FLOWSIC600-XT – Testing of Different Inlet Piping Configurations With and Without CPA Flow Conditioners 50E and 55E According to AGA Report No. 9:2022

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Topic Agenda

- Introduction
  - Background
  - Test Configuration
- Test Facility
- AGA9 Testing Campaign
  - 2021 Testing
  - 2022 Results (AGA 2022)
- Earlier OIML R137 Testing Campaign
  - Testing / Results - 2021
- Conclusion
- Q&A

Introduction

- Background
- AGA Report #9 Forth Edition 2017/2022
- Flow meter manufacturers responsibility to recommend piping and flow conditioning configurations to meet uncertainty requirements
- OIML R137 1 & 2:2012 (Section 8.2)

Introduction

- 2021 Test Configurations Testing of Different Inlet Piping Configurations
  - With CPA Flow Conditioners 50E and 55E
  - According to AGA Report No. 9:2017
- 8” Pipe Diameters – Tested at 10D, 5D, & 3D
- Test Piping for all named meter tests for this paper was provided by testing facility TCC

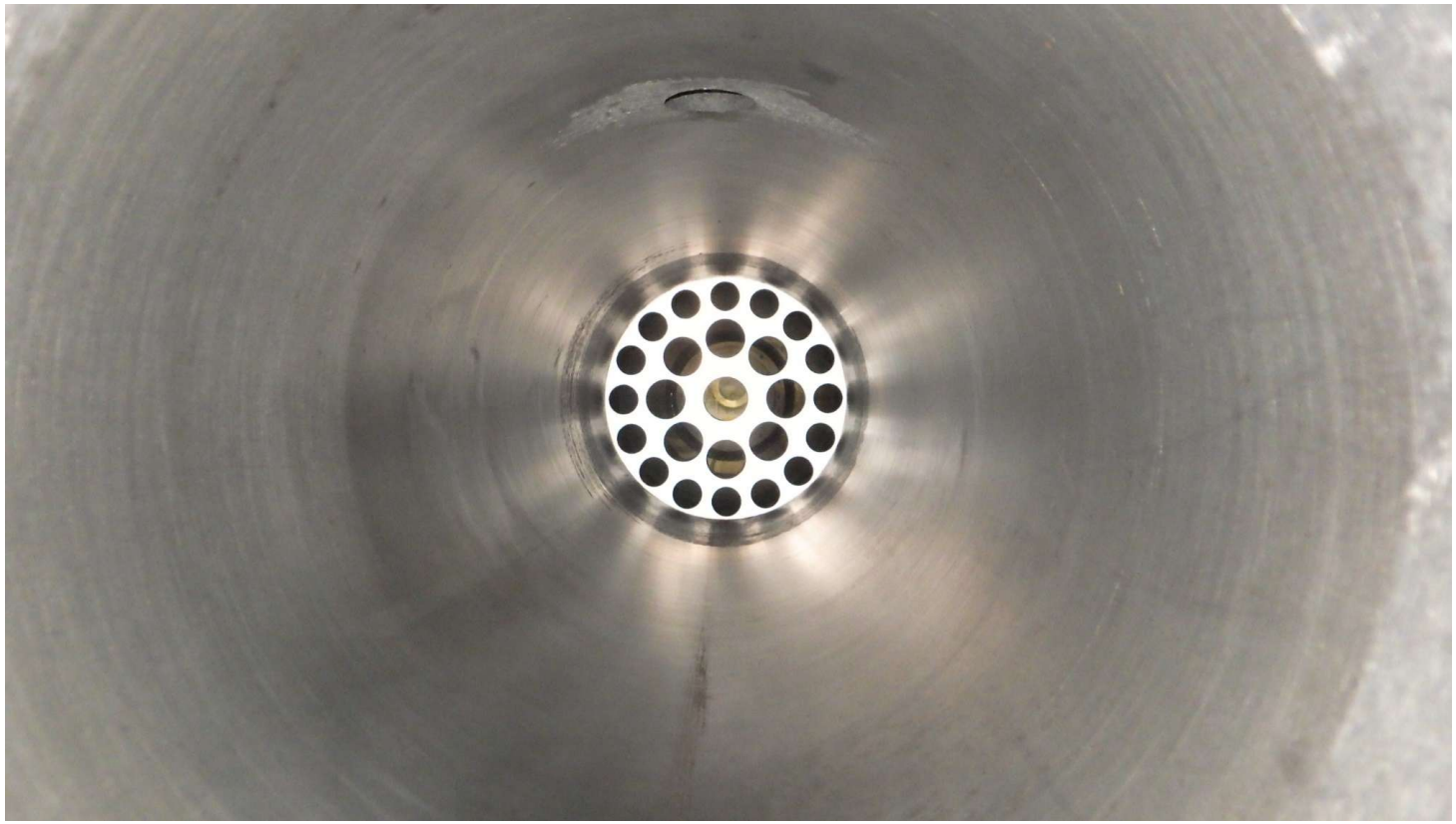
Introduction

- Test Configurations (continued)
- The CPA 50E is the most tested flow conditioner in the industry and is supported by more than 20 years of test data by independent flow laboratories. The CPA 50E is designed to produce a swirl-free, fully developed flow profile, improving reliability and reducing error, while also shortening the meter run.
- The CPA 55E uses an innovative unique stepped design that has been optimized with fluid dynamic fundamentals in mind, giving greater capability over other flow conditioners. The flow conditioner provides lower turbulence and noise generation and create a swirl free flow with a fully developed flow profile
- The CPA 50E and CPA 55E flow conditioners were provided by the CPA team.

CPA 50E

CPA 55E

Introduction



Introduction

- Test Configurations (continued)
- Test devices
- FLOWSIC600-XT 2plex (serial # 18030002) 8” meter with a 4+1 path Westinghouse cord design
- FLOWSIC600-XT Forte (serial # 21221007) 8” meter with an 8 path Westinghouse cord design

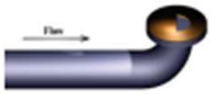
FLOWSIC600-XT 2plex

FLOWSIC600-XT Forte

TransCanada calibrations

- Located in Winnipeg, Manitoba
- TransCanada Calibrations (TCC) is the highest capacity High Pressure Natural Gas Meter testing and calibration facility in the World.
- TCC is ISO 17025 CLAS accredited as well as Measurement Canada government recognized, accredited and audited.
- TCC is traceable to the Internationally recognized European reference value for natural gas and is the representative Canadian flow laboratory for participation in international ISO BIPM fluid flow inter-comparison activities.
- TCC is a past and present participant author on AGA North American measurement best practices documents, AGA Report #9, AGA Report #7, AGA GMM 16 as well as the ISO 17089 international measurement standard.

OIML R 137 1 & 2 Annex B Test Setup

Test		Test conditions	Remarks	Turbine	Ultrasonic	Thermal mass	Vortex
a		Reference conditions	approx. 80 D straight line		×	×	×
			approx. 10 D straight line (see Note)	×			
b		A single 90° bend	radius elbow: 1.5 D	×	×	×	×
c		Double out-of-plane bend	rotating right; radius elbows: 1.5 D	×	×	×	×
d		Double out-of-plane bend	rotating left; radius elbows:1.5 D	×	×	×	×
+		Half pipe area plate	image shows first bend in piping and mounting of half-moon plate.	×	×		

Mild Flow Disturbance

Severe Flow Disturbance

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OIML R137-1 & 2 - Maximum Permissible Errors – MPE / (Flow) Weighted Mean Error – WME / FWME

Maximum Permissible Errors - MPE

5.3.4 Maximum permissible errors (MPE)

Table 2 Maximum permissible errors of gas meters

Flow rate Q	During type evaluation and initial verification			During subsequent verification and In-service *		
	Accuracy class			Accuracy class		
	0.5	1	1.5	0.5	1	1.5
$Q_{min} \le Q < Q_t$	± 1 %	± 2 %	± 3 %	± 2 %	± 4 %	± 6 %
$Q_t \le Q \le Q_{max}$	± 0.5 %	± 1 %	± 1.5 %	± 1 %	± 2 %	± 3 %

* *Note:* National Authorities may decide to implement maximum permissible errors for subsequent or in-service verification.

Weighted Mean Error (WME) / Flow Weighted Mean Error (FWME)

5.4 Weighted mean error (WME)

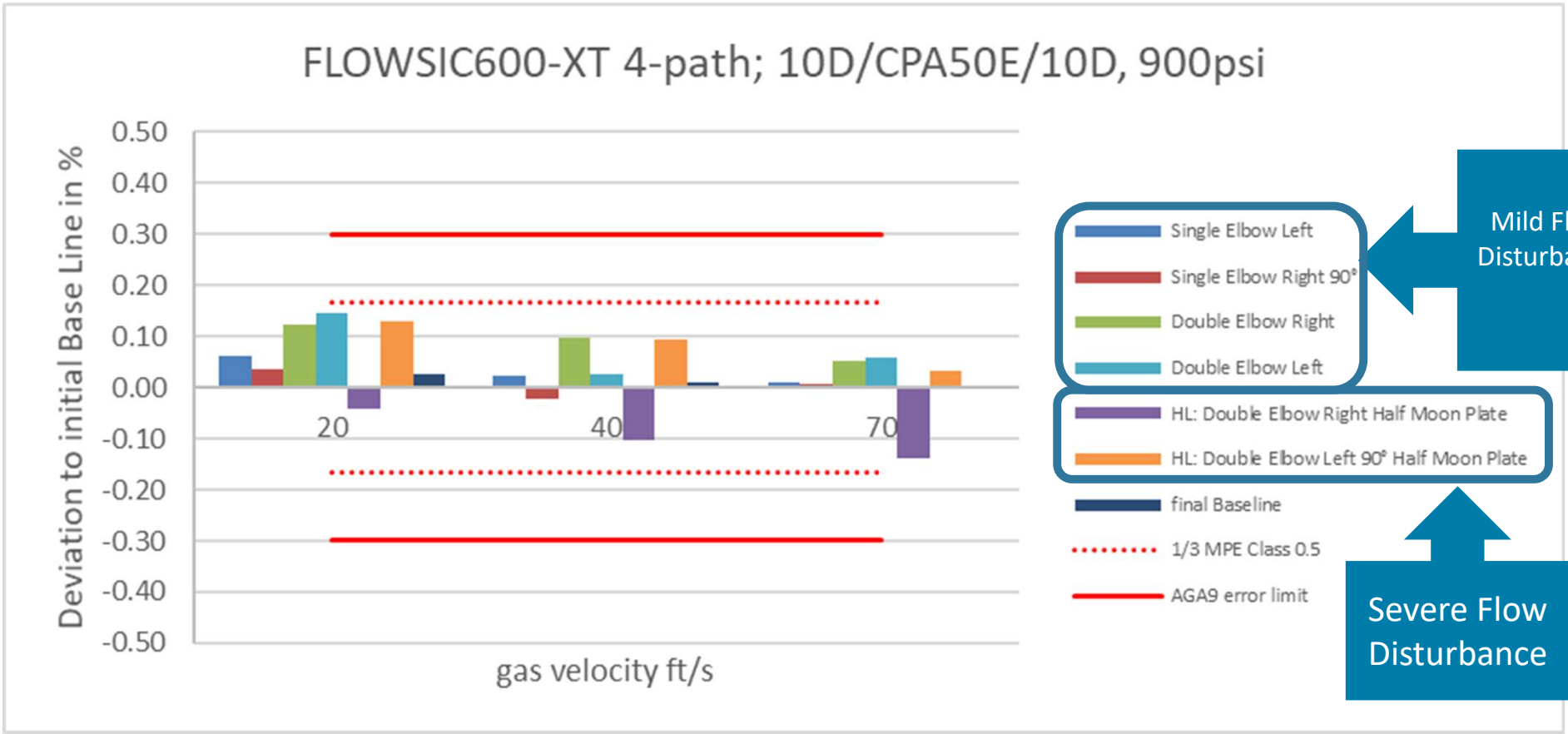
The weighted mean error (WME) shall be within the values given in Table 3.

Table 3 Maximum permissible weighted mean error

Flow rate Q	During type evaluation and initial verification			During subsequent verification and in-service		
	Accuracy class			Accuracy class		
	0.5	1	1.5	0.5	1	1.5
WME	± 0.2 %	± 0.4 %	± 0.6 %	--	--	--

Endress+Hauser

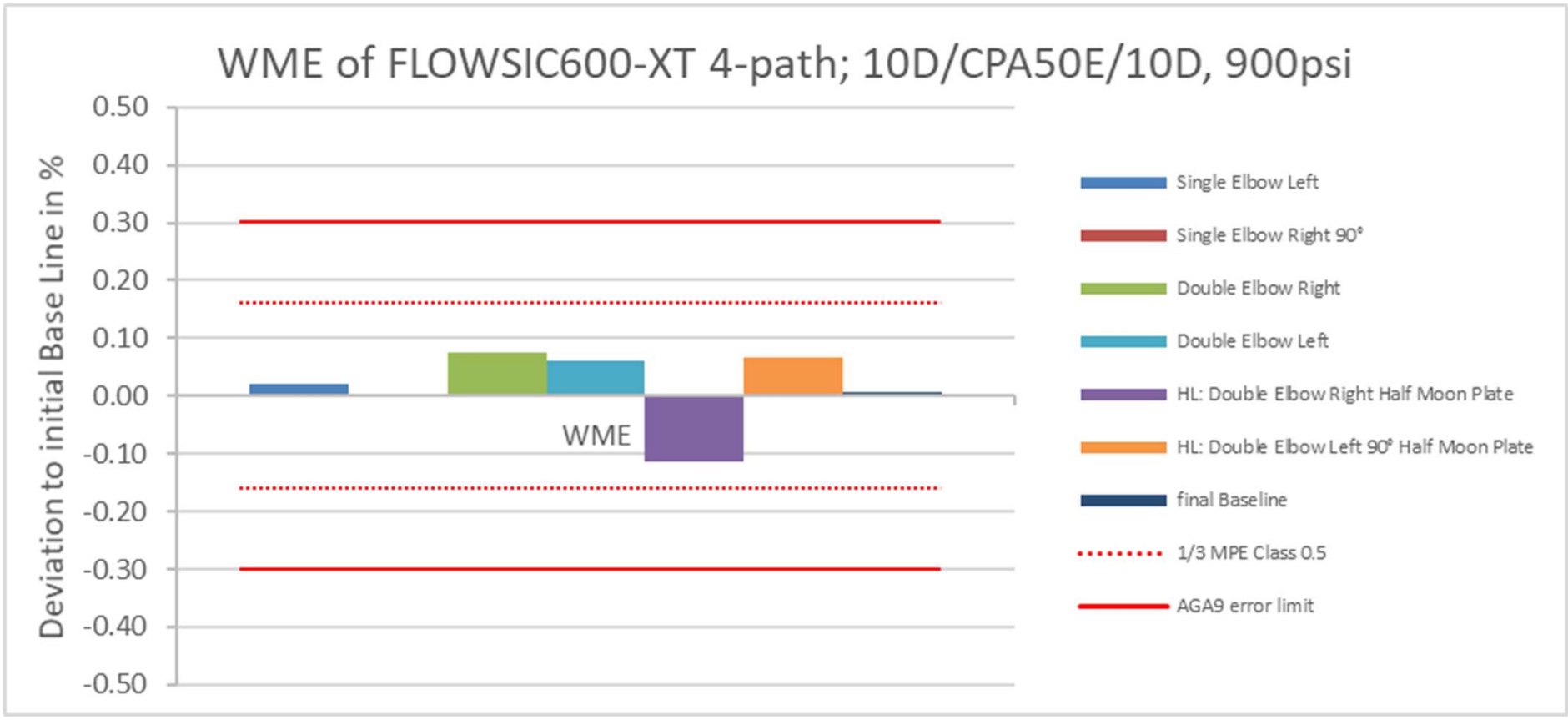
AGA 9 Testing Campaign Results 10D/CPA50E/10D



Errors shown as deviation to initial baseline at different gas velocities
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

Endress+Hauser

AGA 9 Testing Campaign Results 10D/CPA50E/10D



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

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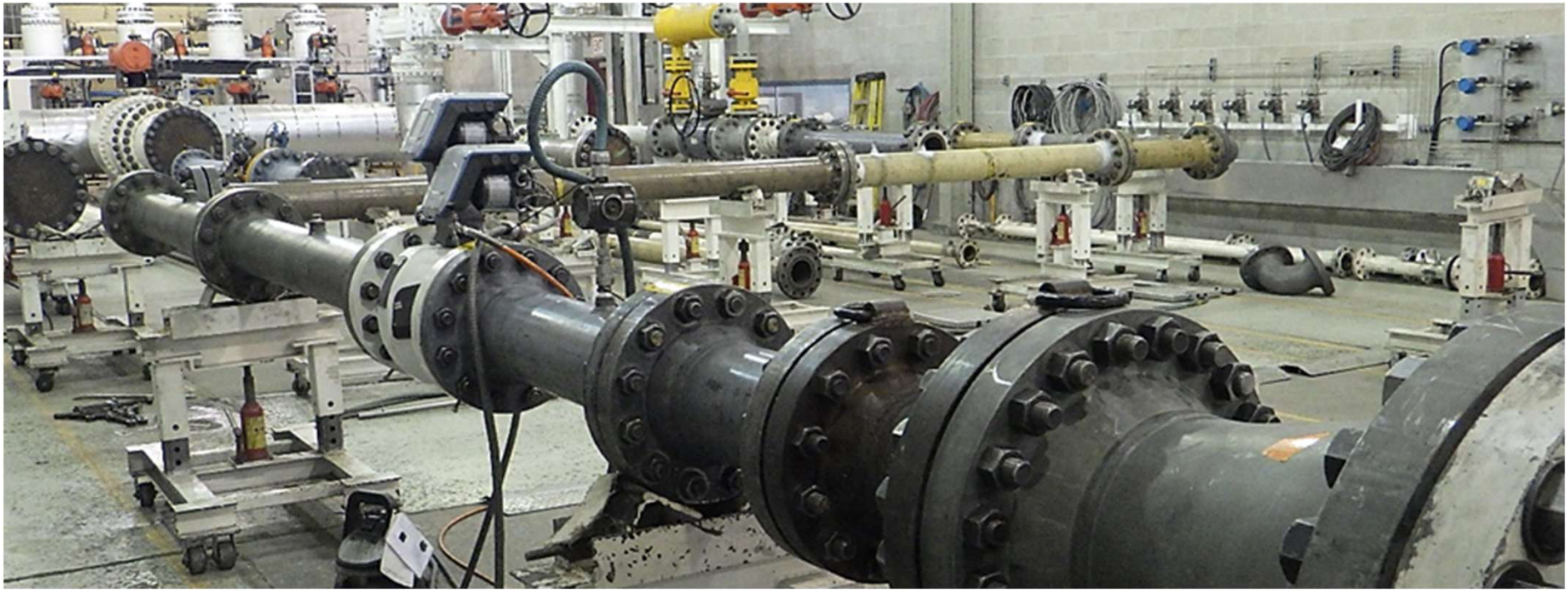
AGA 9 Testing Campaign Results



FLOWSIC600-XT 2plex - Single Elbow Left Testing with
10D|CPA50E|10D

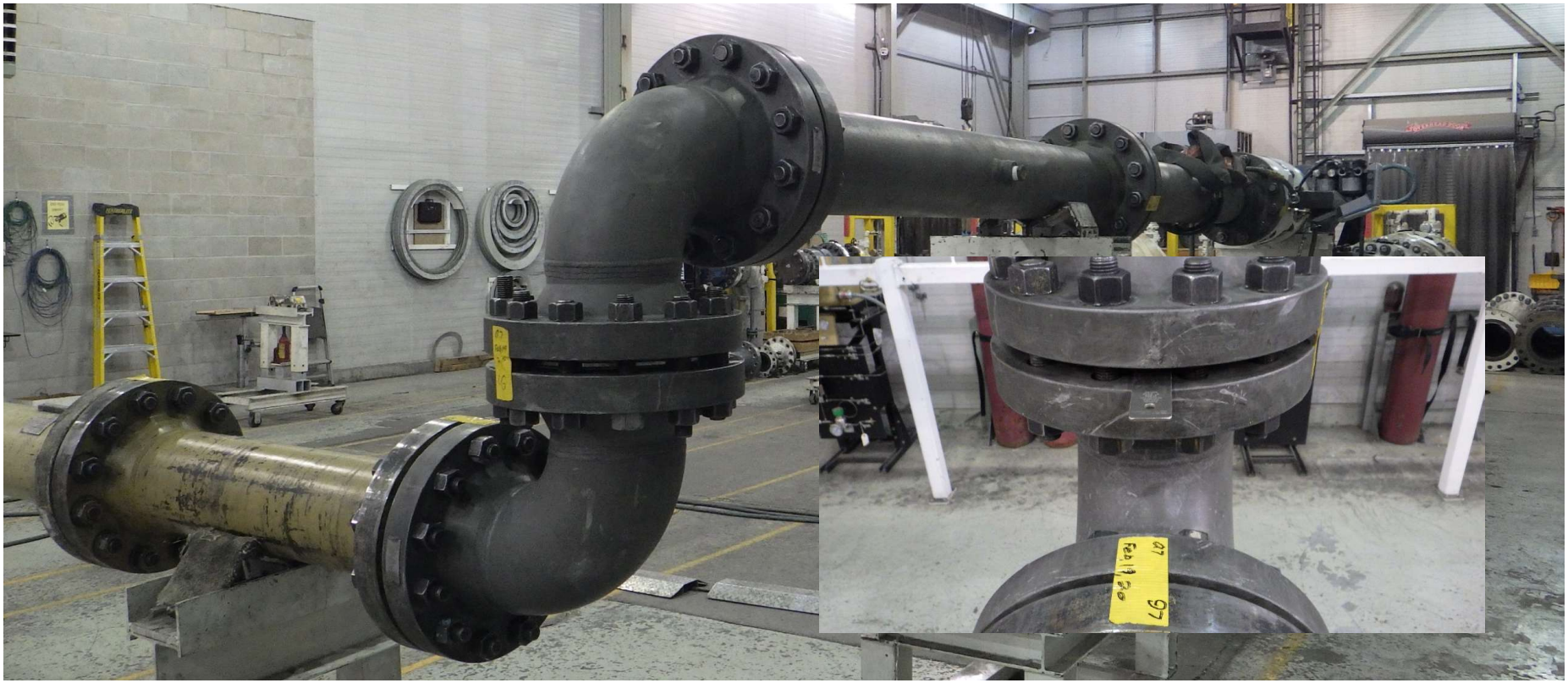
Endress+Hauser

AGA 9 Testing Campaign Results

FLOWSIC600-XT 2plex - DEOOP LT - Double Elbow Out of Plane Left Turn 90 Degrees Testing with 10D|CPA50E|10D

Endress+Hauser

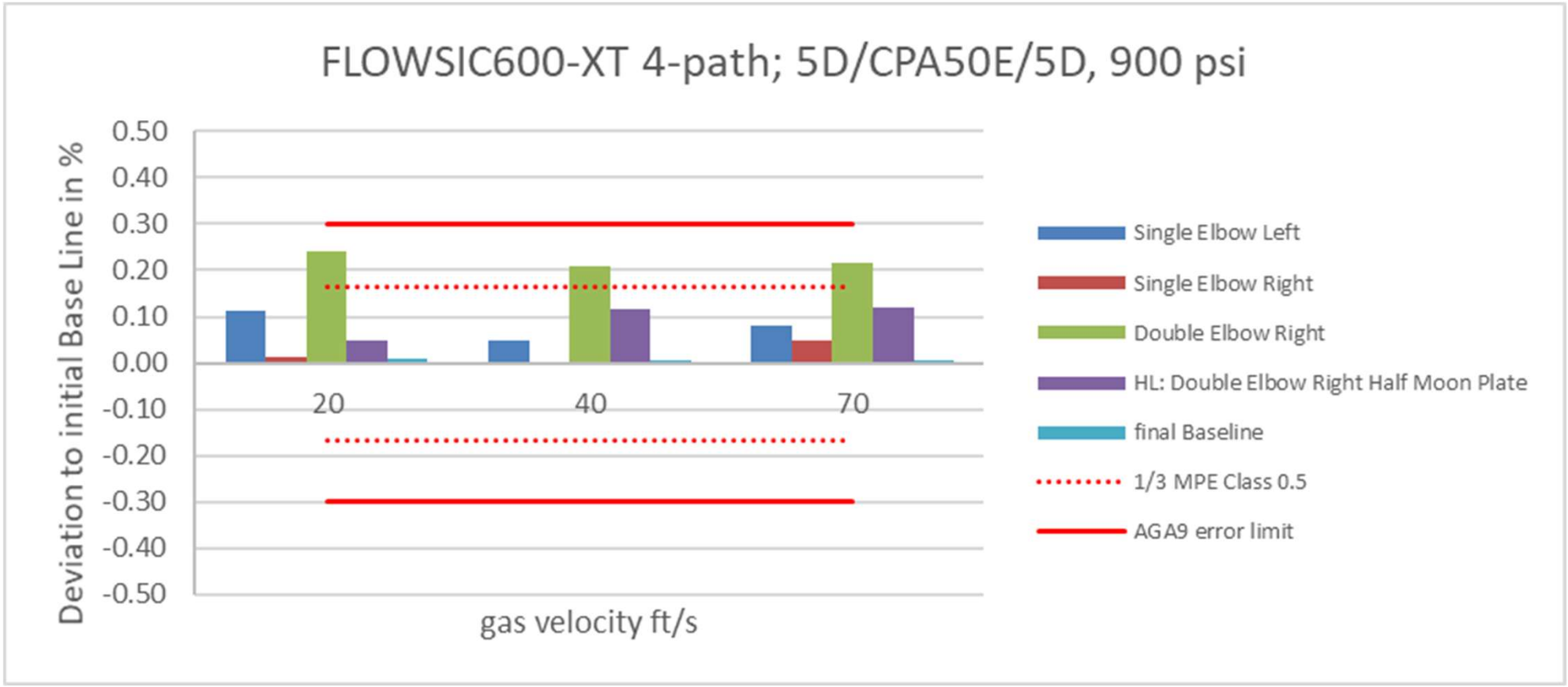
AGA 9 Testing Campaign Results



FLOWSIC600-XT 2plex - DEOOP LT HMP - Double Elbow Out of Plane Left Turn 90 Degrees Half Moon Plate Testing with 10D|CPA50E|10D

Endress+Hauser

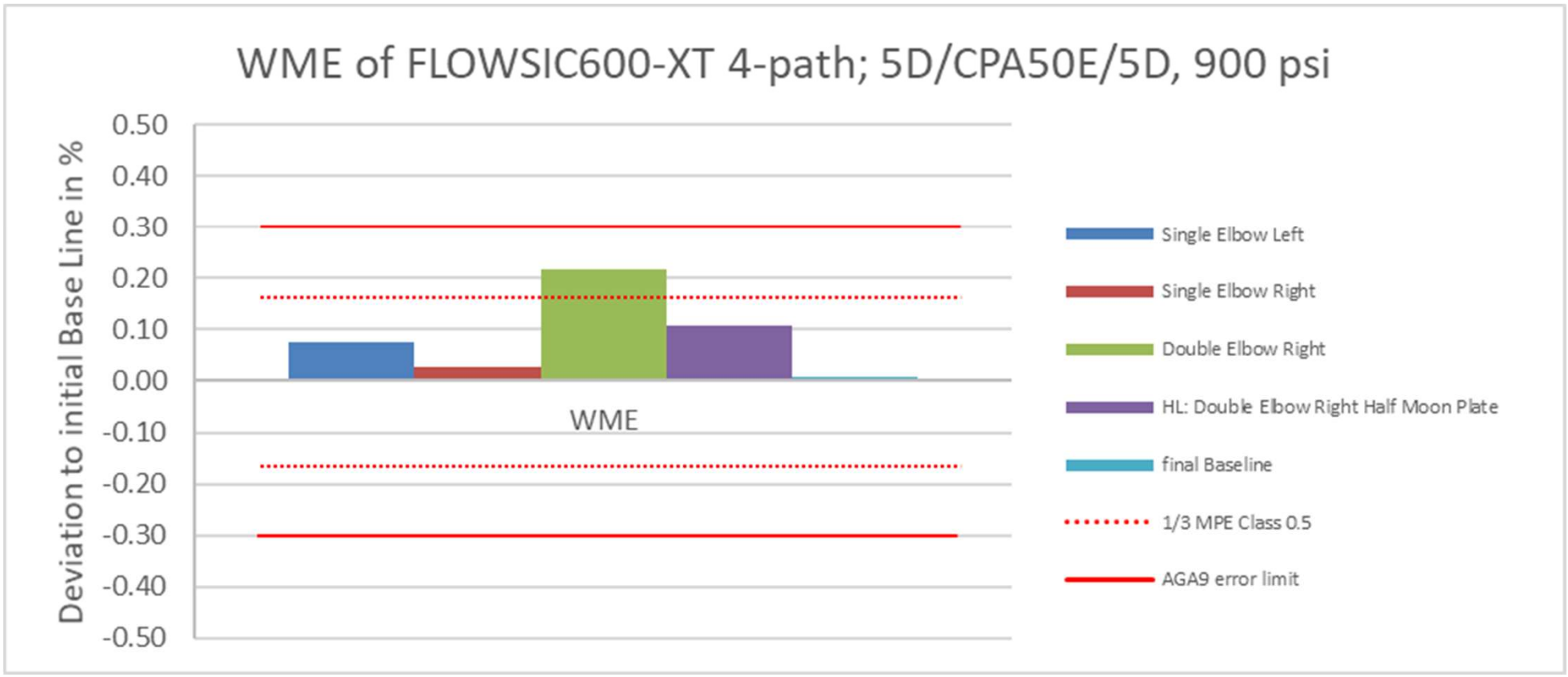
AGA 9 Testing Campaign Results 5D/CPA50E/5D



Errors shown as deviation to initial baseline at different gas velocities
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

Endress+Hauser

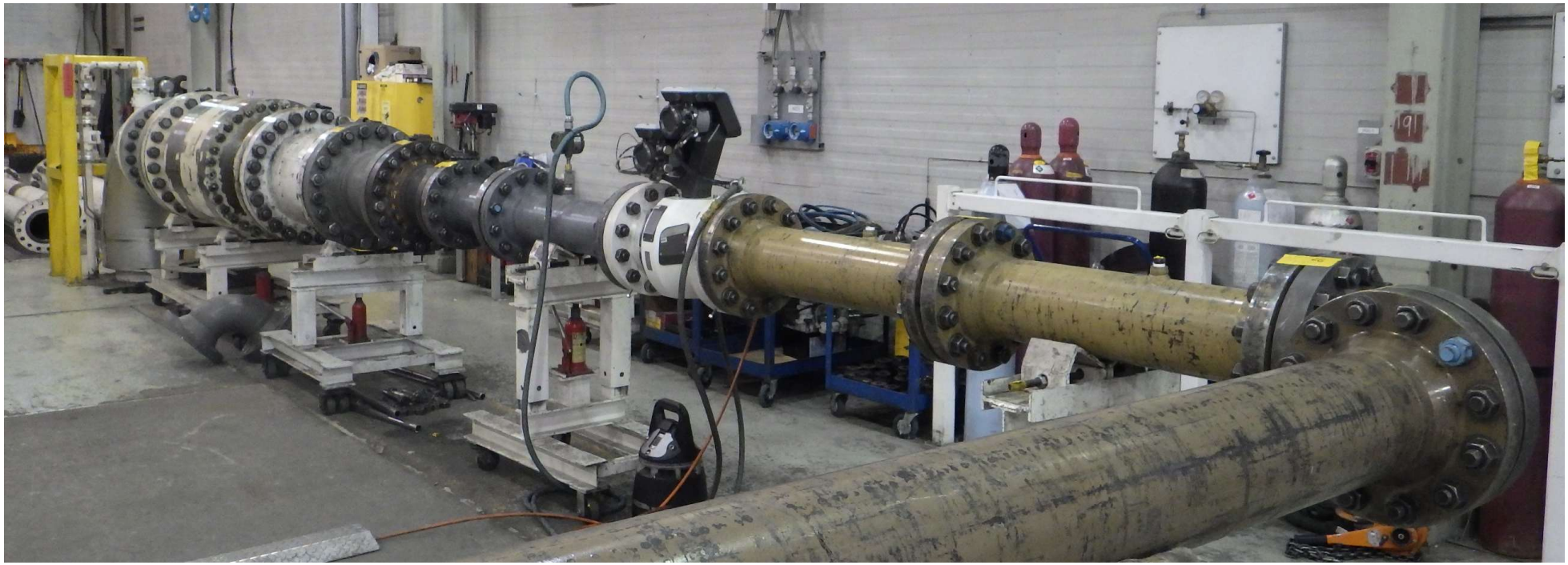
AGA 9 Testing Campaign Results 5D/CPA50E/5D



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

Endress+Hauser

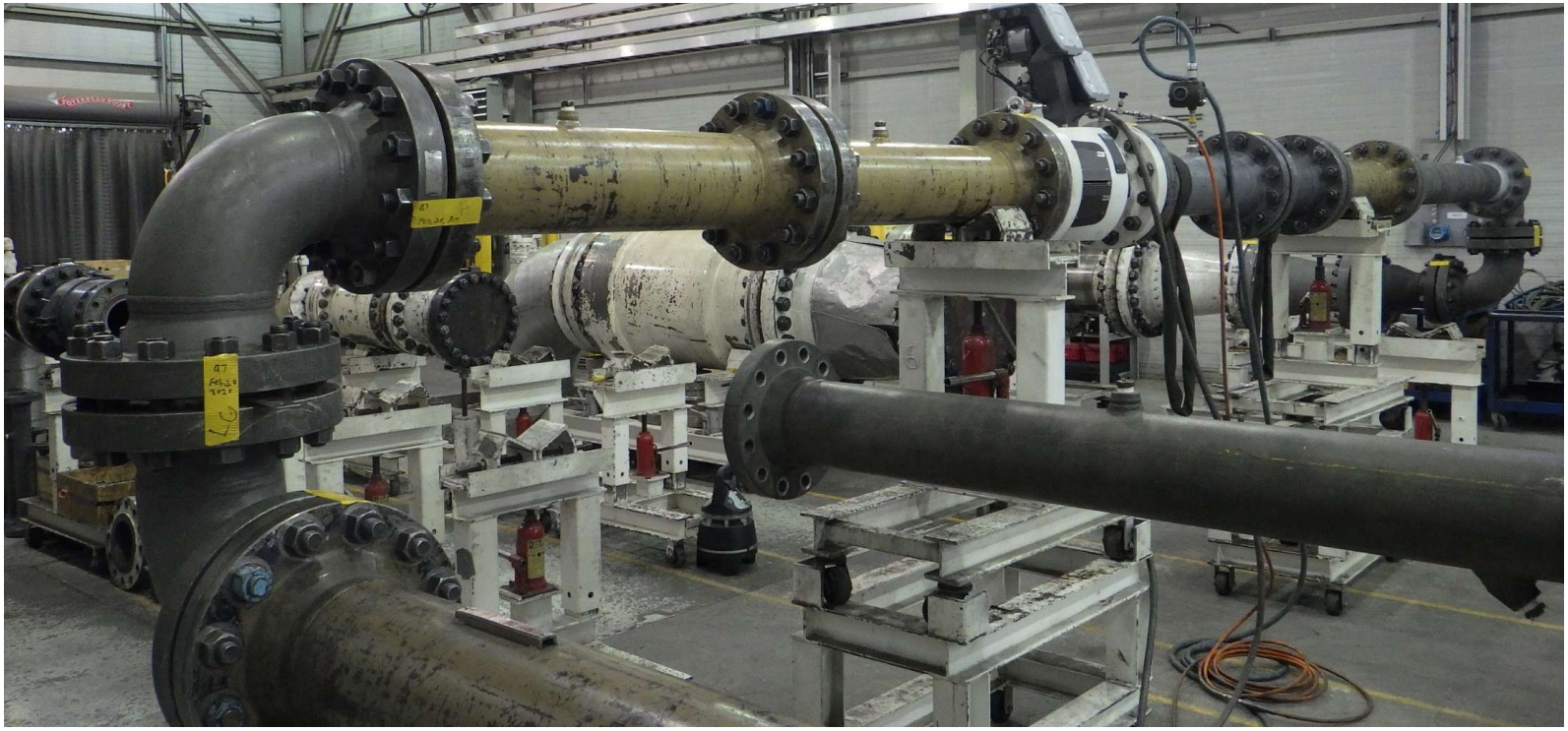
AGA 9 Testing Campaign Results



FLOWSIC600-XT 2plex - Single Elbow LT - Single Elbow
Left Turn Testing with 5D|CPA50E|5D

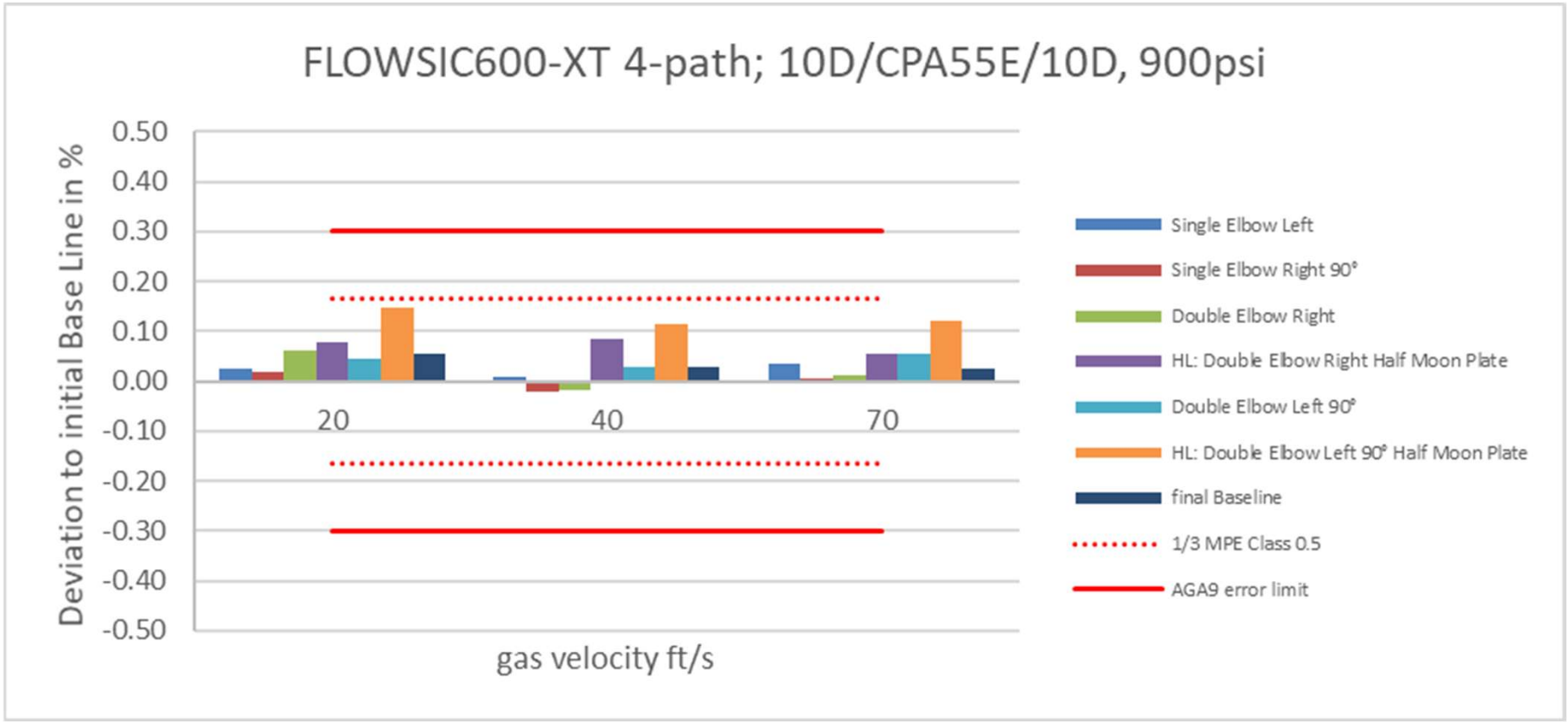
Endress+Hauser

AGA 9 Testing Campaign Results



FLOWSIC600-XT 2plex - DEOOP RT HMP - Double Elbow Out of Plane Right Turn Half Moon Plate Testing with 5D|CPA50E|5D

AGA 9 Testing Campaign Results 10D/CPA55E/10D



Errors shown as deviation to initial baseline at different gas velocities
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

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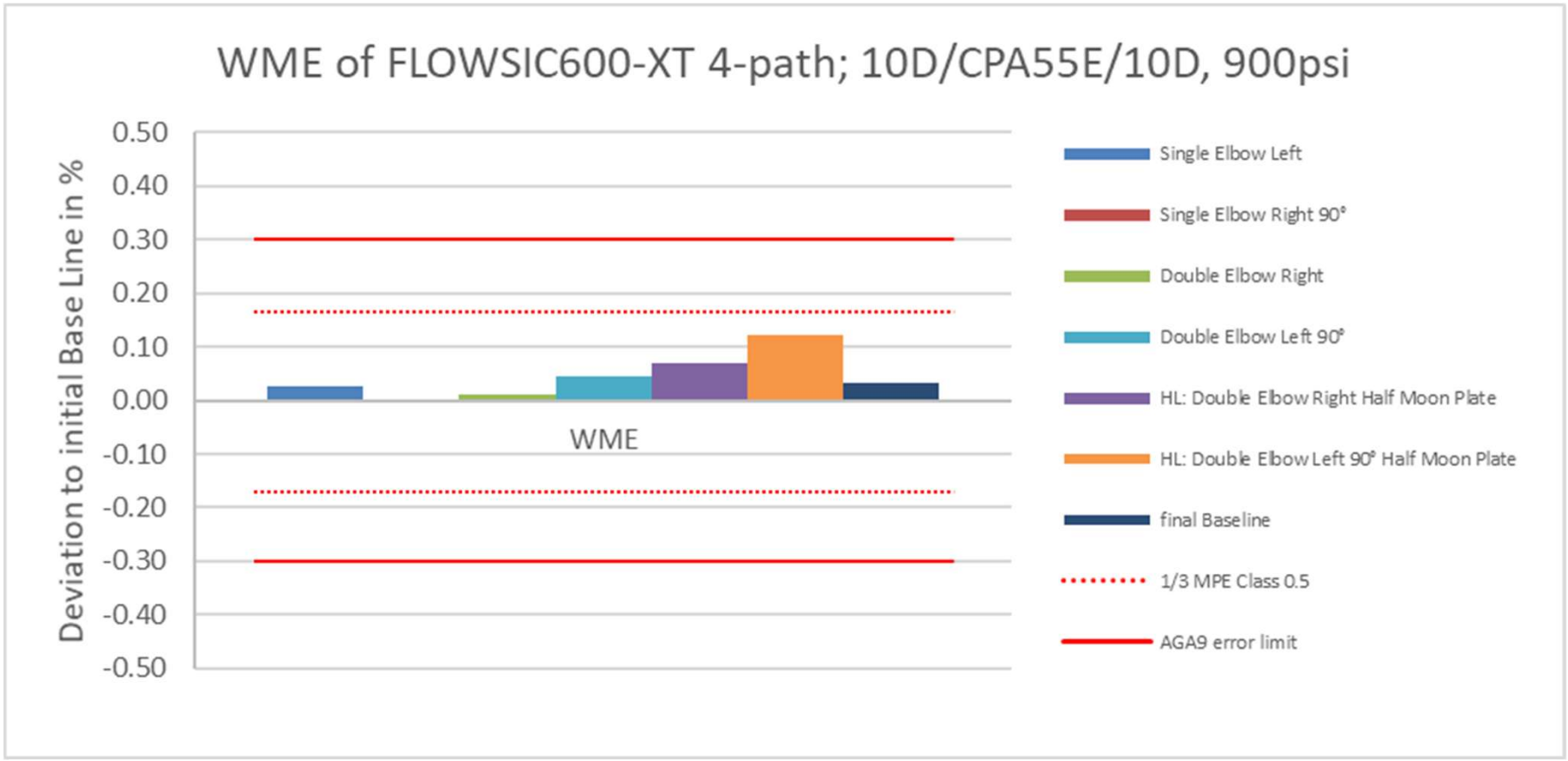
AGA 9 Testing Campaign Results 10D/CPA55E/10D



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

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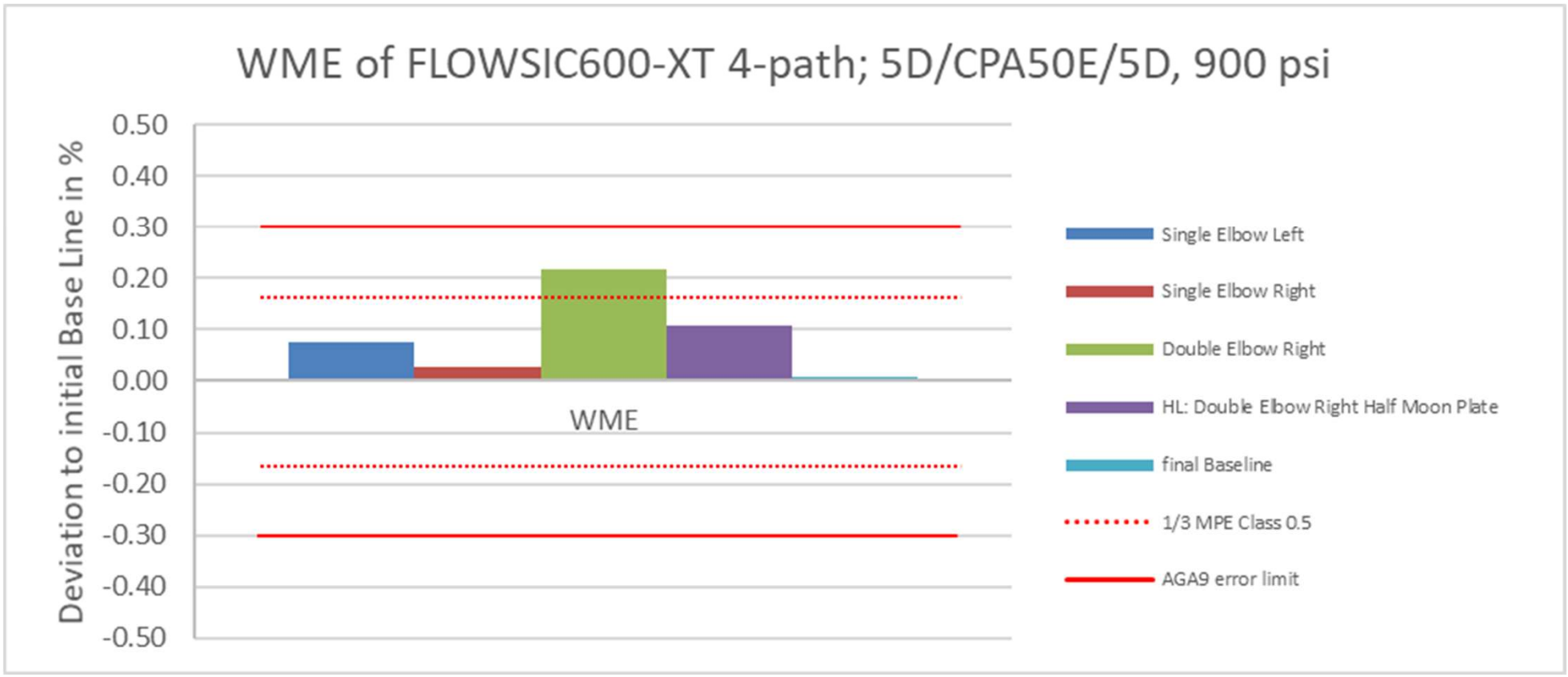
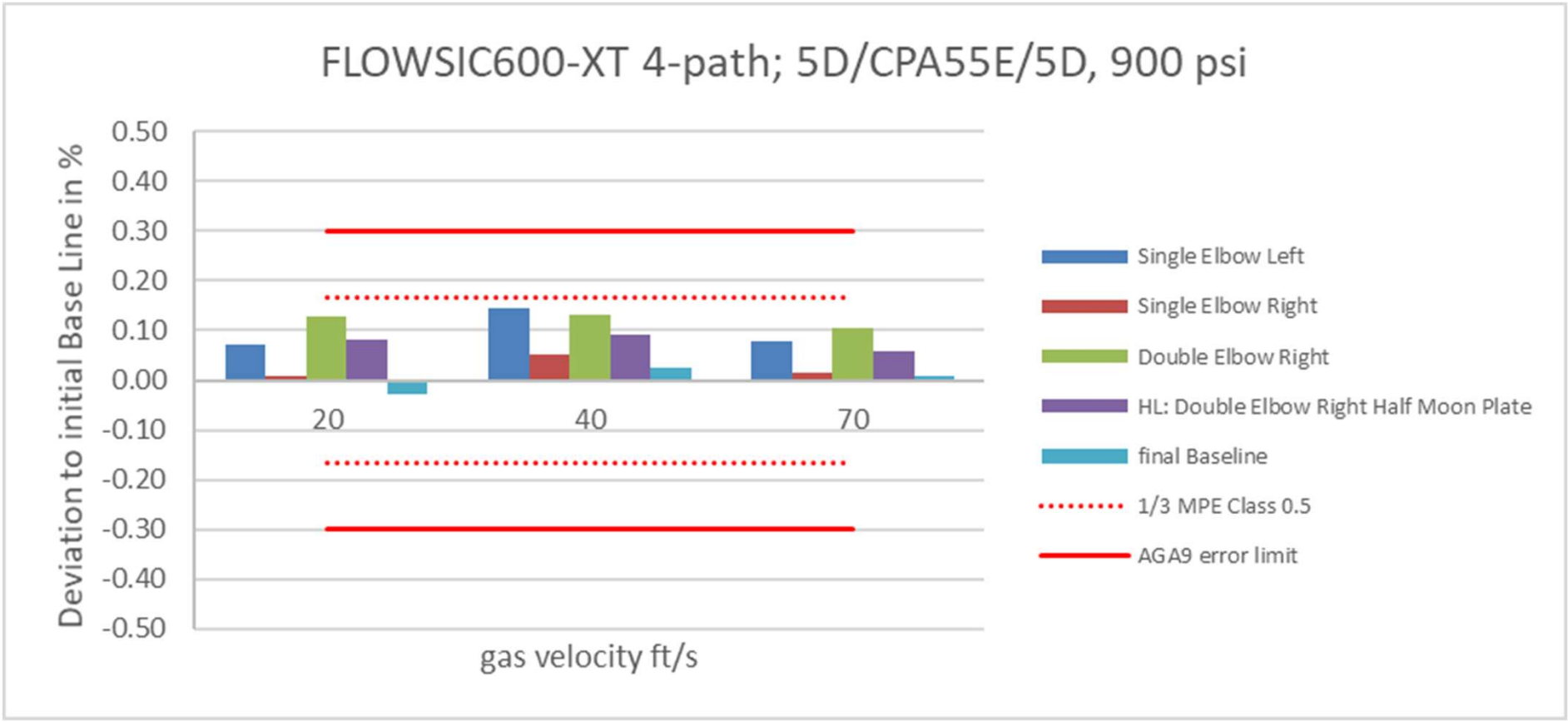
AGA 9 Testing Campaign Results 5D/CPA50E/5D (From Earlier)



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

Endress+Hauser

AGA 9 Testing Campaign Results 5D/CPA55E/5D



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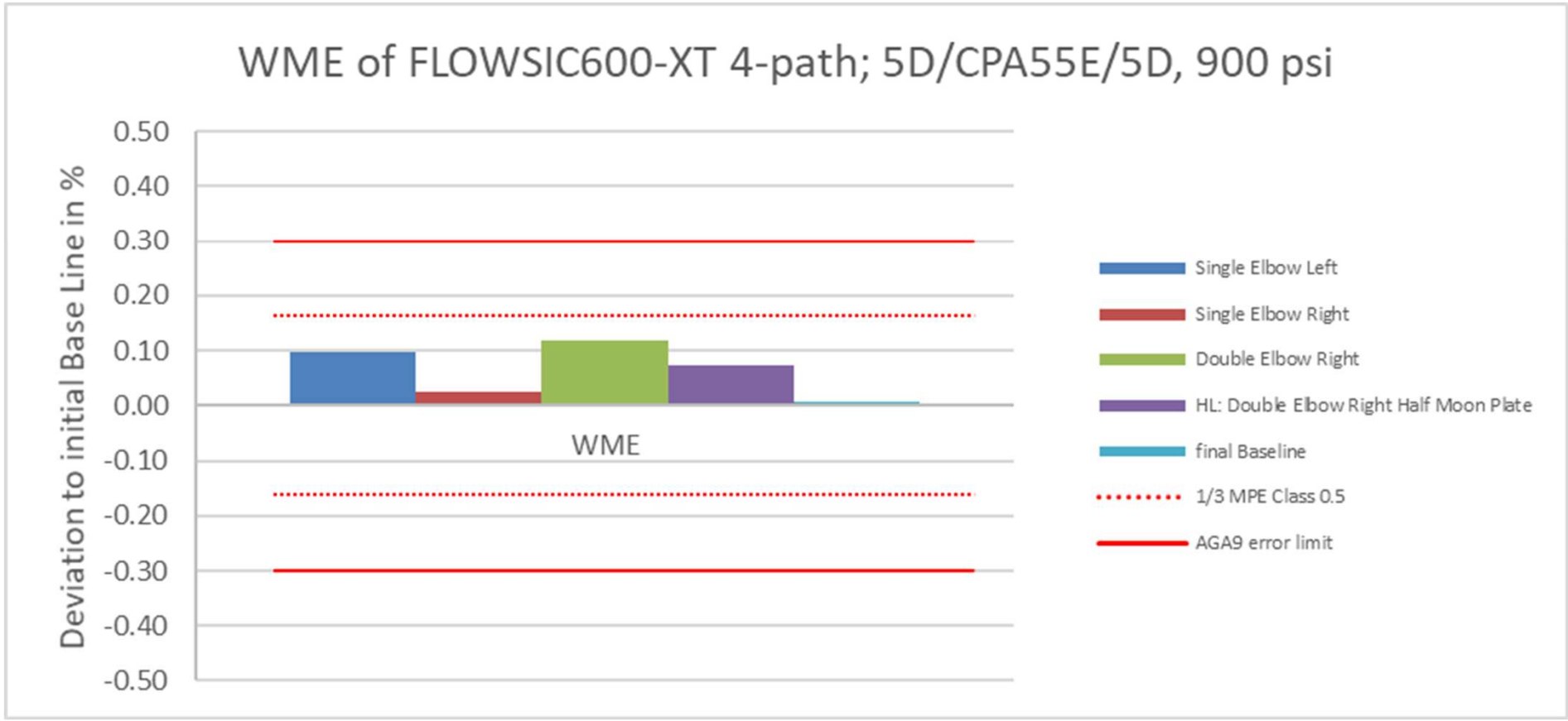
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

Endress+Hauser

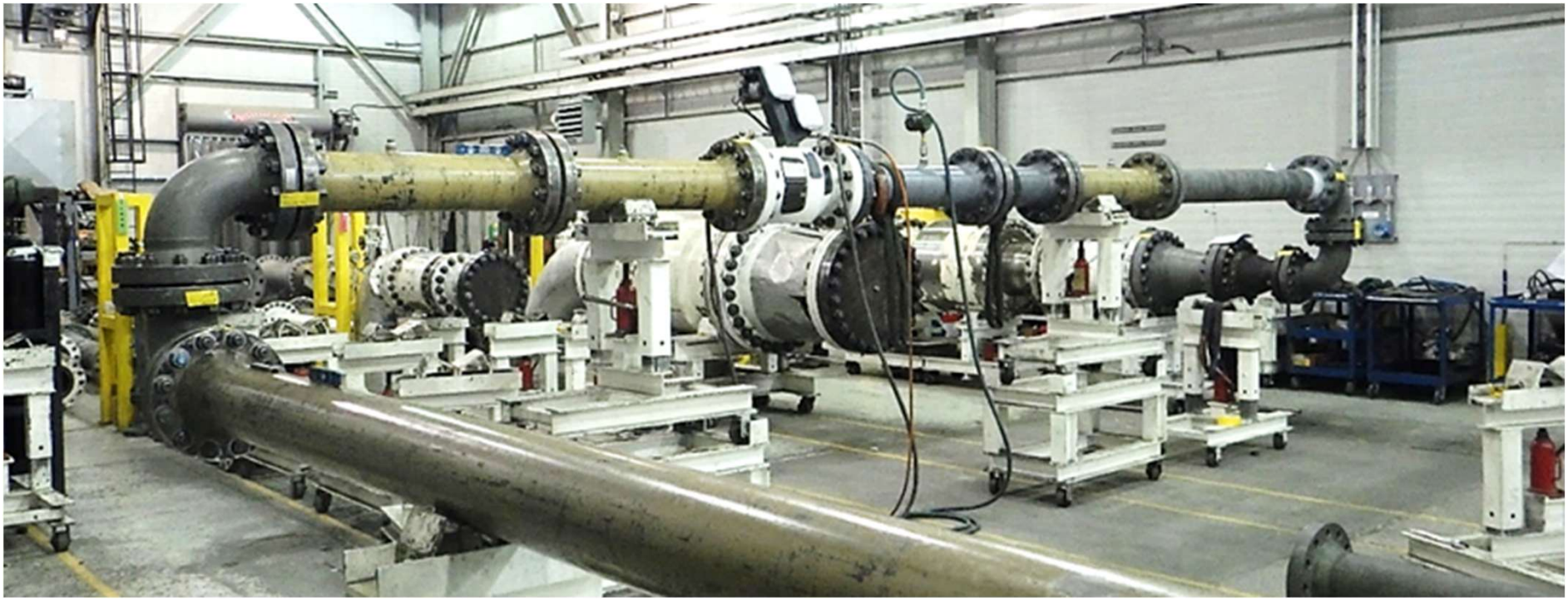
AGA 9 Testing Campaign Results 5D/CPA55E/5D



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

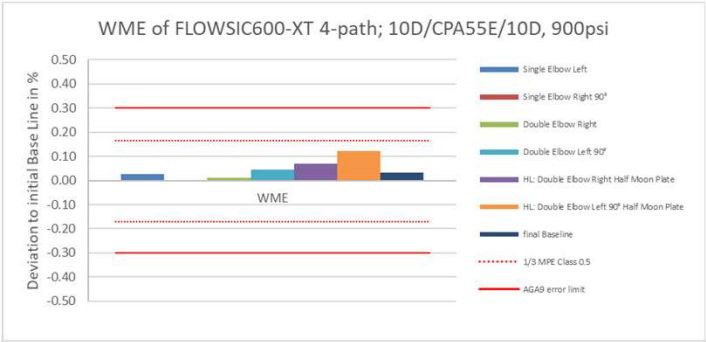
Endress+Hauser

AGA 9 Testing Campaign Results



FLOWSIC600-XT 2plex - Double Elbow Out of Plane
Right Testing with 5D|CPA55E|5D

AGA 9 Testing Campaign Results

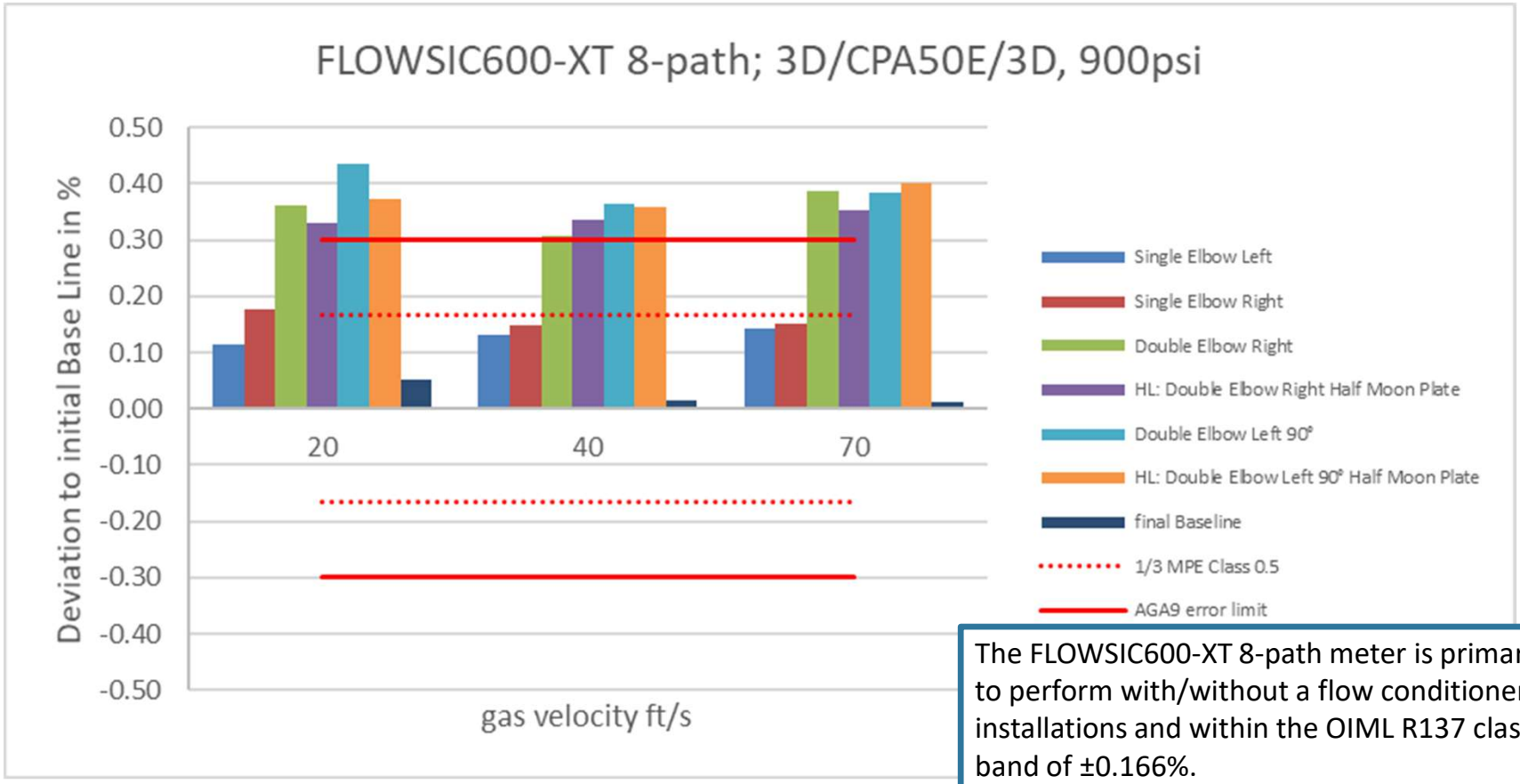


The test results indicate that the error limits of AGA9 and OIML R137 for accuracy class 1.0 and 0.5 can be met using both flow conditioners CPA 50E and 55E in a 10D inlet piping configuration. Furthermore, they illustrate the benefits of using a CPA 55E flow conditioner over a CPA 50E flow conditioner for 5D inlet piping configurations when accuracy class 0.5 is required.

AGA 9 Testing Campaign Results

FLOWSIC600-XT Forte - Single Elbow Right Testing with
3D|CPA50E|3D

AGA 9 Testing Campaign Results 3D/CPA50E/3D

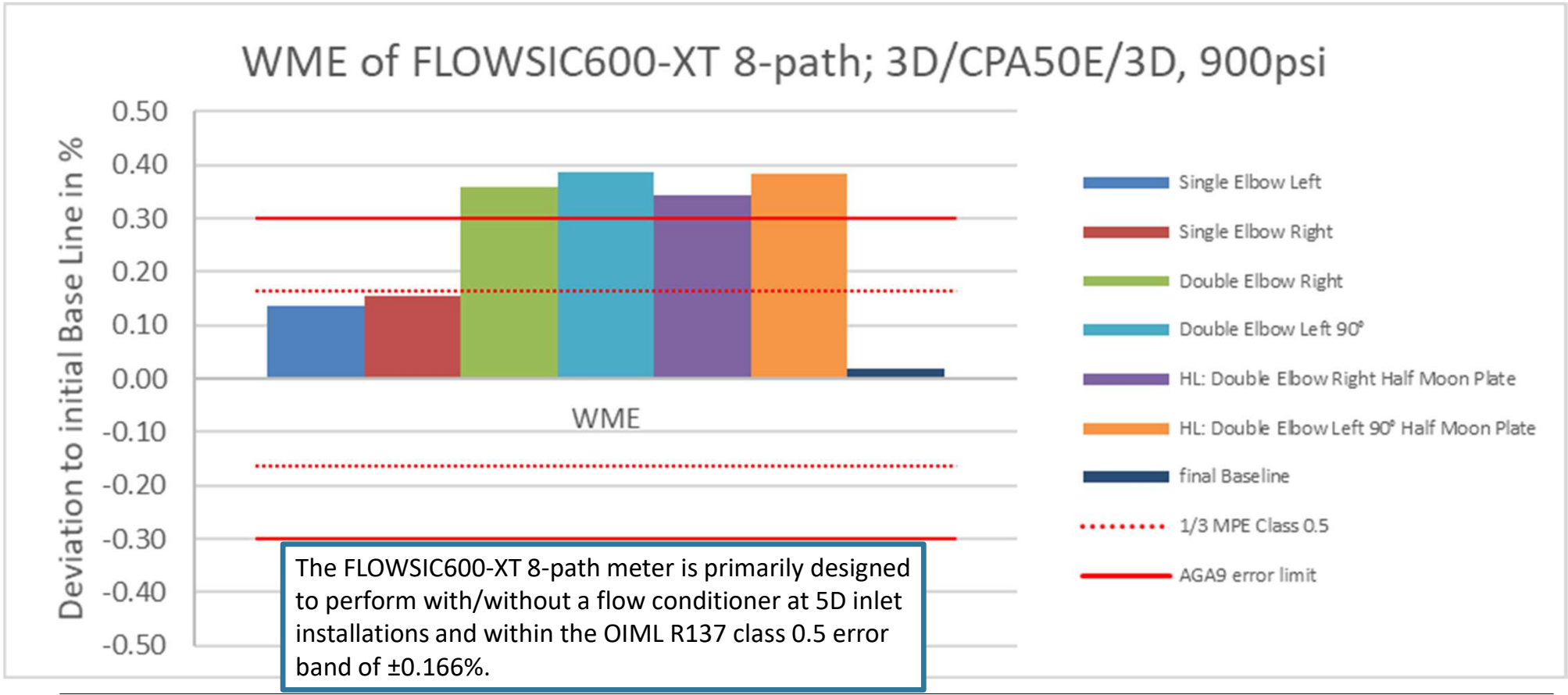


The FLOWSIC600-XT 8-path meter is primarily designed to perform with/without a flow conditioner at 5D inlet installations and within the OIML R137 class 0.5 error band of ±0.166%.

Errors shown as deviation to initial baseline at different gas velocities
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

Endress+Hauser

AGA 9 Testing Campaign Results 3D/CPA50E/3D



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Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

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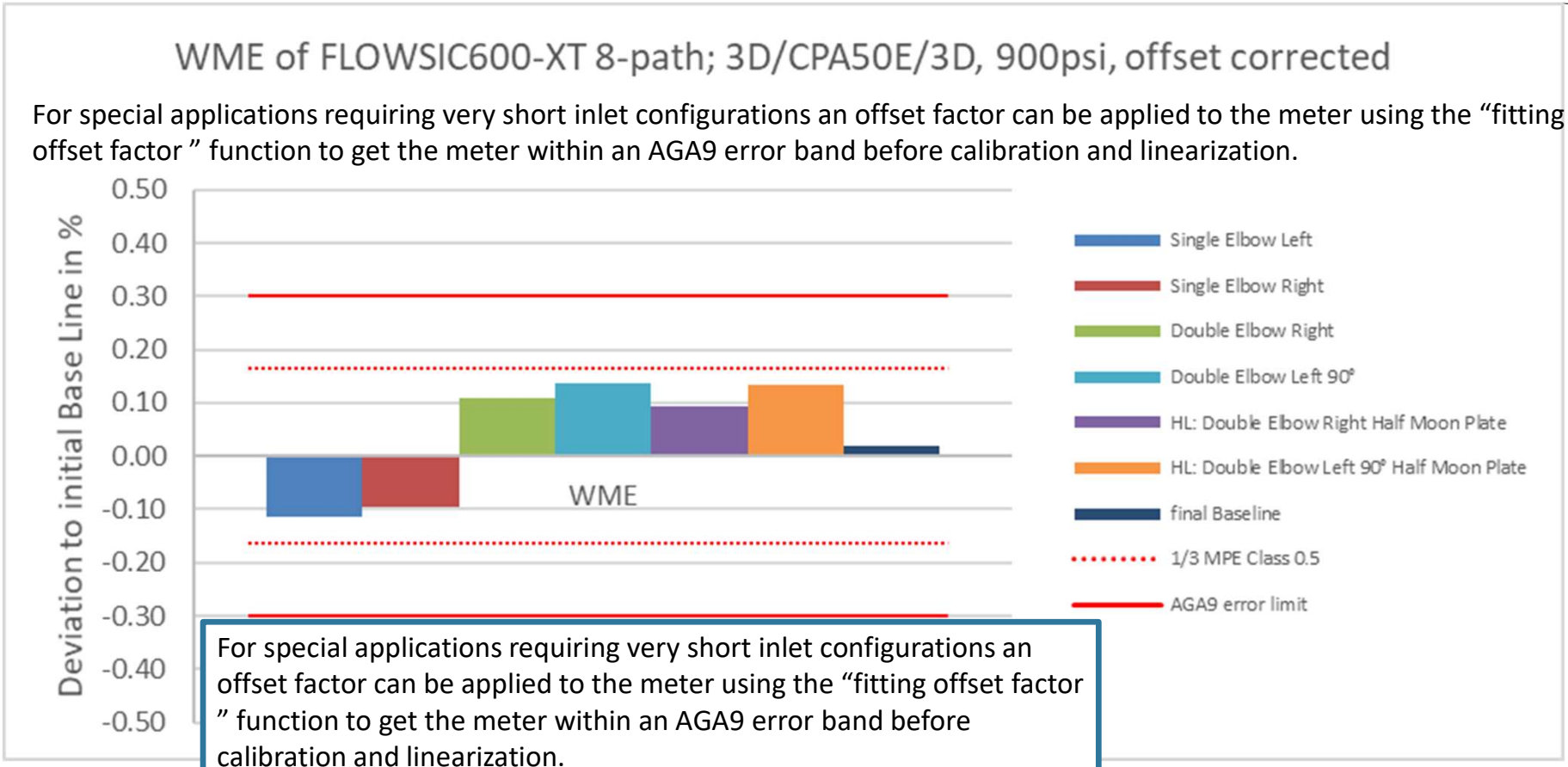
AGA 9 Testing Campaign Results 3D/CPA50E/3D

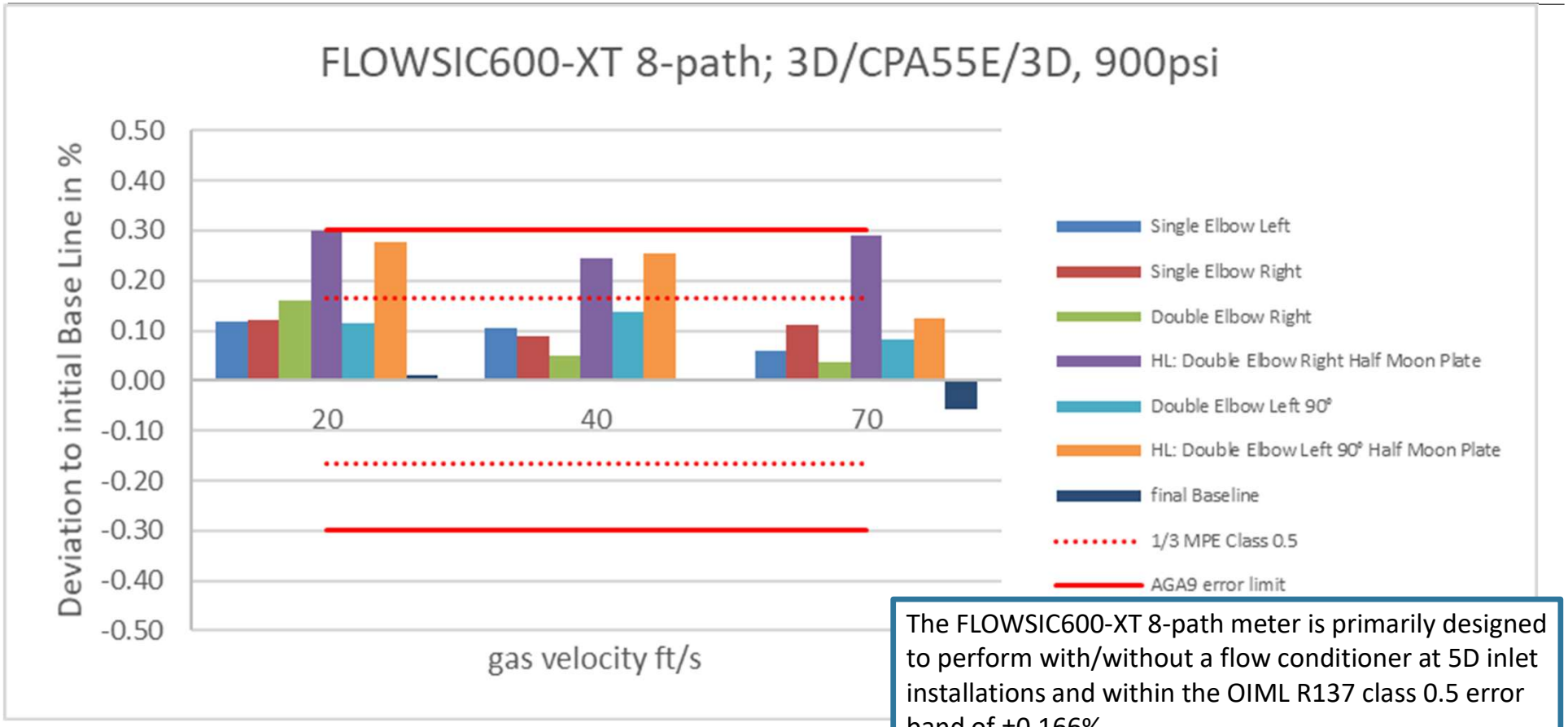


For special applications requiring very short inlet configurations an offset factor can be applied to the meter using the “fitting offset factor ” function to get the meter within an AGA9 error band before calibration and linearization.

Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

Endress+Hauser

AGA 9 Testing Campaign Results 3D/CPA55E/3D



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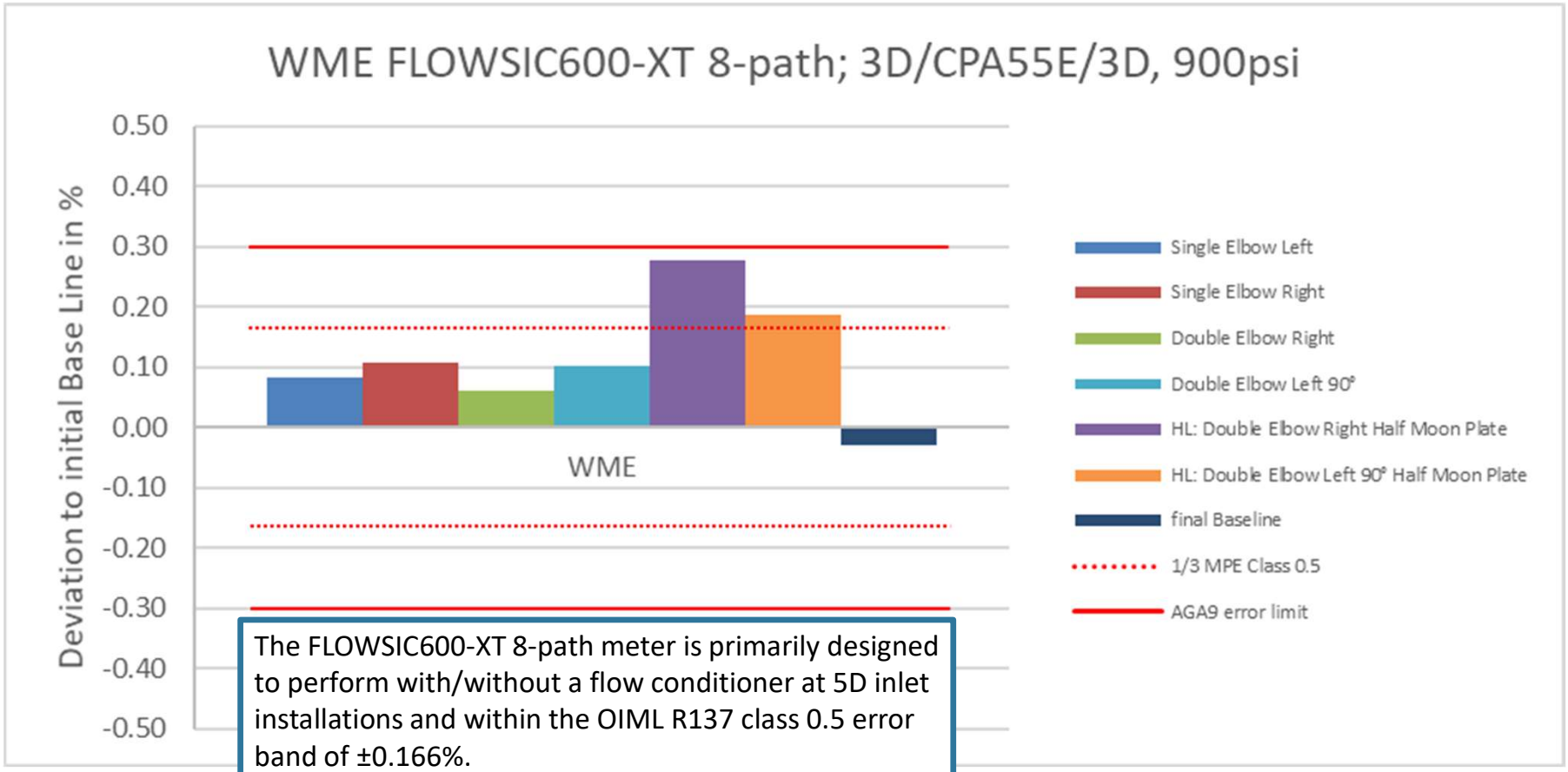
Errors shown as deviation to initial baseline at different gas velocities
OIML R137 Class .5 accuracy band of +/-0.166% / AGA9 & Measurement Canada error limit of 0.30%

Endress+Hauser

AGA 9 Testing Campaign Results 3D/CPA55E/3D



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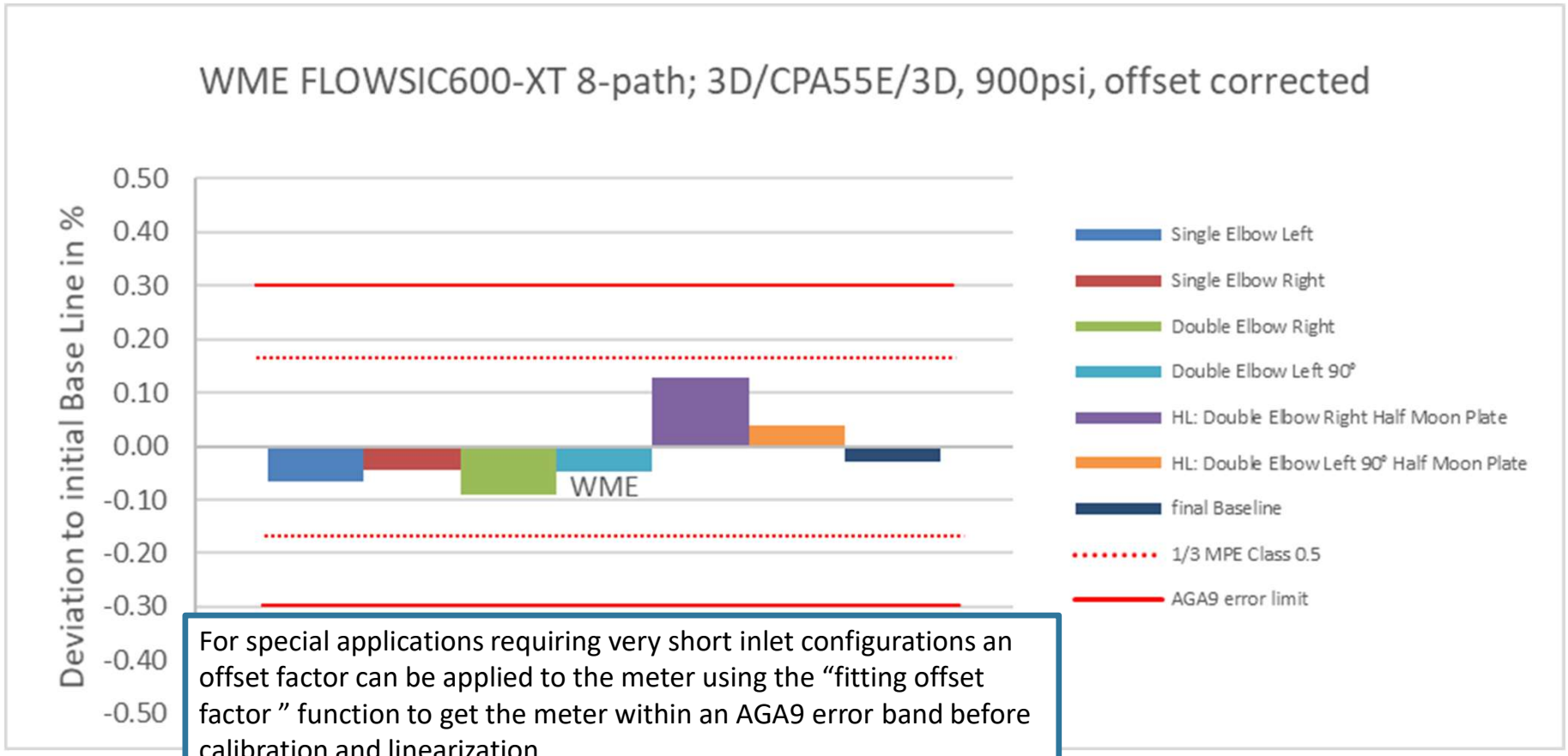
Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

Endress+Hauser

AGA 9 Testing Campaign Results 3D/CPA55E/3D



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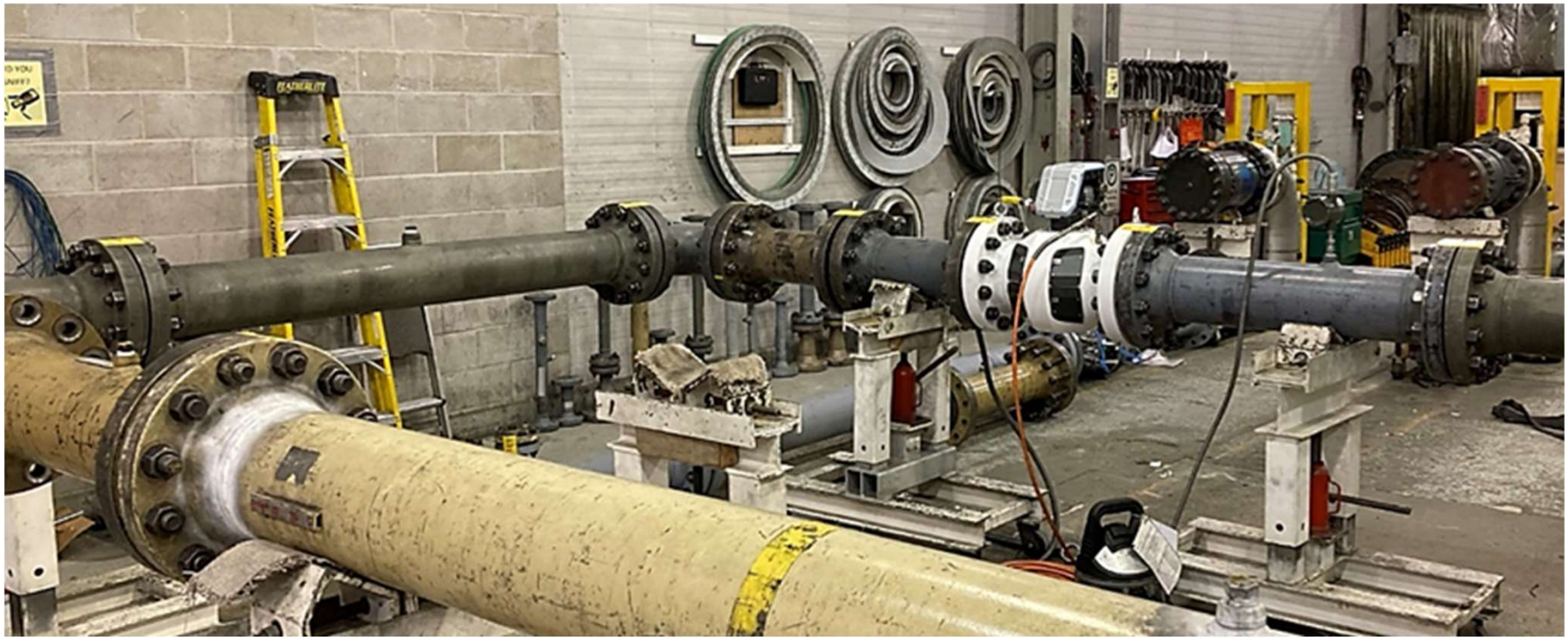
Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

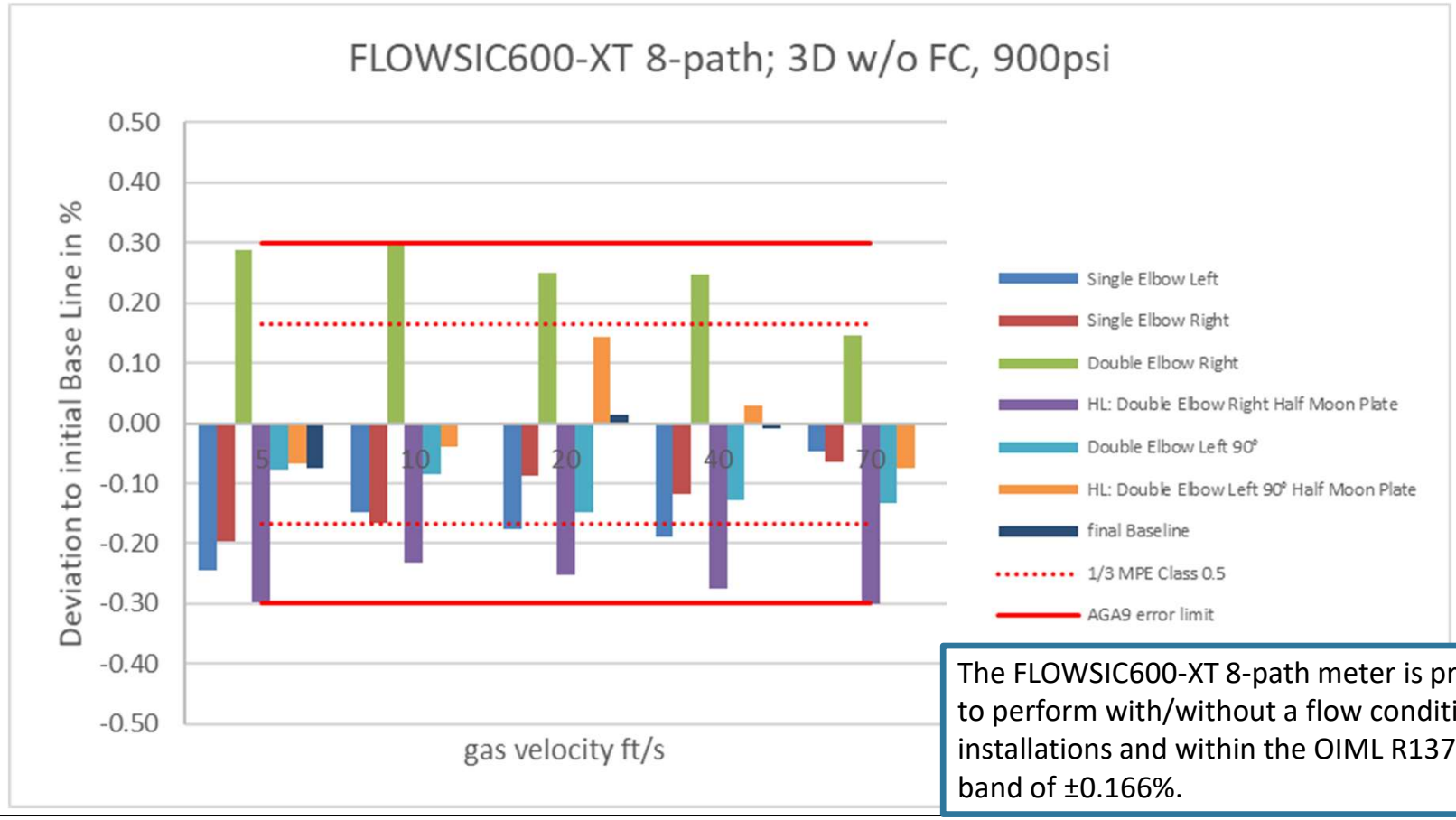
AGA 9 Testing Campaign Results



FLOWSIC600-XT Forte - Single Elbow Right Testing with
3D|CPA55E|3D

Endress+Hauser

AGA 9 Testing Campaign Results
3D w/o FC



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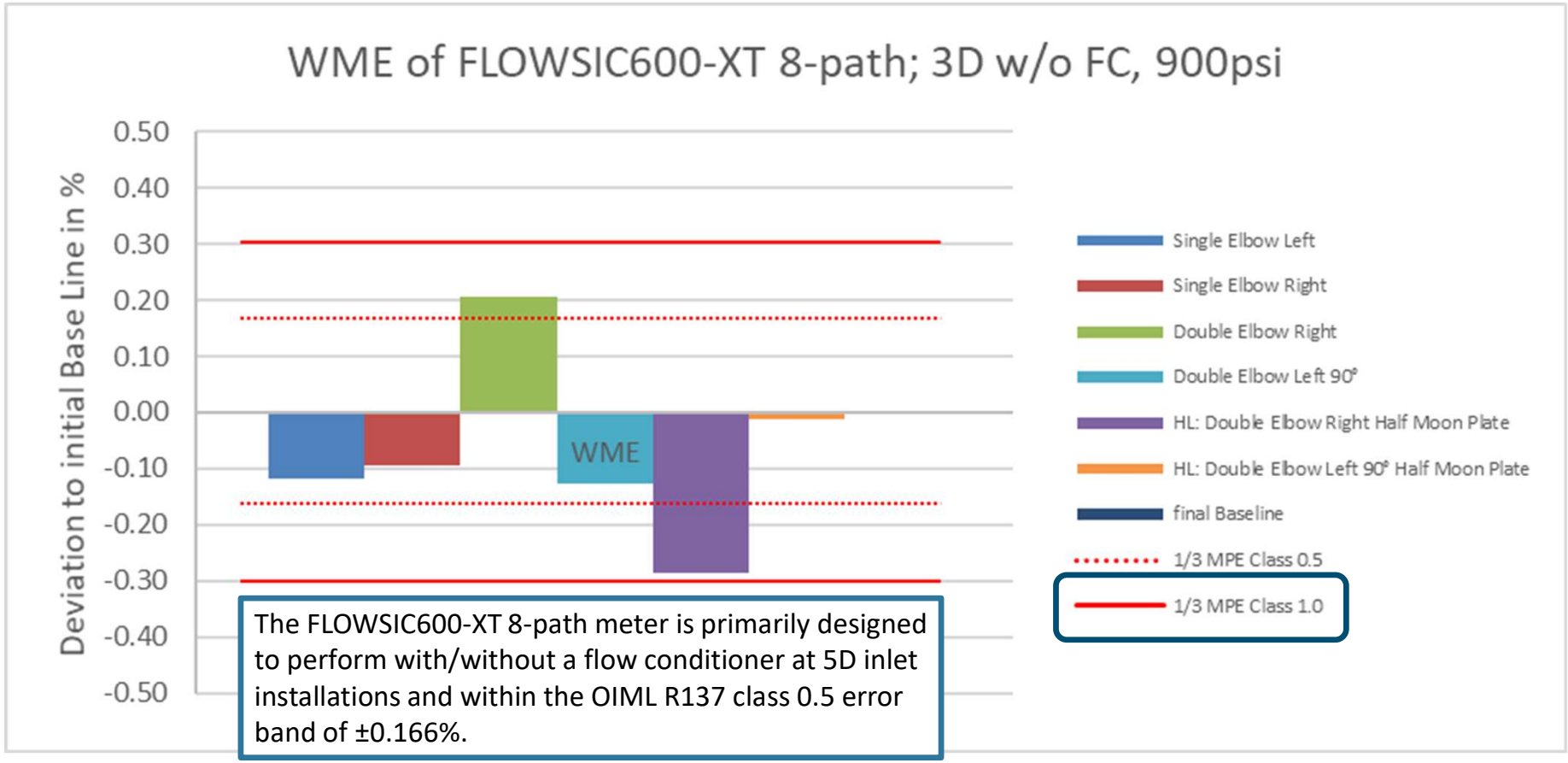
AGA 9 Testing Campaign Results
3D w/o FC



The FLOWSIC600-XT 8-path meter is primarily designed to perform with/without a flow conditioner at 5D inlet installations and within the OIML R137 class 0.5 error band of ±0.166%.

Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

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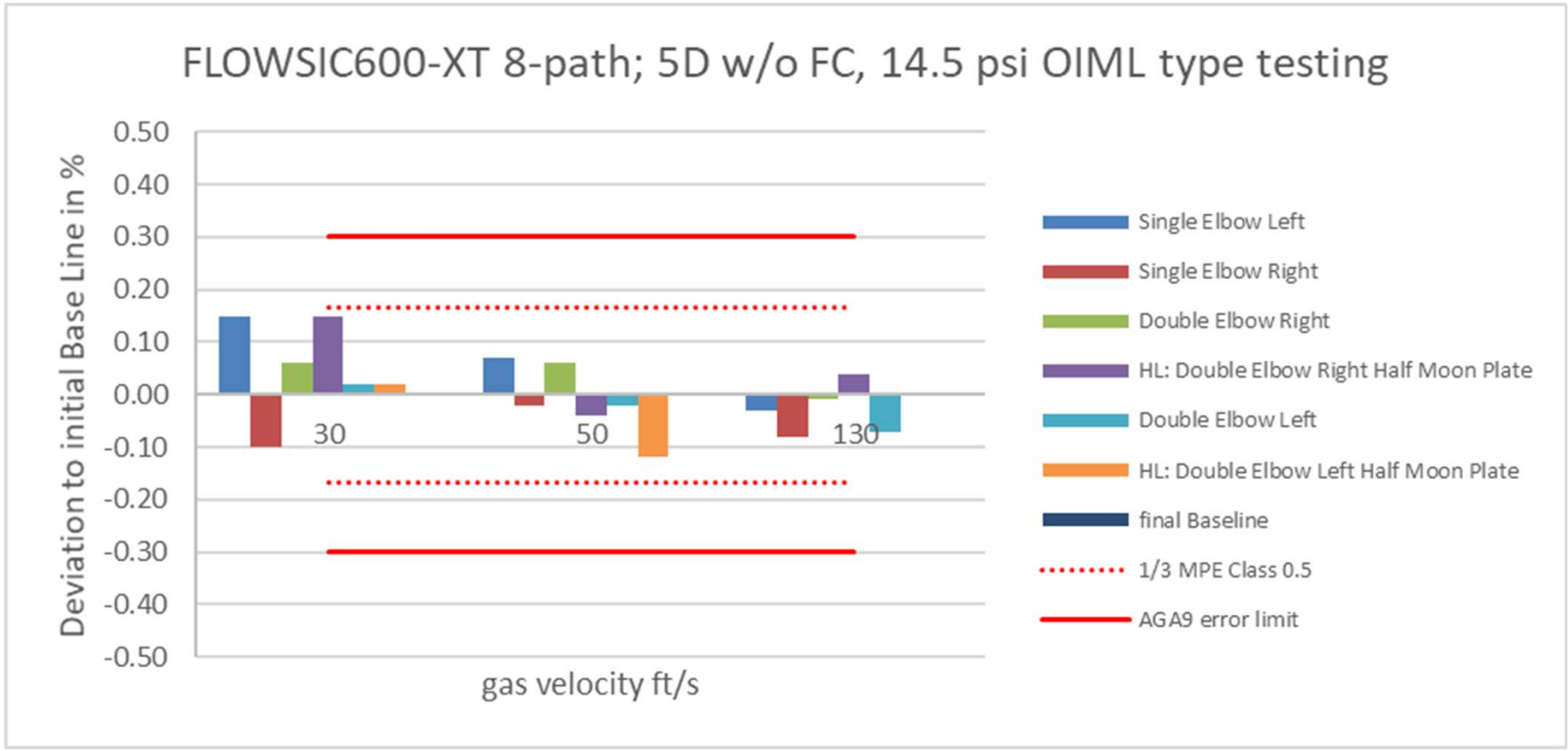
AGA 9 Testing Campaign Results

FLOWSIC600-XT Forte - Double Elbow Out of Plane
Right Testing with 3D w/o FC

OIML 137 Testing Campaign Results
5D w/o FC (2020)



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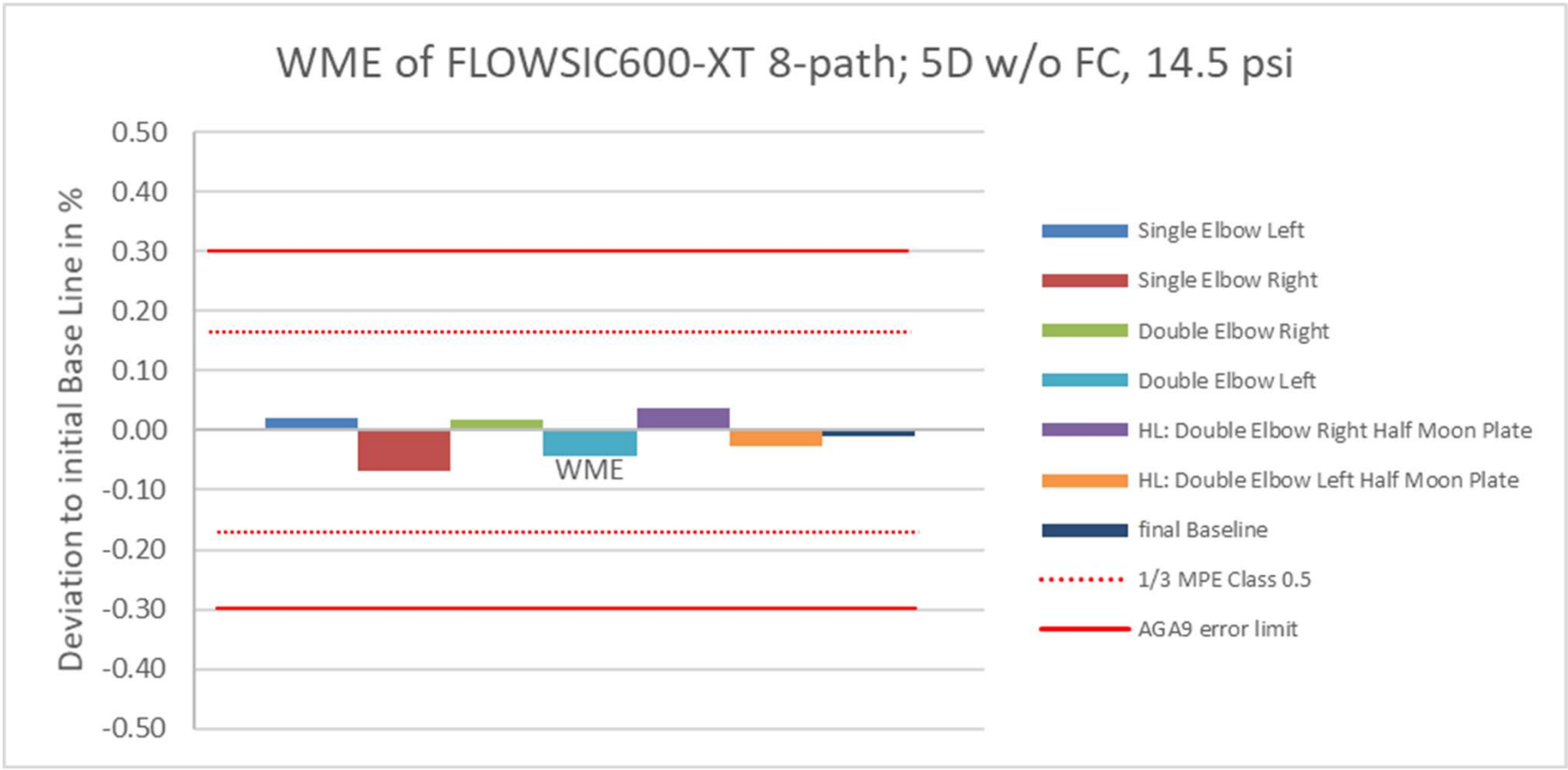
AGA 9 Testing Campaign Results
5D w/o FC (2020)



Weighted Mean Error (WME)/FWME for the specific piping arrangement for mild and severe disturbances

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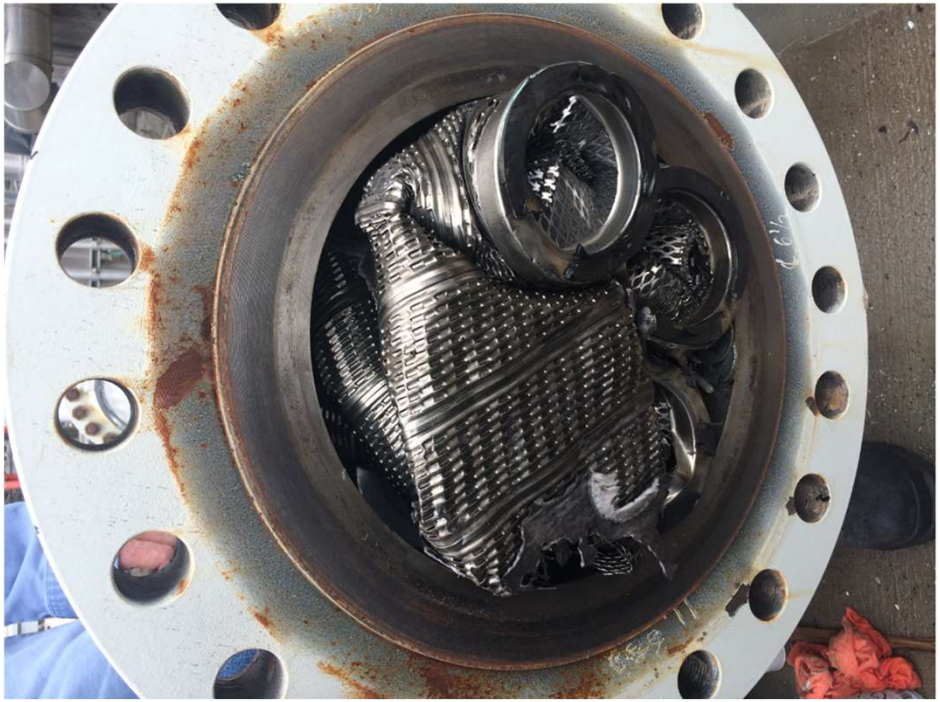
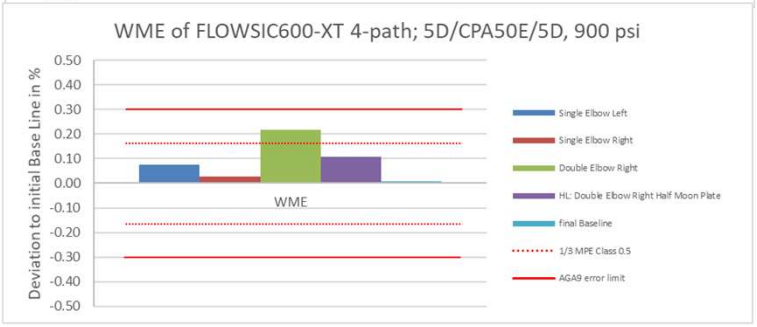
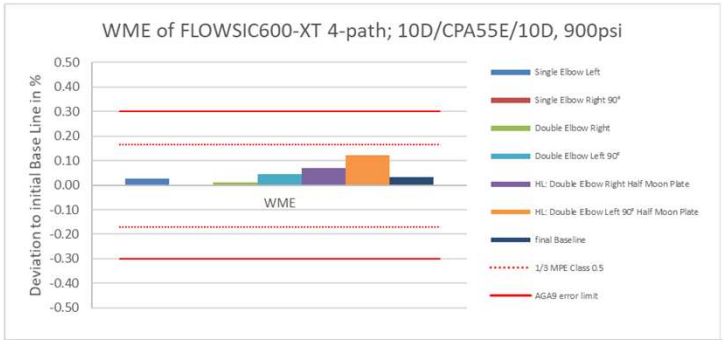
Why Test??



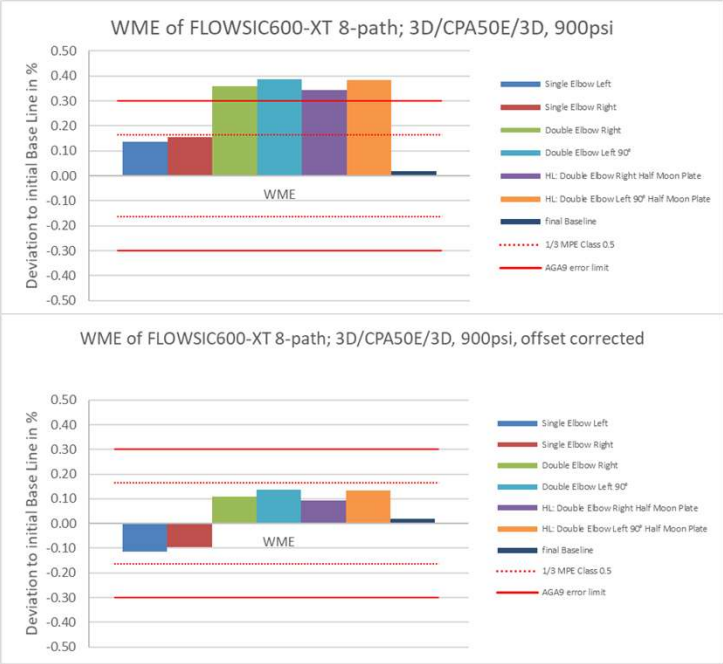
Conclusion

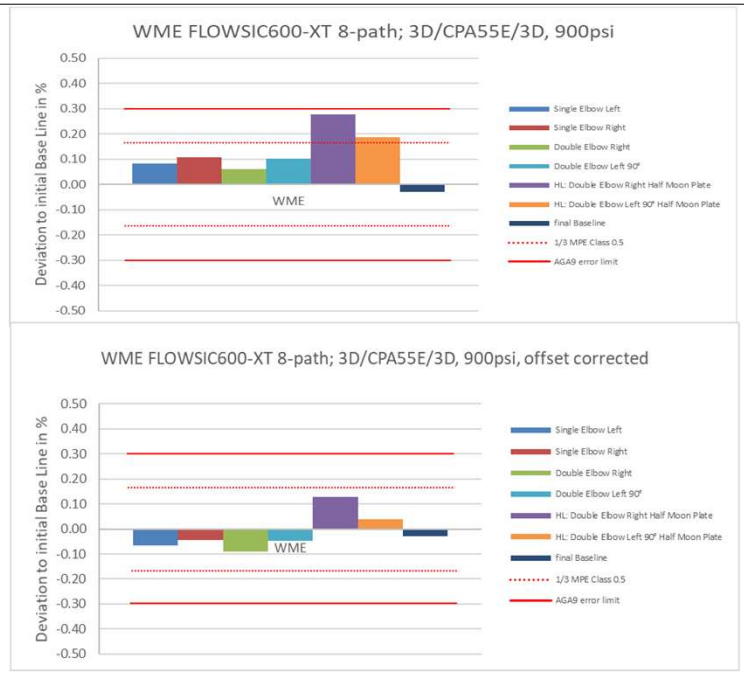




The series of tests outline the benefits of using a CPA 55E flow conditioner over a 50E for shorter (5D) inlet piping configurations in combination with a 4-path ultrasonic flow meter. While AGA9 and Measurement Canada error limits can be met using both flow conditioners for short (5D) inlet piping configurations, a CPA 55E flow conditioner should be utilized to meet OIML accuracy class 0.5.

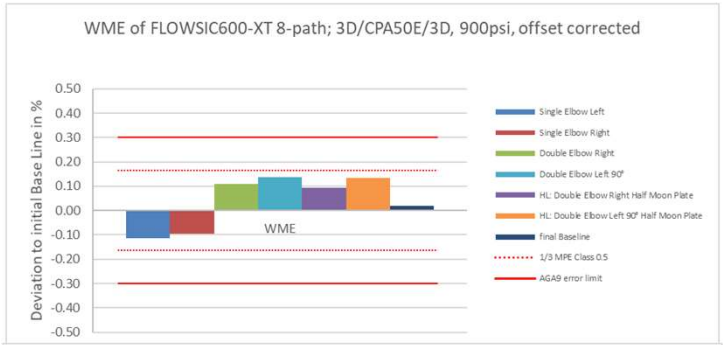
Conclusion

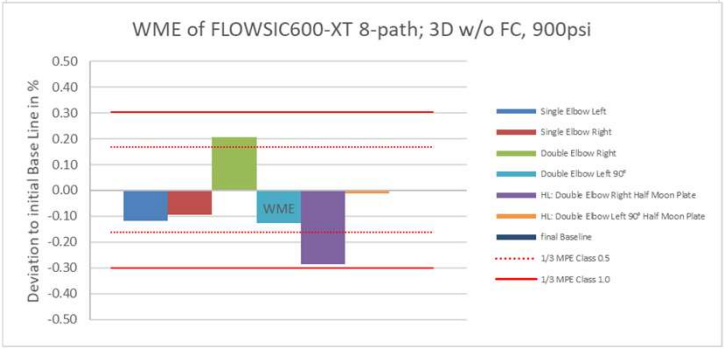


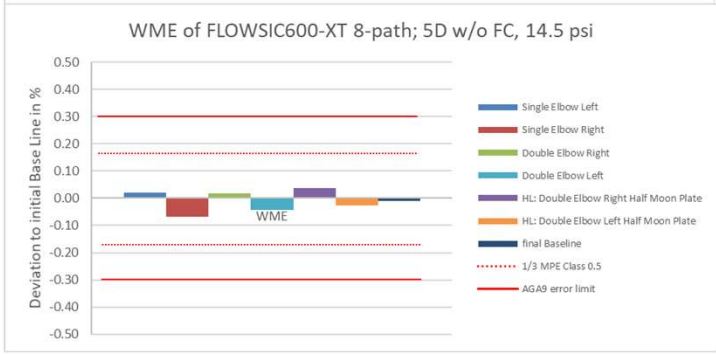


When using an 8-path ultrasonic flow meter in conjunction with the CPA 55E flow conditioner the AGA9 error limits are attainable with short inlet piping configurations of 3D. With or without a flow conditioner the benefits of using an 8-path meter are obvious in short pipe configurations of 3D.

Conclusion







These results show that 8-path ultrasonic meters can save CAPEX money on both, inlet piping length as well as potentially flow conditioning. AGA9 (Class 1.0) accuracy can be achieved for 3D inlet piping, and OIML R137 class 0.5 accuracy can be achieved using 5D inlet with or without a FC.

As pipe sizes increase the monetary benefit potentially grows for all included scenarios.

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THANK YOU!!

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