Associazione Italiana Strumentisti

ISA Italy Section

GdS - Misure Fiscali

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Auditorium TECNIMONT

Custody Transfer: Technical principles for measuring system in the O&G market

EMERSON

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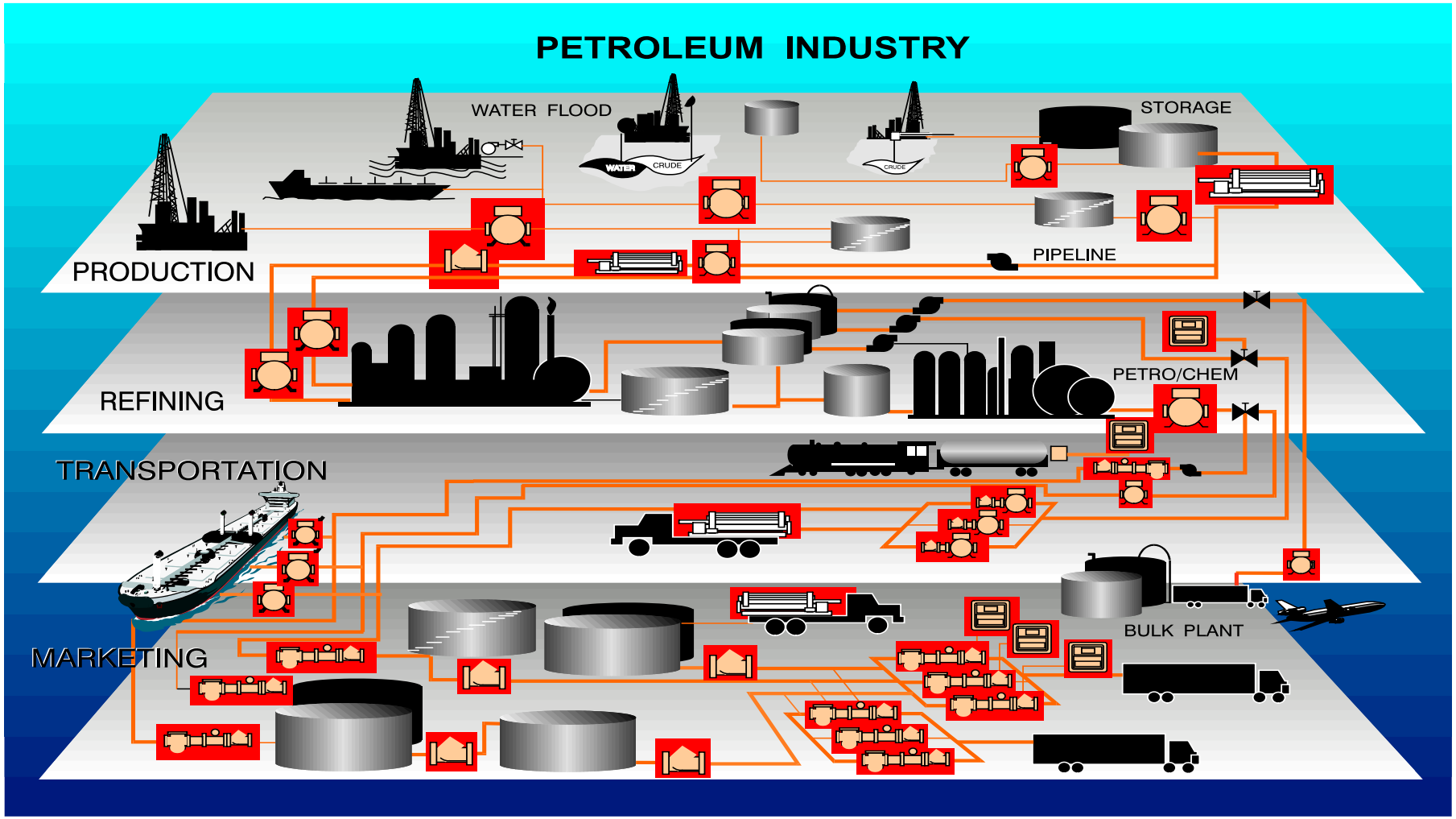
Market Overview



Define Custody Transfer application & Fiscal application

Custody Transfer is where hydrocarbons change ownership; usually this is when one company pays another with money exchange for hydrocarbon. The parties involved usually cover:

- measurement performance/accuracies
- frequency for measurement validation
- dispute resolution

All custody transfer must be compliance with the international measurement industry standards

Field (in-situ) proving method which are tied to known industry standards

Fiscal Measurement is where a government requires taxation payments relating to the sale(Custody Transfer) of hydrocarbon.

Define the Legal approvals and standards

- **Organisation Internationale de Metrologie Legale (OIML)**
- **Directive from the European Parliament and of the council**
- **National Conference on Weights and Measures (NCWM)**
- **International Standards Organization (ISO)**
- **American Petroleum Institute (API)**
- **European Standard (EN)**

Define the process application

Liquid different than water(crudes & derivates)

- *Pipeline*
- *Ship loading*
- *Ship unloading*
- *Bunkering*
- *Truck / Rail loading*
- *Car Loading*
- *Upstream production*

Double phase Liquid Process

- *Petroleum Gas Liquefied (LPG)*
- *Liquid natural gas (LNG)*

Natural Gas

- *Pipeline Transmission*
- *Underground storage*
- *Power Generation*
- *City gates (PRMS)*
- *Flare application*
- *Medium/light industry power-heat generation*
- *Domestic*

Part of all process

- *Utility gases (N2)*

Basic Requirements

Liquids: Basic Requirements

- ***Safety & Environment***
- ***Classification of the measuring system***
- ***Quantity determination***
- ***Liquid measuring installation***
- ***Liquid quality determination***
- ***Prove and subsequence verifications***
- ***Data availability***

Natural Gas: Basic Requirements

- ***Safety & Environment***
- ***Classification of the measuring system***
- ***Quantity determination***
- ***Gas measuring installation***
- ***Gas quality determination***
- ***Prove and subsequence verifications***
- ***Data availability***

Basic Requirements: Safety & Environment

The measuring system shall be designed and constructed such that it operates a ***safe*** *manner. Safety is a management* ***responsibility*** *which requires that all personnel involved in* ***design, installation, testing, commissioning, operation and maintenance*** *of the measuring system shall be competent and have adequate safety* ***training****. The* ***management*** *shall ensure that all areas of responsibility are clearly defined.*

During normal and maintenance operation, the measuring system shall comply with locally established ***environmental limits.***

Basic Requirements: Classification of the measuring system

Liquids: OIML R117

- ***Class 0,3: System for pipeline***
- ***Class 0,5: Loading/unloading***
- ***Class 1,0: Liquefied gases (LPG) / high viscosity fluids***
- ***Class 1,5: Liquefied natural gas(LNG)***

Natural Gas: EN1776-2015

- ***Class A: in-service uncertainty less than or equal to 1,2 %.***
- ***Class B: in-service uncertainty greater than 1,2 % and less than or equal to 2,5 %.***
- ***Class C: in-service uncertainty greater than 2,5 % and less than or equal to 3,5 %.***
- ***Class D: in-service uncertainty greater than 3,5 % and less than or equal to 8,0 %.***

The accuracy class of the measurement system shall be defined as an expanded uncertainty on energy determination over the billing period

Basic Requirements: Liquid quantity determination

PDMeter:

- *Flowing fluid mechanically isolated in known volume segments*
- *Segments totaled as displaced*
  - *Meter mounted totalizer*
  - *Pulse generator to flow computer*
- *Common use for liquid measurement*
  - *Viscous service (crude oil)*
  - *Light hydrocarbons*
  - *Lack of lubrication of propanes, butanes may increase maintenance*

Turbine:

- *Turbine meters represent an inferential type of volume measurement*
  - *Turbine meter body contains a rotor that rotates in accordance to the linear velocity of fluid thru the pipe cross-sectional area*
  - *The regular velocity(rpm) of the rotor is proportional to the linear velocity of the flowing fluid*
- *Three basic types are normally considered for custody transfer*
  - *Rim type*
  - *Blade type*
  - *Multi-viscosity (Hi-Vis turbines)*

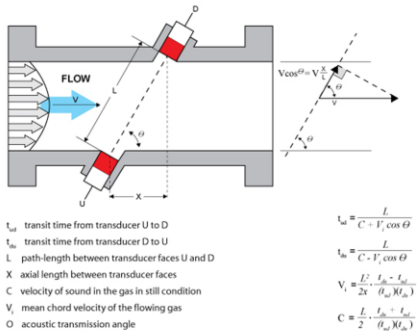
Basic Requirements: Liquid quantity determination

Coriolis meter:

- ***The Coriolis meter is a mass meter, measuring mass flow directly and infers volume***
  - ***Determines the interaction between a flowing fluid and the oscillation of a tube (tubes)***
  - ***Measures mass per unit time (tons/hr.)***
  - ***Volumetric flow rate is mass flow rate ÷ density***
- ***Both mass flow and density depend on tube vibration***
  - ***Vibration of tube depends on rigidity***
  - ***Rigidity is influenced by temperature***
    - ***Calculations must include fluid temperature***
  - ***Two basic types: Curved tube or Straight tube***

Ultrasonic meter:

- ***Ultrasonic flow measurement is determined by measuring the difference in transit time of ultrasonic pulses. Flow measurement is determined by measuring the time required for an ultrasonic pulse to be transmitted between two transducers that are mounted at an angle relative to the gas flow. When the ultrasonic signal is traveling in the downstream direction, the transit time of the pulse is less than when it is traveling in the upstream direction. The difference between the upstream and downstream transit times is directly proportional to the velocity of the fluid.***
- ***Reynolds number >10000 is the correct application***



Basic Requirements: Liquid measuring installation

Mechanical components:

- *Strainer*
- *Centrifugal air eliminator*
- *Drain valves with spectacle plate*
- *Vent valve*
- *TRV(thermal relief valve)*
- *Check valve*
- *Flow conditioning*
- *Inlet/outlet headers*
- *Isolation valves:*
  - *DBB dual expanding plug valves*
  - *Double expanding gate valve*
  - *Trunnion ball valve dual piston effect (liquid gas)*

Automation components:

- *Flowmeter*
- *Flow computer*
- *Secondary instrument(pressure/temperature/density):*
  - *Mechanical compensation*
  - *Process monitoring*
  - *Fluid compensation*
- *FCV flow control valve:*
  - *Guarantee back pressure to the meter*
  - *Flow proportional during normal operation(loading/unloading)*
  - *Flow proportional during the proving*
- *Prover*
- *Supervisory system / Terminal Automation system*

Basic Requirements: Liquid quality determination

Basic:

- *In a typical sampling application, the volume to be analyzed is between 1 and 300 billion tons of the total batch*
- *The sampling system should provide the REPRESENTATIVE samples of liquid required for the determination of chemical and physical properties, which are used to establish standard volumes / mass, prices, and compliance with commercial terms and regulatory requirements.*
- *Therefore the sample system must operate flow proportionally*
- *Standards applicable:*
  - *ISO 3171 / API8.2 / ASTM D4177*
  - *Karl Fischer method (weight %)*
  - *Centrifugal method (volume%)*

Operation:

- *Sample cans should be able to handle the product without loss of high ends*
- *Receiver (cans) should have no voids or water traps*
- *Before sub-sample is drawn in lab, the receiver contents must be properly mixed to ensure no settling*
- *Laboratory analysis must be conducted in accordance with standard and recognized procedures*
- *The sampling system performance must be field proven*
- *There are two normally used types of sampling systems*
  - *Probe based*
  - *Bypass loop (fast loop): 1" or 2" bypass loop flowing iso-kinetically (same velocity) with main pipeline flow*

Basic Requirements: Prove and subsequence verifications

Why prove?:

- ***Physical properties can affect meter performance:***
  - ***Viscosity***
  - ***Pressure / Temperature***
  - ***Flowrate***
  - ***BS&W***
- ***Wear can affect meter performance on influential meters***
- ***Obstructions, product build up, and encrustation can affect the meters***
- ***For all these reasons regular meter performance should be verified to determine that repeatable results are consistently maintained***
- ***Meter proving validates consistent meter accuracy, meter trending and proves traceable evidence of measuring system***

Types of Proving Systems:

- ***Pipe Provers (Bi-Directional)***
- ***Small Volume Prover (Compact Prover)***
- ***Tank Prover***
- ***Weight Scale***
- ***Master Meter Prover***

Basic Requirements: Gas quantity determination

Rotary Meter:

- *Utilizing pressure drop across the meter causing the lobe or gears to register volume*
- *The rotation indicates velocity which is used to determine flow rate*
- *A mechanical or electronic index on the meter gives the user information of the total value of gas which has flown through the meter at operating conditions.*

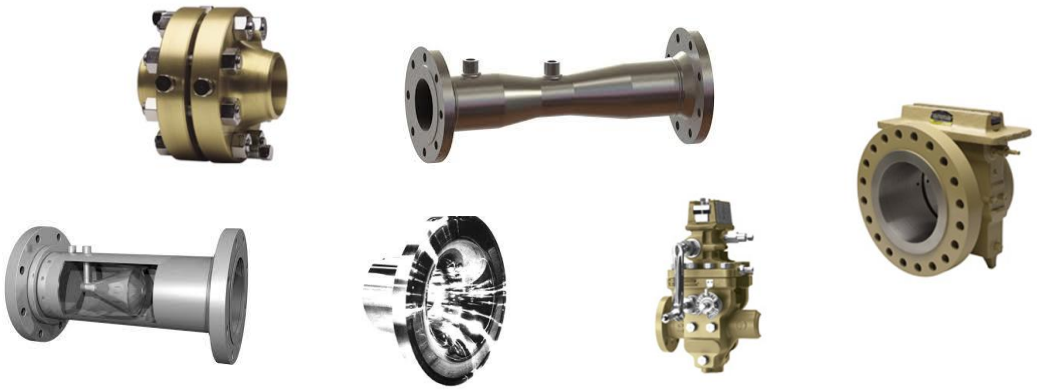
Turbine:

- *The gas flowing through the meter sets a turbine wheel in motion. The number of revolutions of the wheel is proportional to the volume passing through the meter. A mechanical or electronic index on the meter gives the user information of the total value of gas which has flown through the meter at operating conditions.*

Basic Requirements: Gas quantity determination

DP Meter:

- *Utilize the principle of measuring a pressure differential between two points in the flow stream*
- *The pressure differential can be caused by various devices*
- *In all head type meters the rate of flow is proportional to the √ (square root) of the pressure differential*
- *Standards applicable ISO5167 / AGA3*



Diaphragm meter:

- *Diaphragms expanding in a known case volume driving a mechanical indexer to register volume*

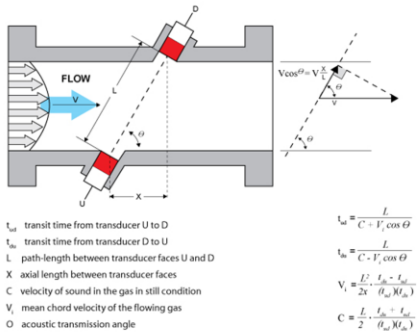
Basic Requirements: Gas quantity determination

Coriolis meter:

- ***The Coriolis meter is a mass meter, measuring mass flow directly and infers volume***
  - ***Determines the interaction between a flowing fluid and the oscillation of a tube (tubes)***
  - ***Measures mass per unit time (tons/hr.)***
  - ***Density from Coriolis meter is not used; on gas application is used different instrument and technology to measure the in line density and gas specific gravity***
- ***Mass flow depend on tube vibration***
  - ***Vibration of tube depends on rigidity***
  - ***Rigidity is influenced by temperature***
    - ***Calculations must include fluid temperature***
  - ***Two basic types: Curved tube or Straight tube***

Ultrasonic meter:

- ***Ultrasonic flow measurement is determined by measuring the difference in transit time of ultrasonic pulses. Flow measurement is determined by measuring the time required for an ultrasonic pulse to be transmitted between two transducers that are mounted at an angle relative to the gas flow. When the ultrasonic signal is traveling in the downstream direction, the transit time of the pulse is less than when it is traveling in the upstream direction. The difference between the upstream and downstream transit times is directly proportional to the velocity of the fluid.***



Basic Requirements: Gas measuring installation

Mechanical components:

- *Strainer*
- *N2 inlet connection*
- *Vent valve*
- *RV(relief valve)*
- *Check valve*
- *Flow conditioning*
- *Inlet/outlet headers*
- *ESD valves*
- *Isolation valves:*
  - *Trunnion ball valve dual piston effect*
  - *Isolation philosophy TBD by end use*

Automation components:

- *Flowmeter*
- *Flow computer*
- *Secondary instrument(pressure/temperature/density/ Gas Chromatograph):*
  - *Mechanical compensation*
  - *Process monitoring*
  - *Fluid compensation*
  - *Energy calculation*
- *FCV flow control valve*
- *Reduction*
- *Heaters*
- *Supervisory system*

Basic Requirements: Gas quality determination

Basic:

- *Determine the quality of the product and compare against the require tariff specifications*
- *The heating value represent the Energy when a given volume of hydrocarbon is burned. It is express in BTU's(British Thermal Units).*
- *Monitoring the contaminant*
- *Monitoring for process purpose Hydrocarbon Dew point and Water Dew point*
- *Therefore the sample system must operate flow proportionally*
- *Standards applicable:*
  - *ISO 6976 / ISO14532*

Operation:

- *A gas sampler system collects a flow or time based gas sample from the flowing line for collection into a retaining sphere (bomb) for transportation to a lab for analysis*
- *On line chromatography collects samples from a flowing line and separates the chemicals in the system and reports the results*
- *Laboratory analysis must be conducted in accordance with standard and recognized procedures*
- *The sampling system must be representative and the filters must not absorb gas components from the sample*
- *The distance between the sample probe and the sampler should be as small as possible*

Basic Requirements: Prove and subsequence verifications

Why prove?:

- *Wear can affect meter performance on influential meters*
- *Obstructions, product build up, and encrustation can affect the meters*
- *For all these reasons regular meter performance should be verified to determine that repeatable results are consistently maintained*
- *Meter proving validates consistent instruments accuracy, meter trending and proves traceable evidence of measuring system*

Types of Proving Systems:

- *"Wet calibration" done by 3rd party laboratory using high pressure natural gas*
- *"Wet calibration" done by 3rd party laboratory using low pressure gas / air*
- *On-line pay/check meter using 2 meter in series with different measuring technology(example Ultrasonic + Turbine)*
- *On-line pay/check meter using the same technology with 2 different meter design*
- *3rd party laboratory calibration for secondary instruments (P & T) and Flow computer*
- *Field calibration for analytical instruments*
- *Advance SOS(speed of sound) evaluation with ultrasonic technology. Measuring system validation technique.*

Basic Requirements: Data availability

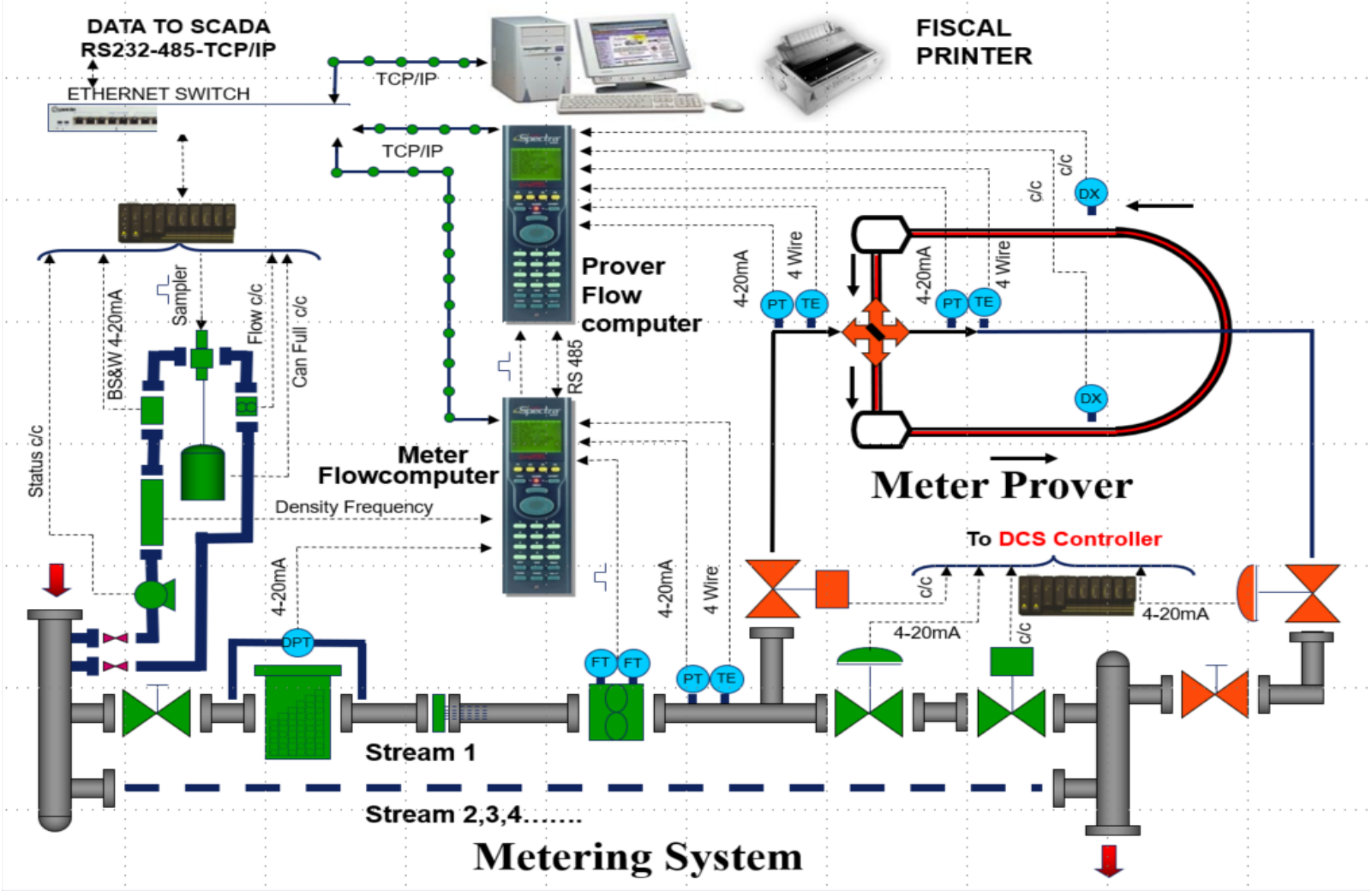
Basic:

- *A flow computer forms the "Brain" of the metering system*
- *The time synchronization is essential for metering system performance*
- *Emphasis should be given on the metering stream availability. Equipment redundancy is required to minimize downtime*
- *The metering system must provide data reports, alarm history and alarms/data archive*
- *The metering system must provide the ticket/report*
- *The metering system should be configured for different security levels with each security level having defined privileges.*

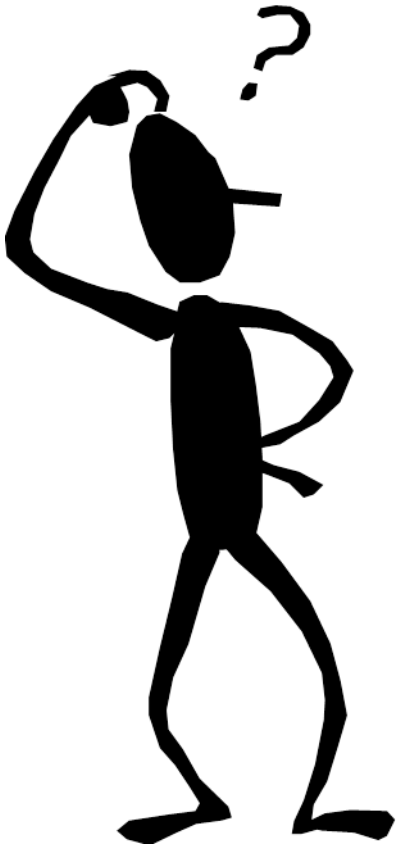
Operations:

- *The flow computer philosophy (duty/standby, main/backup) should be clearly defined*
- *Based on the owner's requirements the streams/ Electronic Flow Measurement system should be selected for various criteria as Duty/Standby, Main/ Backup etc. It is a normal industry practice to have one metering stream as standby. The redundancy concept implementation should be clearly specified and documented*
- *Cyber security philosophy should be clearly specified and documented*
- *TAS (Terminal Automation System) provides terminal operators with the ability to manage and optimize loading and unloading operations for truck, rail, and barge, and provides complete order-to-cash commercial management to execute contracts and orders, manage inventory, produce invoices, and perform measurement accounting of liquid hydrocarbons.*

Basic Requirements: Data availability



Question??



Thank you for Attending!