

Flow measurement technology for Water/Wastewater



**MEXICAN WATER
CHAPTER**

Fernando Sosa
FLEXIM Regional Mgr





About FLEXIM

FLEXIM Berlin

312 Direct employees

Manufacturing, Calibration and R&D

Corporate offices

Technology Driven Development

Branches Worldwide



FLEXIM Americas, Edgewood, NY

Final production, Calibration, and Service for the Americas

Regional Sales and Service Partners



Product Overview

Flow Measurement

FLUXUS® Transmitters



4 series

Portable flowmeter for water and waste water applications



5 series

Permanent flowmeters for water and waste water applications, BTU / Energy



6 series

Portable flowmeters for liquids, gases & steam



7 series

Permanent flowmeters for liquids, gases and steam



8 series

Permanent flowmeters for liquids and gases in explosion-hazardous areas

Communication Knowledge and Sharing Experiences

For customers and for colleagues



Individual Trainings

Together with you, we develop the content of the respective training having regard to the concrete demands of your company as well as the needs of your industry.



Webinars

We offer free webinars on a regular basis, dealing with various topics around flow measurement technology and process analytics.



Expert Conferences

Experts from diverse industries using our measuring technology come together with our own experts and with partner companies with which we organise these conferences.

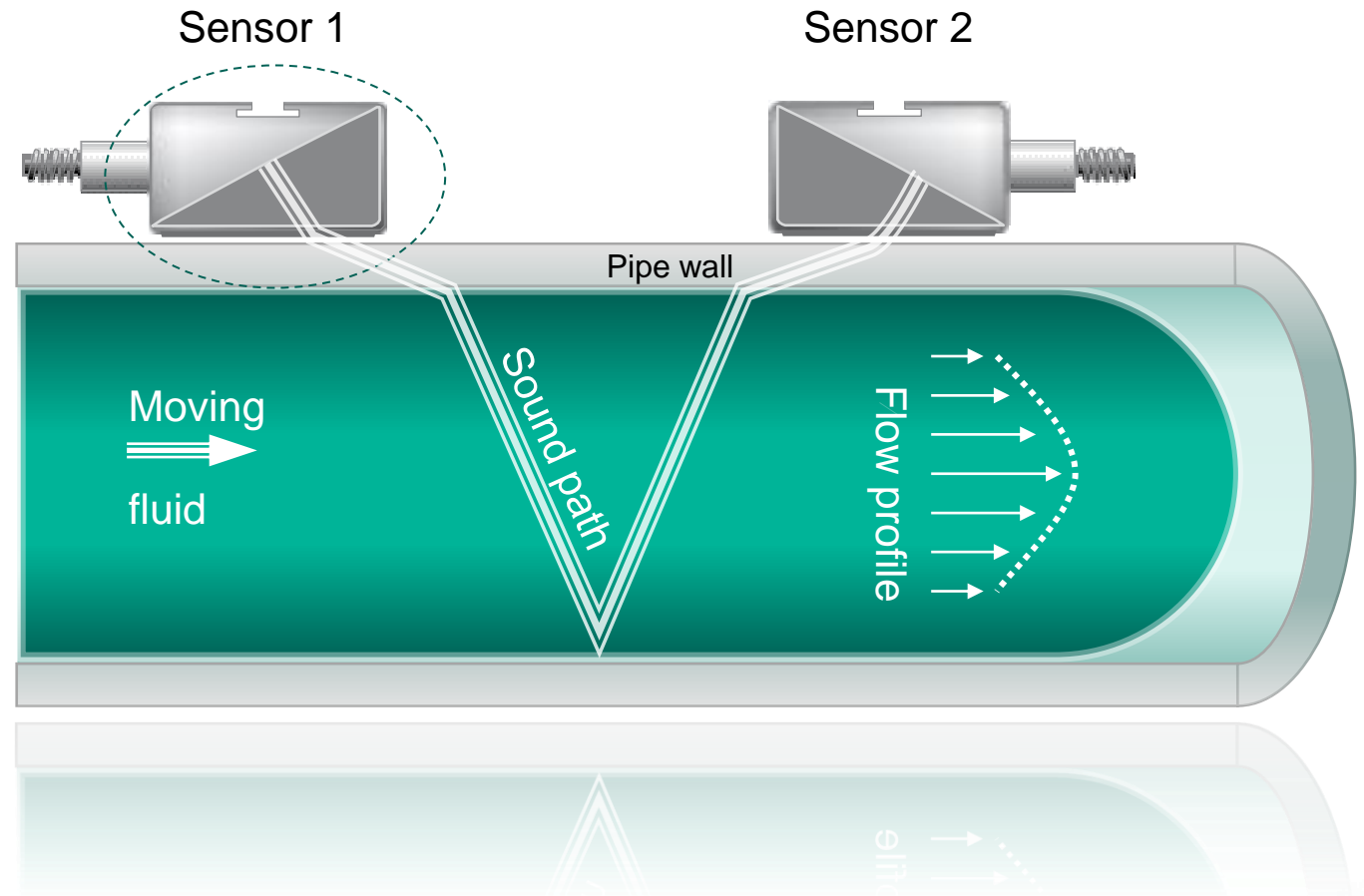


Commissioning Trainings

We offer special practical in-depth trainings for users of our measuring systems.

Transit time difference Flow Measurement

- Two ultrasonic sensor pairs act alternately as transmitter and receive.
- The sound signal is "accelerated" in the flow direction and "braked" against the flow direction.
- The time difference between the signals is proportional to the mean flow velocity.
- From this, the volume flow is calculated on the basis of the pipe parameters.



Advantages of Clamp-On Ultrasonic Flow Measurement

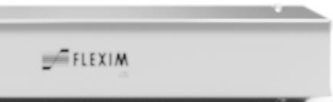
Reduction of energy consumption
no pressure loss

No maintenance required



No additional costs for special alloys
compared to inline devices

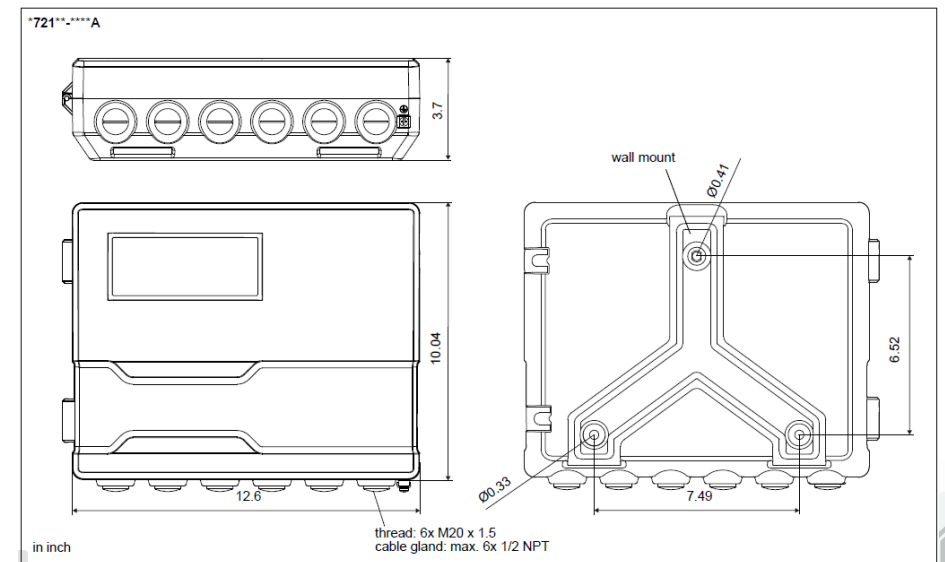
Cost reduction



Distinct Benefits of F721WD

FLEXIM's non-invasive flow meters ensure:

- Non-invasive flow measurement solution
- No wear due to aggressive media
- Bidirectional flow
- Independent of process pressure
- Installation without interruption of operation
- High turndown
- Calibrated accuracy
- Advanced Meter Verification



6 Factors for Success

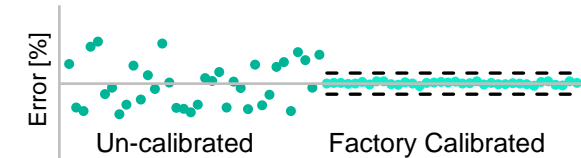
1 Zero Maintenance

No gels, greases or coupling compounds - 10 year “fit and forget” convenience and reliability



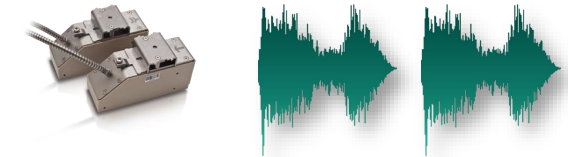
2 Factory calibration

All transmitters and transducers are ISO17025 factory calibrated.
Traceable to National Standards



3 Matched pairs

Matched, paired transducers = best in class low flow



4 Robust mounting rail

Robust Mounting system & cable protection

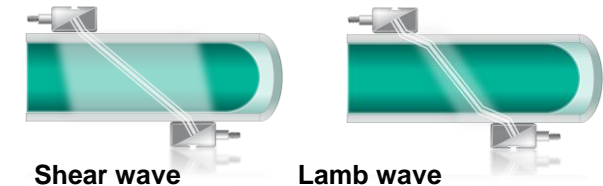
FLEXIM:
- Stainless steel armoured cables
- No connectors on sensors
- Heavy duty rails & protective shrouds



5 Shear Wave & Lamb Wave

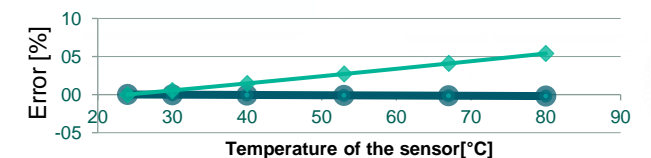
Transducers – two available propagation techniques:

- Shear Wave for standard liquids
- Lamb Wave for Gas and heavily aerated or sedimented liquids



6 Temperature compensation

Temperature compensated transducers
(Meets the ASME MFC-5M-1985 Standard)



Factors for Success: No Gels or Grease

No gels, greases or coupling compounds

- high reliability and zero maintenance
- FLEXIM uses zero maintenance solid Viton pads
- zero degradation for 10 years at 200°C
- ...and we use Lead or Silver coupling foils for high temperatures



1

Zero
Maintenance

Some competitors use coupling gel:



Competitor product video

Some use gel pads (which dry)

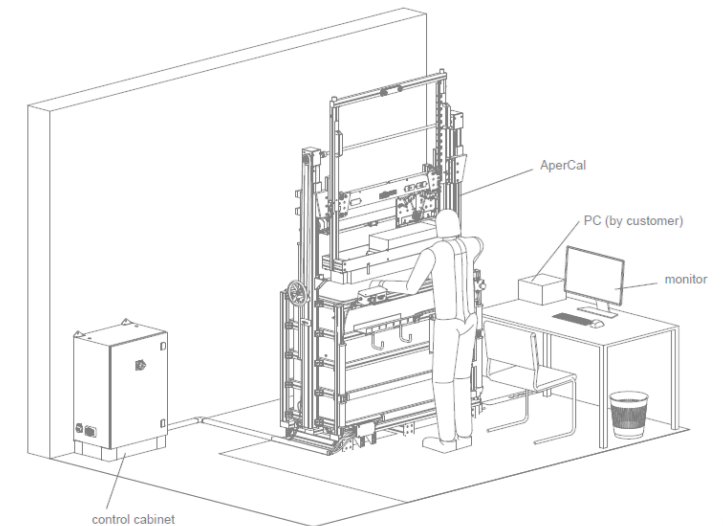
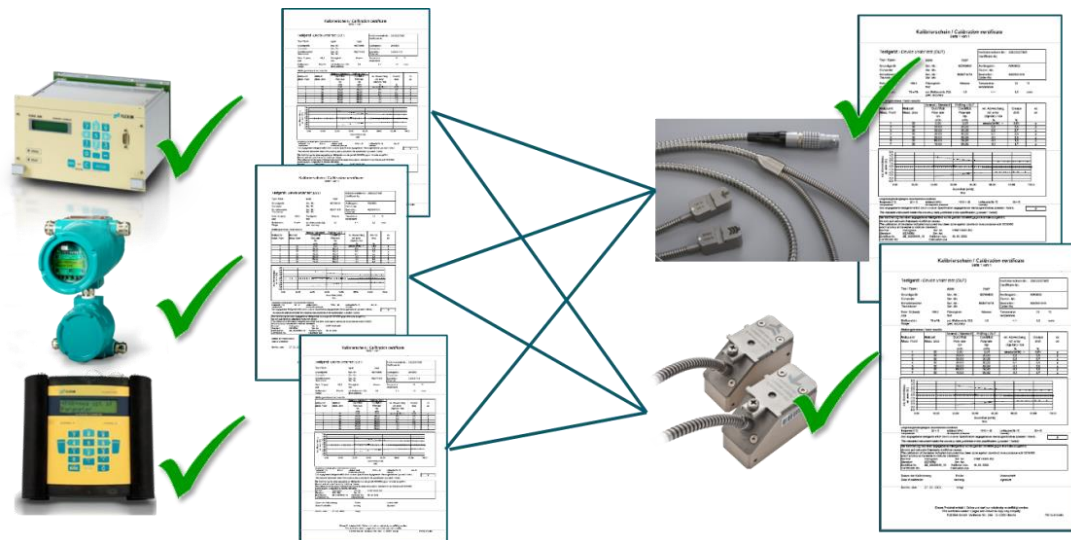


Competitor installation instructions



Factors for Success: Pre-calibration

- Every Transmitter & Transducer Pair Pre-Calibrated
- Wet aperture calibration as standard; stored on a Sensprom chip
- Total uncertainty of calibration 0.1–0.25%, transducer type dependent
- 5 times more accurate than a wet flow calibration – no influence of flow calibration facility profile uncertainty
- Calibration re-scaled to each application during commissioning for optimum start-up accuracy
- Accurate pre-zero; no on-site zeroing

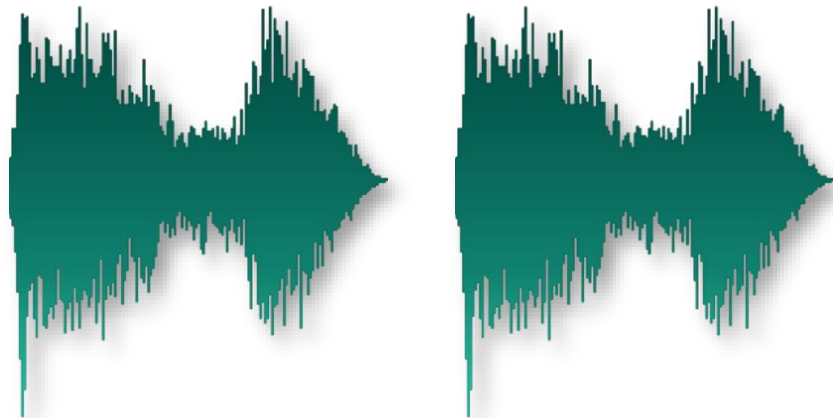


Factors for Success: Matched, Paired Transducers

- Every transducer pair manufactured with matched piezo crystals to maximize measurement performance and low flow resolution

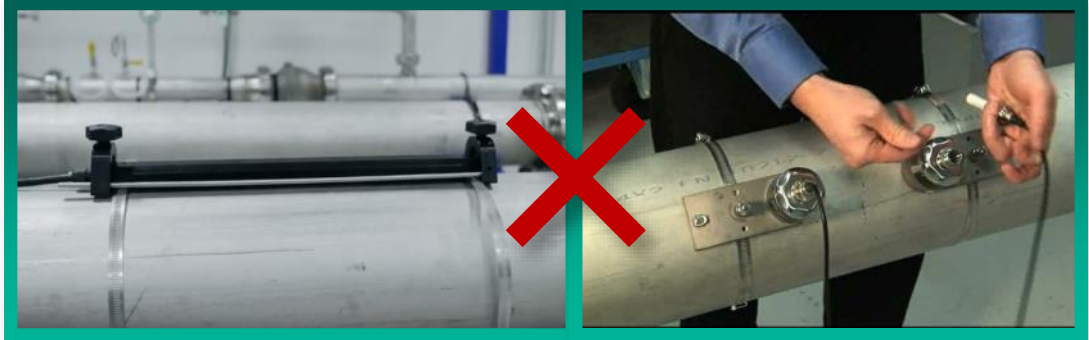
3

Matched
pairs



Factors for Success: Rugged Build & Protection

Competitor mounting systems:



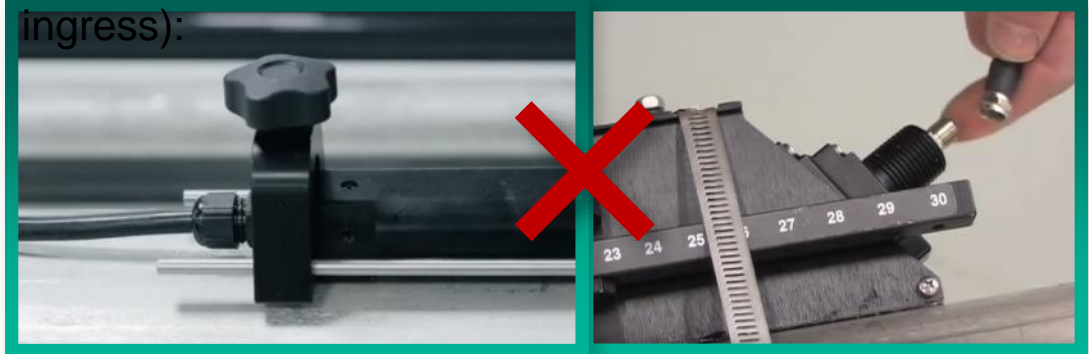
Competitor product video

Competitor product video



4 Robust mounting rail

Competitor cable connectors (possible damage and ingress):

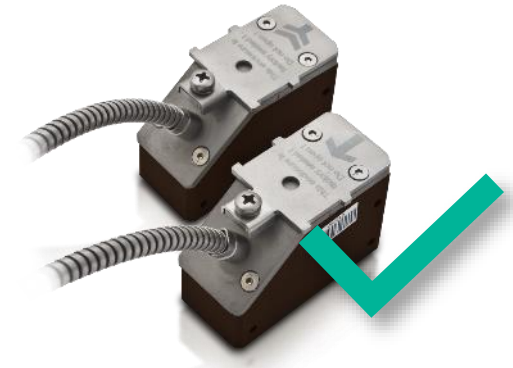


Competitor product video

Competitor product video



- Robust
- Tamper proof design



- No connectors
- Fully sealed design
- IP68 option available

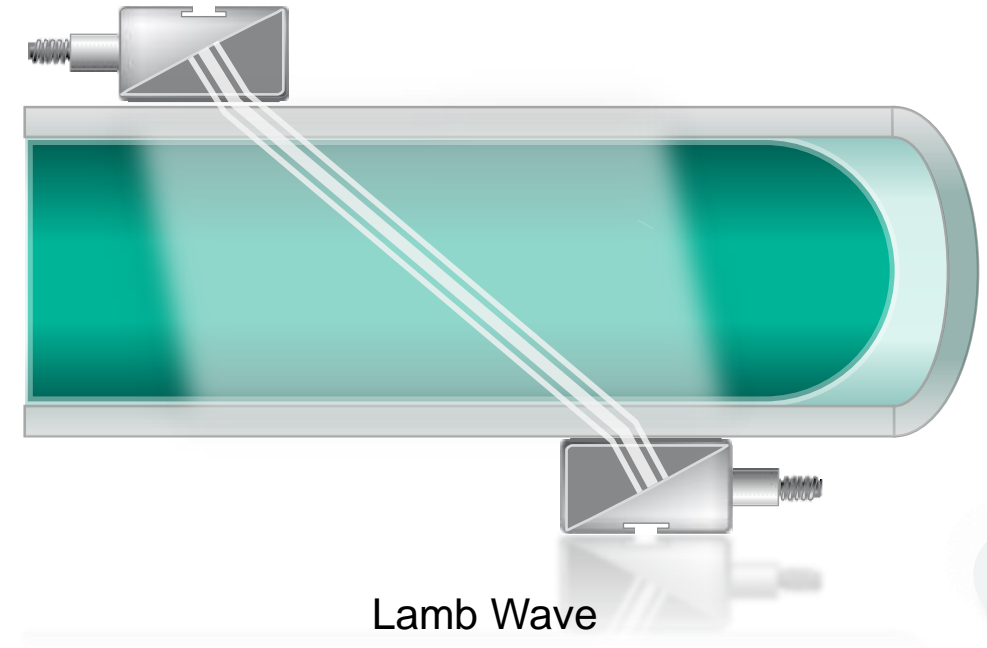
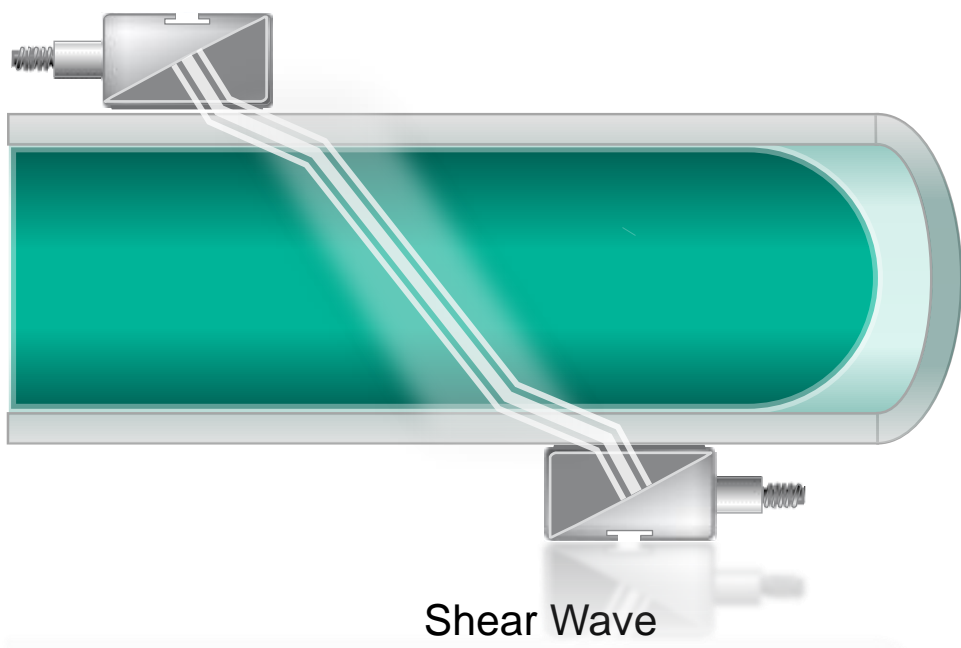


Factors for Success: Two Propagation Techniques

Two different & complementary transducer technologies

- maximum application flexibility
- Shear Wave – 80% of all liquid applications
- Lamb Wave – for challenging heavily sedimented or aerated flows

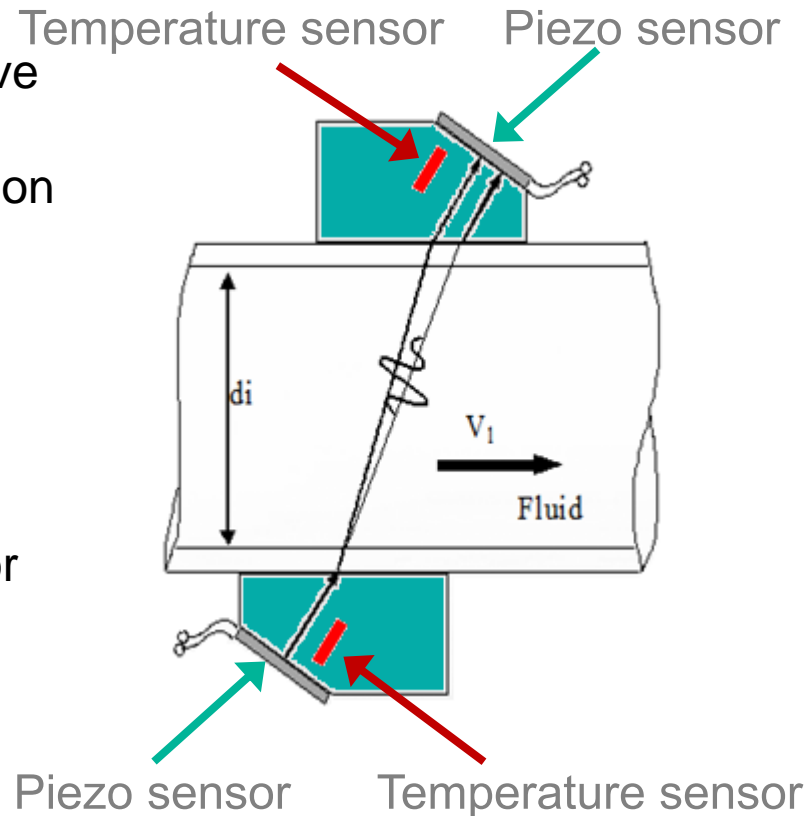
5 Shear Wave & Lamb Wave



Factors for Success: Temperature Compensation

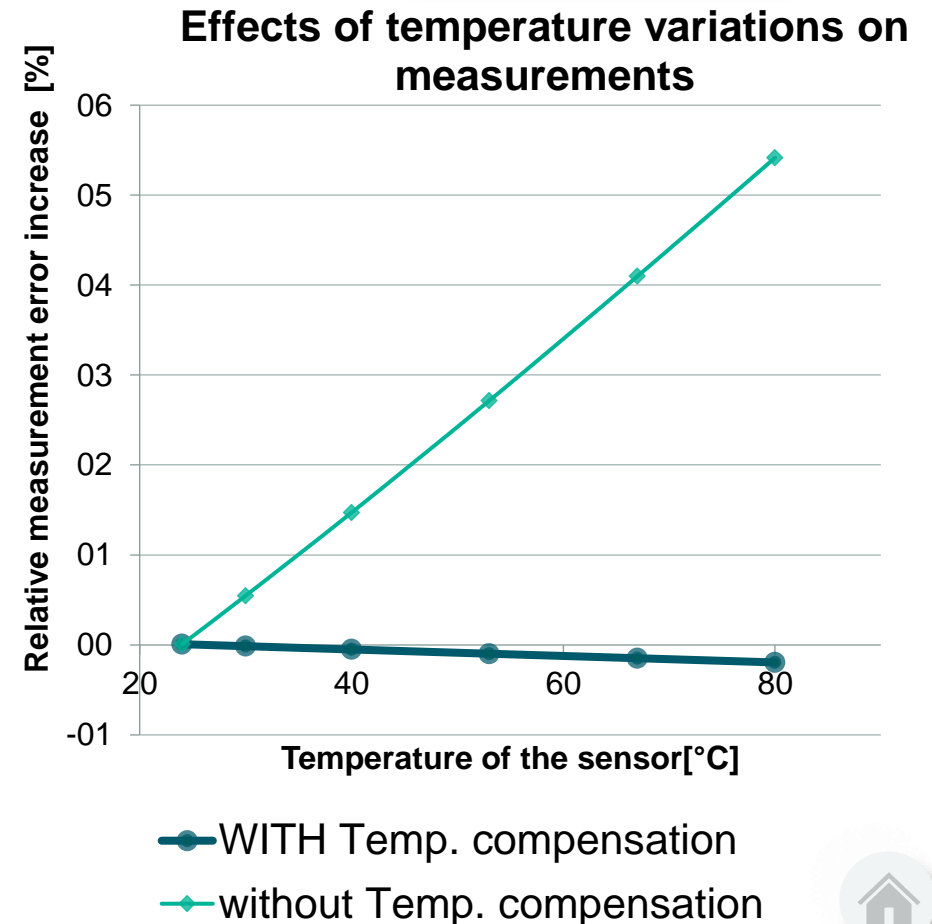
The only Clamp-On Manufacturer with inbuilt automatic temperature compensation
Meets the requirements of ASME MFC-5.1–2011

- FLEXIM transducers have built-in automatic temperature compensation
- No other clamp-on manufacturer offers this compensation
- Without compensation a shift in temperature of 30° F equates to an error of ~ 1%

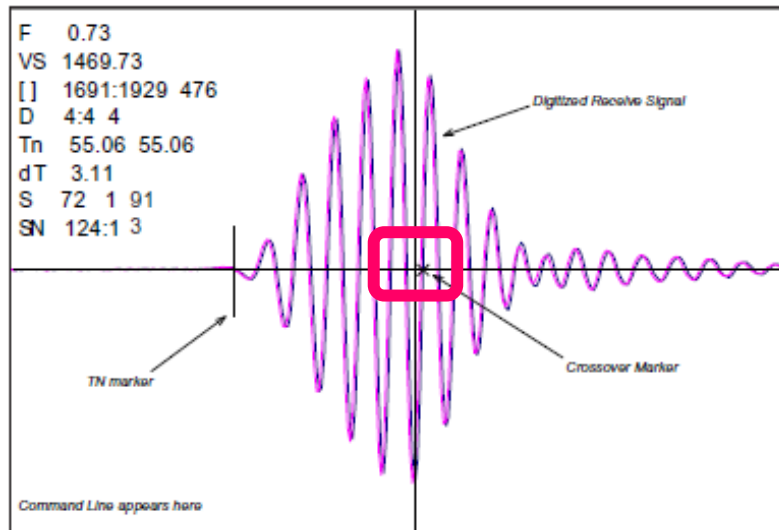


6

Temperature compensation



Competitors Signal Processing



Zero Crossover Adjustment: (Hot Key 4)

Observe the small "X" mark located on the zero crossing line near the middle of the receive signal in the Graph Screen above. This "X" indicates the central crossover which the FUG1010GN is using to measure the transit-time delta. This crossover will generally be close to the peak of the receive signal with at least

4-59

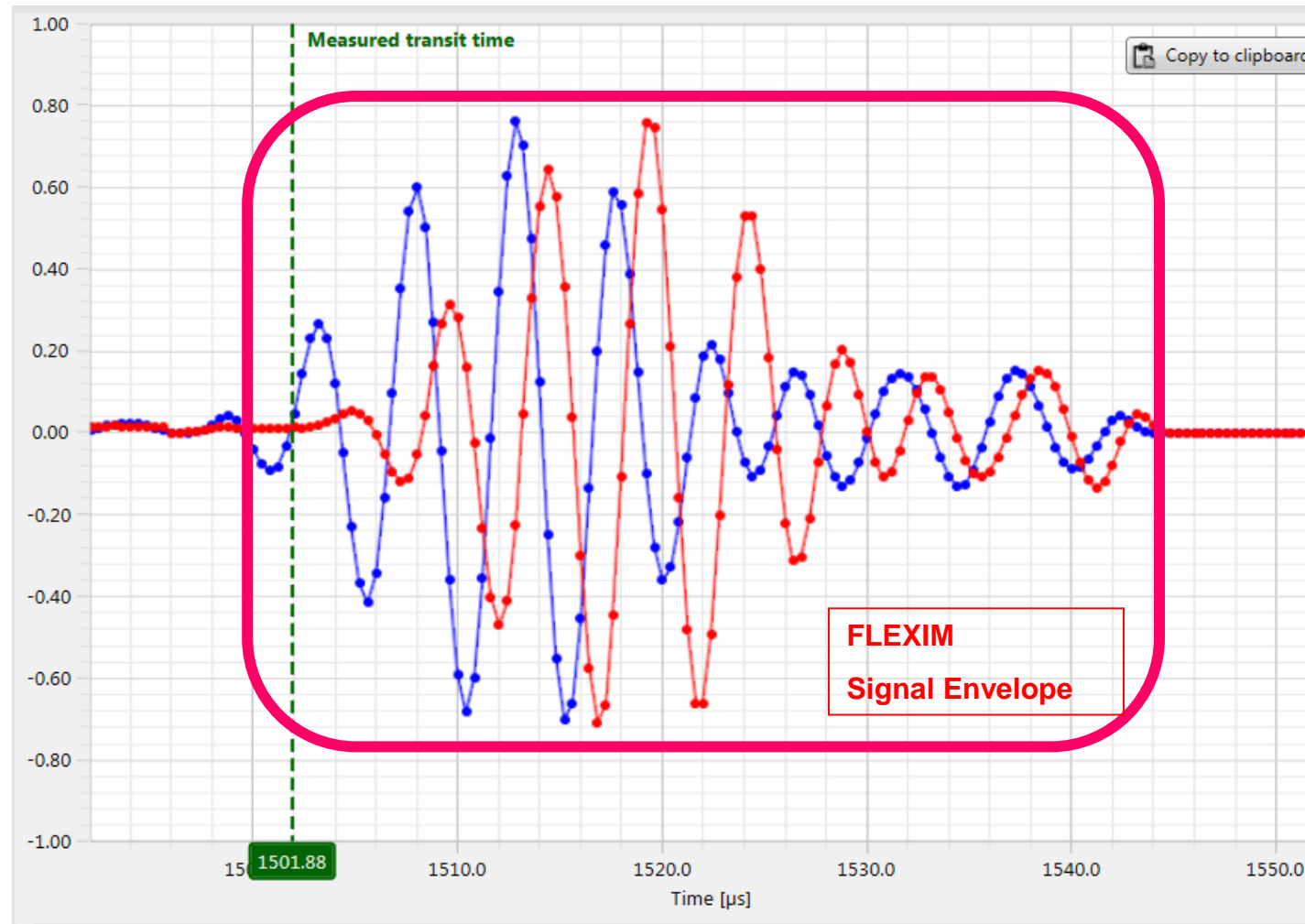
Section 4

FUG1010GNFM-3B

one well formed (non-aberrated) receive cycle on each side of the crossover. If it appears that the placement of this crossover is unsatisfactory then it can be adjusted by pressing the <4> key on the keypad, which will invoke the [ZCOSet] command. The crossover point can then be moved in either direction on the waveform using the <+> or <-> keys. The change from the default value (in receive cycles) will appear in the number to the right of the command. To exit this mode, press the <0> key.

FLEXIM signal processing

- Entire signal is used – each marker on the signal is a digital point used to calculate time difference measurement



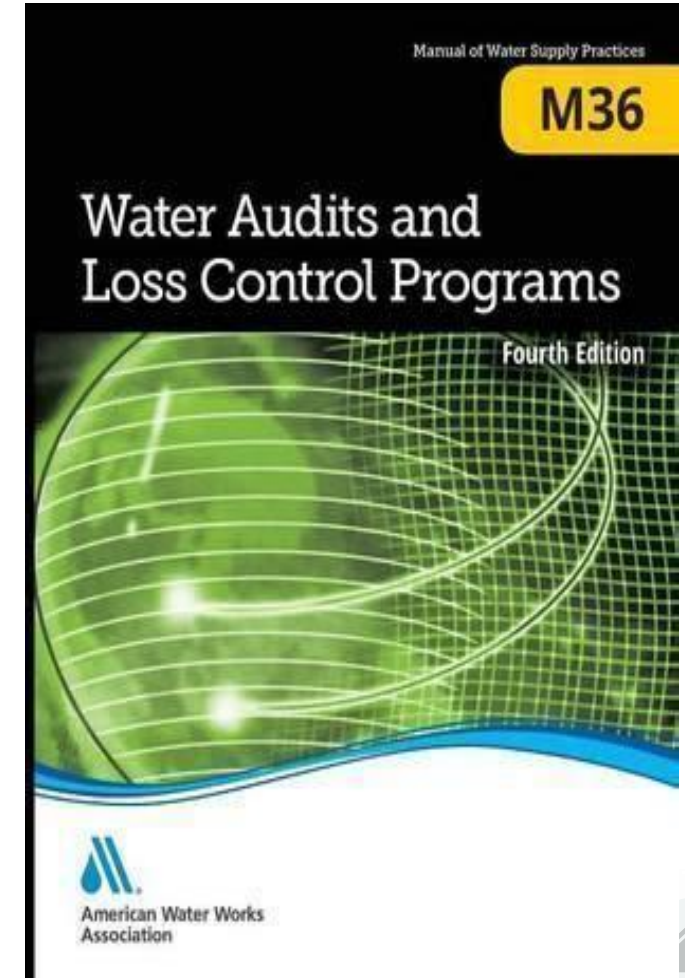
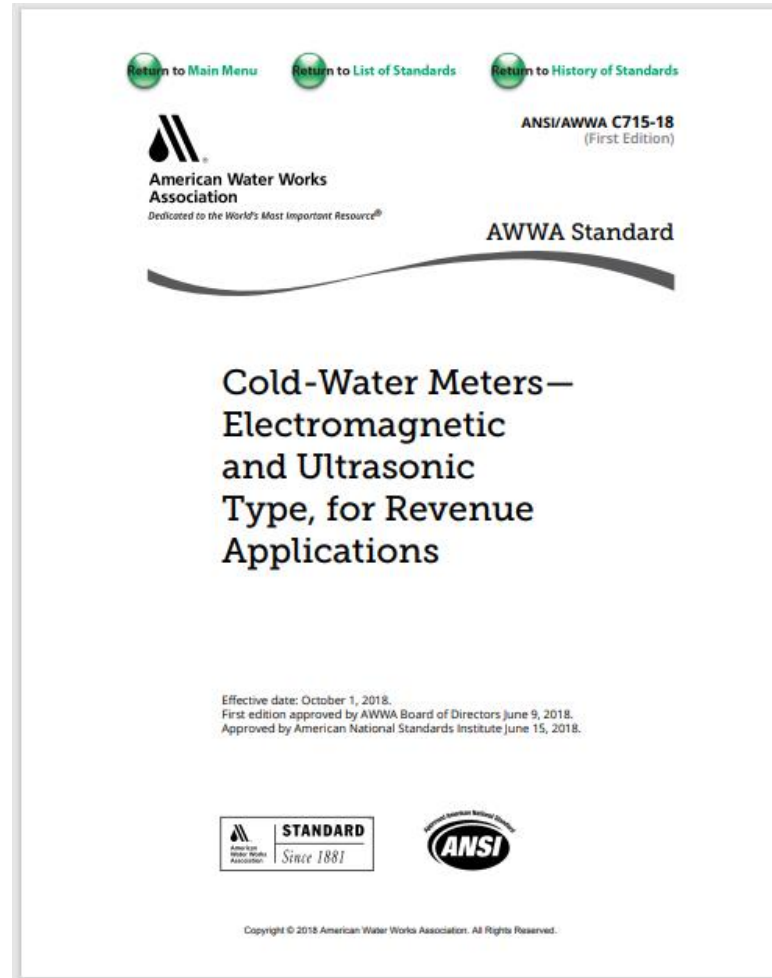
Factors for Success: We Meet the Specifications



Transit-Time Flowmeters in Full Closed Conduits

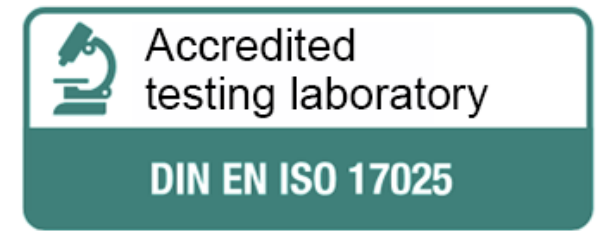
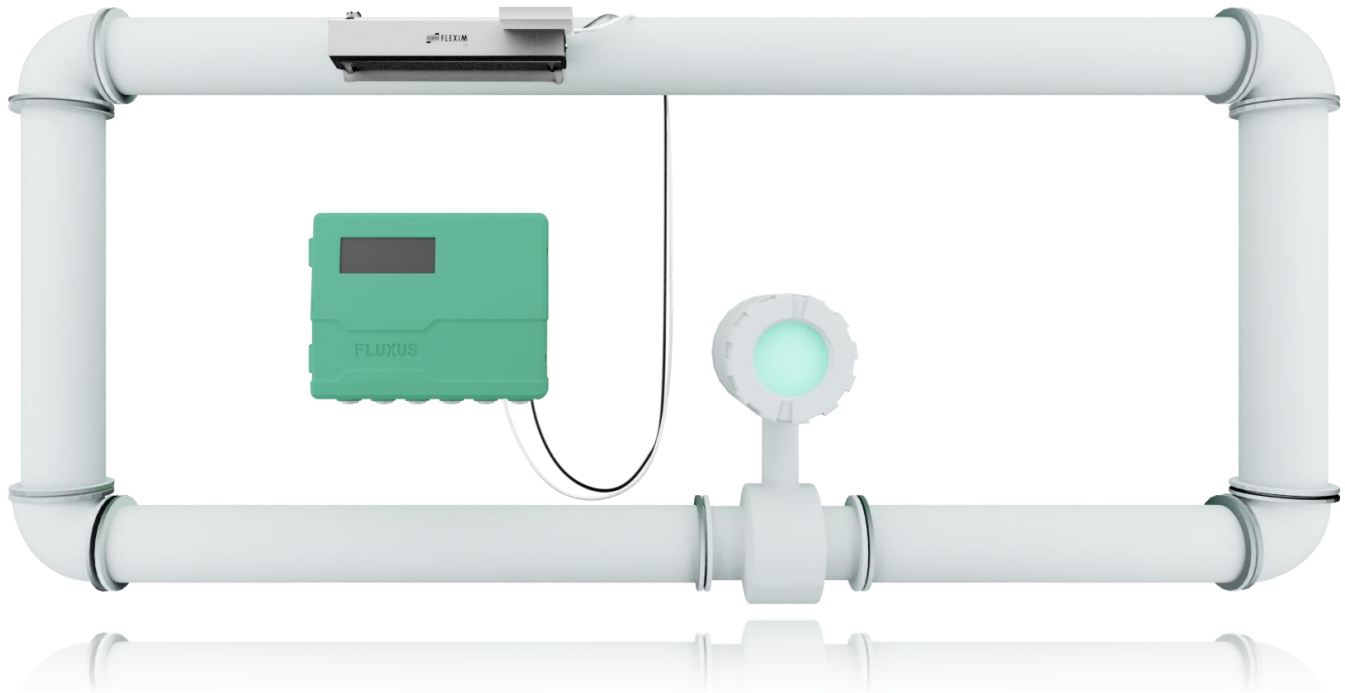
Effective date: March 1, 2020.

First edition approved by Board of Directors June 19, 2003.
This edition approved Oct. 28, 2019.
Approved by American National Standards Institute Sept. 9, 2019.



Conventional calibration

- Non-standard calibrations are performed with a conventional wet section calibration device at FLEXIM.
- Since 2021, this structure has been certified according to **DIN EN ISO 17025**.



Calibration with FLEXIM AperCal

- Worldwide unique and most precise calibration method for clamp-on ultrasonic flow measurement systems.
- 5 times more accurate, as influences of the pipe and the flow profile are avoided.
- Available for calibration laboratories

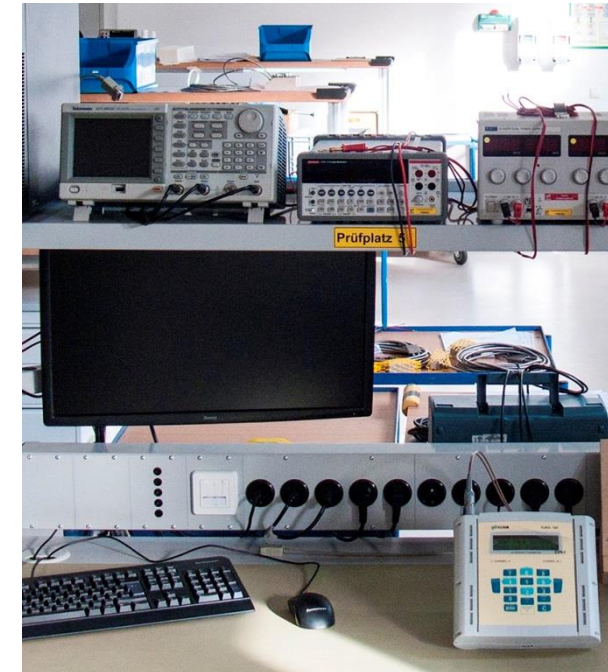
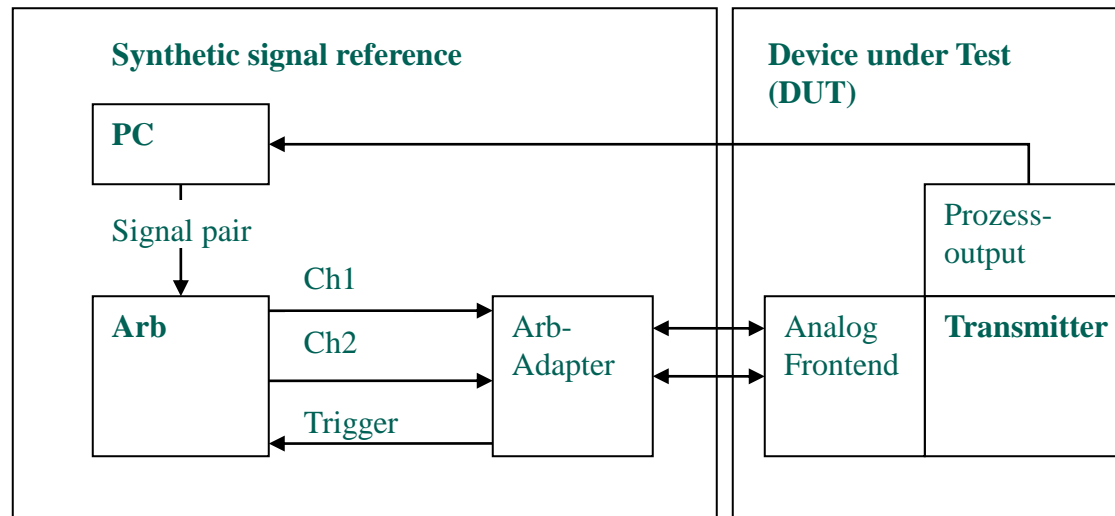
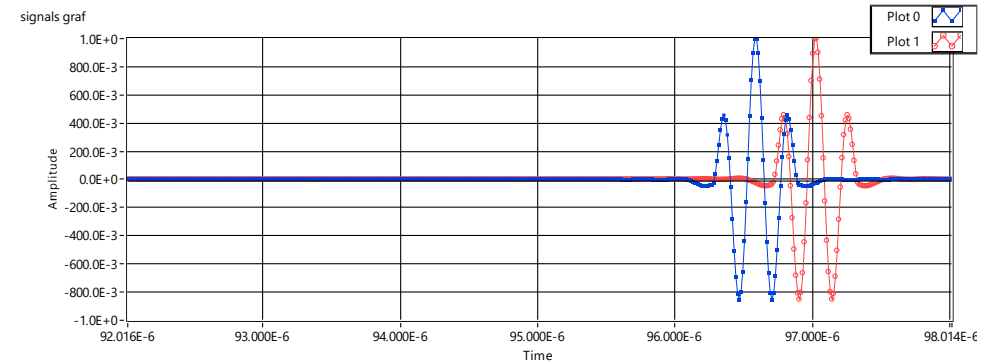


	Description	Measurement uncertainty	Repeatability
Flow rate (liquid)	Measurement system	$\pm 0.3\%$ MV ± 0.005 m/s	0.15% MV ± 0.005 m/s
Flow rate (liquid)	System at measuring point	$\pm 1\%$ MV ± 0.005 m/s	0.15% MV ± 0.005 m/s



Calibration concept - Transmitter

- Calibration of time measurement
- by using synthetic signals
- with pre-defined transit time and
- time difference



Calibration

- Transducer Calibration
- Transmitter Calibration
- Certificate for each
- SensProm hold calibration data



Calibration Certificate

Device under test (DUT)

Transducer: CDM1N27 Ser. No.: 26380
 Transmitter: Flexim G721 Ser. No.: Master25
 Orifice diameter [inch]: 7.91 Fluid: Water Temperature: 60.8 °F
 Flow rate [gpm]: 5000.00 Spec. Accuracy: 1.0% of rate Offset Allowance: 0.023 ft/s
 Measurement uncertainty (k=2): 0.16% of rate Offset uncertainty: 0.016 ft/s

Certificate No.: (US) 20180108-01

Device under test (DUT)

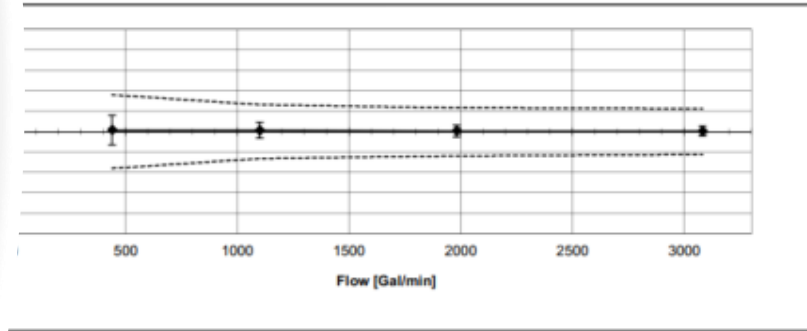
Transmitter: FLUXUS F 721 Ser. No.: 72116121
 Orifice diameter [inch]: 7.87
 Flow range [Gal/min]: 2202
 Sound velocity [ft/s]: 4921
 Environmental conditions: Temperature [°F]: 68±3

Customer Name & Address:
 Flexim Americas

Certificate No.: FT_20220404-020
 Customer information

Results

Point	Meas. time	Standard	DUT	measurement error		Limit	Standard	pass/fail
		Flowrate Qn Gal/min	Flowrate Qp Gal/min	Flowrate (Qp-Qn) Gal/min	Flowrate (Qp-Qn) / Qn %	Flowrate Q Gal/min, %	Velocity v ft/s	
16	0.00	0.00	0.44	0.44	-	3.51Gpm	0.00	p
16	439.74	439.74	440.05	0.30	0.07%	1.8%	2.87	p
16	1100.18	1100.18	1100.85	0.67	0.06%	1.3%	7.19	p
16	1981.62	1981.62	1982.18	0.56	0.03%	1.2%	12.95	p
16	3081.04	3081.04	3081.63	0.59	0.02%	1.1%	20.14	p



within the specification limit when the measurement uncertainty is taken into account (passed / failed). **p**

Measurement specified above was calibrated against measurement standards which are traceable to National Institute of Standards and Technologies (NIST). Calibration was carried out according to the guidelines monitored by our certified QM system in accordance with DIN EN ISO 9001 & ISO 17025. Reference meters are calibrated in accordance with AFC-9M, "Measurement of liquid flow in closed conduits by weighing method".
 Standard: Flexim Ser. No. 10350
 Transmitter: VXX1NH0
 Calibration due: 10/2/2018 Certificate No. VXX1NH010350_20170207
 Calibration conducted in accordance with Working Procedure WP_04-032_aperture calibration

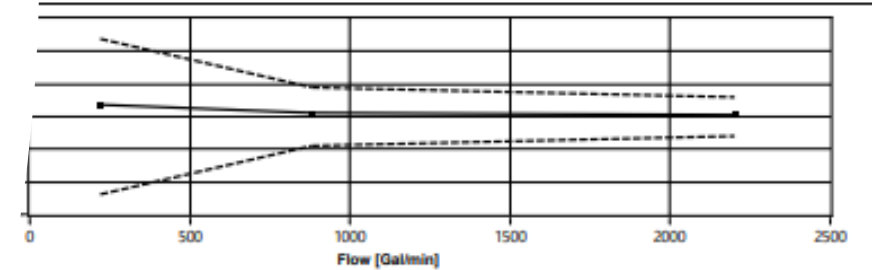
Date: 1/8/2018 Test eng.: Frank Colombo II Signature:

Measurement results Flow

Accuracy: u(Q): 0.002 % ± 0.002 ft/s
 Q: 0.200 % ± 0.017 ft/s

Measurement uncertainty is resulting from the standard deviation multiplied by a coverage factor of k = 2. The value of the uncertainty is usually within the related interval with a probability of 95%.

Flow velocity [ft/s]	Flow [Gal/min]				Limit incl. uncertainty	Result
Standard V	Standard Qs	DUT Q _{DUT}	Measurement error Q _{DUT} - Q _s	Measurement error (Q _{DUT} - Q _s) / Q _s		
0.00	0.00	0.40	0.405	-	2.188	passed
1.45	220.15	220.55	0.405	0.184%	2.626	passed
5.80	880.60	881.11	0.514	0.058%	3.939	passed
14.50	2201.50	2202.10	0.604	0.027%	6.566	passed



The measuring system meets the specified accuracy (passed / failed). **passed**

Measuring system specified above was calibrated against measurement standards which are traceable to national measurement standards (NIST). The calibration was carried out according to the guidelines monitored by our certified QM in compliance with DIN EN ISO 9001.

Calibrating Standard: Type: Ser. No.: Calibration due: Calibration certificate:
 at Time Calibrator FS100 PMS3-15 05/28/2022 FS100-IE0158-022022

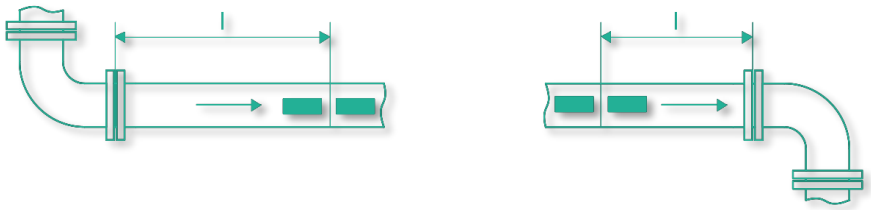
Calibration certificates with the full names of the approval responsible persons are valid without signature.

Date: 04/04/2022 Calibration laboratory supervisor: Tobias Jochum Person in charge: Robert Brown

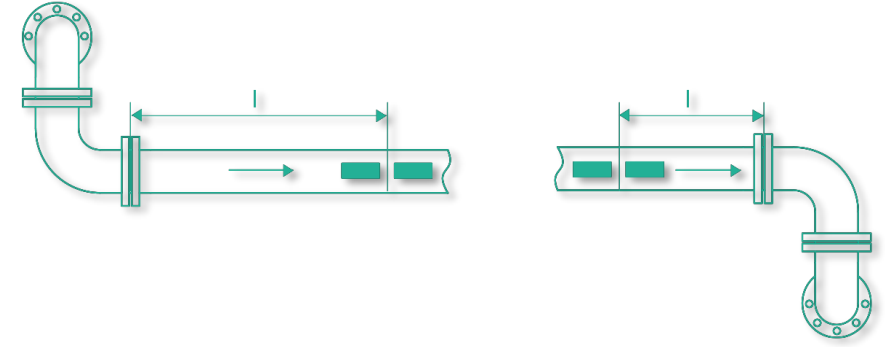
This certificate contains 1 page and should be copied only in its entirety.

In- and outlet length

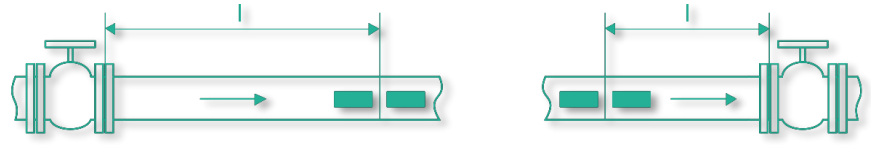
Disturbance type: 90° bend
Inlet: $l \geq 10D$ **Outlet:** $l \geq 5D$



Disturbance type: Double 90° bend (2 planes)
Inlet: $l \geq 40D$ **Outlet:** $l \geq 5D$



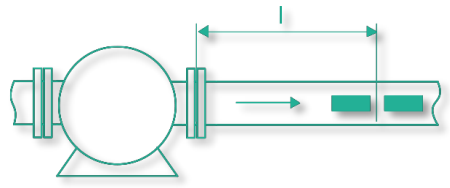
Disturbance type: valve
Inlet: $l \geq 40D$ **Outlet:** $l \geq 5D$



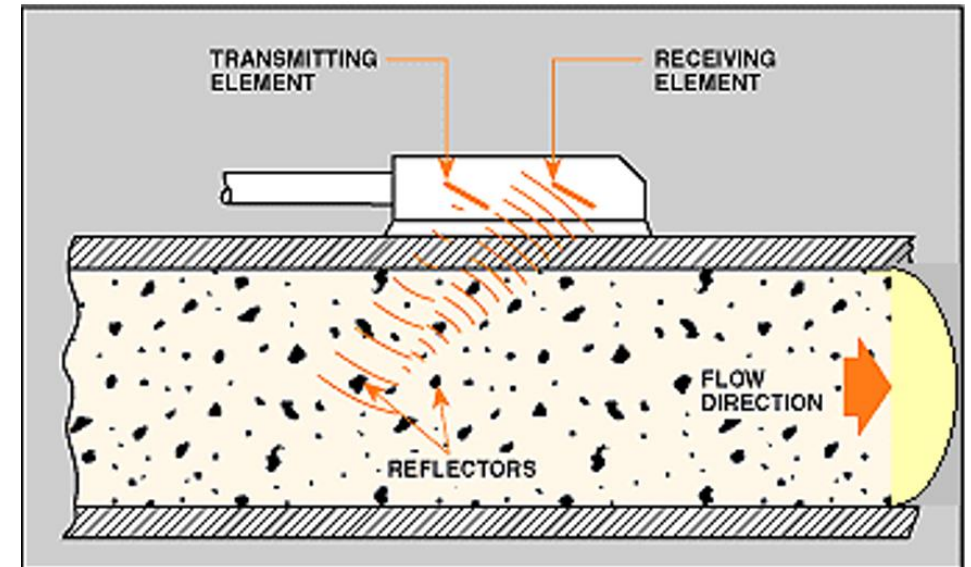
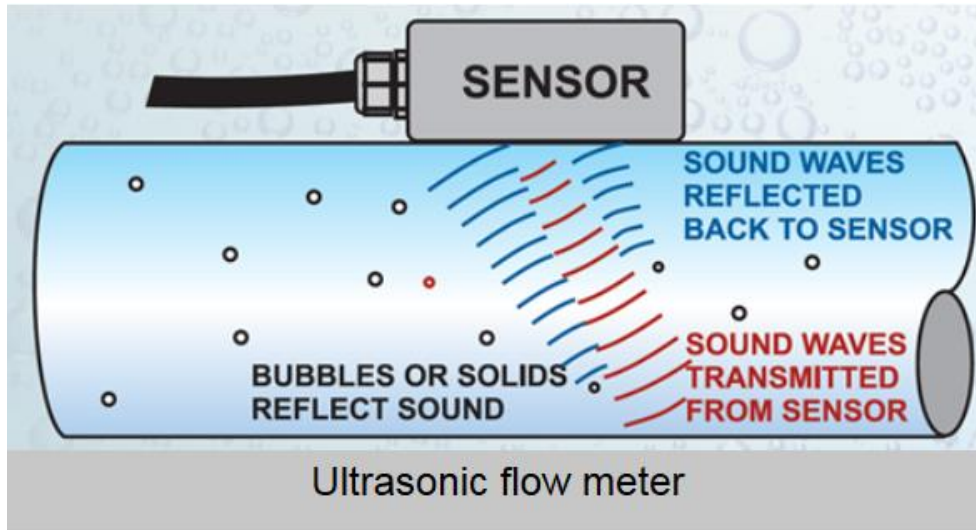
Disturbance type: Reducer
Inlet: $l \geq 10D$ **Outlet:** $l \geq 5D$



Disturbance type: compressor
Inlet: $l \geq 20D$



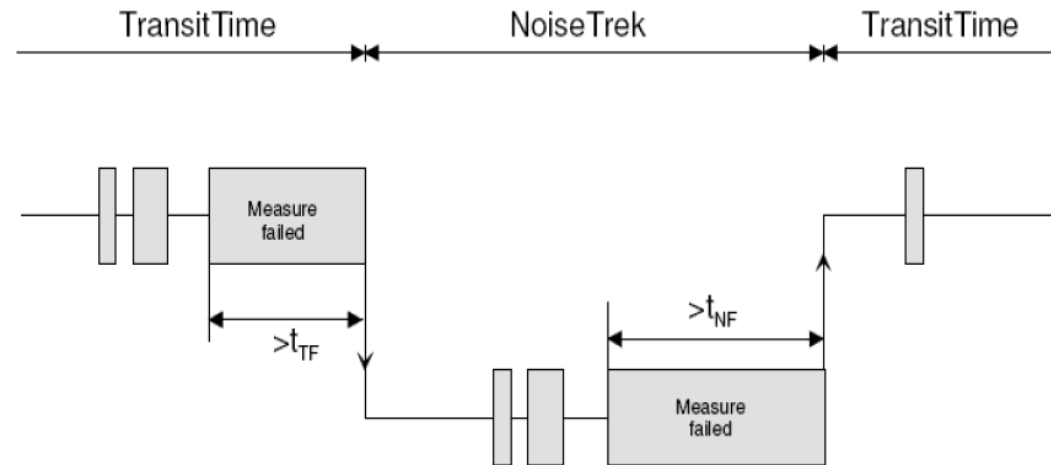
FLEXIM NoiseTrek Measurement Principle



Doppler meters use sound pulse reflection principle to measure liquid flow rate, solids or bubbles in suspension in the liquid reflect the sound back to the receiving transducer.
Assumption - Reflected particle representative of average flow

FLEXIM Flow meters are capable of both Transit-Time and NoiseTrek technologies.

- Transit-Time as standard for liquids with < 10% of gas / solids
- NoiseTrek = combines Doppler method with signal travelling time, for liquids with > 10% of gas / solids
- Programmable automatic switchover between both principles (HybridTrek mode)



FLUXUS® 721WD

Performance overview

- Multi Channel
- Bi-directional
- Measurement uncertainty (liquid): **±1.0% of reading**
- Repeatability: **0.15% of reading**
- Outstanding low flow resolution **down to 0.03 ft/sec**
- **Based on transit-time difference method**
- Extensive **diagnostic** functions and verification tool

Application range:

- Media: **Water only**
- Pipe diameter (ID): **2 inches and larger**
- Temperature range: **up to 266° F**
- **Water and Wastewater municipal applications only**

Communication:

- Outputs: Switchable current, Modbus, Ethernet connection for meter facilities
- Advanced Meter Verification (optional)



Portable Ultrasonic Flow Measurement Systems

FLUXUS F/G 601, FLUXUS F/G 608 (C1 D2)

- Can be used for liquids, gases and steam
- Robust housing with protection class IP 65
- 2 measurement channels as standard
- Extensive material and media database
- 25 hours of measurement operation with Li-Ion battery
- Variety of inputs and outputs, MOD bus
- Internal measurement data memory
- Report, diagnostic and evaluation software
- Robust, waterproof transport case
- Combined wall thickness measurement
- Optional surface temperature sensors
- Volume flow, mass flow and heat flow measurements
- Operating & standard volume flow measurement for gases



Portable Ultrasonic Flow Measurement Systems

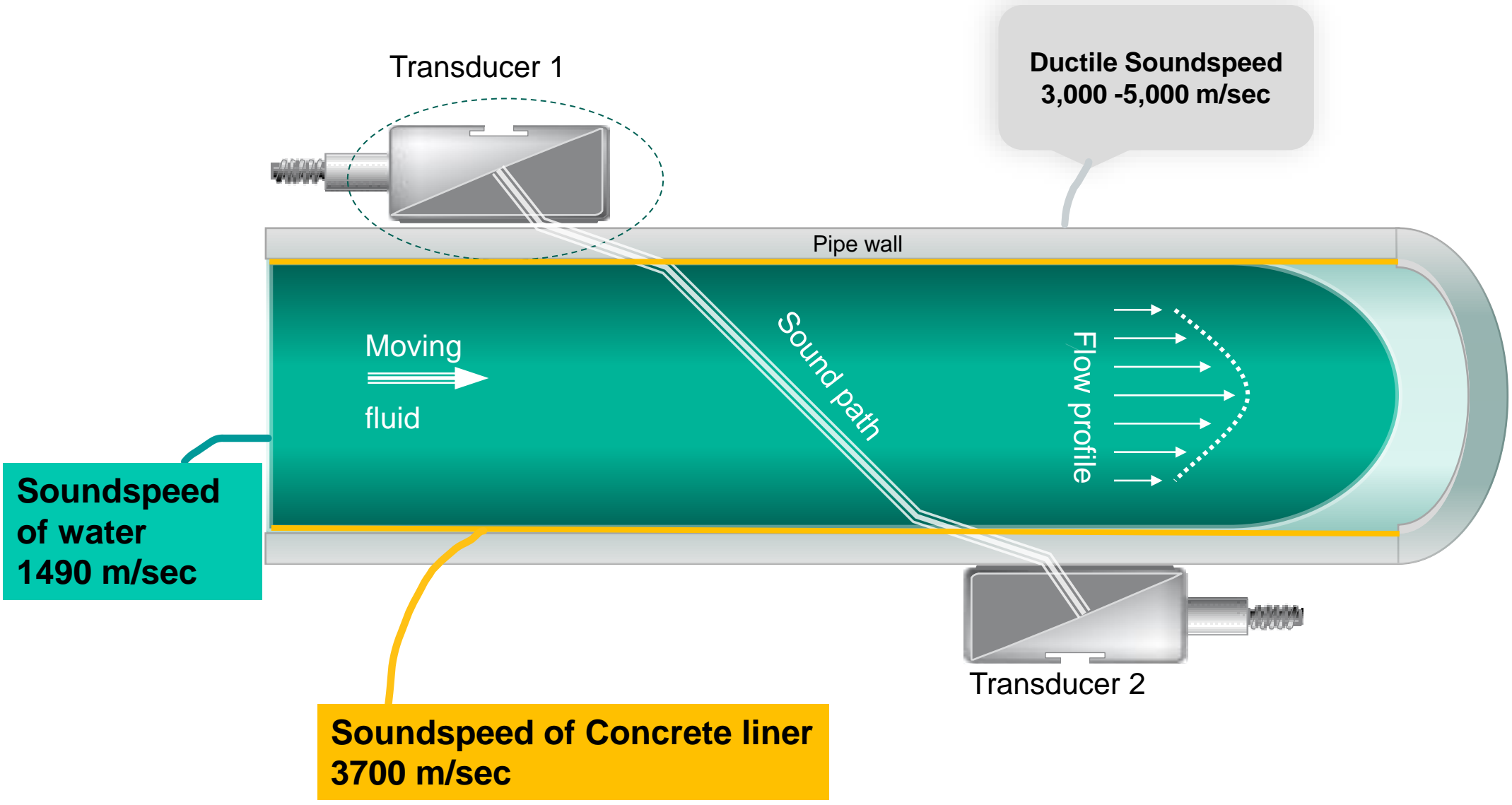
FLUXUS F401



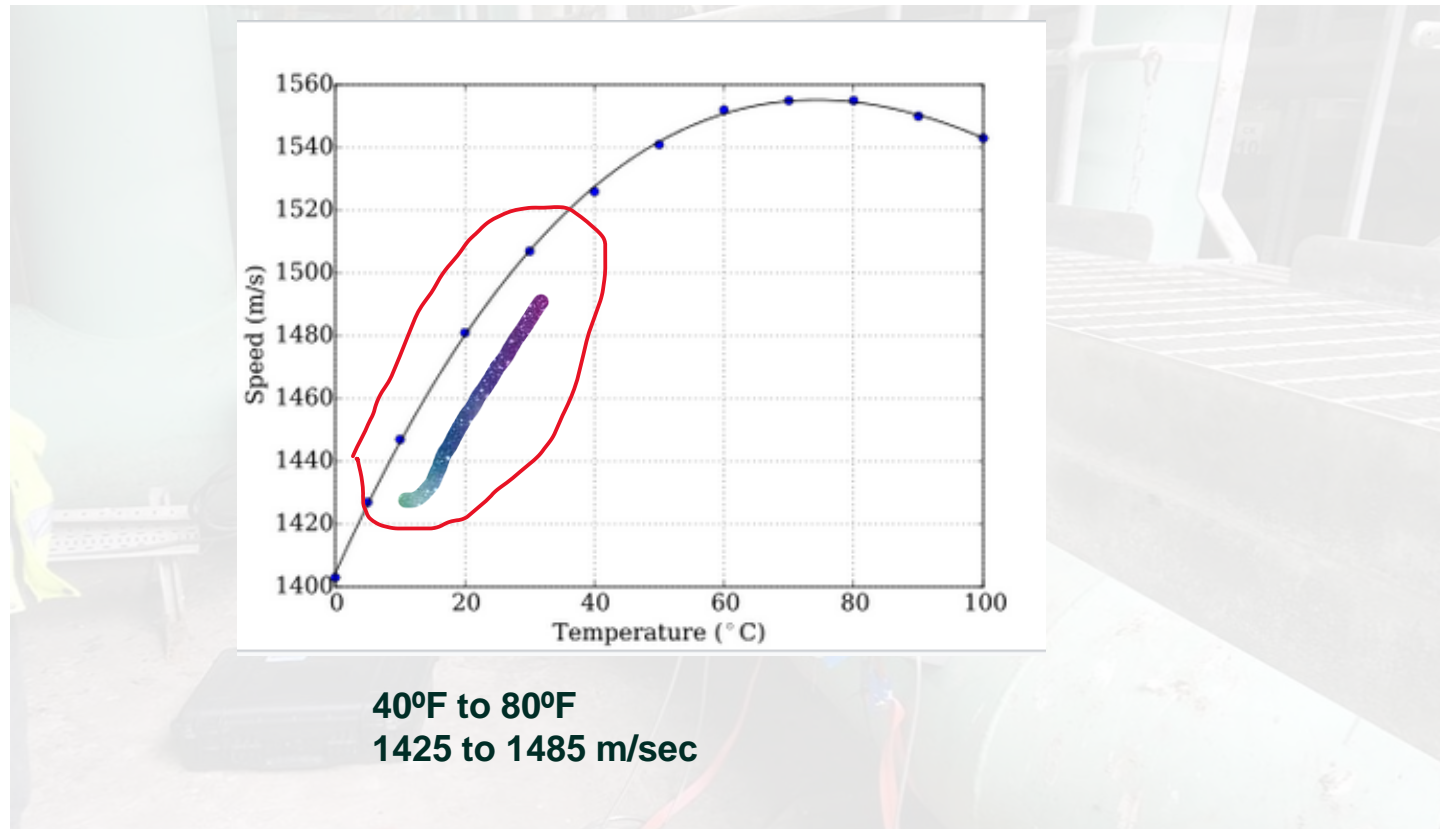
- Several months of battery operation possible
- Very high bidirectional measuring accuracy and highly dynamic flow measurement
- IP68 transducers, reinforced transducer cables and very robust housing
- Easy and intuitive use
- Very fast and easy installation
- Permanent coupling foil
- High measuring accuracy, even at low flow velocities
- Suitable for highly diverse nominal pipe sizes and pipe materials
- Minimum night flow mode



Ductile Iron Pipe with Cement Liner

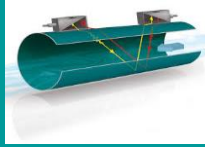


Soundspeed and Temperature



Technology is changing in water and wastewater

Selection



Model	FLUXUS 721	FLUXUS 721 WD	F501
Media	Liquids, gases and steam	Water only	Water only
Industries / markets	All	Municipal only Water/wastewater	All
Accuracy with NIST traceable calibration	±1.0% of rate	±1.0% of rate	±1.5% of rate
Temperature compensation in transducers	✓	✓	X
FM Approval	Can be C1 D2	General Purpose	General Purpose
Data logger	800,000 data points	800,000 data points	100,000 data points
AMV	✓	✓	X
Outputs	RS485, Modbus RTU/TCP BACnet MS/TP, HART, Profibus PA, FF, BACnet IP, Current, Binary	RS485, Modbus RTU/TCP BACnet MS/TP, HART, Profibus PA, FF, BACnet IP, Current, Binary	Modbus, BACnet, RS485, Current, Binary
Transducer Selection	All	CDM, CDK & CDG	CDQ, CDP, CDM, CDK
Transducers cables	Stainless steel or PVC int. IP68	PVC int. IP68	Poly jacket
Transducer Ingress	IP67 / IP68	IP68 only	IP65 / IP68
Process temperature limits	-40 to +1100°F	32 to 212°F	32 to 212°F
Channels	Single or Dual	Single or Dual	Single channel only
Temperature measurement using soundspeed	✓	✓	X
Profile Correction	✓	✓	X
Multi-function Keyboard	✓	✓	X

PermaRailTM Track System



- Robust SS Design
- Ensures Proper Alignment and Spacing
- Maintenance Free Install
- Permanent Couplant Pads





Advanced Meter Verification

The health check for your FLUXUS



Report Overview: Advanced Meter Verification

AMV guides you through the verification process with two types of reports:

Installation Report

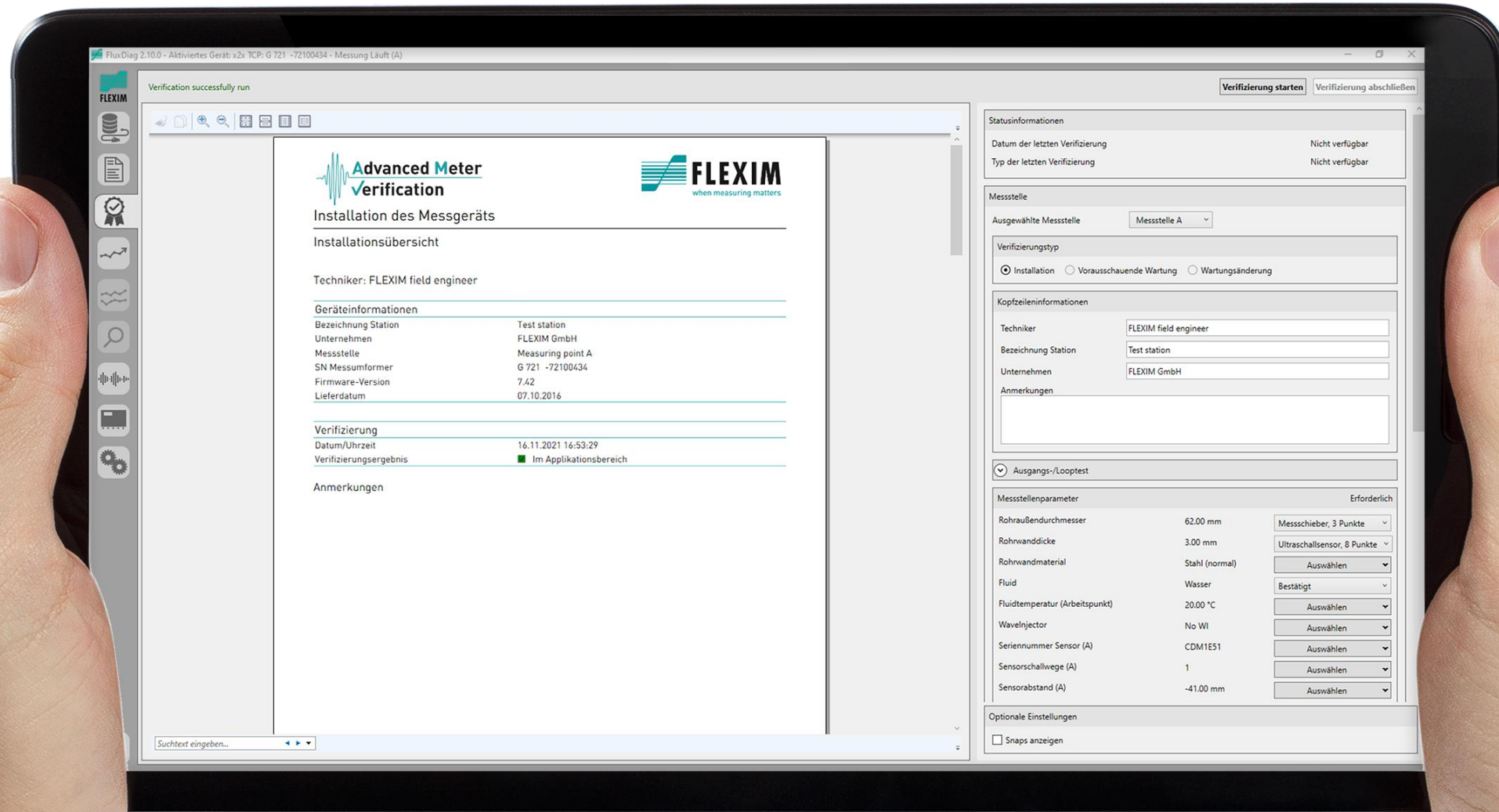
- Verification after installation
- Installation verification is the reference point for subsequent, regular inspections

Predictive Maintenance Report

- Regular verifications after installation
- Changes in diagnostic values are evaluated
- Trends become visible
- Maintenance requirements are clearly marked



Advanced Meter Verification in FluxDiag



Virtual Technician

Facilitate a complete installation – with customer assistance for the transducer mounting.

At your desk, you can upload the newly created site without any power source, using only the USB cable for the 5-volt logic to run on the F721 and add the site before hanging the meter on the wall.

Create and upload sites

Assist with troubleshooting

Configure Modbus Bacnet

Anything that can be done standing in front of the meter can be done via VT



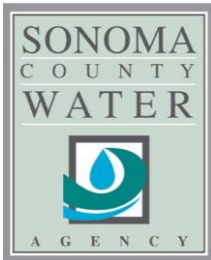
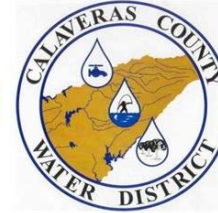
Some References



Birmingham Water WORKS



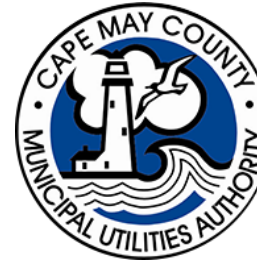
Washington Suburban Sanitary Commission



metrovancouver



Stewards of the Environment™



Application - Subterranean Drinking Water

Basic project info

Media type: Drinking Water

Project year: 2009

Customer: Public utility of Duisburg

Pipe 1

Outer diameter: 635 mm

Wall thickness: 9.9 mm

Liner: 5 mm

Pipe material: Ductile iron

Flowmeter: 7407 + 1 x K

No. of meters: 1

Pipe 2

Outer diameter: 813 mm

Wall thickness: 8 mm

Liner: 10 mm

Pipe material: Carbon steel

Flowmeter: 7407 + 1 x M

No. of meters: 1



Application – Concrete Pipe

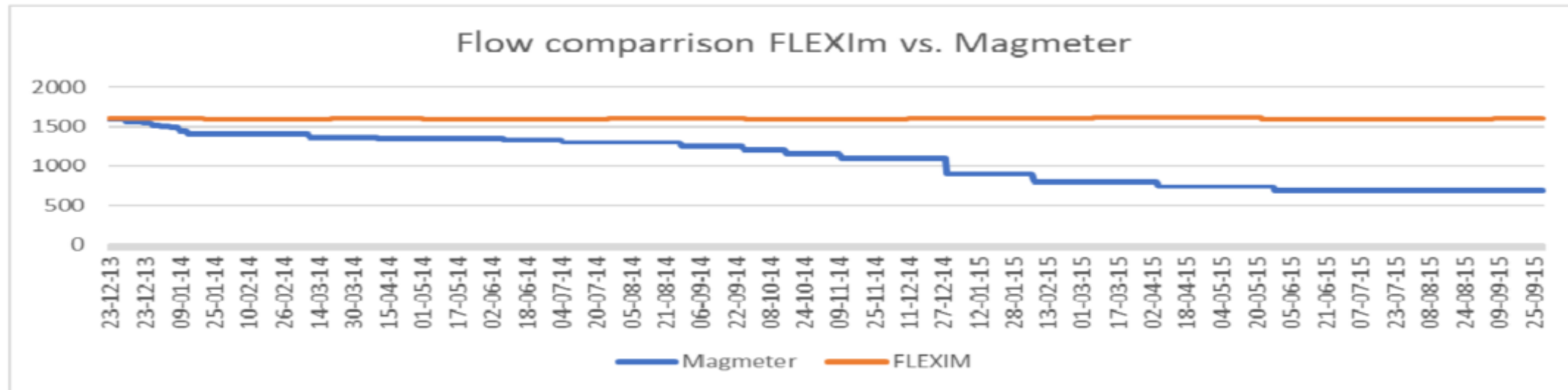
The NTMWD at the Frisco McKinney Pump Station needed a metering solution for their outgoing water flow. The line is a 63” steel reinforced concrete line (PCCP). Previous metering solutions have failed and they wanted to avoid having to go the costly route of installing a massive in line mag meter.



Application – Coating inside the pipe Manganese and Orthophosphate

Why has my Magmeter become useless

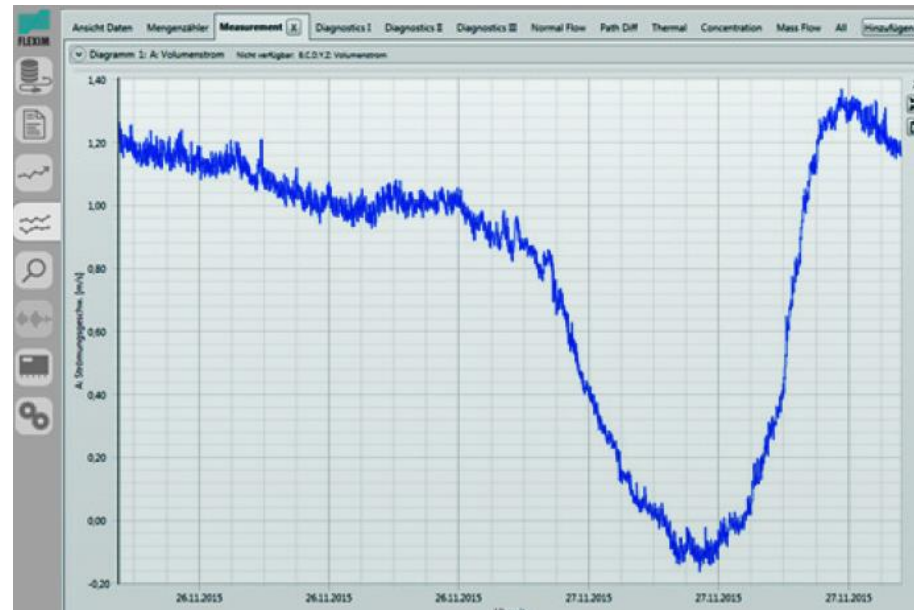
Injecting chemicals have unintended consequences on magnetic flowmeters.



The coating fouls the electrodes and renders the Magmeter useless.

Disadvantages when using inline flow meters: measurement data

- Many flow meter technologies that are used in the water supply industry are not suitable for low flow monitoring
- Due to oversized pipes, water-saving equipment and increased environmental awareness flow rates have become very low in many areas
- During the night this can lead to flow velocities of well below 0.1 m/s, which leads to high inaccuracies for many flow meter technologies
- Without accurate low flow data it is not possible to carry out effective minimum night flow monitoring and therewith detect leaks
- Many flow meter technologies drift, leading to steadily increasing data inaccuracy



Technical details of the FLUXUS WD

- The characteristics of each piezo-transducer are analyzed before matching **ideal clamp-on transducer pairs**. This results in permanently drift-free measurements.
- The transducers have **IP68 protection** and reinforced transducer cables.
- **Permanent coupling pad** is used instead of coupling gel. This is possible due to the strong signal power of the transducers.
- FLEXIM has the **most robust mounting system** which is made of high quality stainless steel (316Ti / 1.4571).
- **Suitable for the most difficult pipes** (e.g. PCCP or GRP) and all wall thicknesses, due to extra powerful transducers and advanced algorithms.



Subterranean Install



Water Production Wells



Application – Pump station

- Nocatee Pump Station
- 8” Stainless steel pipe
- Serving 300 homes ~ 1000 GPM



Ultrasonic flowmeter inspection report



Transmitter		Measuring point	
Calculated sound speed	N/A	Technician	
S/N flowmeter	F 721 -72110109	Firmware version	7.38.2
K-factor	N/A	Inverse K-factor	N/A
Flow at max. frequency	N/A		

Application parameters (Measuring point A)

Parameter		Value
Transmitter type		Device 721
Outer diameter	D_O	8.625 in
Pipe wall thickness	w	0.322 in
Wall sound speed	c_w	3099.80 m/s
Fluid sound speed	c	1482.20 Unknown
4ax. flow velocity	$V_{a,max}$	5.00 m/s
4in. flow velocity	$V_{a,min}$	0.10 m/s
Wiring thickness	w_i	N/A
Wiring sound speed	c_i	N/A
Fluid temperature	T	68.00 °F
Kinematic viscosity	ν	0.99 mm ² /s
Number of sound paths	N_{Path}	2
Number of channels	N_{Ch}	1
Number of planes	N_{Pl}	1
Disturbance correction		Off
Disturbance type		None
Disturbance distance	Z_{Dist}	N/A

Application – Ductile Iron Cement Lined Pipe



Anastasia Island
20" Ductile Iron Pipe
Cement lined
Raw Sewage

Revenue Application - Low Flow

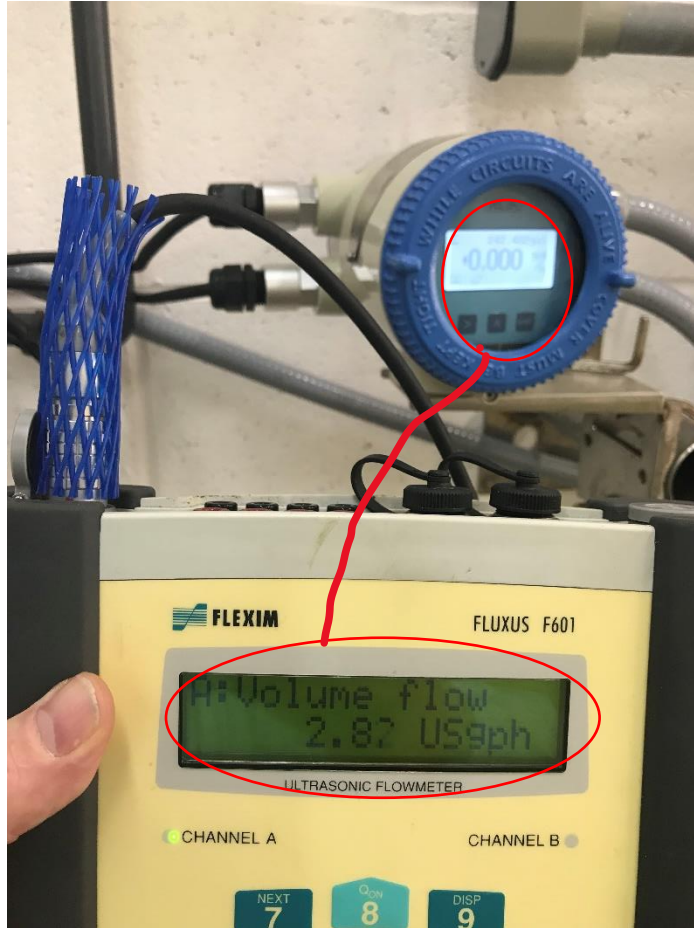


- 4 million gallons/day is transferred from Connecticut to New York at this major Interconnect located in Greenwich, CT.
- This flow was being measured by a Turbine meter.
- Due to water loss in the area, Aquarion suspected that the Turbine meter was reading lower than expectations.
- Aquarion determined that the Turbine meter needed to be replaced and was in search for a possible solution.
- Infrastructure began in 1857
 - 16"
 - DIP
 - Cement liner

Oregon Water Utility Calibration



Magmeter could not read the low feed rate



We began by running a test at a very small remote plant with very low flow.

Lambwave Liquid Transducers.

The magmeter did not register below 0.5 ft/sec.
1" Sched 80 PVC 2.82 GPH = 0.013 ft/sec

Results



The meter has been installed for several months and tracking across the entire range. Down to 0.1 ft/sec.

These are Lambwave transducers with the F501 Transmitter.

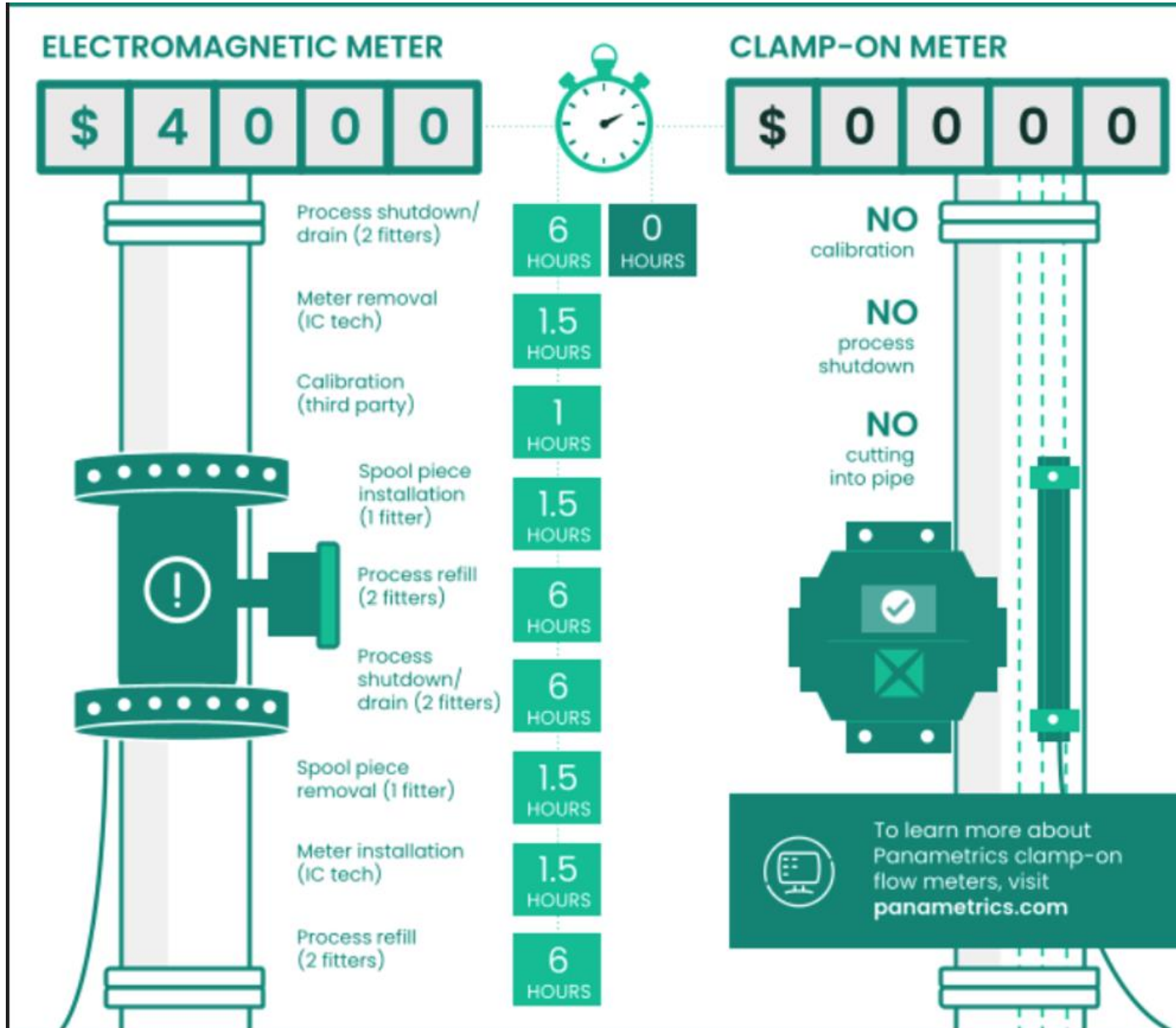
Application Submerged



48" Ductile Iron Wastewater



Cost of Installation



Why clamp-on meters for leak detection and water balance?

- **Clamp-on Advantages**

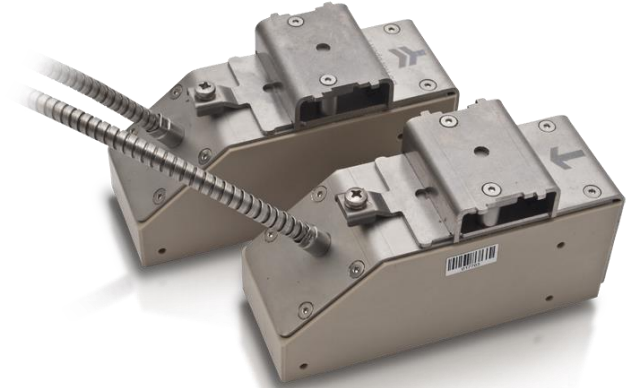
- No pipeline shutdown for installation
- Easy retrofitting
- No elaborate equipment required for installation

- **Ideal solution for remote locations or hard-to-reach areas**

- Extremely low maintenance – but maintenance under pressure / during operation possible
- A clamp-on meter does not add up to the risk of leakage

- **But: Are clamp-on measuring instruments accurate enough?**

- What counts for the leak detection system is repeatability, not absolute accuracy
- Clamp-on meters can be very repeatable: $\pm 0.15\%$ of reading
- but for this some conditions must be met...





Questions and Discussion

jvannostrand@flexim.com
fsosa@flexim.com

