CURSO DE INTRODUCCIÓN A LA MEDICIÓN DE GAS POR ULTRASONIDO
NEUQUÉN, SEP. 2003

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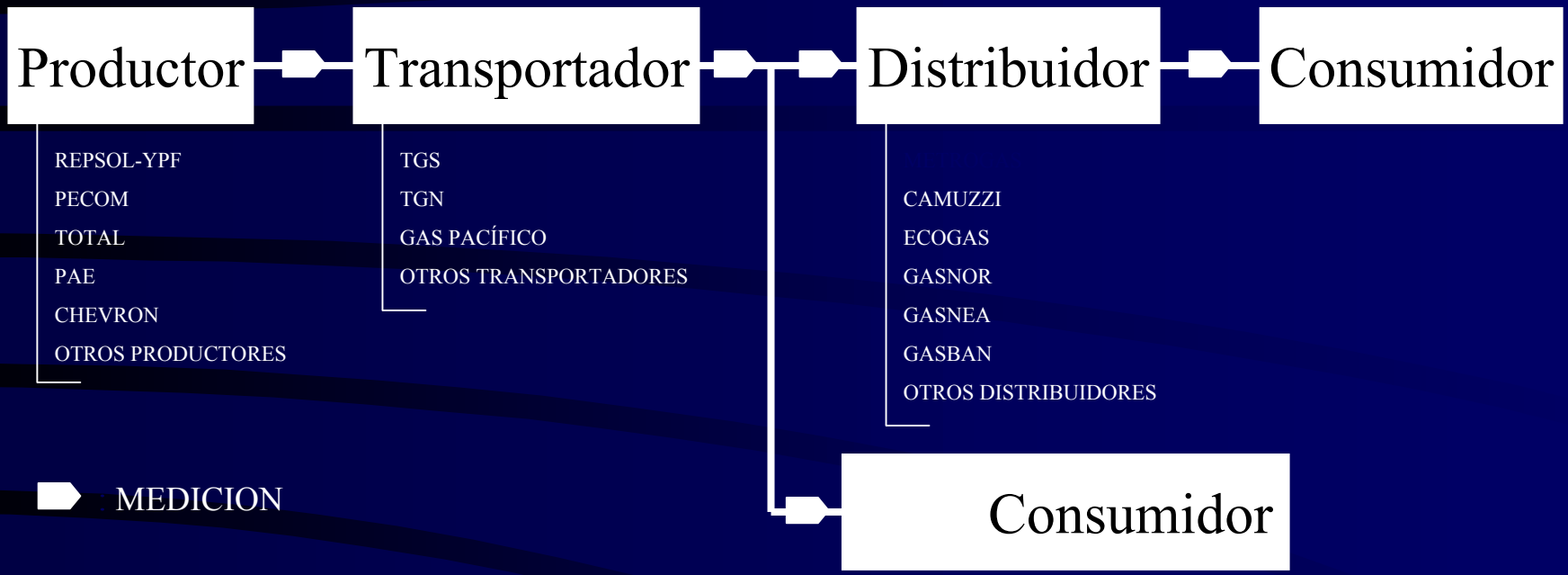
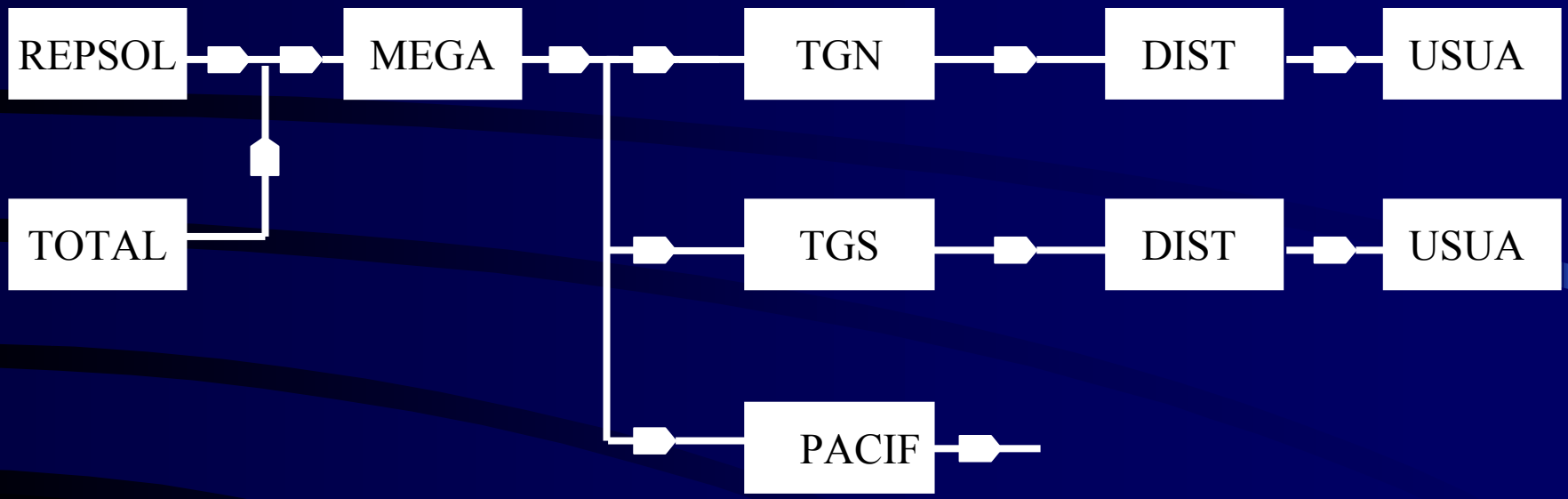
MEDICION DE GAS



- La medición diaria de gas triplica, al menos, la producción diaria.
- La custodia del producto pasa del productor al transportador, luego al distribuidor y finalmente llega al usuario final.

MEDICION DE GAS
EJEMPLO CUENCA NEUQUINA



: MEDICION

INCERTIDUMBRE

- La incertidumbre de una medición (banda de posible error de la medición) con placa de orificio es en la práctica de 1,2 % (NMI).
- La incertidumbre de una medición con ultrasónico o turbina es, con igual criterio, de 0,6%.

INCERTIDUMBRE
VOLUMENES INVOLUCRADOS

- Una cadena de dos mediciones con placa de orificio tiene una incertidumbre de 1,7%, mientras que con medidores volumétricos es de 0,85%.

- Por día se miden 390 millones de sm^3. Con medición con placa de orificio tendríamos una banda de posibles no contabilizados del orden de 7 millones de sm^3. Con ultrasónicos sería de 3,5 millones de sm^3.

MEDIDORES ULTRASONICOS

- La tecnología ultrasónica se emplea en un porcentaje importante de las mediciones fiscales de gran volumen:

TGS	**50%**
MEGA	**100%**
TOTAL	**75%**

- La participación será mayor por la reducción constante de precios.

Otros Clientes

Capex

Andina

PETROBRAS

Litoral Gas S.A.

pluspetrol

Chevron

Gas Andes

PROFERTIL

PIONEER
NATURAL RESOURCES
(ARGENTINA) S.A.

TECPETROL

Techint

Gas Atacama

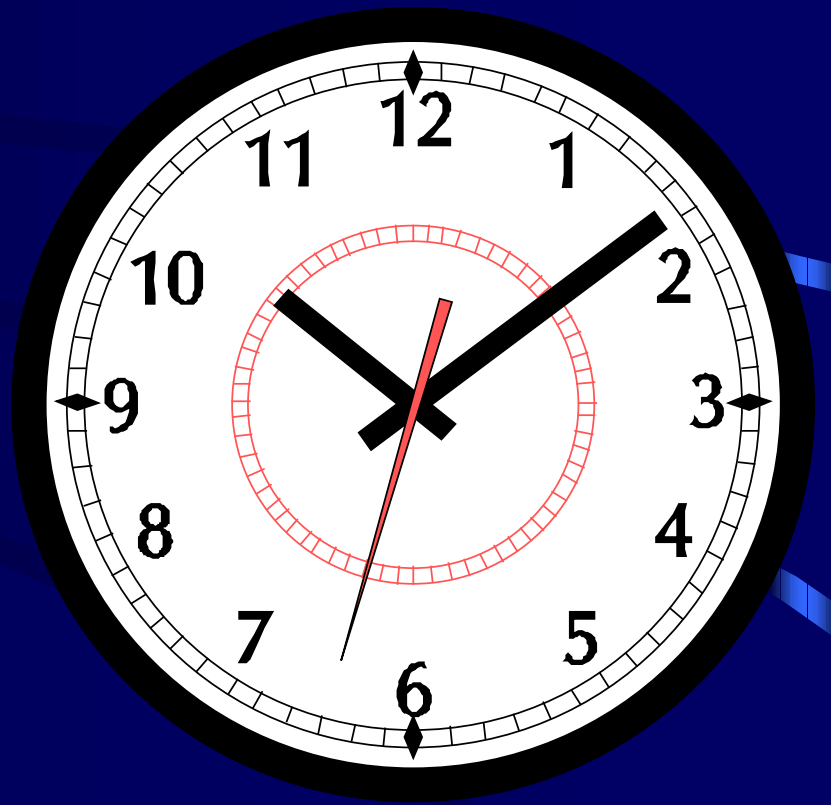
TECNA

Benefits of Ultrasonic Metering

- High rangeability (typically > than 50-1)
- High accuracy and very linear
- No moving parts
- Virtually no maintenance
- No pressure drop
- Reliable with dirty gas
- Low cost of ownership

Requirements for an Accurate Ultrasonic Flow Meter

- Precise Meter Body
- High Resolution Clock
- Stable Electronics
- Intelligent Signal Processing
- Well Documented Dry/ Zero Calibration
- Extensive Testing and Calibration Results

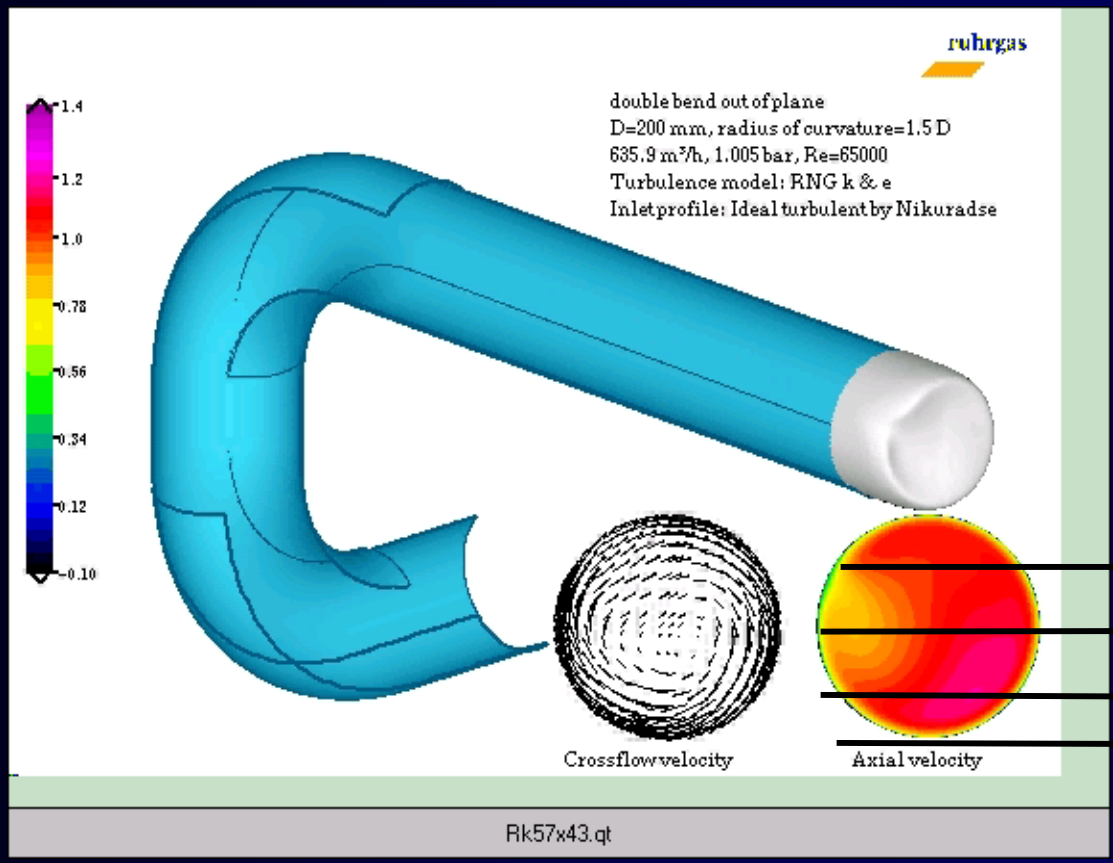


Path configurations

- Single path reflective (check meters)
- double path reflective (small custody)
- three path reflective (custody)
- four path parallel chords (custody)
- five path reflective (custody)

Perfil de flujo 2 Codos fuera de plano

8” Piping



Chords

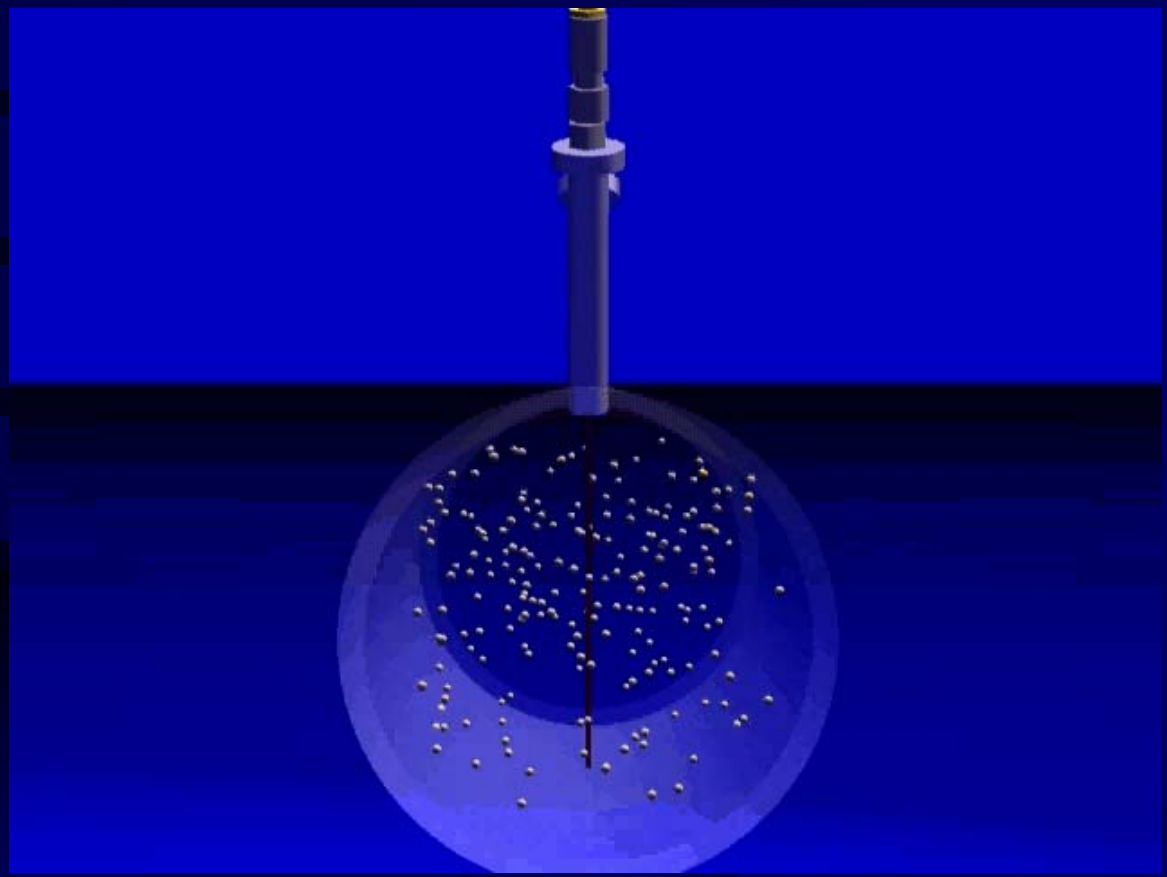
A

B

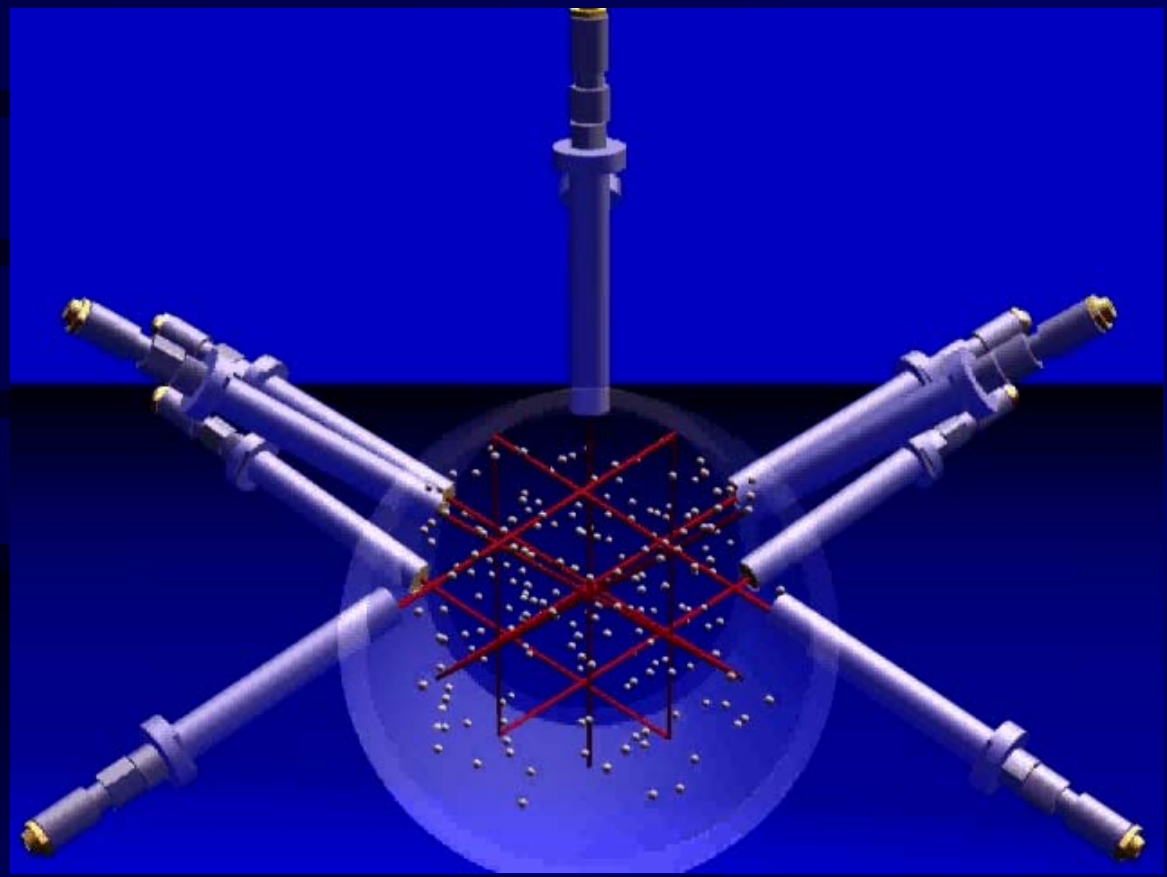
C

D

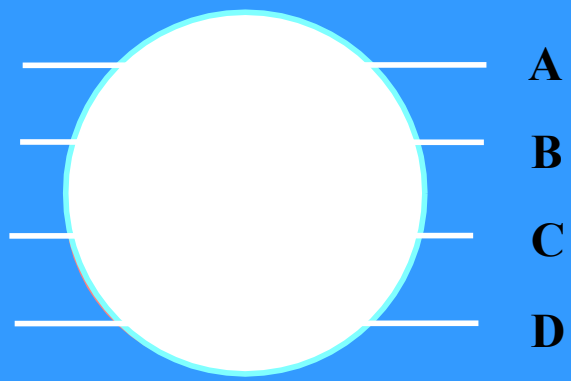
Single path single reflective



Five path matrix combination



Cálculos para el SeniorSonic
Multipath significa medición múltiple de velocidades

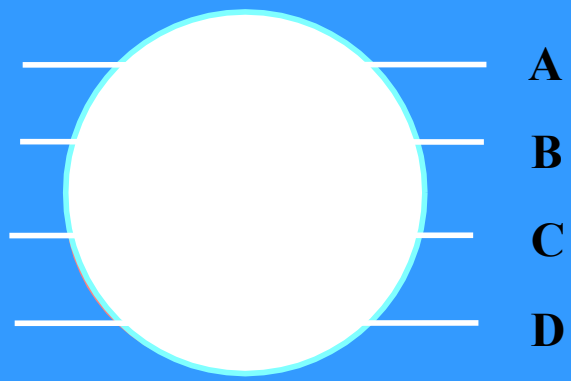


Multipath Meter

$$V_n = \frac{L^2}{2x} \frac{(t_1 - t_2)}{(t_1 t_2)}$$

$$V_{avg} = \sum_{n=1}^{4} W_n V_n$$

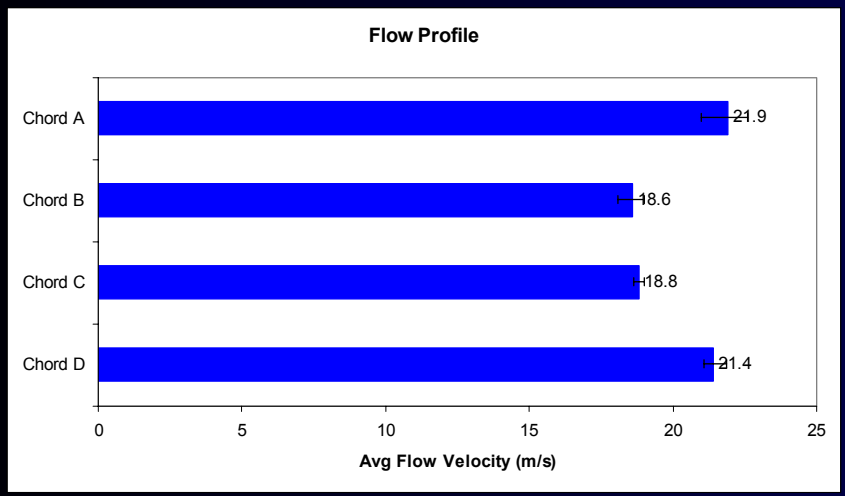
Factores de ponderación por Geometría
Los factores de ponderación dependen únicamente de la geometría!

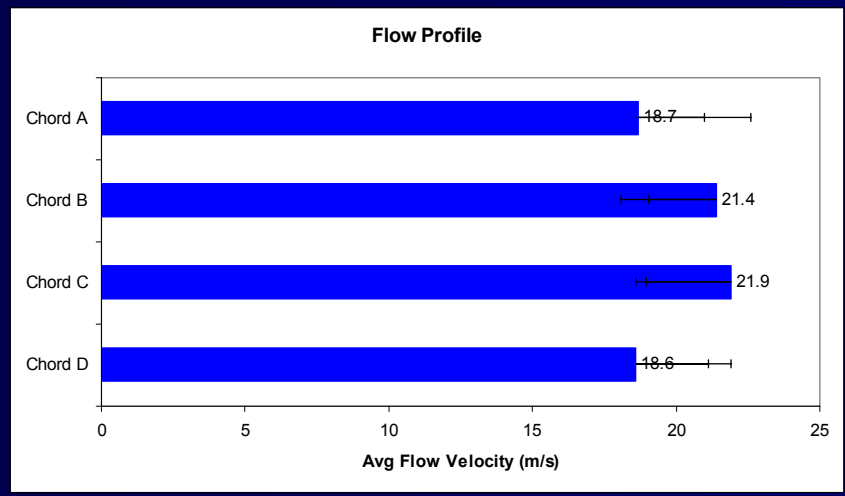


Multipath Meter

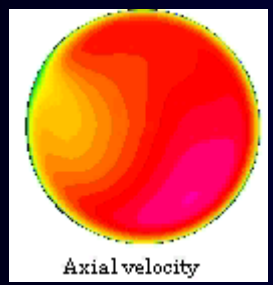
$W_a = 0.1382$
$W_b = 0.3618$
$W_c = 0.3618$
$W_d = 0.1382$

Flow Profiles Posibles

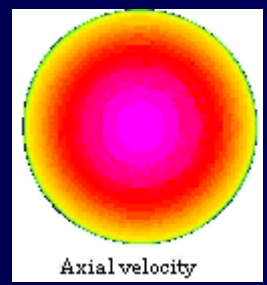


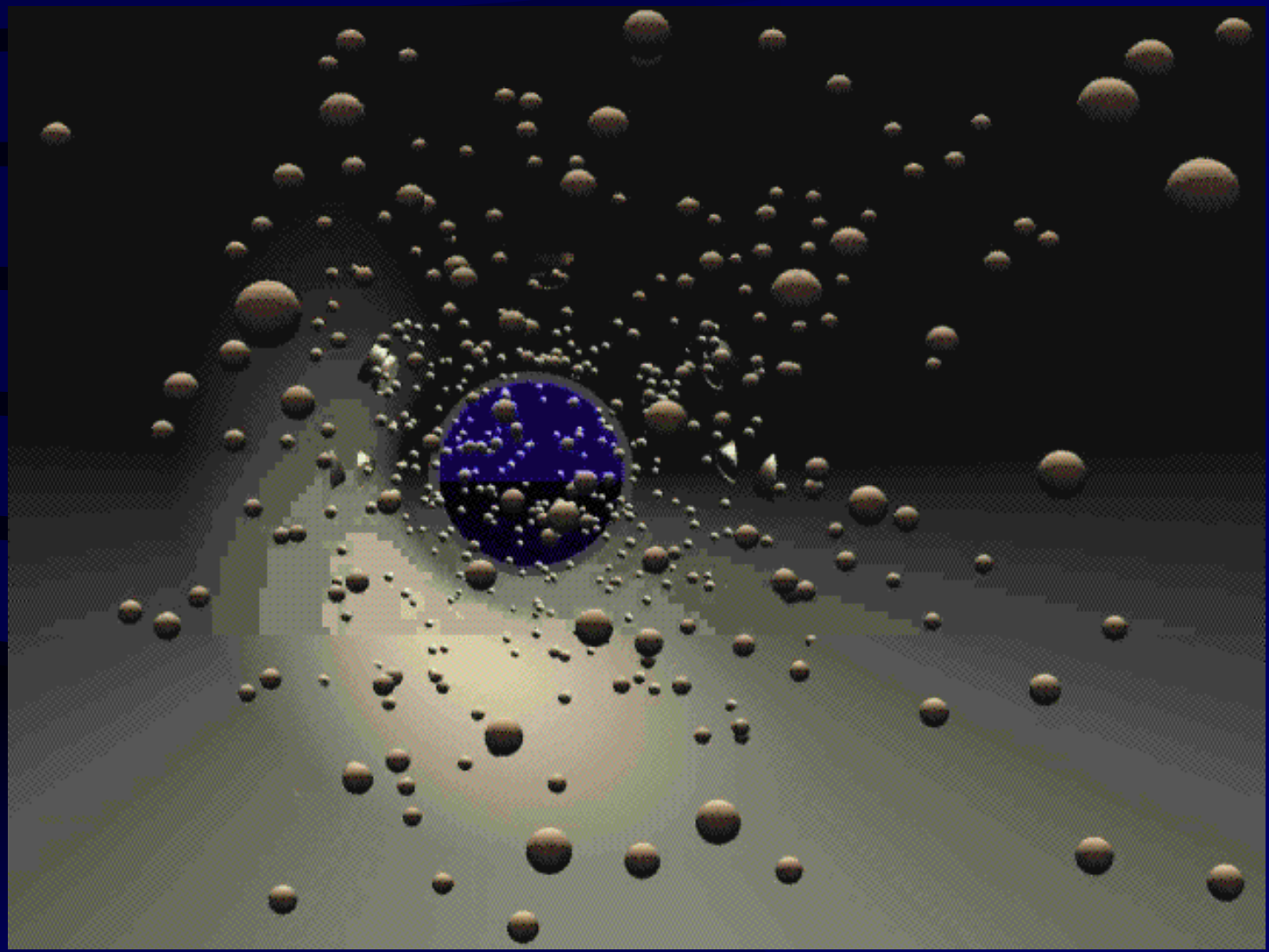


- Con “Swirl”



- Sin “Swirl”





Ultrasonic Meter Applications

- Custody transfer (2, 3, 4, 5 & 6 Path)
- Check metering
- Pipeline operation
- Underground storage
- Compressor control
- Lost and unaccounted for gasw

AGA Report No. 9

Measurement of Gas by Multipath Ultrasonic Meters

Transmission Measurement Committee
Report No. 9

Operating Section
American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

Catalog No. XQ9801

June 1998

Performance Specification Summary

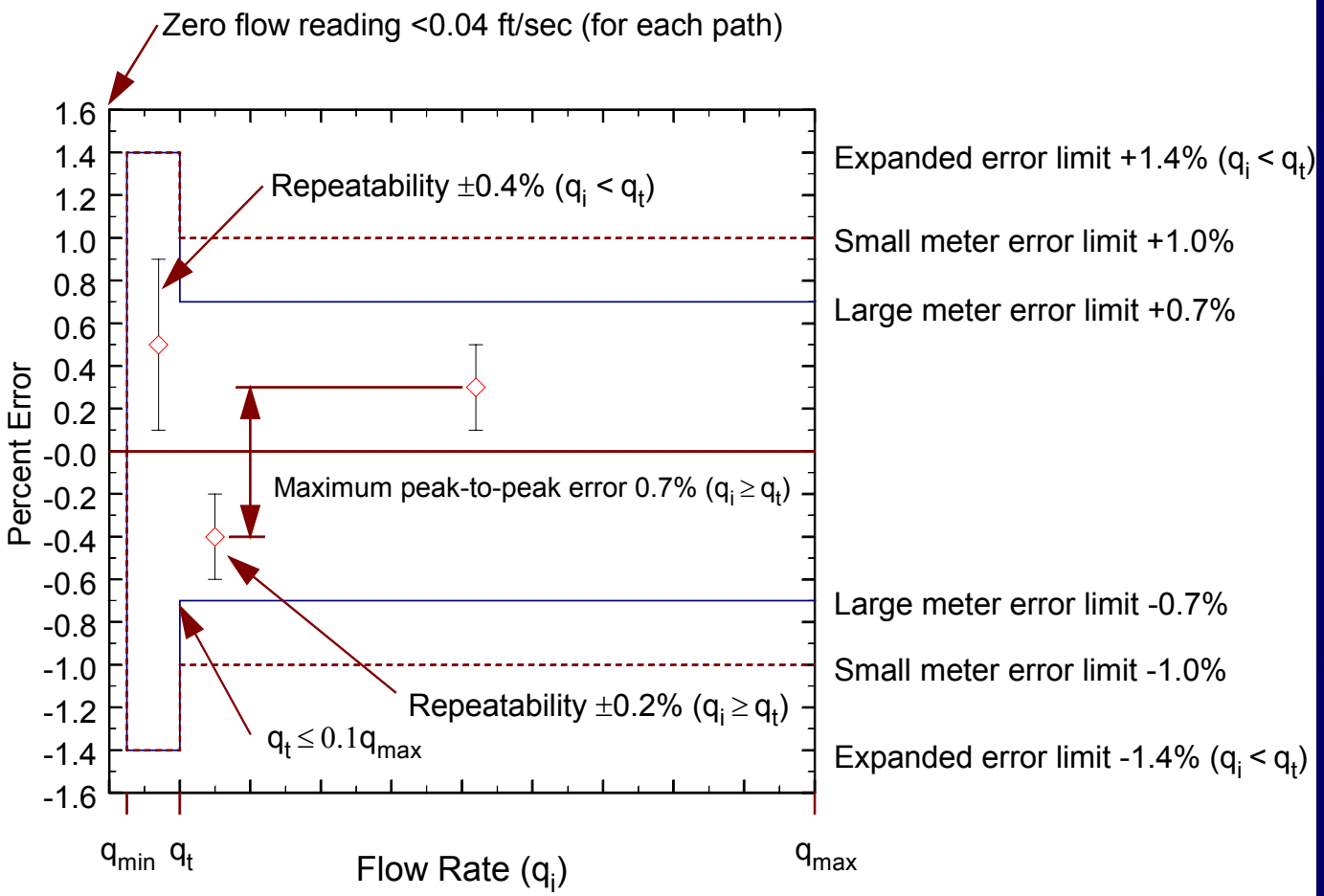
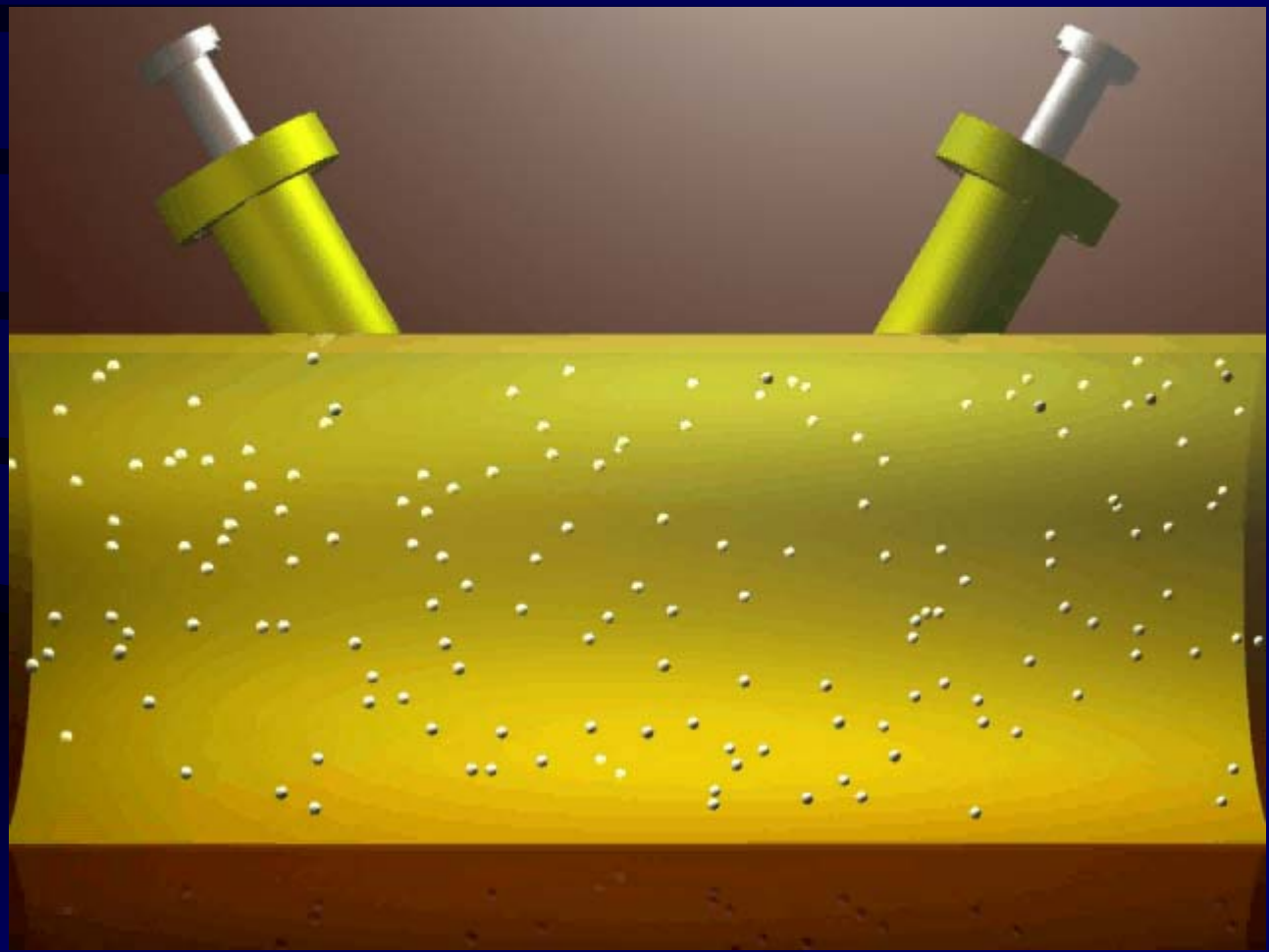


Figure 1 from AGA 9

Principles of Operation

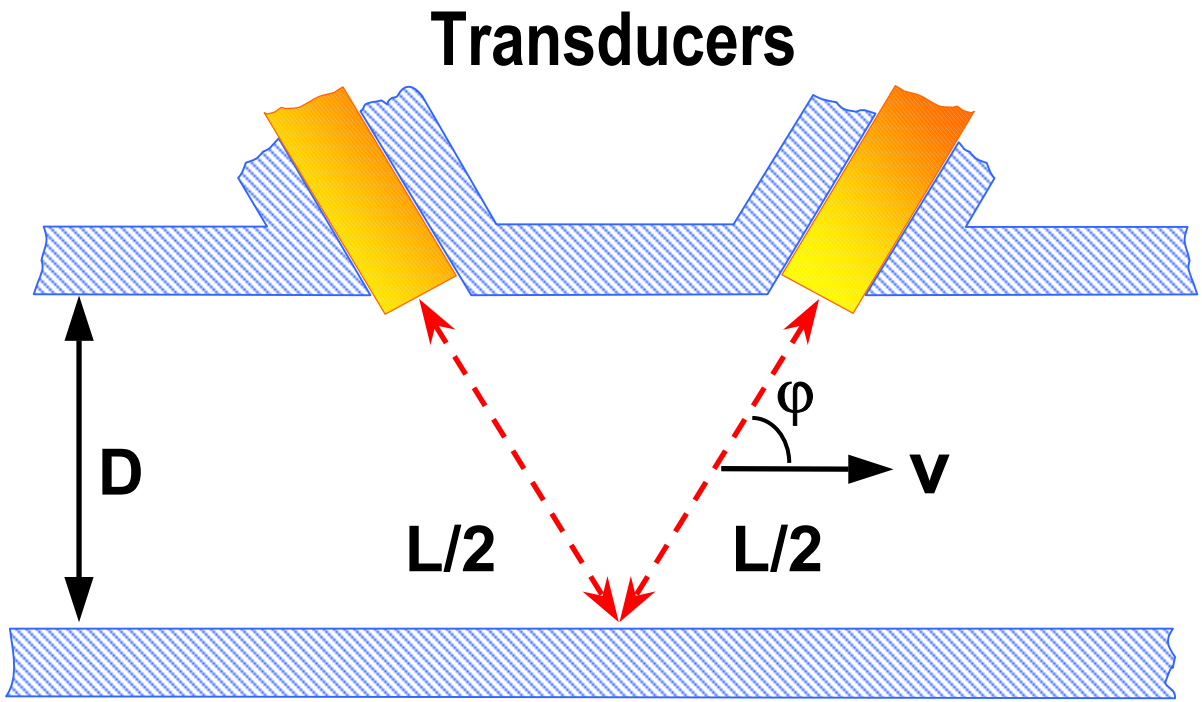
- One (or more) pair of transducers
- Alternately transmit 100 (& 200) kHz signal
- Measure difference in transit time
- Each pair samples several times/second
- Determine velocity of gas
- Compute volume from velocity

Ultrasonic Signal Transmission



Single Bounce Reflective Path

» Datos básicos



Important Basic Equations

Travel Time Equations

$$t_U = \frac{L}{c - v \bullet \cos\varphi}$$

$$t_D = \frac{L}{c + v \bullet \cos\varphi}$$

Velocity Equation

$$\hat{v} = \frac{L}{2 \bullet \cos\varphi} \left(\frac{1}{t_D} - \frac{1}{t_U} \right)$$

More Complex Equations

$$v(r) = v_{\max}\left(1 - \frac{r}{R}\right)^{\frac{1}{n}}$$

$$v_L = \frac{1}{L}\int_L v(r)dL$$

$$k_c = \frac{\frac{1}{S}\iint_S v(r)dS}{\frac{1}{L}\int_L v(r)dL}$$

$$v_m = \frac{1}{S}\iint_S v(r)dS$$

$$v_m = f_{adjust} \cdot k_c \cdot v_L$$

The Most Important One !!!

$$Q_{Line} = v_m \cdot A = v_m \cdot \frac{\pi D^2}{4}$$

Transit Time Example

Nominal Meter Diameter	**=**	**12 Inches**
Typical Axial Path Length	**=**	**27.56 Inches**
	=	**2.296 Feet**
Typical Natural Gas VOS	**=**	**1270 Ft/Sec**

Zero Gas Velocity Transit Time =

Path Length (Ft.) / VOS (Ft./Sec.) =

2.296 / 1270 = $\underline{1.8082\ 10^{-3}\ \text{Seconds}}$

Transit Time Example (Cont.)

Transit Time Downstream = $t_D = \frac{L}{c + v \cdot \cos\varphi}$

(Gas Velocity of 2 feet per second)

T_d **= (2.296) / (1270 + 2*Cos 60°) =** $\mathbf{1.8065*10^{-3}}$ **Sec.**

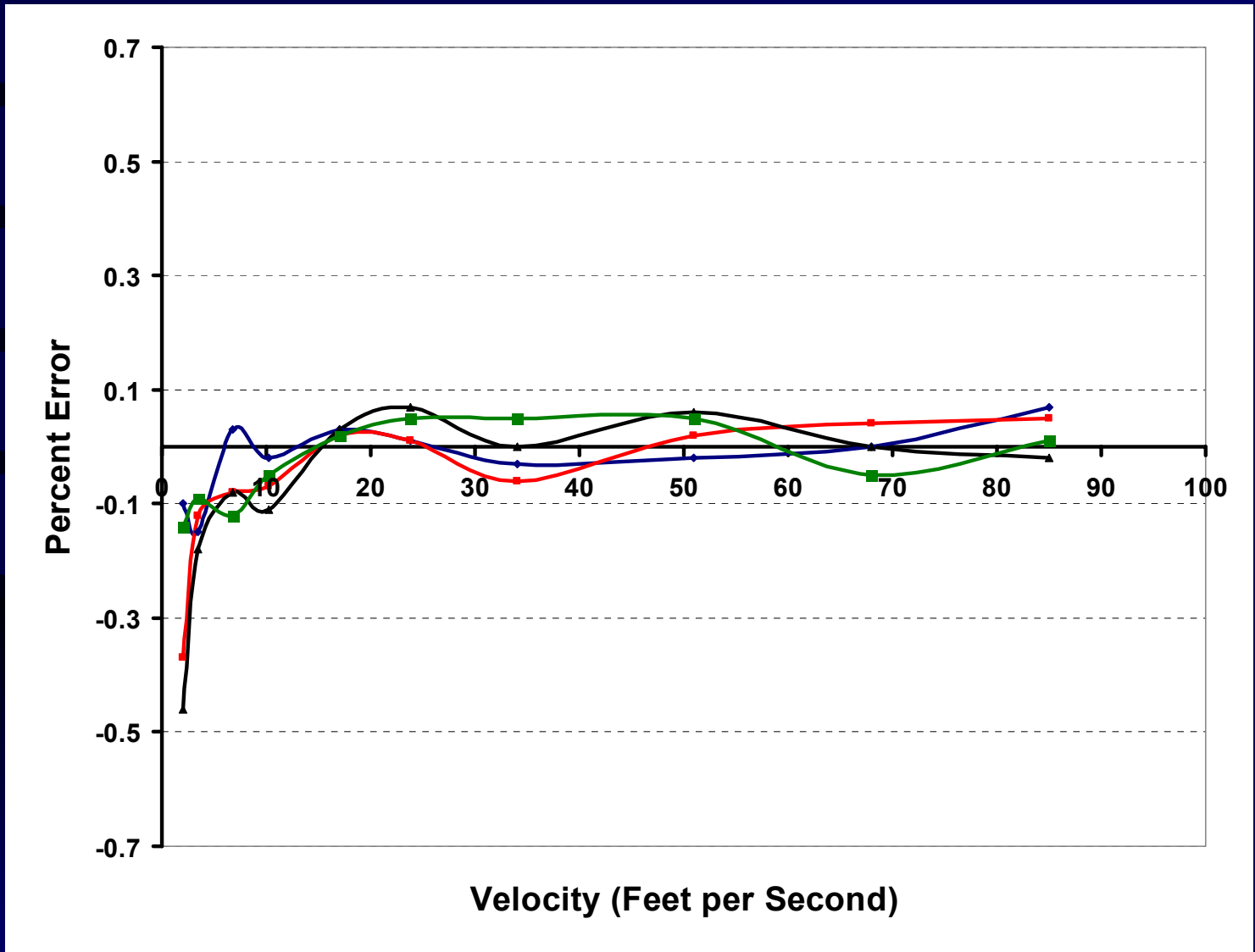
Transit Time Upstream = $t_U = \frac{L}{c - v \cdot \cos\varphi}$

T_u **= (2.296) / (1270 - 2*Cos 60°) =** $\mathbf{1.8093*10^{-3}}$ **Sec.**

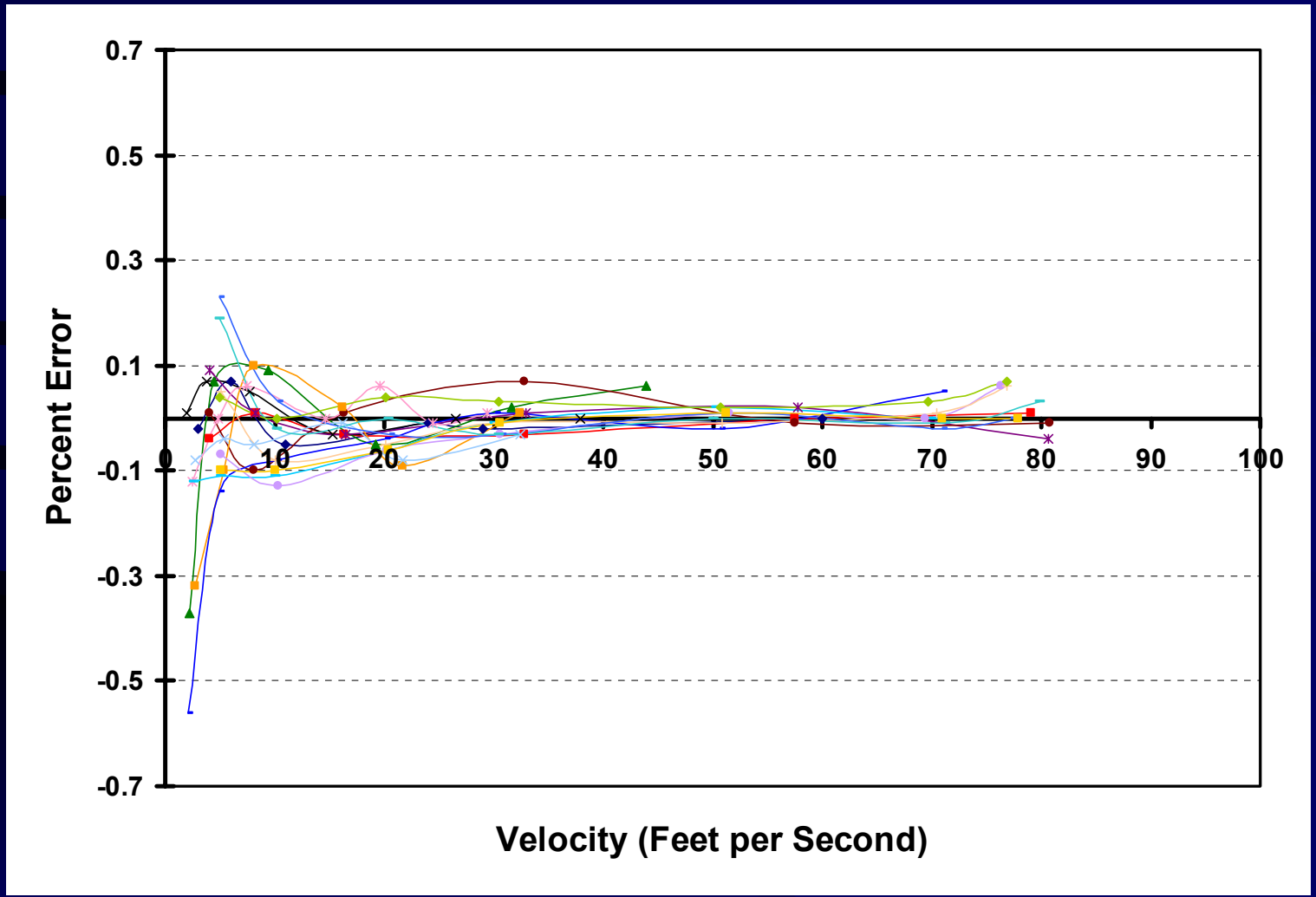
Difference = $\mathbf{1.8065*10^{-3} - 1.8093*10^{-3} = 2.753*10^{-6}}$ **Sec.!**

For 0.1% resolution the required time = $\mathbf{2.753*10^{-9}}$ **Sec.!**

Typical 24 Inch Calibrations



Typical 12 Inch Calibrations

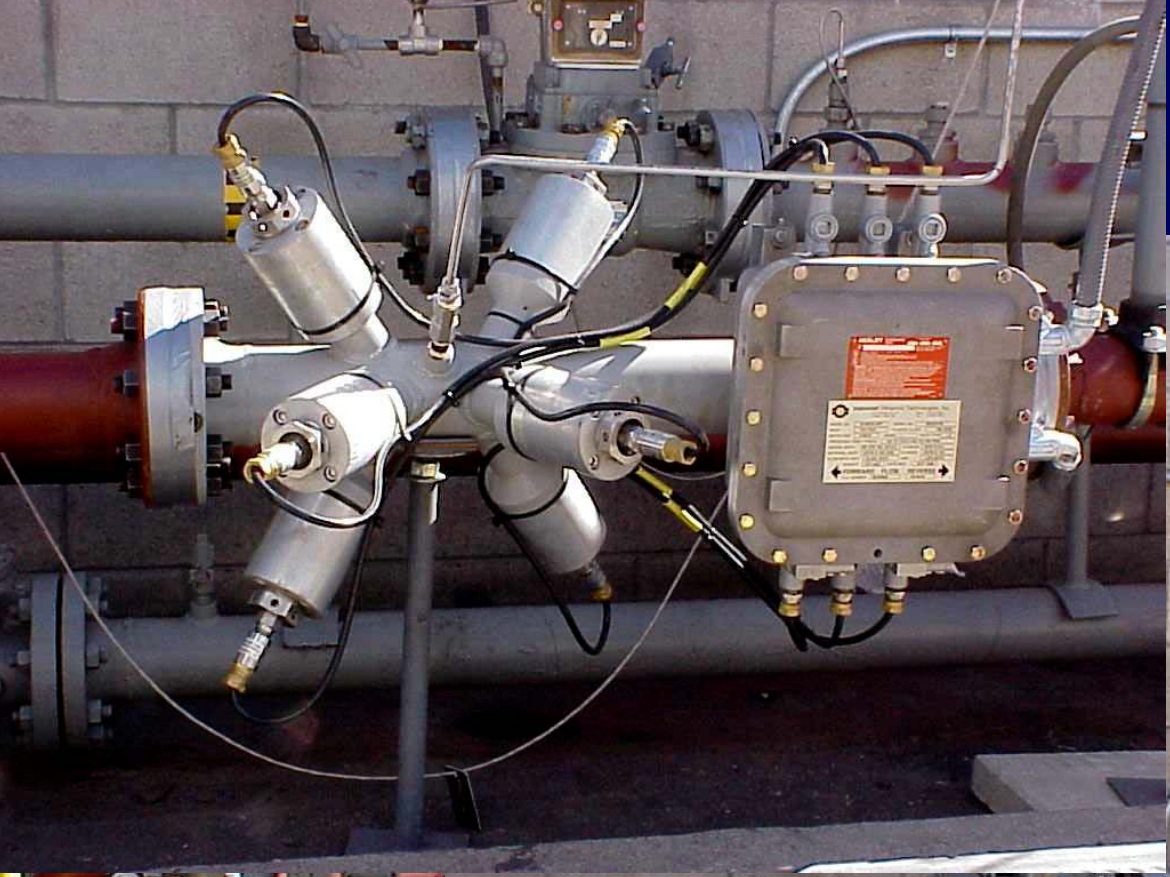


Single Path Insertion Meter

Completed Multi- path Insertion Meter

Single-Path Spool Piece Meter Installation

Multi Path 4-inch Custody



6 Inch Multi Path
Going Vertical!

Neuquén

Bahía Blanca

16 Inch Custody Application

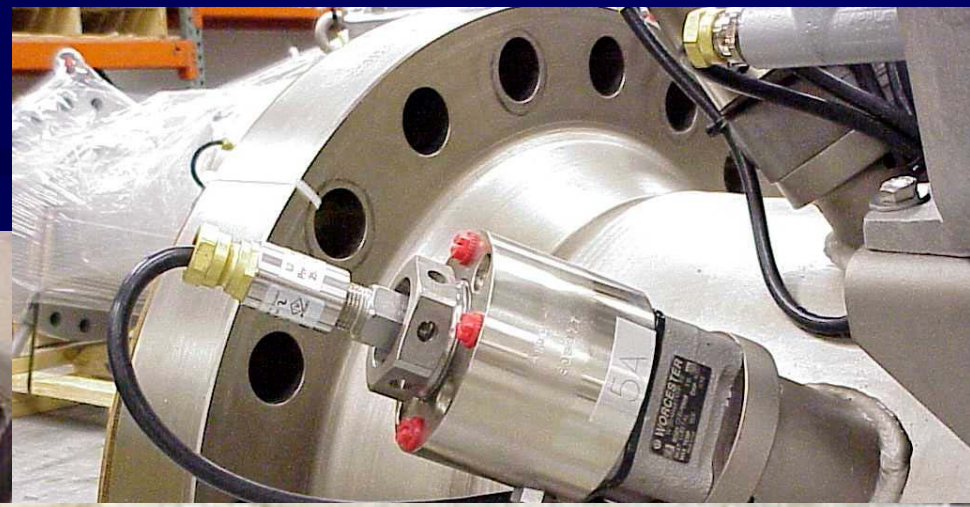
Before and After

- USM

Electronic Outputs

- Two 0-10 kHz frequency (forward & reverse)
- Flow direction outputs (forward & reverse)
- RS-485 or RS-232 serial communications
- Data Valid output
- 4-20 mA inputs for P & T
- 4-20 mA output

Retractable Transducer Assembly



Typical Operational Limitations

- Gas temperatures -20 $\Rightarrow$ +176 F
- Gas pressures 15 - 10,000 psig
- CO_2 less than 20%
- Ambient temperatures -40 $\Rightarrow$ +140 F
- H_2S level depends upon transducer
- Velocities up to 100 fps

General Installation Issues

- 10 / 20 D upstream recommended
- 5D downstream recommended
- Flow conditioning optional
- Avoid tees immediately upstream
- Avoid control valves with >200 psid
- Flow calibration optional

General Piping Considerations

- Upstream diameter within ±1.0% (AGA 9)
- Surface finish relatively unimportant
- Use of alignment pins/flanges optional
- Thermowells 2-5 D (3-5 for bi-directional)
- Recommend cathodic isolation
- Allow room for maintenance

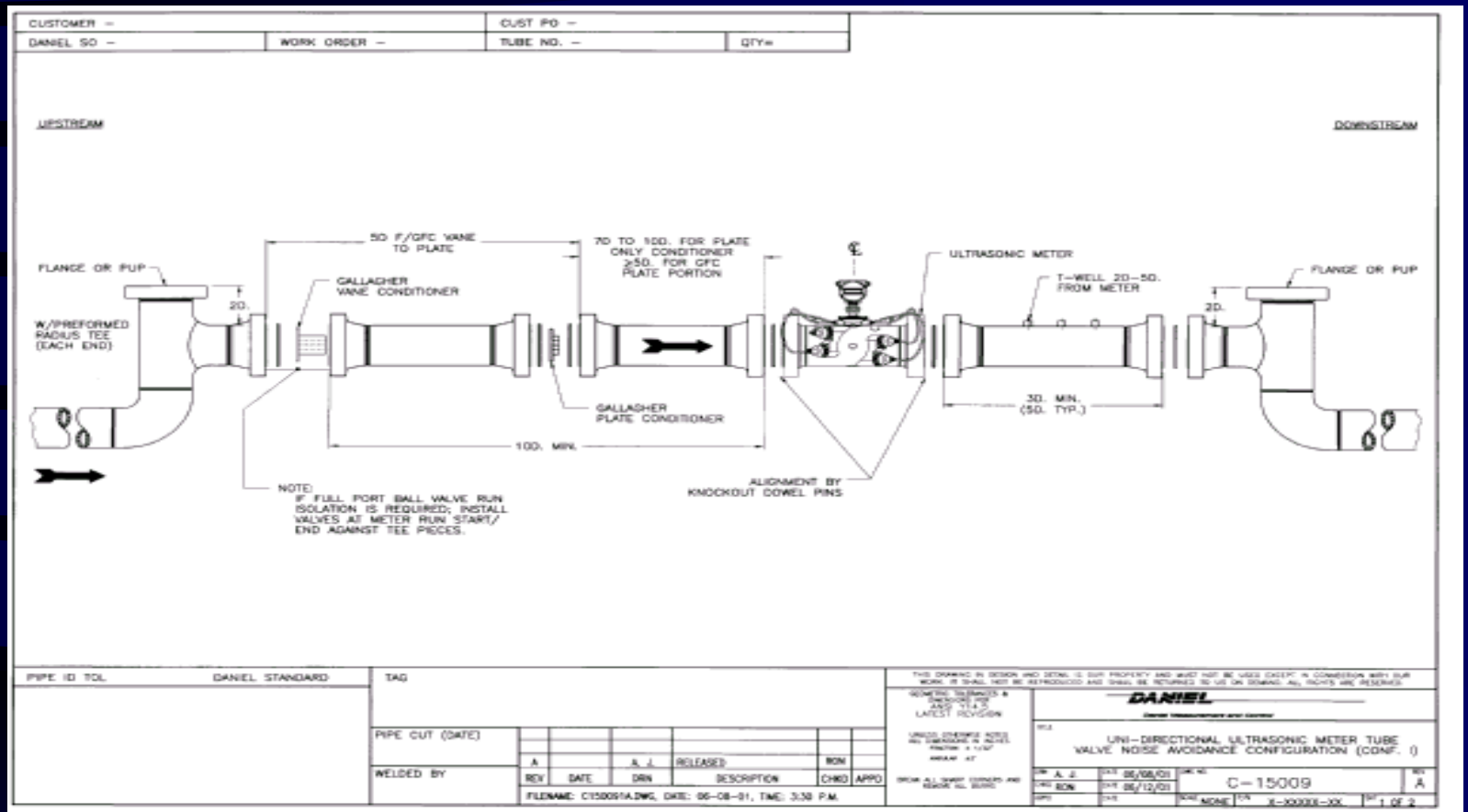
Flow Conditioner Issues

- Not all flow conditioners help USMs!
- Conditioners create pressure loss
- Conditioners may limit meter capacity
- Conditioners increase installed cost
- Conditioners may create noise
- Consult with USM manufacturer first!

Control Valve Application Issues

- Some valves are noiser than others
- Pressure and flow rates more important
- Elbows & tees reduce noise effects
- Effects are significant above 100-200 psid
- Special transducers available
- Consult with manufacturer during design

Diseño para atenuación mecánica



Conclusions

- USMs have many benefits
- USMs have few disadvantages
- USMs are widely used for custody apps
- Performance typically exceeds other meters
- Installation requirements are Mfr. Specific
- Products will continue to improve