Is High Pressure Recalibration of Ultrasonic Meters really necessary?

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Recalibration of Ultrasonic Gasflow meters

Jost Körte

1985	3M Germany	– Module Manager, Process & Project engineer
1994	Elster	– Managing Director
2003	Schottel	– Managing Director – Ship propulsion
2006	RMG Messtechnik	– Managing Director
2010	Honeywell	- Global Marketing Director Gas
2012	GasCon	- Owner and Founder
	2013 Metreg Technologies	
	2014 Metreg Solutions	

Recalibration of Ultrasonic Gasflow meters

Typical Application Types of Ultrasonic Meters in the Gas Network

1. Gas Wells	**High pressure**
2. Transmission Pipelines	**High pressure, large capacity**
3. Border stations	**High pressure, large capacity**
4. Underground storage	**High pressure, bi-directonal**
5. Interconnectors	**High pressure, bi-directional**
6. Offtake or city gate	**High/Medium pressure**
7. District stations	**Medium/Low pressure, low capacity**
8. End customer	**Medium/Low pressure, low capacity**

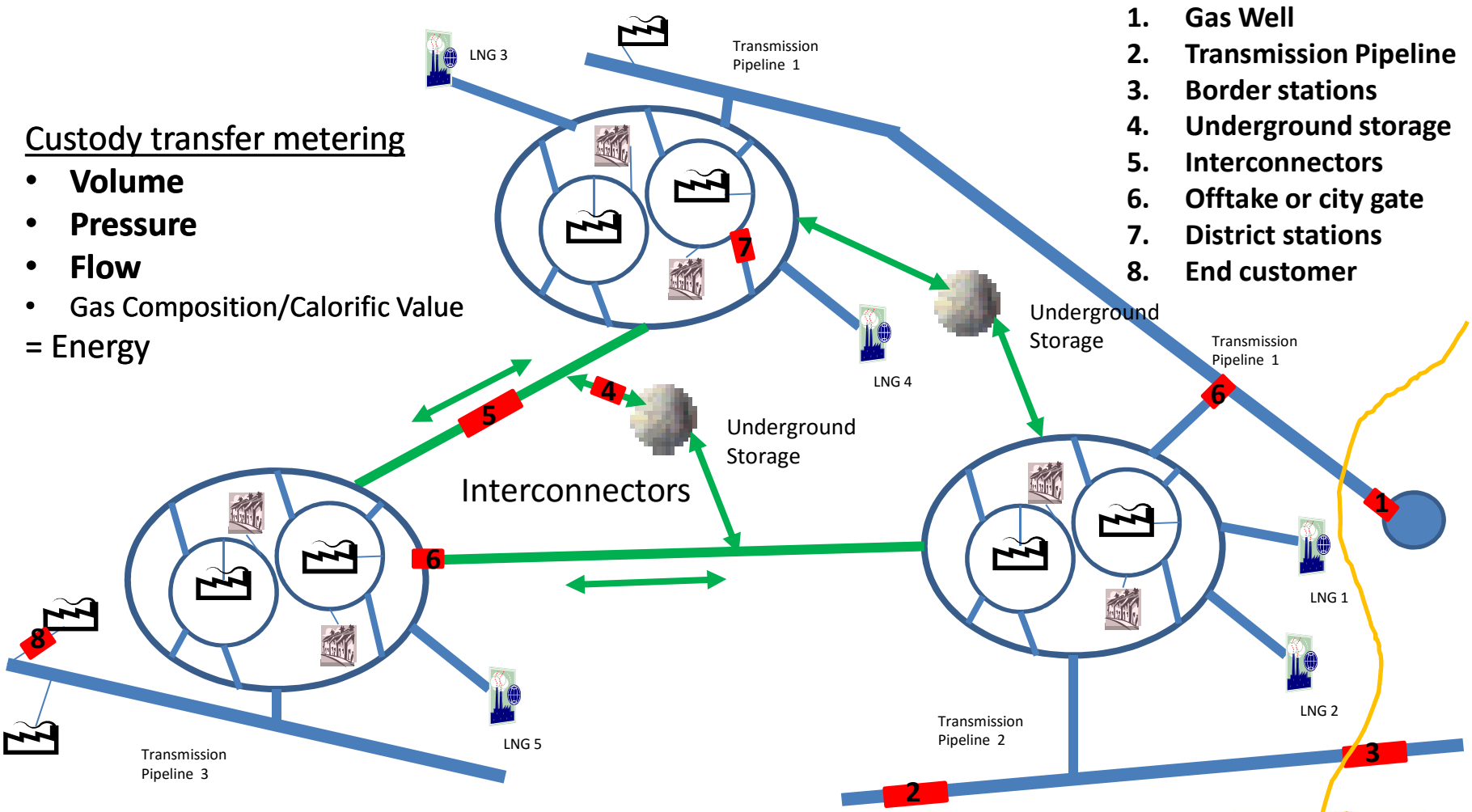
Recalibration of Ultrasonic Gasflow meters

Typical Applications of Ultrasonic Meters in the Gas Network

<u>Custody transfer metering</u>

- **Volume**
- **Pressure**
- **Flow**
- Gas Composition/Calorific Value

= Energy



1. **Gas Well**
2. **Transmission Pipeline**
3. **Border stations**
4. **Underground storage**
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7. **District stations**
8. **End customer**

Recalibration of Ultrasonic Gasflow Meter
Is it still necessary?

Ultrasonic Meters of the latest generation
Status quo

1. Approx. 10+ manufacturers internationally
2. Almost 100% of the customers require an initial high pressure calibration
3. Many installations in Europe have inline check-meters
4. Meters are multipath with proven track-records
5. Significant improvements (reductions) on straight inlet & outlet spoolpieces – down to 5 DN without flow straigthener
6. All manufacturers provide data analysis & monitoring SW
7. Static calibrations of USM´s under different pressures
8. Some manufacturers calibrate standard with air at atmospheric conditions
9. No mechanical parts for wear & tear in the meters
10. Some manufacturers provide options for p & T compensation

Recalibration of Ultrasonic Gasflow Meter
Is it still necessary?

…and

1. Most national regulations require a recalibration after some years
2. Outside of Europe some meters are not even intially calibrated because there are no test facilities available
3. Electronic equipment is not free of wear & tear, especially under harsh environmental conditions
4. Mechanical changes inside the meter and out of operational influences can have an impact on the meter registration
5. Software is never free of bugs

Recalibration of Ultrasonic Gasflow Meter
Is it still necessary?

…and to consider

The impact of the financial risk in buying or selling gas due to

- measurement uncertainty of your meters and the calibration
- measurement uncertainty due to installation influences reflecting
  - Design
  - Operation
  - Type of metering station

Recalibration of Ultrasonic Gasflow meters

Value of Gas Metering and measurement uncertainty

Already small shifts in measurement uncertainty create high financial risk !

					Capacity of meter	cost of NG	@ max Capacity	25%		0,10%	0,10%
DN	G	Qmax	pmax	h/a	max. [m³]	€/m³	max €/a	Utilization	realistic invoice amount per year @ utilization of meter	value of measurement uncertainty 0,1%	value of measurement uncertainty over 5 yrs. for 0,1%
				8760		0,30 €		25%		equivalent in €	5
100	650	1000	16	8760	140.160.000	0,30 €	42.048.000 €	25%	10.512.000 €	10.512 €	52.560 €
200	1600	2500	40	8760	876.000.000	0,30 €	262.800.000 €	25%	65.700.000 €	65.700 €	328.500 €
400	6500	10000	100	8760	8.760.000.000	0,30 €	2.628.000.000 €	25%	657.000.000 €	657.000 €	3.285.000 €
750	25000	40000	100	8760	35.040.000.000	0,30 €	10.512.000.000 €	25%	2.628.000.000 €	2.628.000 €	13.140.000 €
1200	65000	100000	100	8760	87.600.000.000	0,30 €	26.280.000.000 €	25%	6.570.000.000 €	6.570.000 €	32.850.000 €

Recalibration of Ultrasonic Gasflow meters

Value of Gas Metering

Risk of measurement uncertainty vs. Recalibration cost (excl. Logistical cost)

value of measurement uncertainty 0,1%	value of measurement uncertainty over 5 yrs. for 0,1%		Recalibration Cost under High pressure in €	
equivalent in €	5		min	max
10.512 €	52.560 €		2.000	3.000
65.700 €	328.500 €		3.500	4.000
657.000 €	3.285.000 €		8.500	10.500
2.628.000 €	13.140.000 €			27.000
6.570.000 €	32.850.000 €			30.000

Recalibration of Ultrasonic Gasflow meters

Influences of Measurement uncertainty

a. Calibration center — **0,15% - 0,35%**

b. Installation in-situ — **up to 0,5% , in severe cases > 1% - estimation based on experience**

i. Flow disturbances
   1. From piping installations
   2. From regulators or other valves, etc.
   3. From flow straighteners

ii. Upstream or downstream installations
   1. Regulator influences
   2. Compressor influences

c. Meter changes over time through operation — **up to 0,5% - estimation based on experience**

i. Environmental influences
   1. Corrosion due to condensation in pipe or meter
   2. Pressure and temperature influences

ii. Gas contaminations
   1. Condensate
   2. Liquids
   3. Solids
   4. Other chemicals and “sticky” stuff

Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations

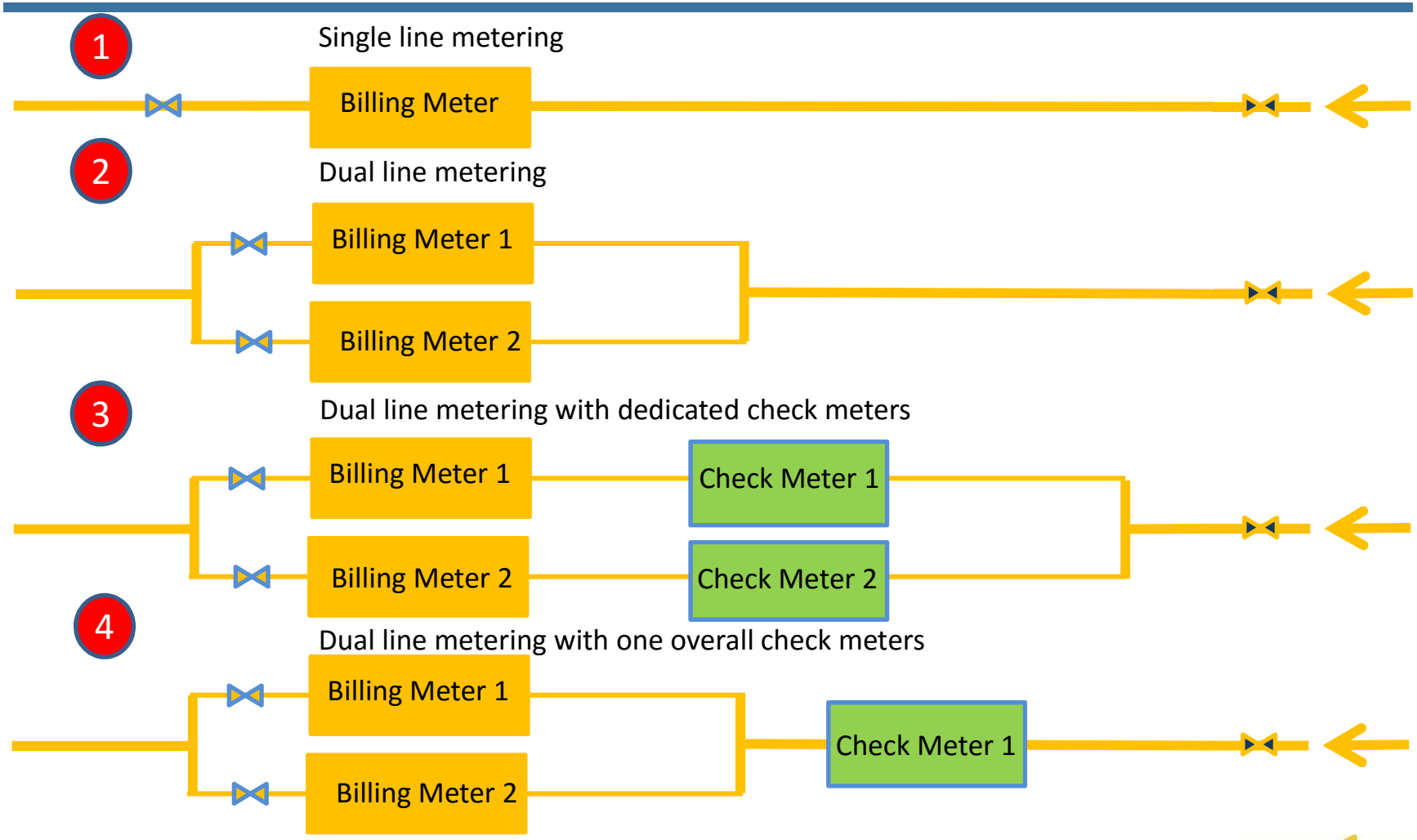
The design of the metering stations determines to a large extent the measurement uncertainty in operation

(in this case the view is limited to flow and volume – p, T or calorific value are not viewed)

- The design can increase or reduce the risk and measurement uncertainty
- Protect your measurement equipment by efficient filtering and reduction of contaminations
- Provide for long enough straight and same diameter inlet piping in front of the meter
- Eliminate installation influences – offsets, diameter changes, gasket misalignments, etc.
- Avoid upstream and downstream pulsations and ultrasonic noise from installations, regulators, flow control valves, compressors, etc.
- Plan parallel and redundant measurement runs

Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations



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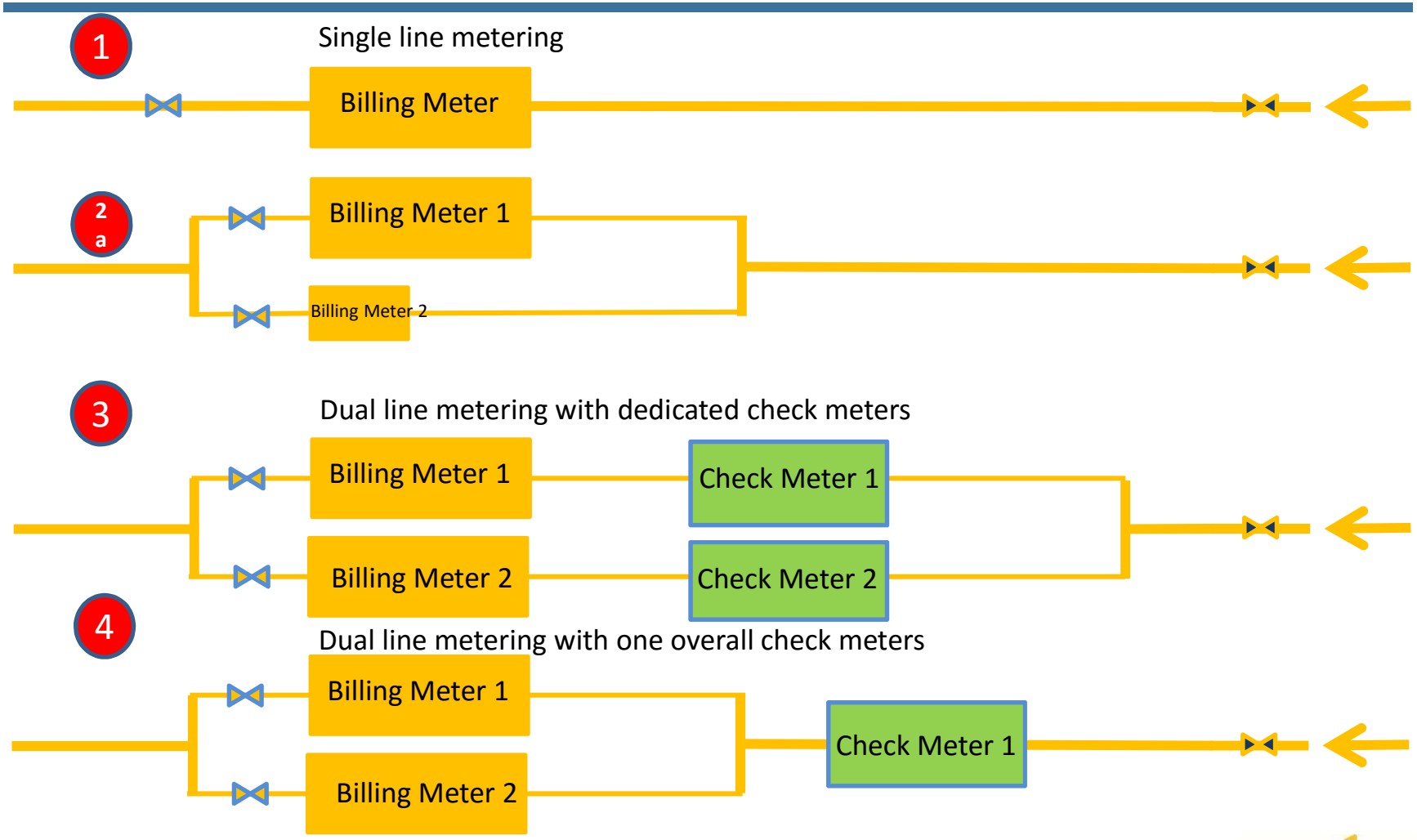
Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations



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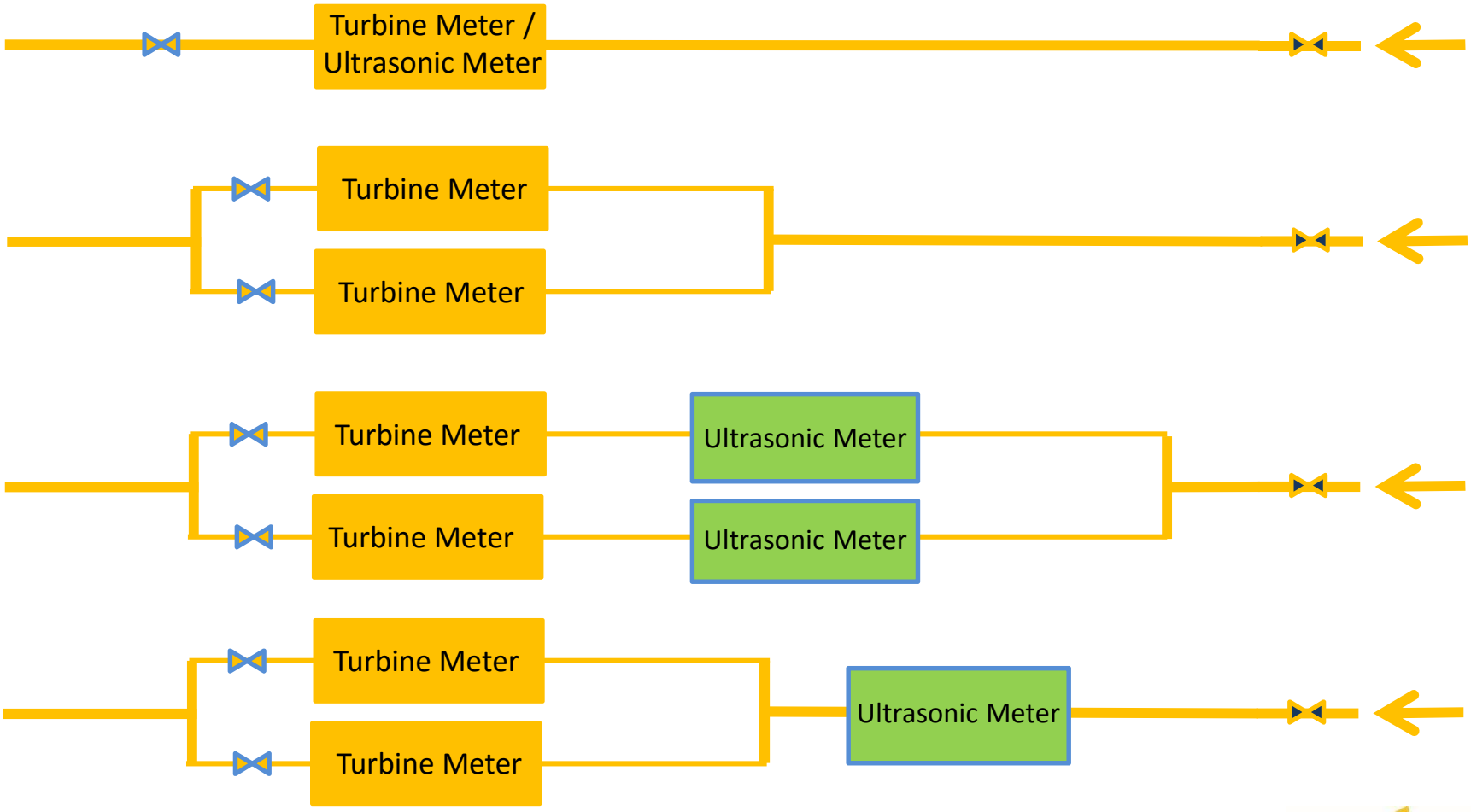
Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations – Meter principles



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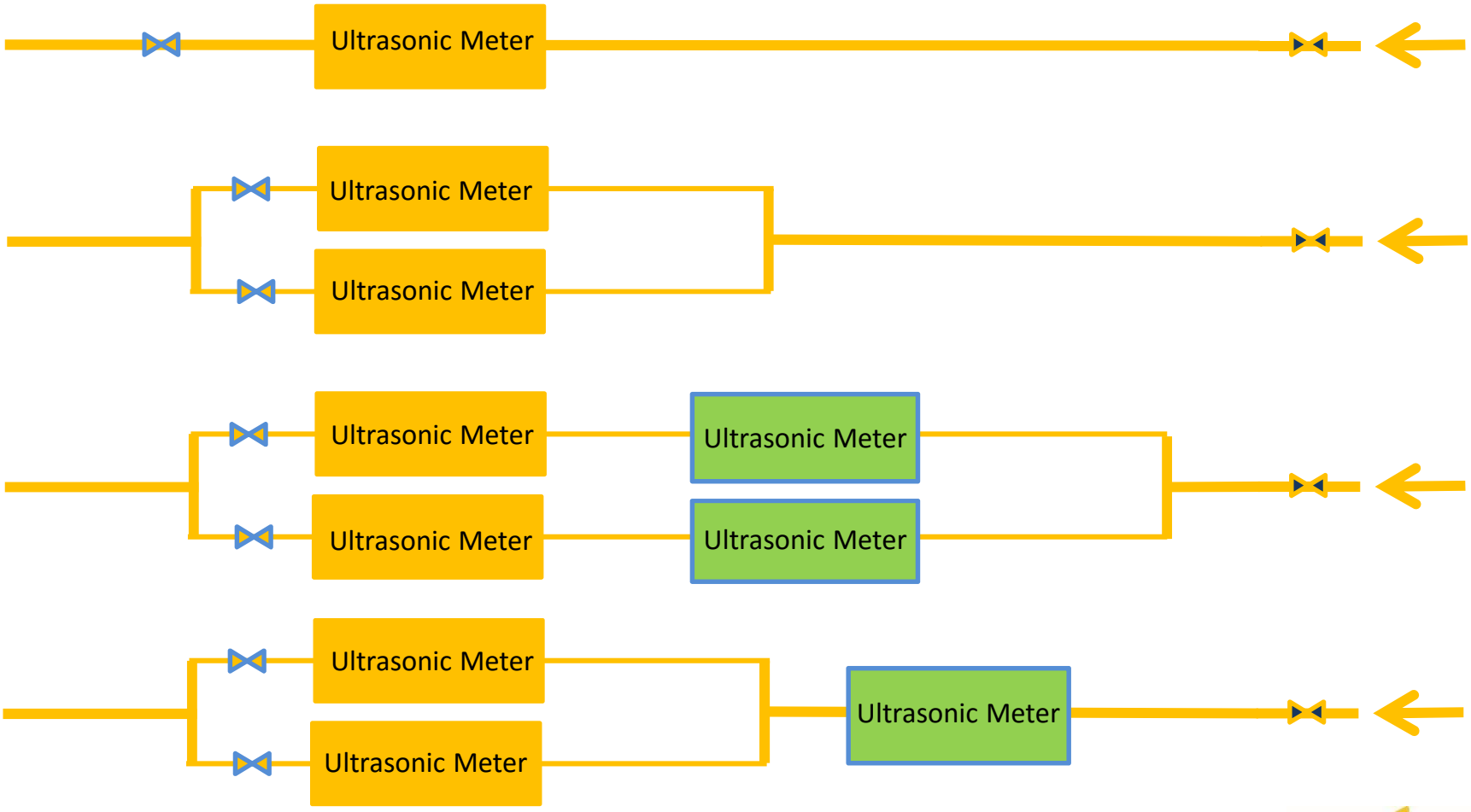
Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations – Meter principles



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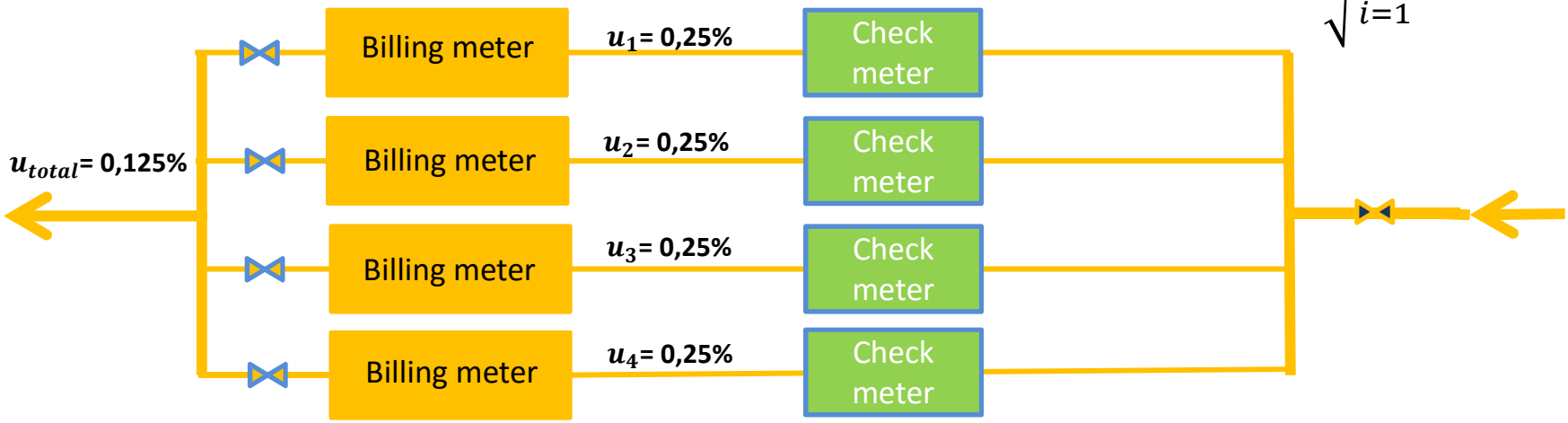
Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations

Measurement uncertainty on Multistream Inline check metering

$$u_{total} = \sqrt[2]{\sum_{i=1}^{k} u_k^2 * \frac{1}{n}}$$



Advantages:

- Smaller meters – easier handling,
- More calibration facilities available due to flow rates
- Redundancy in measurement – recalibration or failure of meter without interruption of operation
- Significantly reduced overall measurement uncertainty
- Early warning through check meters

Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations - example

Inline pipeline meter

Measurement uncertainty:

Individual meter: **0,25 %**

DN 700/ **DN 750**
29 m/s / **25 m/s**
Qmax 40.000 m³/s
Qmin 400 m³/s

Parallel meters

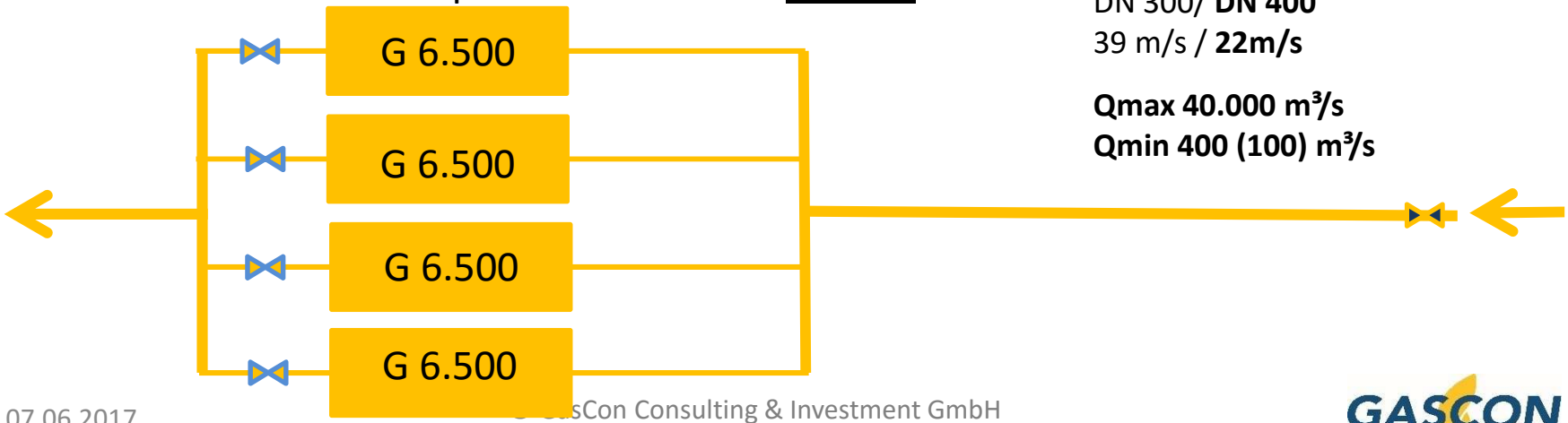
Measurement uncertainty:

Individual meter: 0,25 %

Parallel operation 4 meters: **0,125%**

DN 300/ **DN 400**
39 m/s / **22m/s**

Qmax 40.000 m³/s
Qmin 400 (100) m³/s



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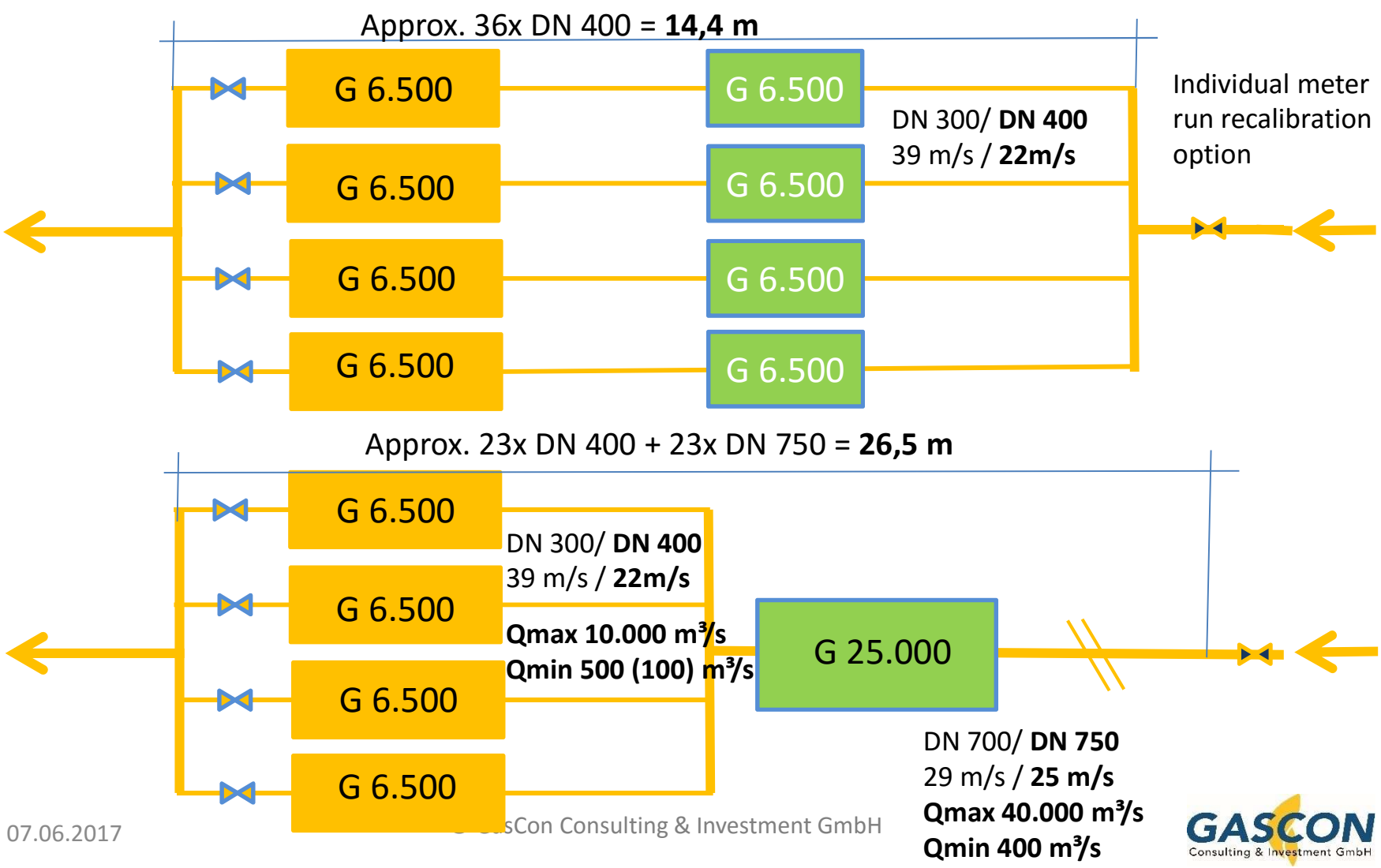
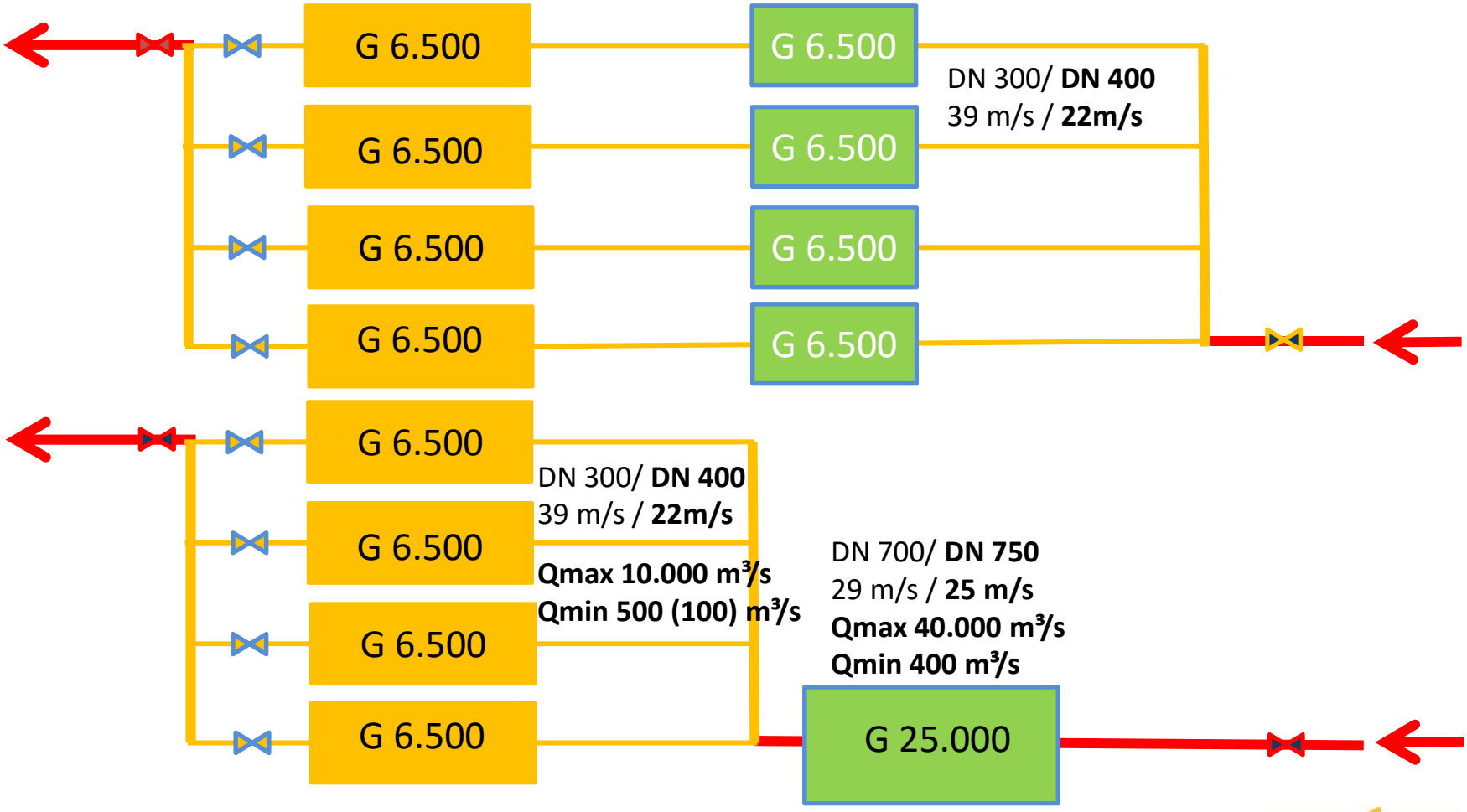
Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations



Recalibration of Ultrasonic Gasflow meters

Conceptual design of Metering stations – equal line length, pressure loss and equal load



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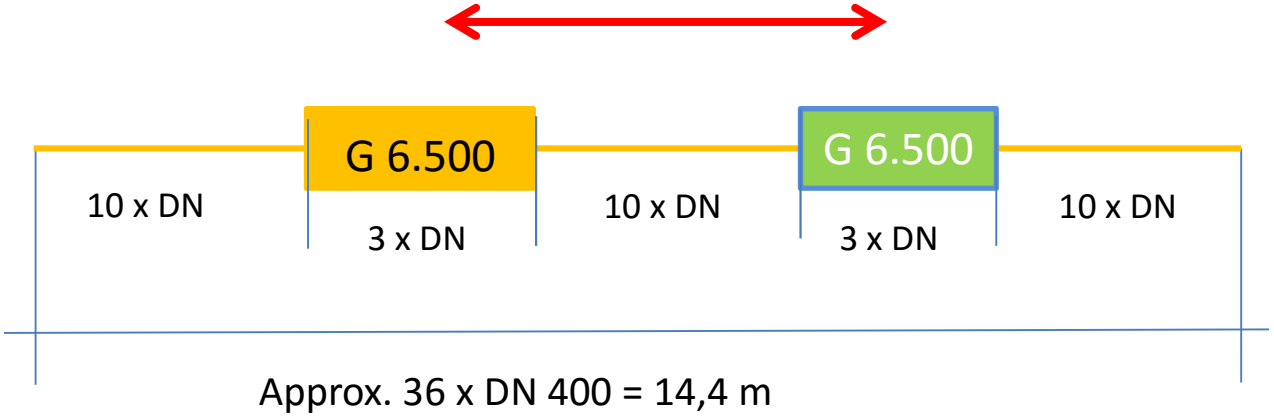
Recalibration of Ultrasonic Gasflow meters

Conceptual design **of bidirectional** Metering stations

Bi-directional measurement with ultrasonic meters

- Underground storage
- Interconnector pipelines

- Symmetrical design of the stations –> inlet = outlet
- Bi-driectional calibration of complete original meter runs
- Main meter and check meter both USM to same specifications (schedules and internal diameters full bore)



Recalibration of Ultrasonic Gasflow meters

Conceptual design **of bidirectional** Metering stations

Bi-directional measurement with ultrasonic meters

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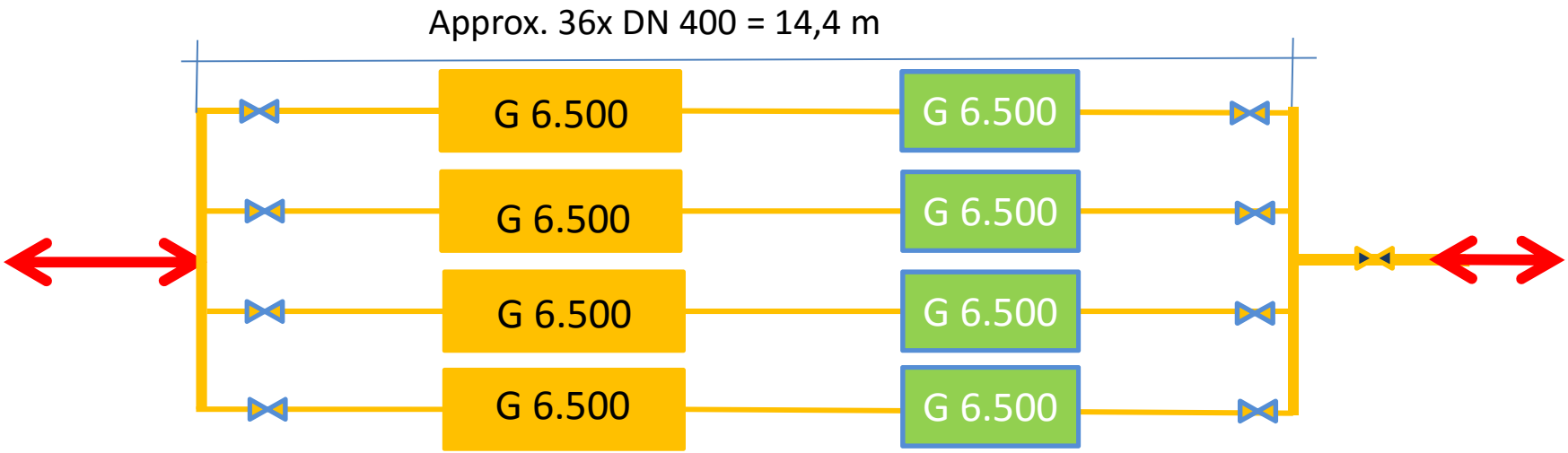
- Interconnector pipelines



- Each meter run individually isolatable for maintenance and recalibration
- Redundancy in case of meter failure
- Planned Re – Calibration on rotational basis (e.g. 1 run/year)
- Very high total measurement range

Recalibration of Ultrasonic Gasflow meters

Possible Influences of metering station design on measurement uncertainty

Flow straightening devices:

Intention:

1. Improvement of the gas flow under metering conditions independent of the upstream flow disturbances
2. Shortening of inlet section of the meter
3. „it is always better to condition the flow“

Actual results:

1. Flow straighteners always cause additional pressure loss (=energy cost for compression)
2. Especially for Ultrasonic meters, the flow straightener is an additional obstacle in an undisturbed, free metering section
3. Partially blocked flow straigtheners will actually cause significant disturbances in flow
4. Flow straighteners may change over time due to particle build up or wear
5. Flow straighteners cause additonal acoustic disturbances which may be in ultrasound range

Recalibration of Ultrasonic Gasflow meters

Recommendations for meter station design, specifications, recalibration intervals

Measurement uncertainty

of custody transfer gas metering should be the primary target of meter station design and maintenance of metering stations

Recommendations:

1. Put high priority on the **design** custody transfer metering stations for
    1. minimum basic measurement uncertainty
    2. Redundancy and regular maintenance
    3. Reproducability after maintenance
    4. Avoid flow straighteners – provide for adequate straight inlet length
    5. Avoid any flow and noise disturbances
2. **Recalibrate** your meters at operating conditons on a **regular basis**
    1. Where to calibrate – how long can you afford to have your meter out of operation?
    2. Calibrate and recalibrate, if possible, the complete meter runs. Fix the positions of the inlet and outlet spools
    3. Look at the basic measurement uncertainty for the (re)calibration for the measurement range
    4. The larger the meter, the higher the risk for the financial impact of mismeasurement

Recalibration of Ultrasonic Gasflow meters

It is all about reduction of financial risk and cost !

It is all about measurement uncertainty

….and it is all in your hands !

Thank you for your attention.

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