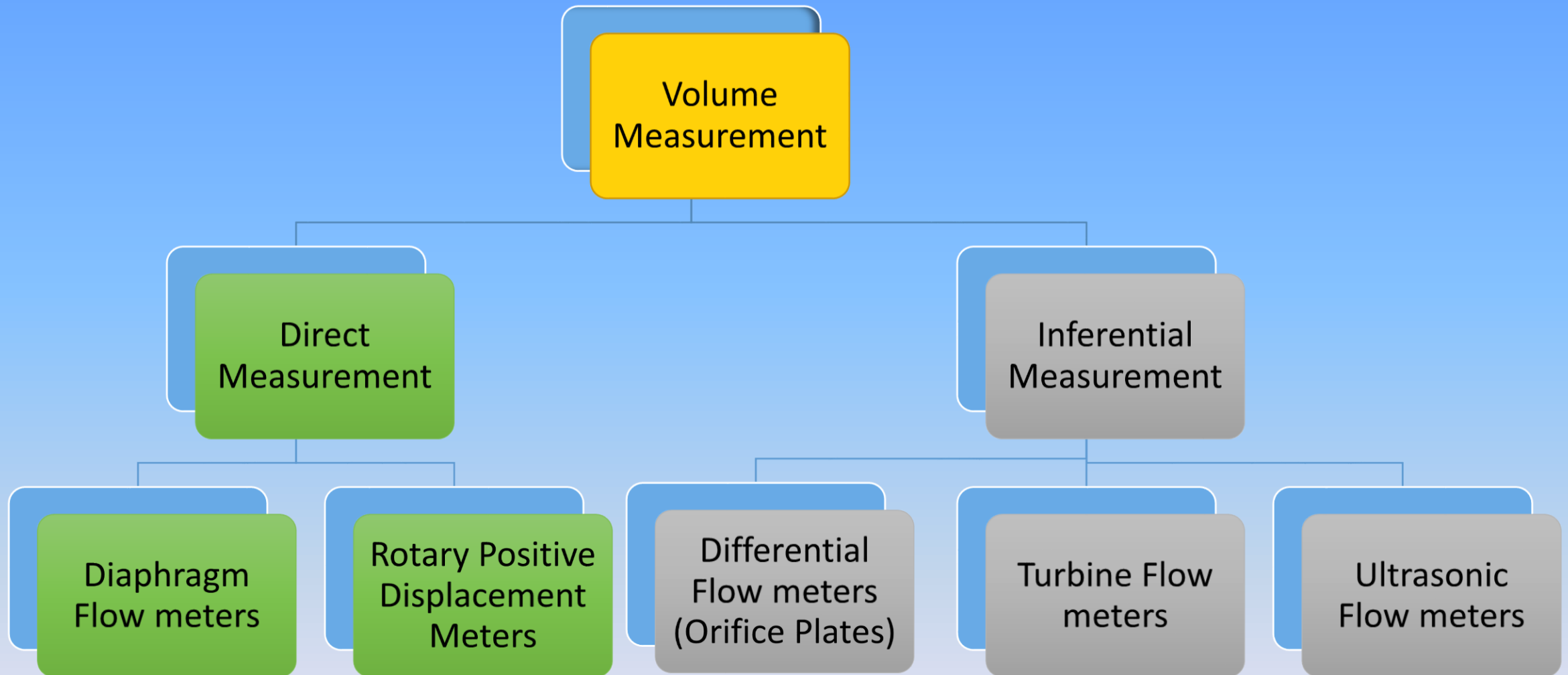
# **GAS MEASUREMENT SYSTEM CITY GATE STATIONS**

FOUR TYPE OF GAS MEASUREMENT SYSTEM IS BEING USED

1. ORIFICE METERING.
2. TURBINE METERING
3. ULTRASONIC METERING
4. CORIOLIS METERING

FOR GAS ANALYSYS GAS CHROMATOGRAPHS ARE BEING USED.







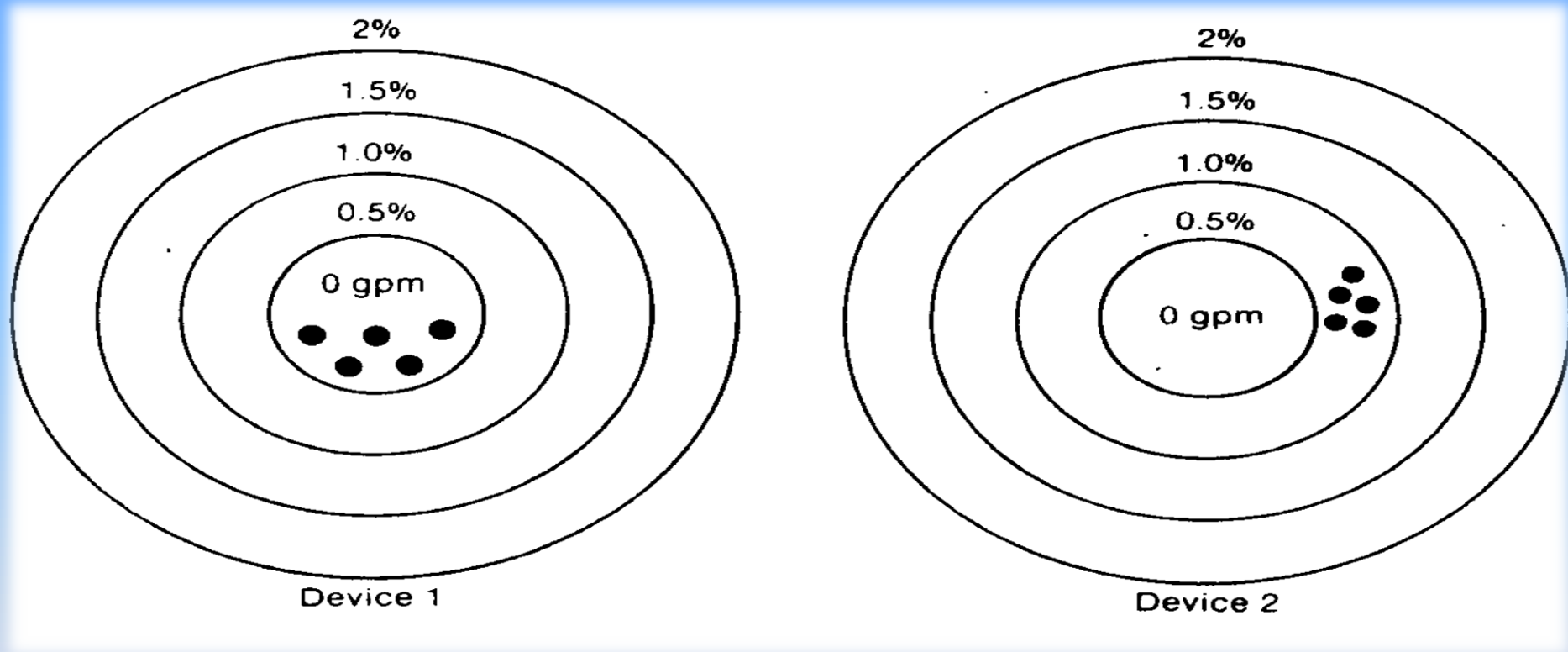
# Important parameters on gas metering

- Standards : ISO9951,OIML ,AGA
- Rangeability
- Accuracy, Uncertainty
- Linearity,
- Calibration
- Repeatability
- Legal metrology aspects
- Stability

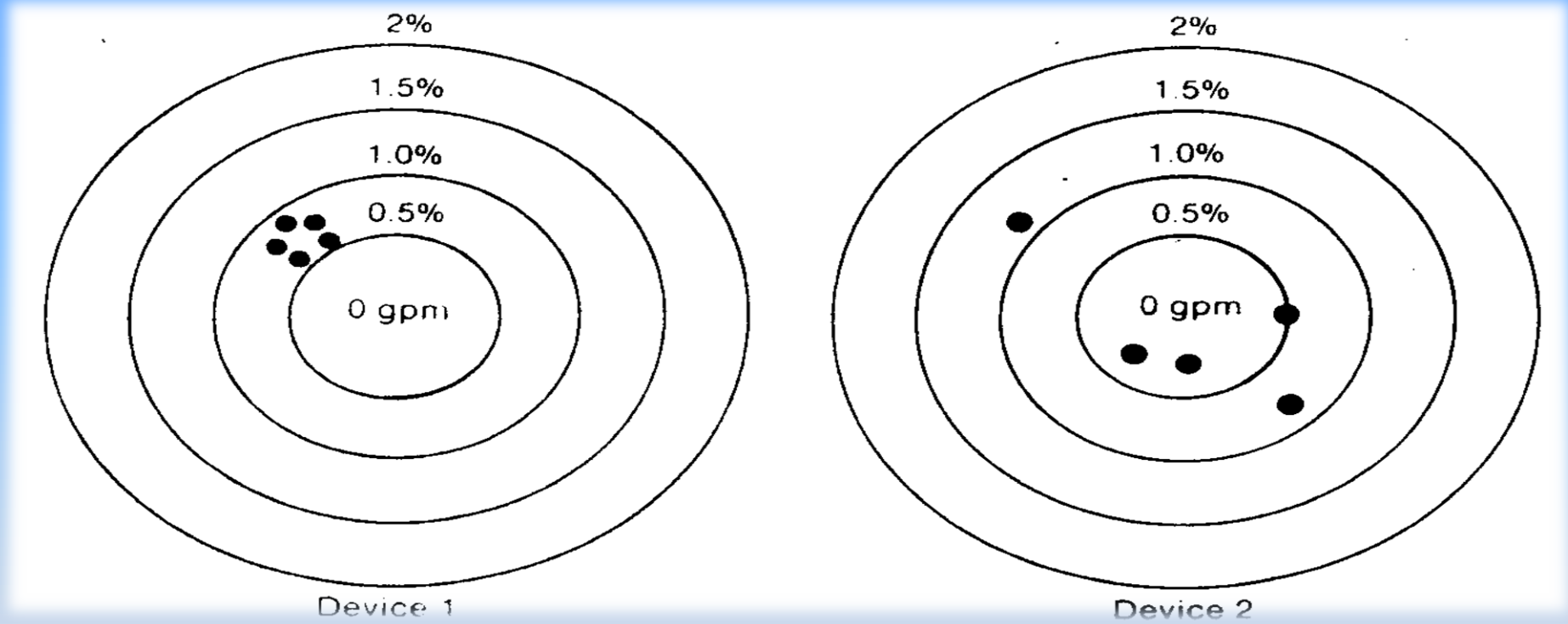
## Let's Start with Explaining a Few Key Definitions

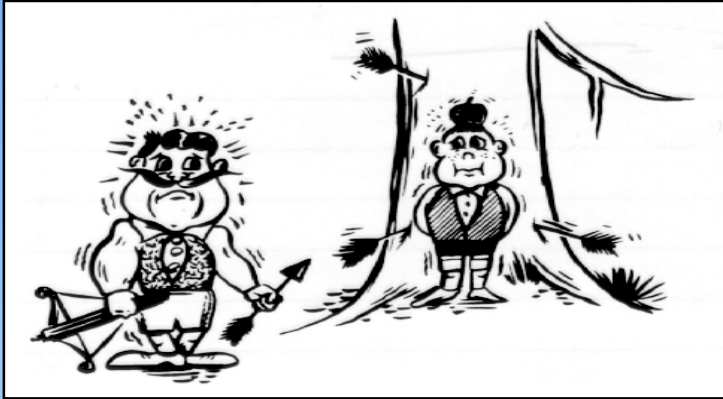
Error	The different between a measurement and its true value.
K-factor	A number by which the meter's output pulses are multiplied to determine the flow volume through the meter.
Meter factor	A number by which the result of a measurement is multiplied to compensate for systematic error.
MAOP	Maximum allowable operating pressure
Pressure drop	The permanent loss of pressure across the meter
$Q_{max}$	The maximum gas flow rate through the meter that can be measured within the specified performance requirement.
$Q_{min}$	The minimum gas flow rate through the meter that can be measured within the specified performance requirement.
Rangeability	The ratio of the maximum to minimum flow rates over which the meter meets specified performance requirement. Rangeability is also known as the turndown ratio.

# Accuracy

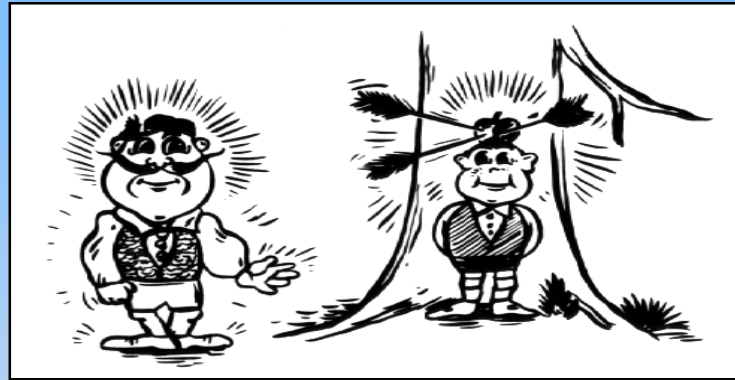


# Repeatability





**Poor Repeatability Means  
Poor Accuracy**

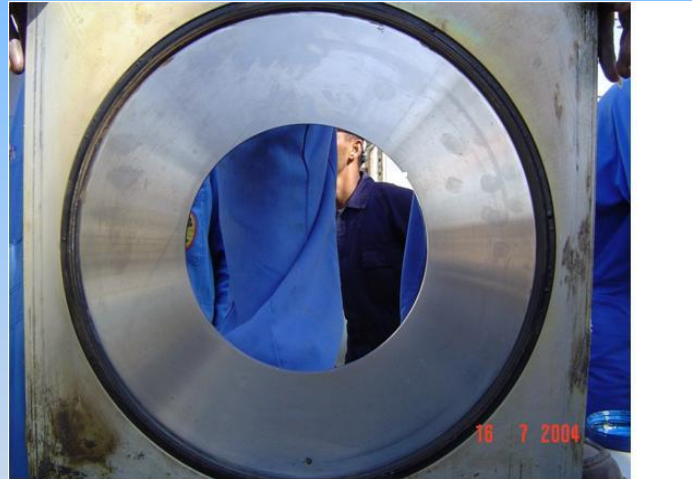


**Good Accuracy Means  
Good Repeatability**



**Good Repeatability Does Not  
Necessarily Mean Good Accuracy**

# ORIFICE METER



## *International Standards*

- ISO 5167
- AGA-3 / API 14.3



# ORIFICE METER

## Advantages & Disadvantages

ADVANTAGES	DISADVANTAGES
Well documented in standards	Pulsating flow
Industry acceptance	Low rangeability
Low unit capital cost	High pressure loss
No moving parts	Flow profile sensitive
Dry calibration acceptable	Requires long meter tube/flow conditioner
No limits on temp, pressure or size	Not self cleaning
Mechanically robust	Can be damaged by high flow rates

# TURBINE METER



## *Turbine Meter Components*



## *International Standards*

- ISO 9951: Measurement of gas flow in closed conduits – Turbine Meters
- AGA7: Measurement of gas by Turbine Meters



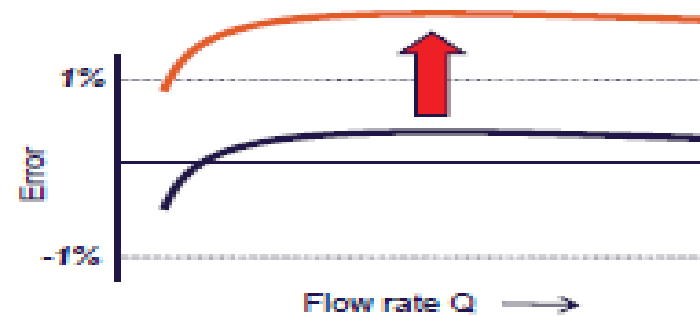
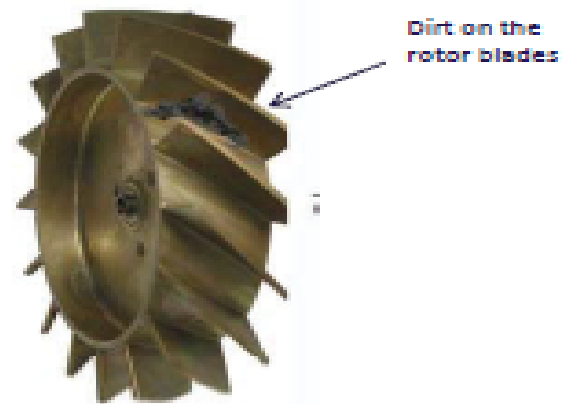
# TURBINE METER

## *Advantages & Disadvantages*

<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>
Good accuracy over linear flow range	Requires flow calibration
Industry acceptance	Relatively high pressure loss
Medium capital cost	Moving parts require maintenance
Medium rangeability at high pressure	Cannot tolerate dirty processes
Electronic output available	Possible damage due to over speeding
Digital output, high repeatability	
Natural flow totaliser	

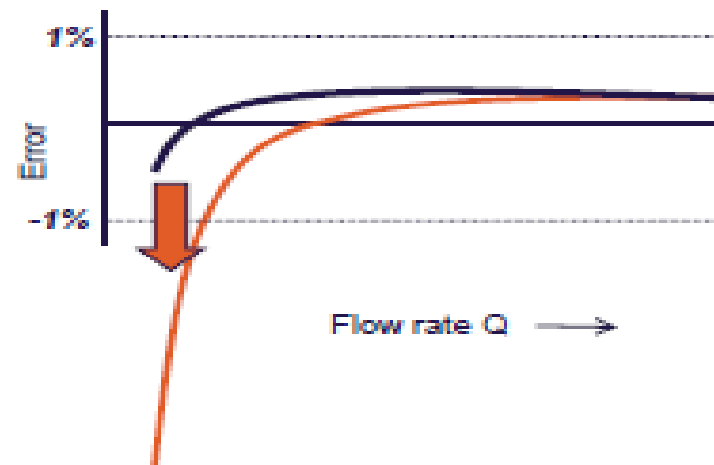
## Impact of Dirt on Turbine Meter

Dirt accumulated on the rotor blades has a tendency to speed up a turbine meter, thus resulting in overestimated flow volume.



## Impact of Dirt on Turbine Meter

Dirt accumulated in bearings slows down a turbine meter, therefore results in underestimated flow volume.



# ULTRASONIC METER



## *International Standards*

- AGA 9
- BS 7965:2000
- ISO/TC 30/SC 5/WG1 (Being Developed)
- AGA 10



# ULTRASONIC METER

## *Advantages & Disadvantages*

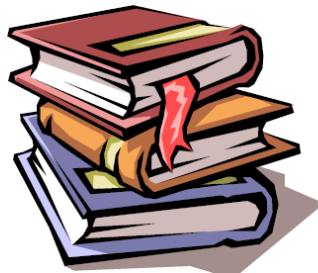
<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>
No flow calibration required	Not fully accepted by industry
High accuracy	Susceptible to pressure reduction valve noise
Sophisticated Self Diagnostic Capability	
Large rangeability	
No additional pressure drop	
No moving parts	
No maintenance	
Low operational cost	
Low installation cost-multipath units	

# Coriolis Mass Flow Meter

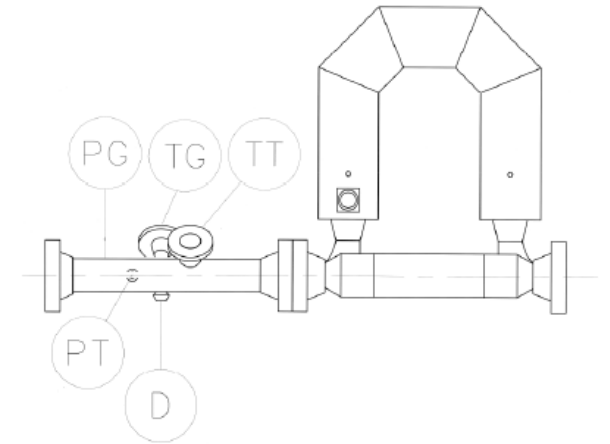
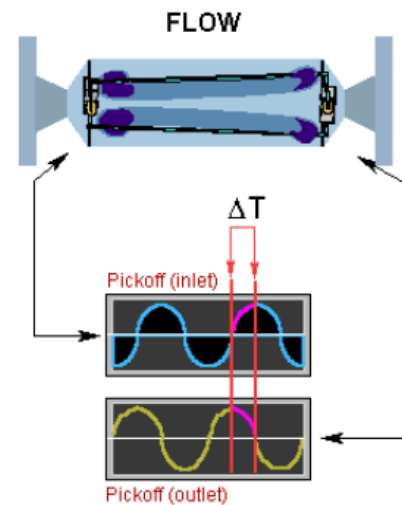


## International Standards

- AGA 11 / API 14.9



## Coriolis Meter



# Coriolis Meter

<b>ADAVANTAGES</b>	<b>DISADVANTAGES</b>
Mass flow	Potential erosion due to abrasive particles
Liquid calibration for gas use	High pressure loss may effect turn down ratio
Insensitive to flow distortions/profile	Sensitive to vibration close to operating freq.
Linear – good range	Sensitive to pulsations close to operating freq.
Accurate for BTU	Only available in small sizes
Flowing density – meter health diagnostic	
No wearing parts	
Elimination of $T_f$ , $P_f$ , and $Z_f$ uncertainties	
Bi-directional	

# FIELD REGULATING STATION(FRS)

It is inlet point of the pipeline system from which natural gas which is at 20 pressure in steel pipeline enters in MDPE pipeline network in which gas flowing at 4 bar pressure. Field Regulating stations are also known as District Regulating Stations(DRS)

## BASIC FUNCTIONS OF FRS

- a) CONTROL & REGULATING OF GAS PRESSURE.
- c) MEASUREMENT OF THE NATURAL GAS
- d) SAFETY AGAINST HIGH PRESSURE.

## GAS MEASUREMENT SYSTEM IN FRS

TWO TYPE OF GAS MEASUREMENT SYSTEM IS BEING USED

1. RPD METERING.
2. TURBINE METERING

## MAIN EQUIPMENTS IN FRS

- ISOLATION VALVES
- SCRUBBER
- FILTER SEPARATOR
- PRESSURE REDUCTION SKID
- PRESSURE SAFETY VALVES
- FLOW MEASUREMENT SYSTEM
- REMOTE MONITERING, AUTOMATIC METER READING & EMEGENCY ALARM SYSTEMS



# METERING & REGULATING SKIDS(MRS)

It is the custody transfer point where gas supply pressure is regulated as per the requirement of end user & gas flow measurement is done.

## BASIC FUNCTIONS OF MRS

- a) CONTROL & REGULATING OF GAS PRESSURE.
- c) MEASUREMENT OF THE NATURAL GAS
- d) SAFETY AGAINST HIGH PRESSURE.

## GAS MEASUREMENT SYSTEM IN MRS

THREE TYPE OF GAS MEASUREMENT SYSTEM IS BEING USED

1. RPD METER.
2. TURBINE METER
3. DIAPHRAGM METERS

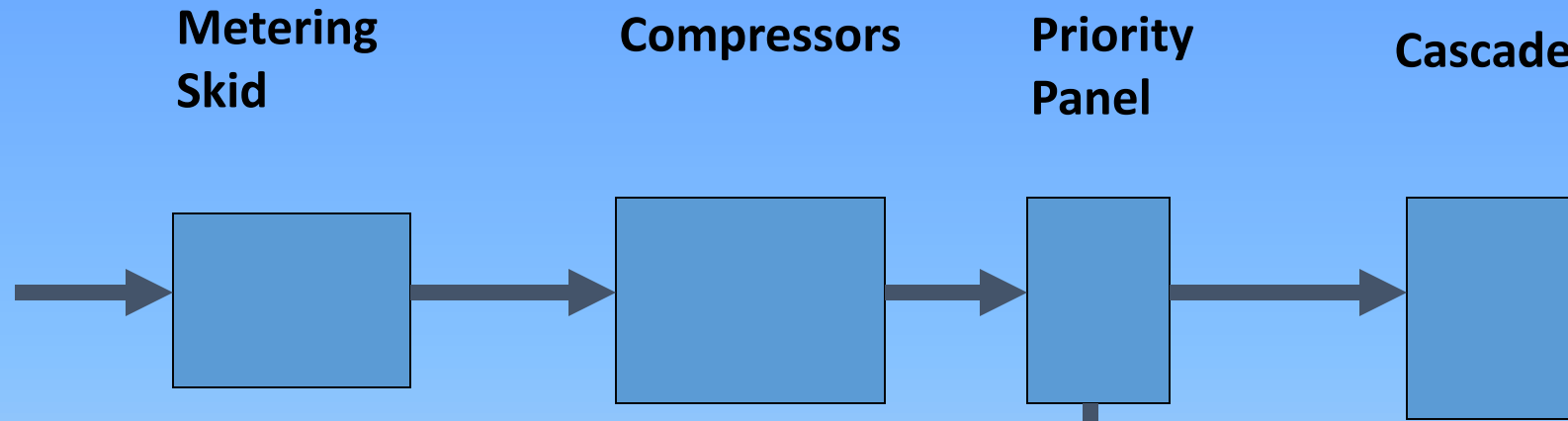
## MAIN EQUIPMENTS IN MRS

- ISOLATION VALVES
- FILTER SEPARATOR
- PRESSURE REGULATOR & NRV
- FLOW METER
- ELECTRONIC VOLUME CONVERTER
- AUTOMATIC METER READING SYSTEM

## NEW DEVELOPMENTS

- PRE PAID GAS METERING.
- GPRS /LoRa BASED AMR SYSTEM
- THERMAL GAS METERING

# CNG STATION COMPONENTS & GAS METERING

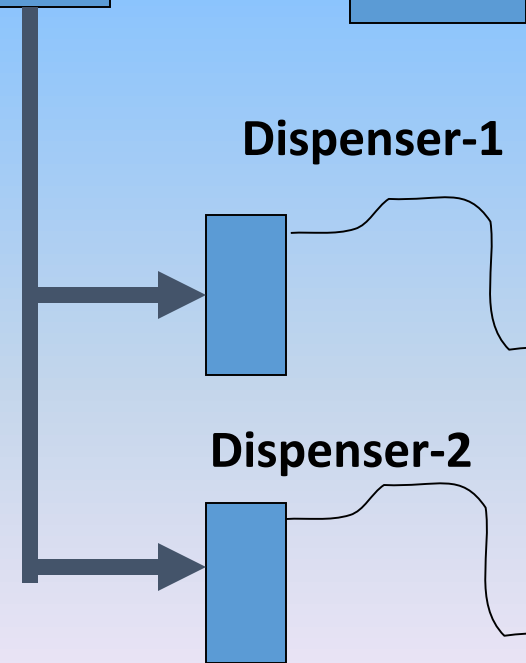


## GAS METERING AT CNG STATIONS

- INELT METERING SKID.
- GAS COMPRESSOR INLET, OUTLET & ENGINE FUEL CONSUMPTION
- DISPENSERS

## GAS MEASUREMENT

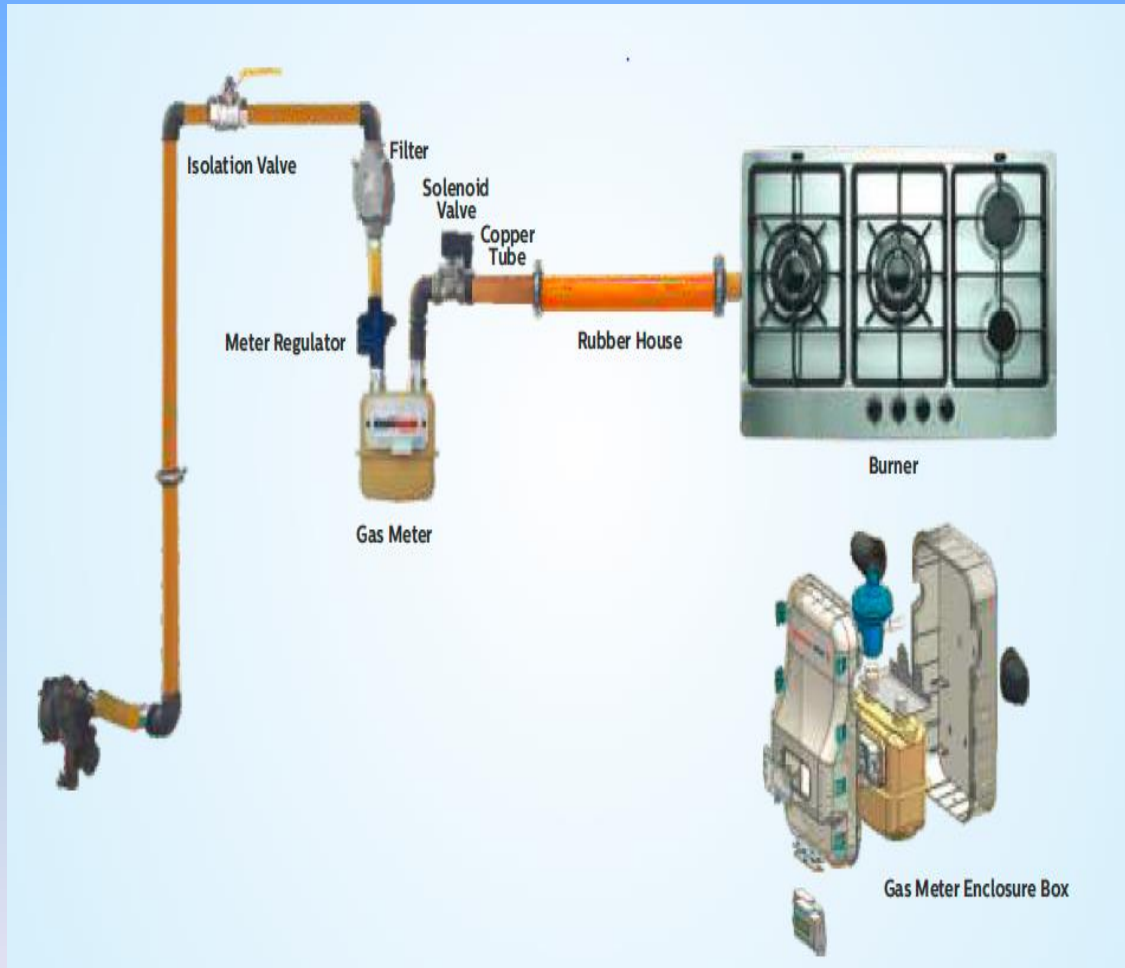
- CORIOLIS MASS FLOW METER



# Why Use Coriolis Mass

- **Volumetric flow metering is affected by changes in the temperature, pressure, density, viscosity, and flow profile of the process fluid.**
- **Coriolis flow metering provides direct mass measurement that is unaffected by changing fluid characteristics.**

# DOMESTIC GAS METERING



## BASIC FUNCTIONS

- CONTROL & REGULATING OF GAS PRESSURE.
- MEASUREMENT OF THE NATURAL GAS

## MAIN EQUIPMENTS IN MRS

- ISOLATION VALVES
- PRESSURE REGULATOR
- FLOW METER
- AUTOMATIC METER READING SYSTEM

## GAS MEASUREMENT

- DIAPHRAGM METERS ARE USED IN DOMESTIC

## NEW DEVELOPMENTS

- PRE PAID GAS METERING.
- LoRa BASED AMR SYSTEM

# Standards:

1) BS EN 1359 :2006

2) OIML R31

## AS PER OIML STANDARD

Gas Meter Designation G	Q max . M <sup>3</sup> / h	Q min M <sup>3</sup> / h
0.6	1	0.016
1	1.6	0.016
1.6	2.5	0.016
2.5	4	0.025
4	6	0.040
6	10	0.060
10	16	0.100
16	25	0.160
<b>25</b>	<b>40</b>	<b>0.250</b>
40	65	0.400
65	100	0.65

Flow Rate	MAX permissible Errors as per OIML Standard	
	On initial verification	In service
$Q_{min} \leq Q_t < 0.1 Q_{max}$	+/- 3%	-6% to +3%
$0.1 Q_{max} < Q_t \leq Q_{max}$	+/- 1.5%	+/-3%

**THANKS**