

# Accuracy Testing of Domestic Gas Flow

## Meters with 20% Hydrogen Blend

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# HyDeploy Project

- UK Demonstration Project, aims to prove that blending up to 20% volume of hydrogen with natural gas is a safe and greener alternative to the gas currently used
- Led by Cadent, consortium included Progressive Energy, Northern Gas Networks, Keele University, HSE, ITM Power
- Providing evidence that existing pipeline components and customer appliances can operate with the blend, less disruption and cost implications
- Live demonstration of hydrogen/natural gas blend at the private gas network of Keele University.
  - 100 homes and 30 university buildings supplied with blend
  - No disruption to service, positive feedback from students and university staff
  - Accelerated durability testing on boilers and other appliances
  - Concluded in Spring 2001
- 2nd and 3rd phases: larger demonstrations on public networks (> 650 homes) in North East of England, then North West
- Evidence required for accuracy of domestic gas flow meters operating with hydrogen blend

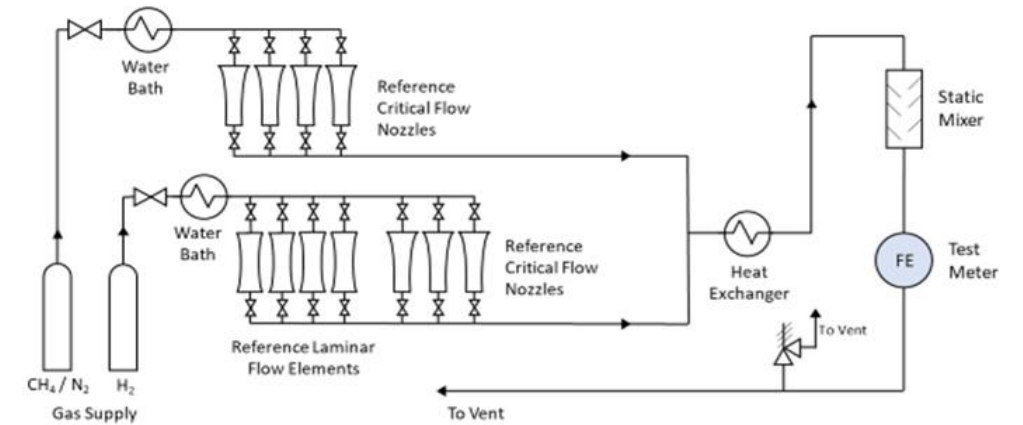


# Test Meters

Meter Type	Identifier	Size	Qmax (m <sup>3</sup> /h)	Condition Prior to Testing
Diaphragm	A1	G4	6	New
Diaphragm	A2	G4	6	New
Diaphragm	B1	G4	6	New
Diaphragm	B2	G4	6	New
Diaphragm	B3	G4	6	From Keele University trials, previously metered 16 565 m <sup>3</sup> natural gas
Diaphragm	B4	G4	6	From Keele University trials, previously metered 12 619 m <sup>3</sup> natural gas
Diaphragm	B5	G4	6	From Keele University trials, previously metered 15 186 m <sup>3</sup> H <sub>2</sub> blend
Diaphragm	B6	G4	6	From Keele University trials, previously metered 11 206 m <sup>3</sup> H <sub>2</sub> blend
Diaphragm	C1	G4	6	New
Diaphragm	C2	G4	6	New
Diaphragm	D1	G10	16	New
Ultrasonic	E1	G4	6	New
Ultrasonic	E2	G4	6	New
Ultrasonic	F1	E6	6	From gas networks, first installed 1997
Ultrasonic	G1	E6	6	From gas networks, first installed 1999
Ultrasonic	G2	E6	6	From gas networks, first installed 1999
Thermal Mass	H1	G4	6	New
Thermal Mass	H2	G4	6	New

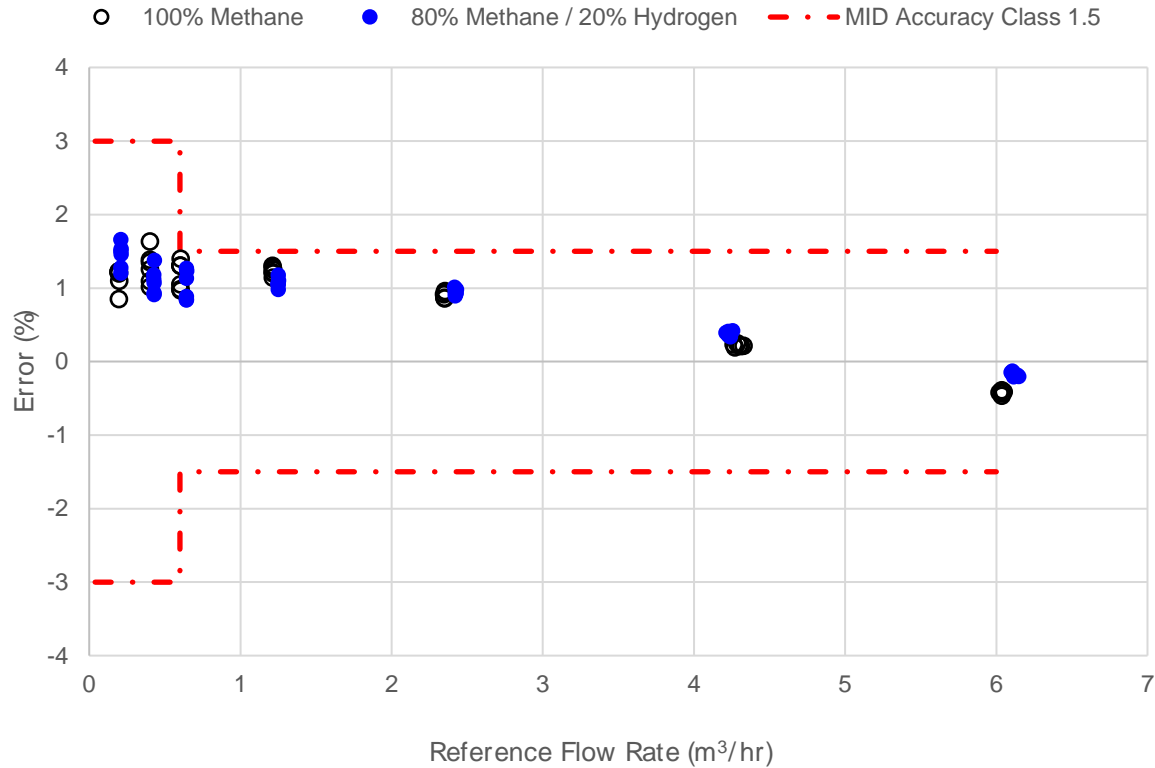
# NEL Facility

- Hydrogen, methane or nitrogen supplied from gas bottles
- Pure gases or mixture of two
- Maximum flow rates approx.  $50 \text{ Sm}^3/\text{h}$  , or  $4 \text{ kg/h}$  hydrogen
- Critical flow nozzles used for flow reference
  - Calibrated with air
  - Estimated uncertainty  
Nitrogen 0.2% (k=2)  
Hydrogen 0.3% (k=2)

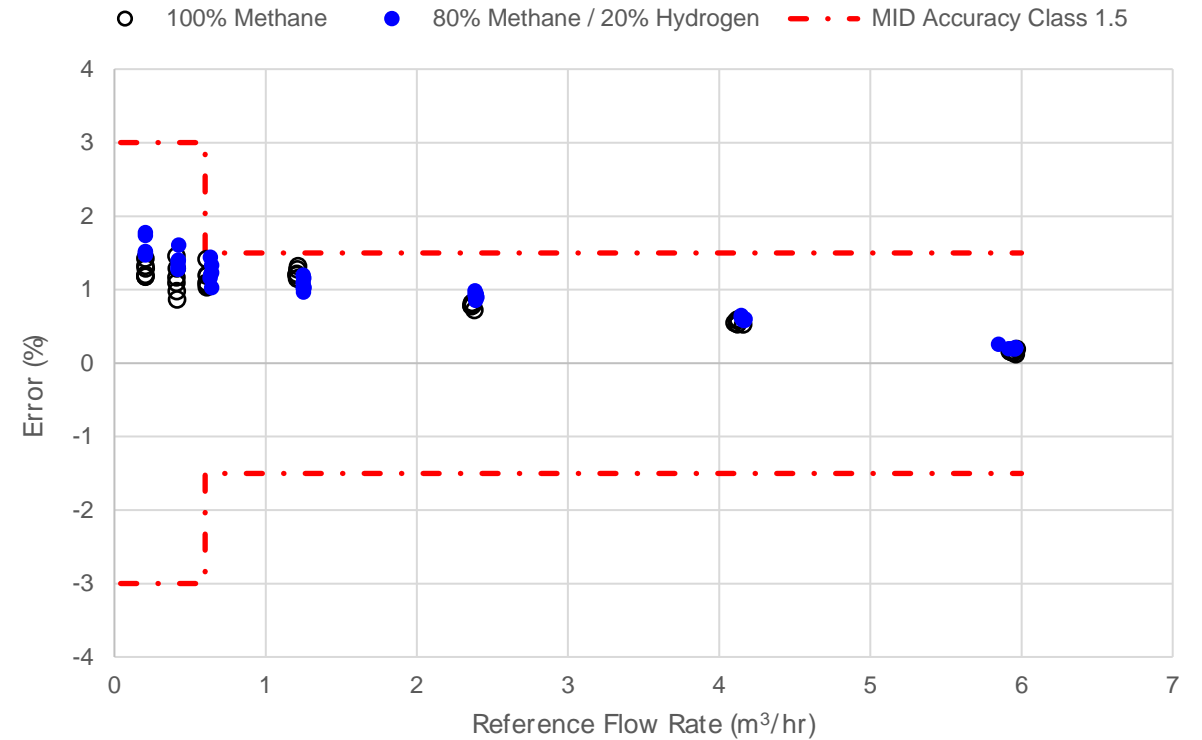


# Diaphragm Meter Results

## Meter A1

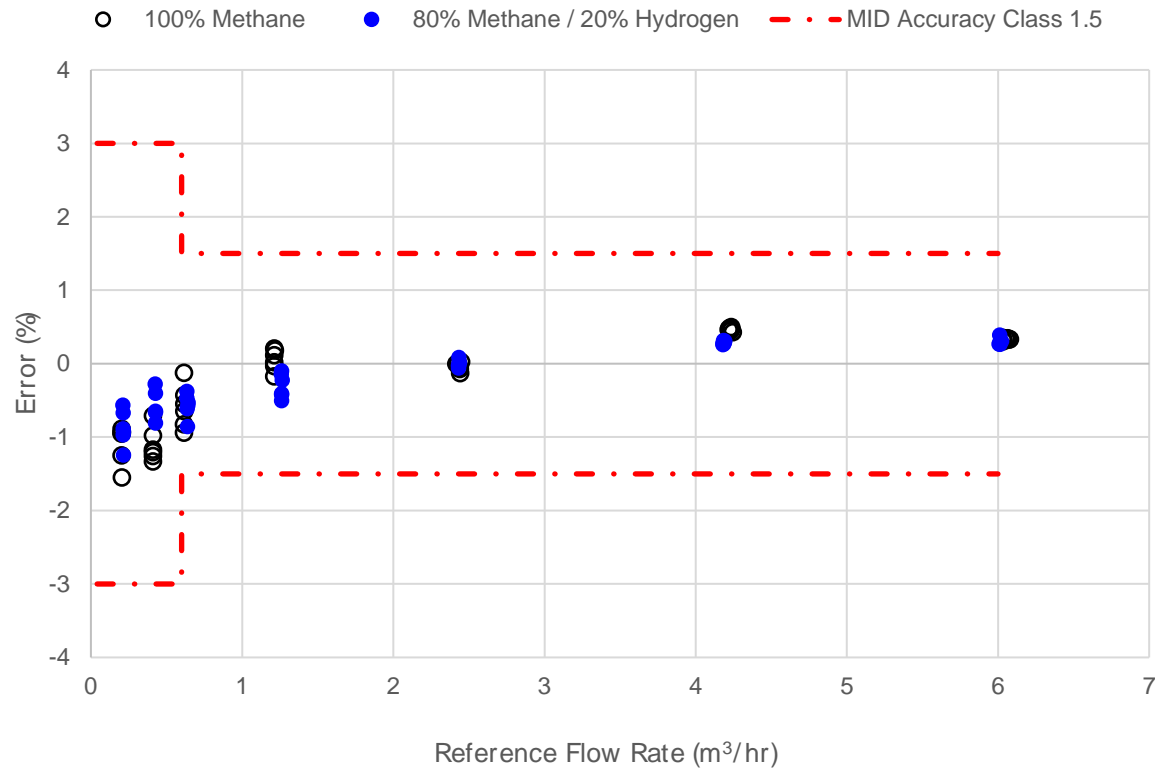


## Meter A2

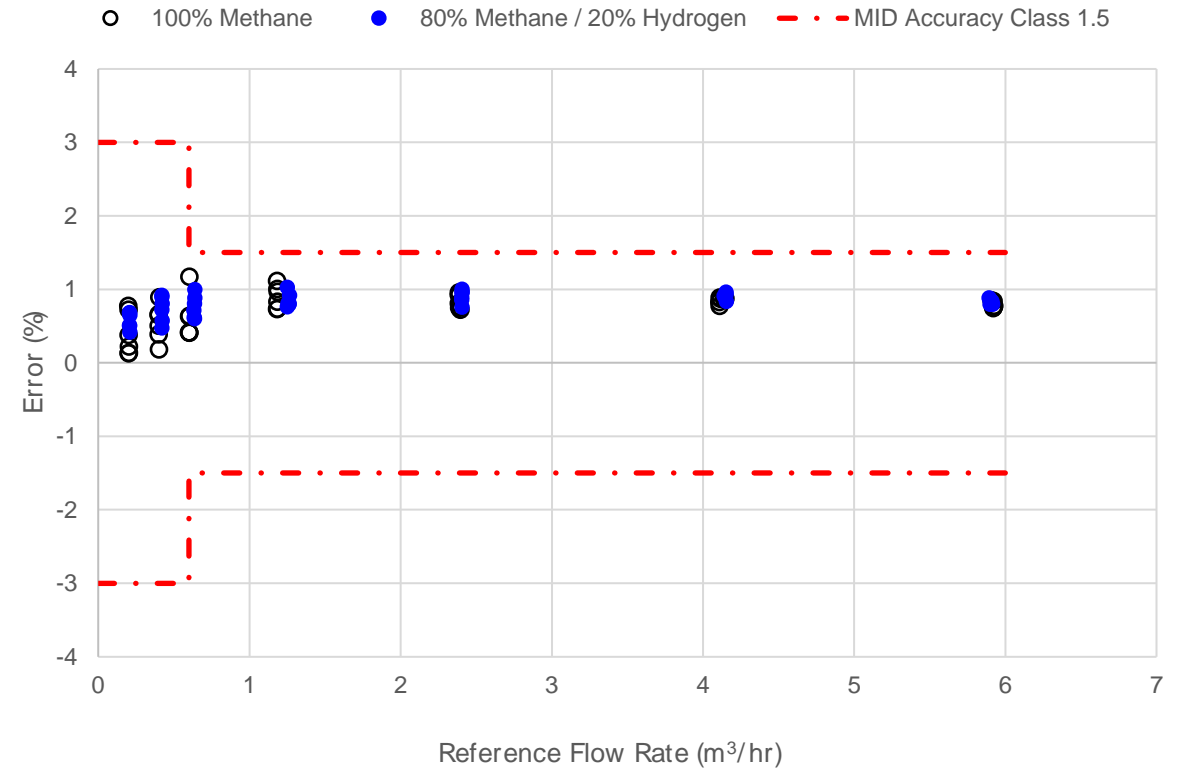


# Diaphragm Meter Results

## Meter B1



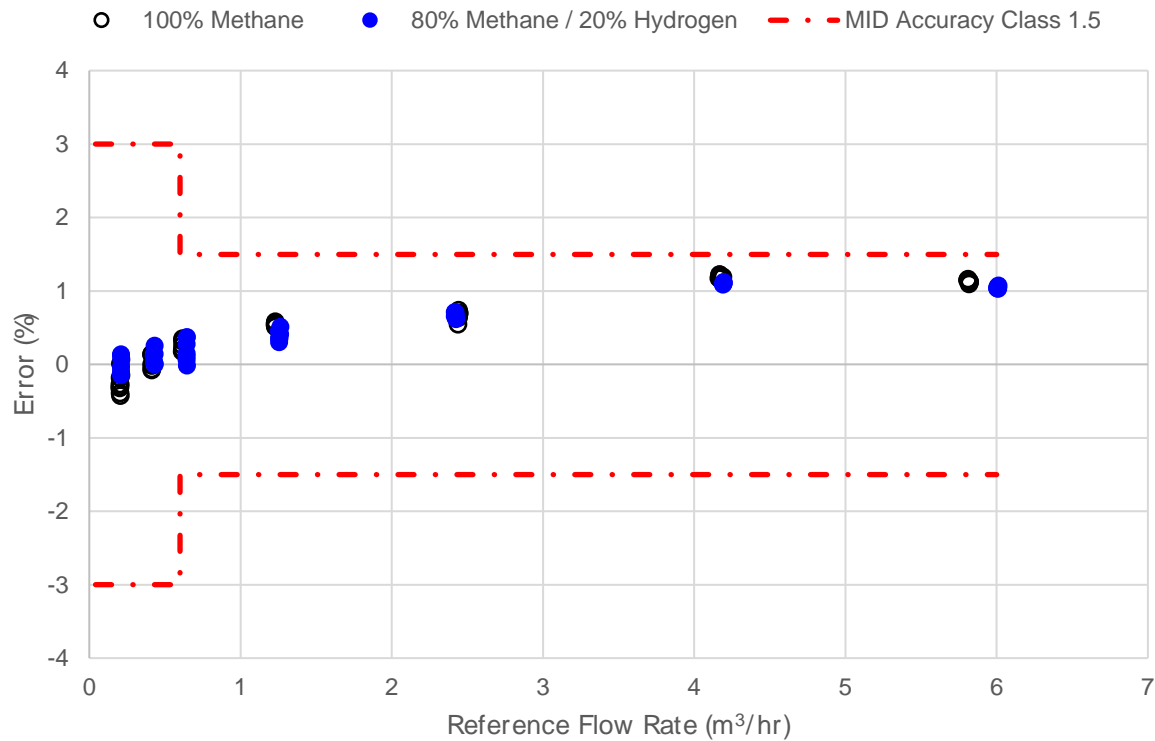
## Meter B2



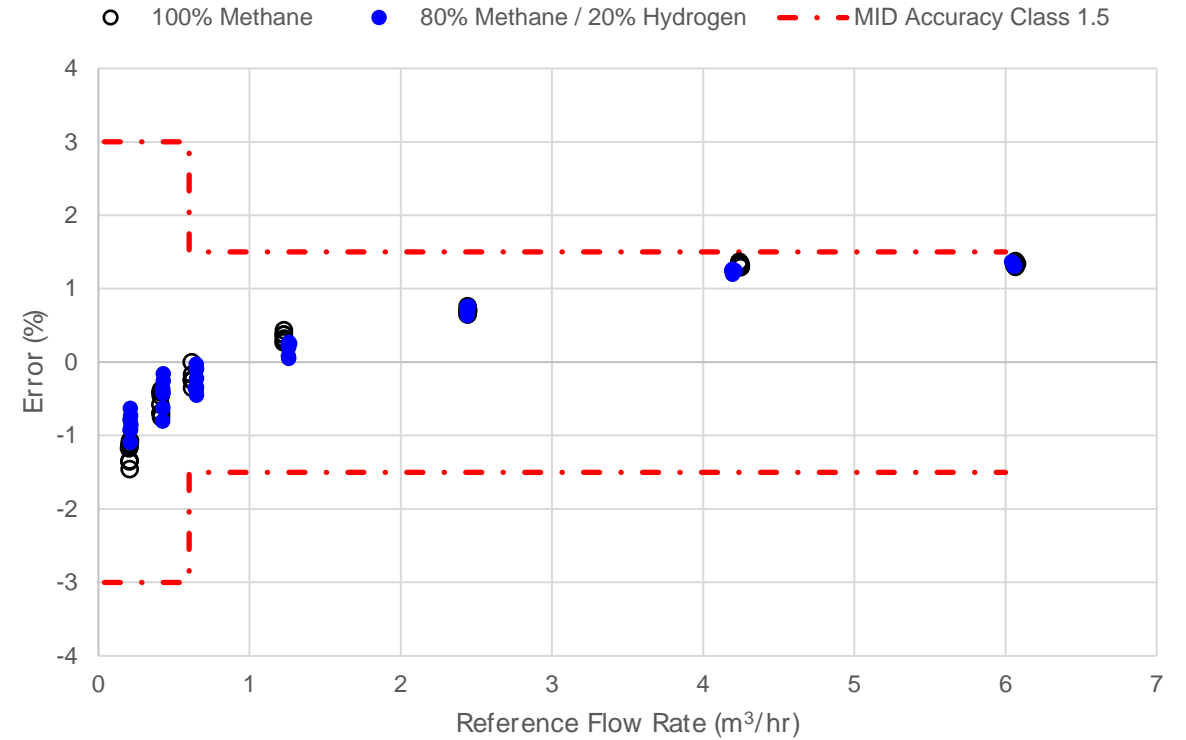
# Diaphragm Meter Results

From Keele University trials, previously operated with NG

## Meter B3



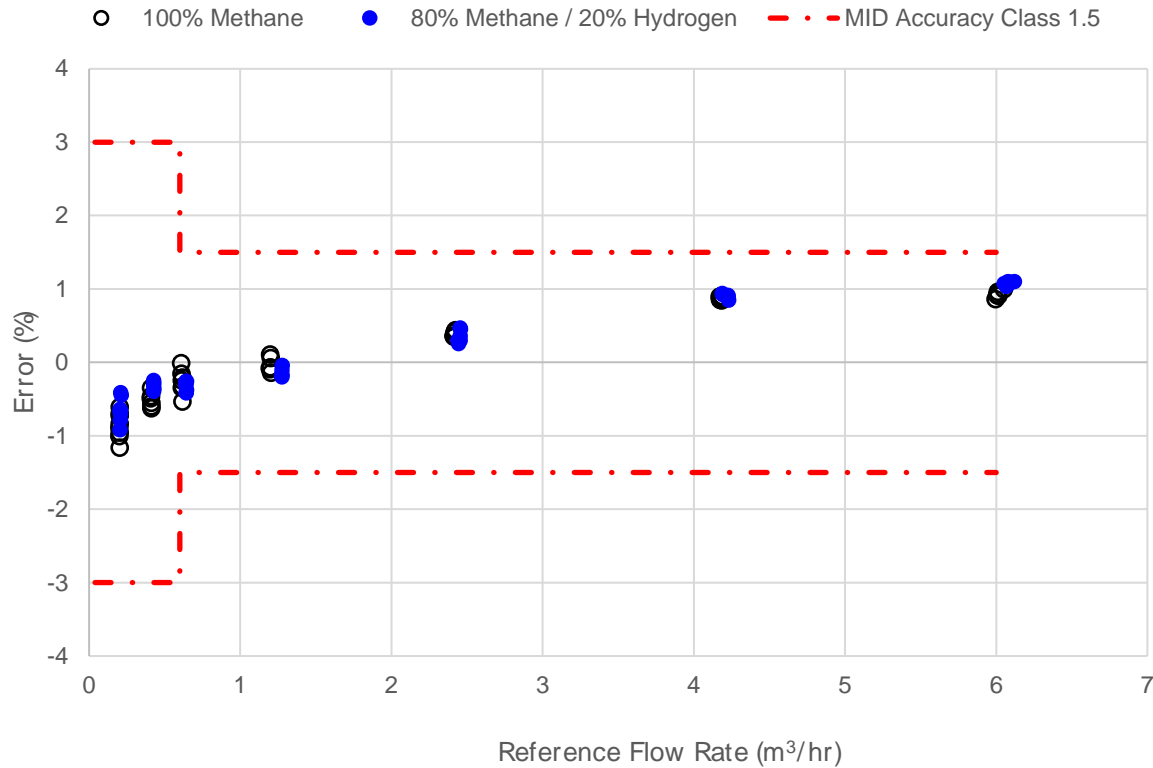
## Meter B4



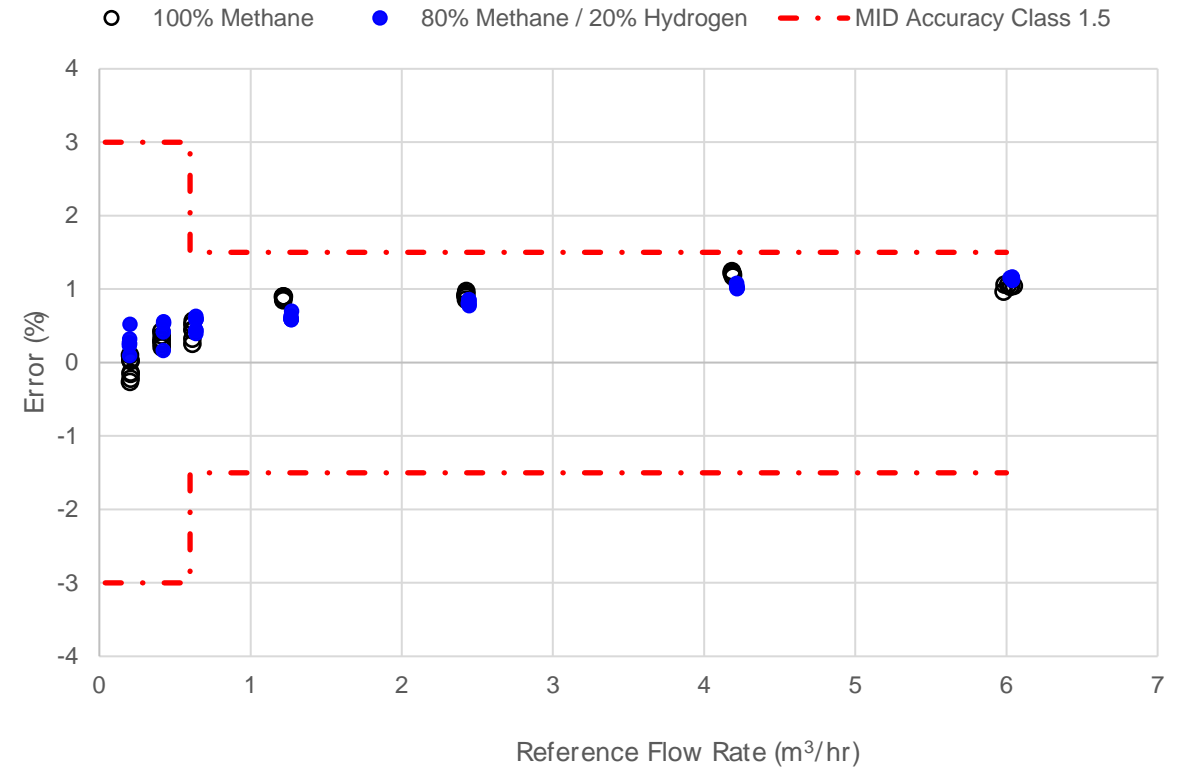
# Diaphragm Meter Results

From Keele University trials, previously operated with H<sub>2</sub> Blend

## Meter B5



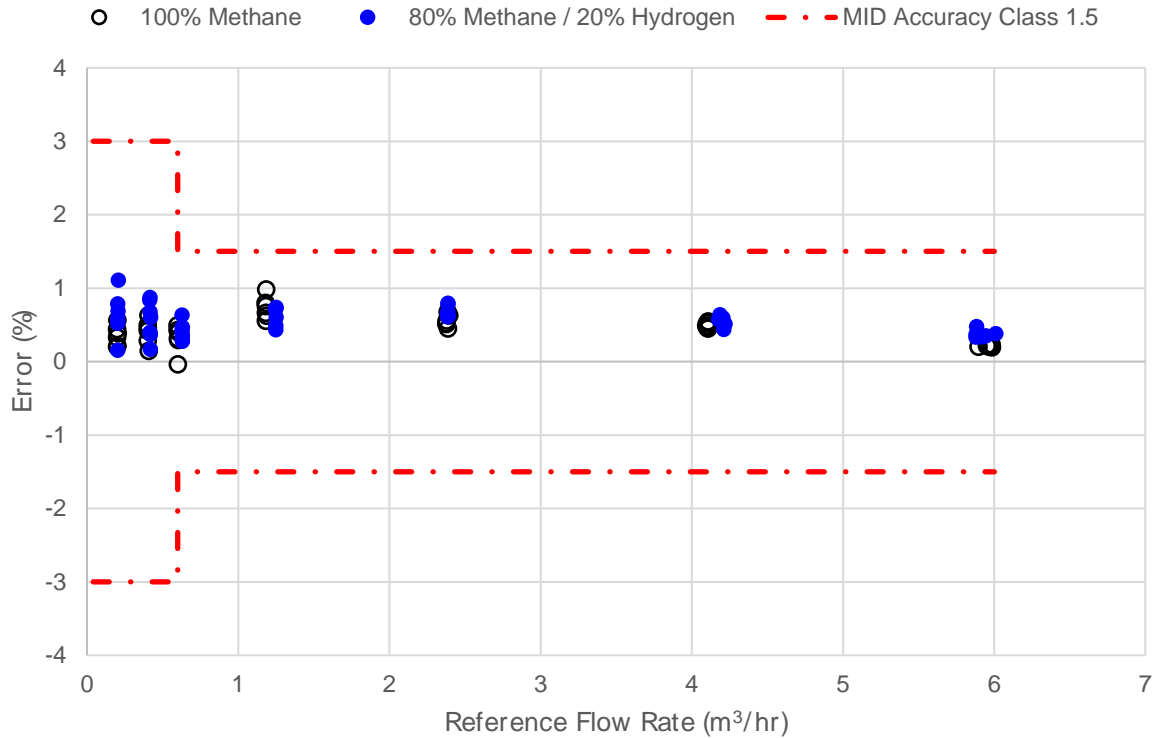
## Meter B6



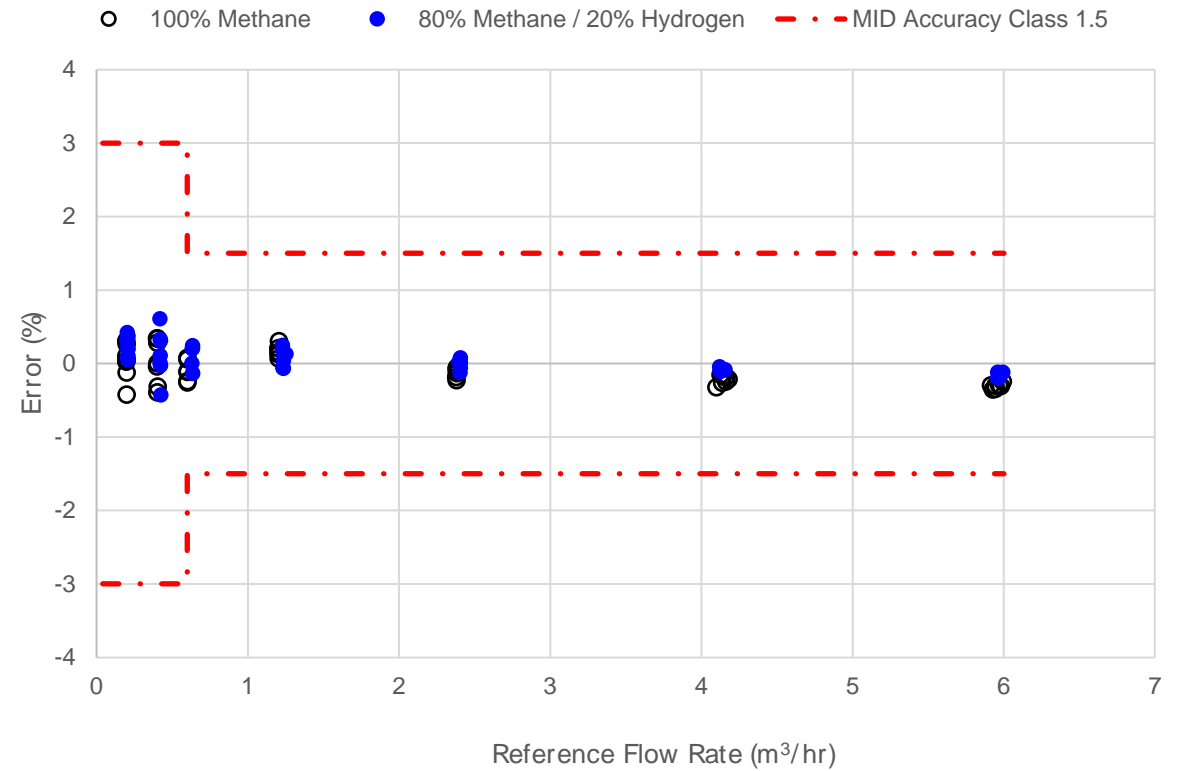


# Diaphragm Meter Results

## Meter C1

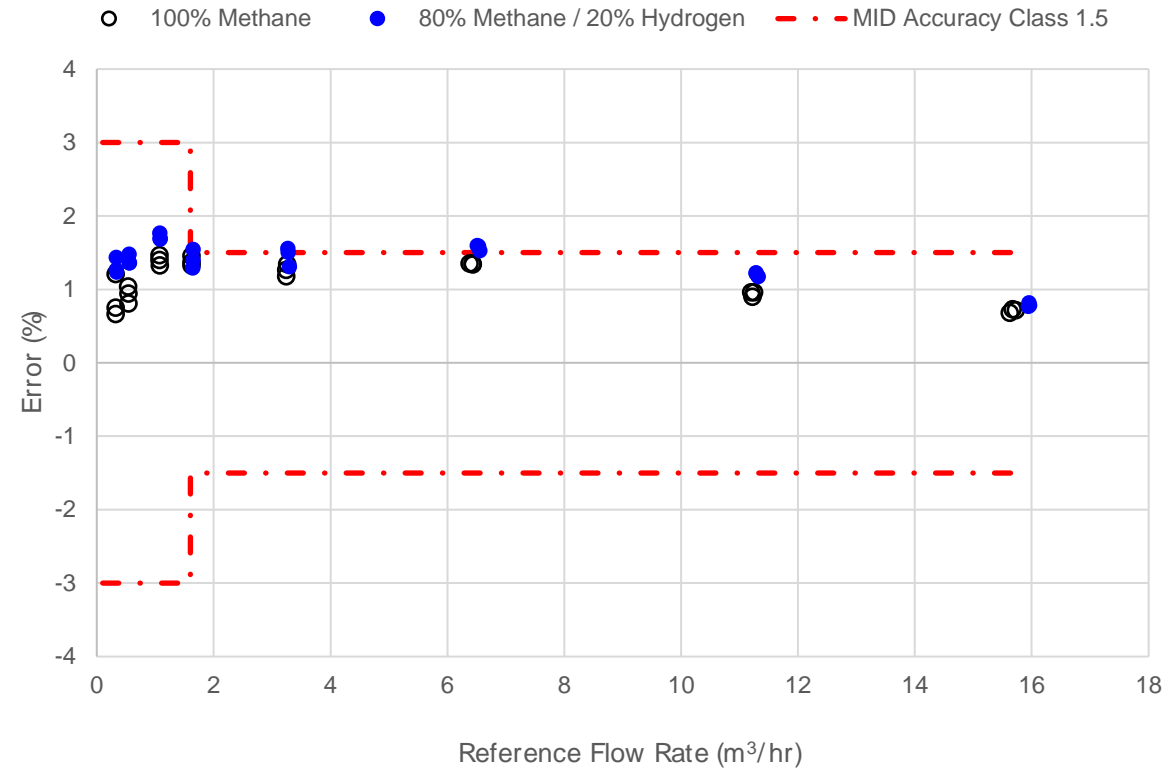


## Meter C2



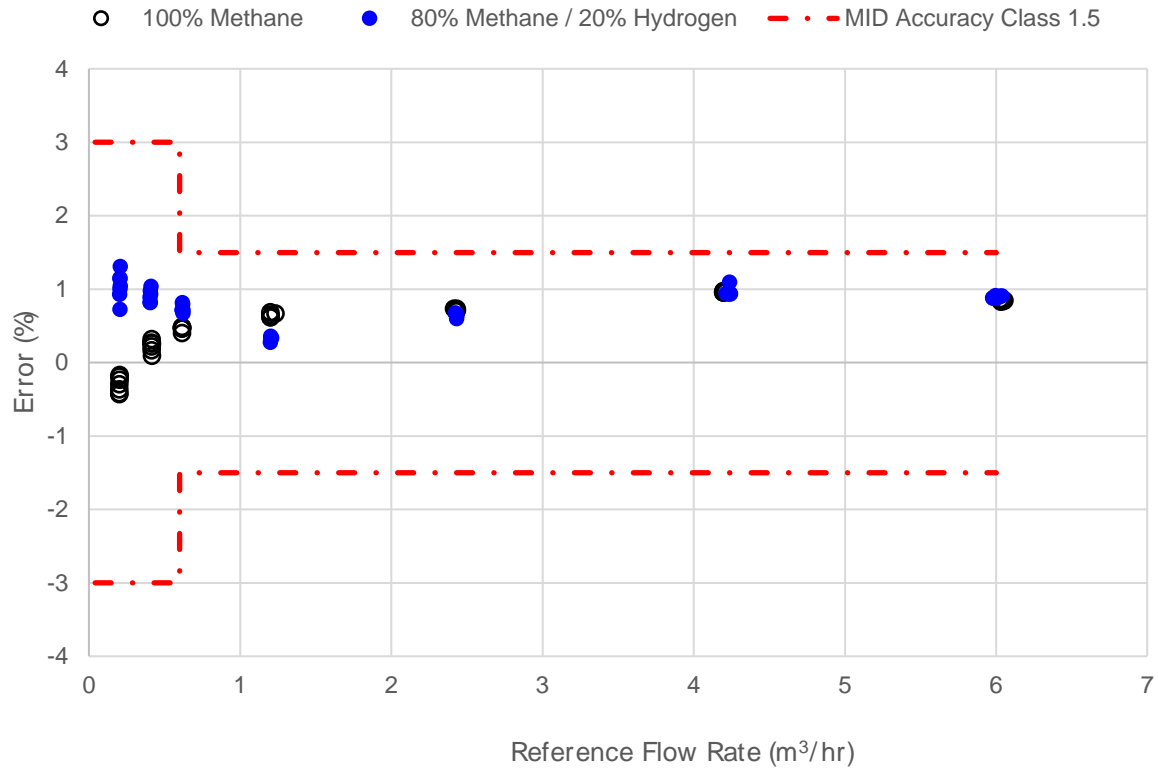
# Diaphragm Meter Results

Meter D1

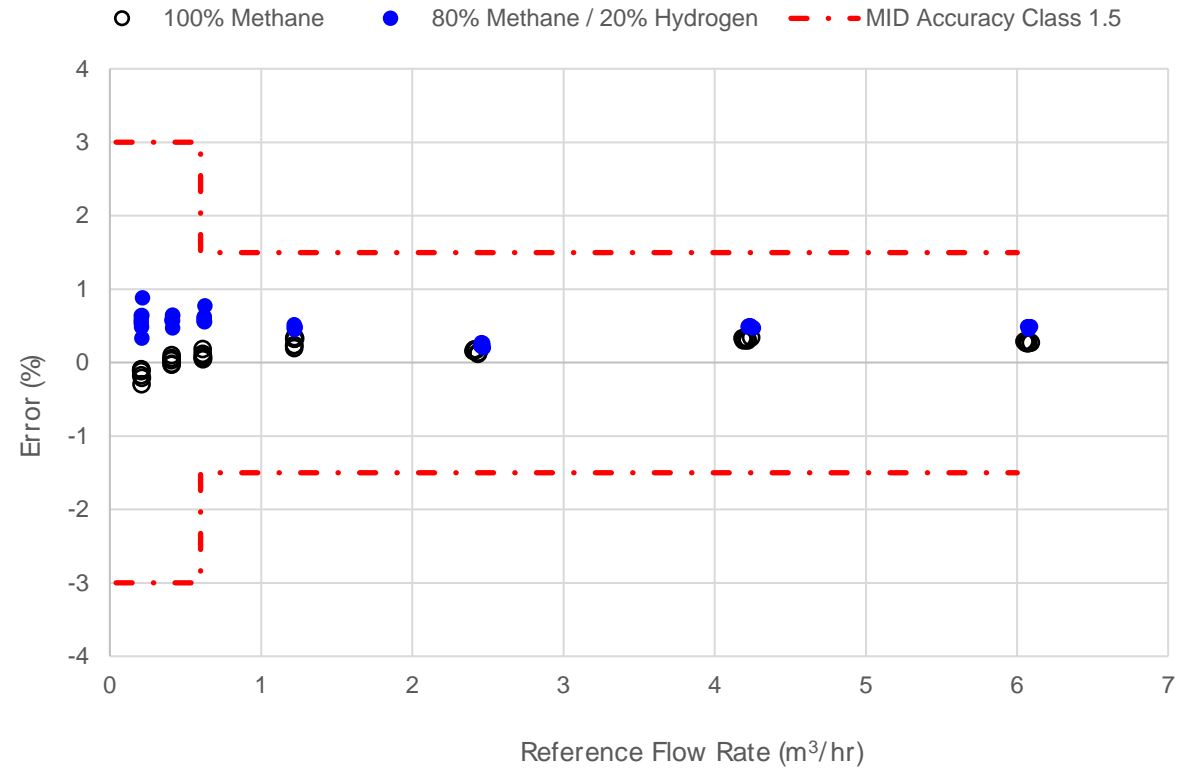


# Ultrasonic Meter Results

## Meter E1



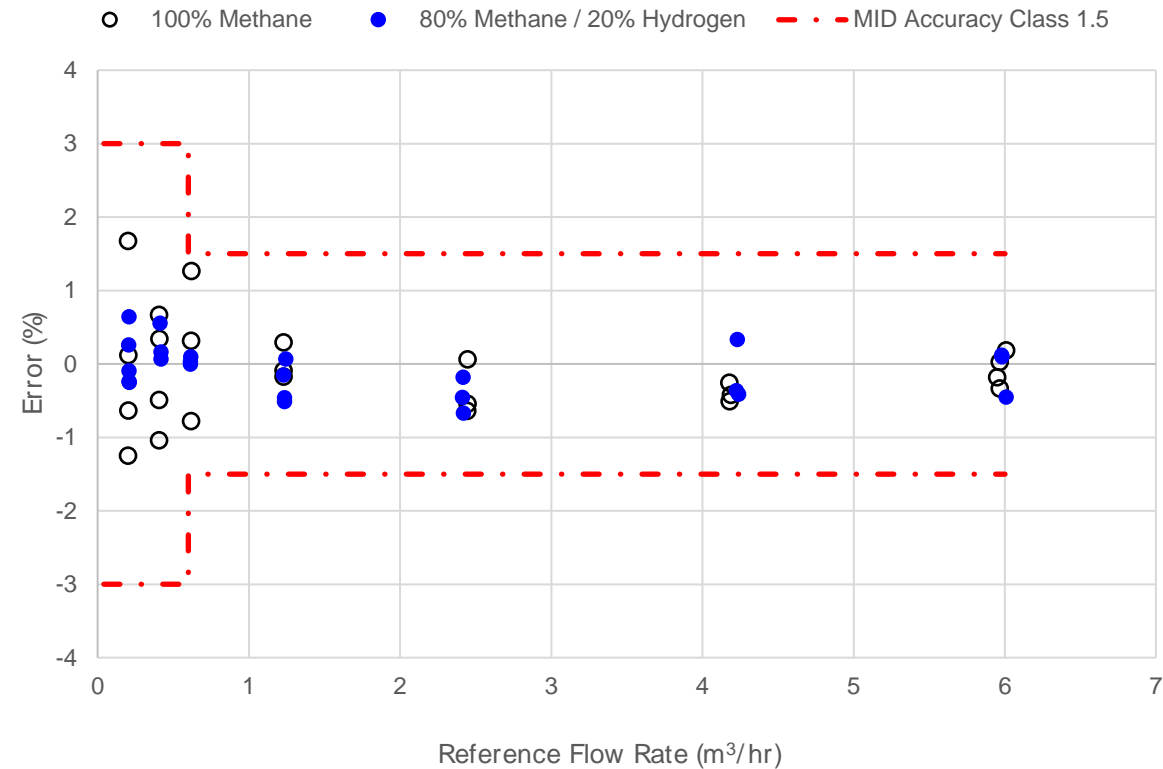
## Meter E2



# Ultrasonic Meter Results

Older Meter from Gas Networks, first installed 1997

Meter F1

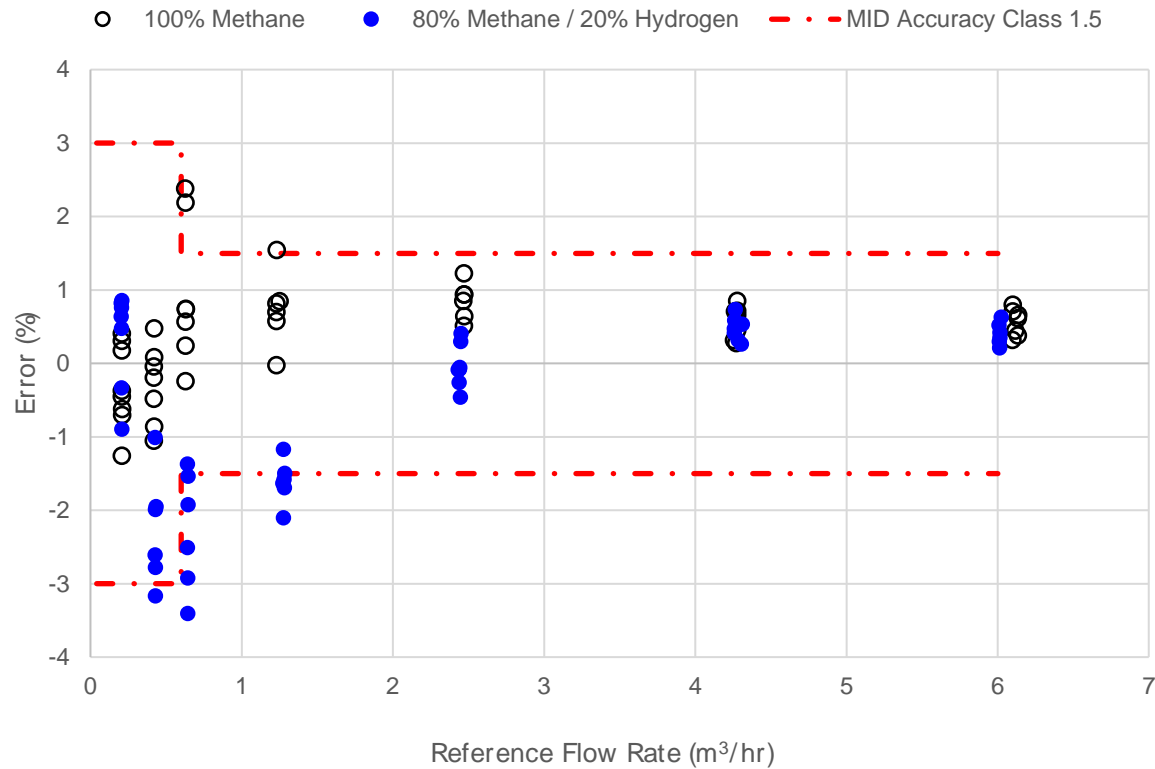




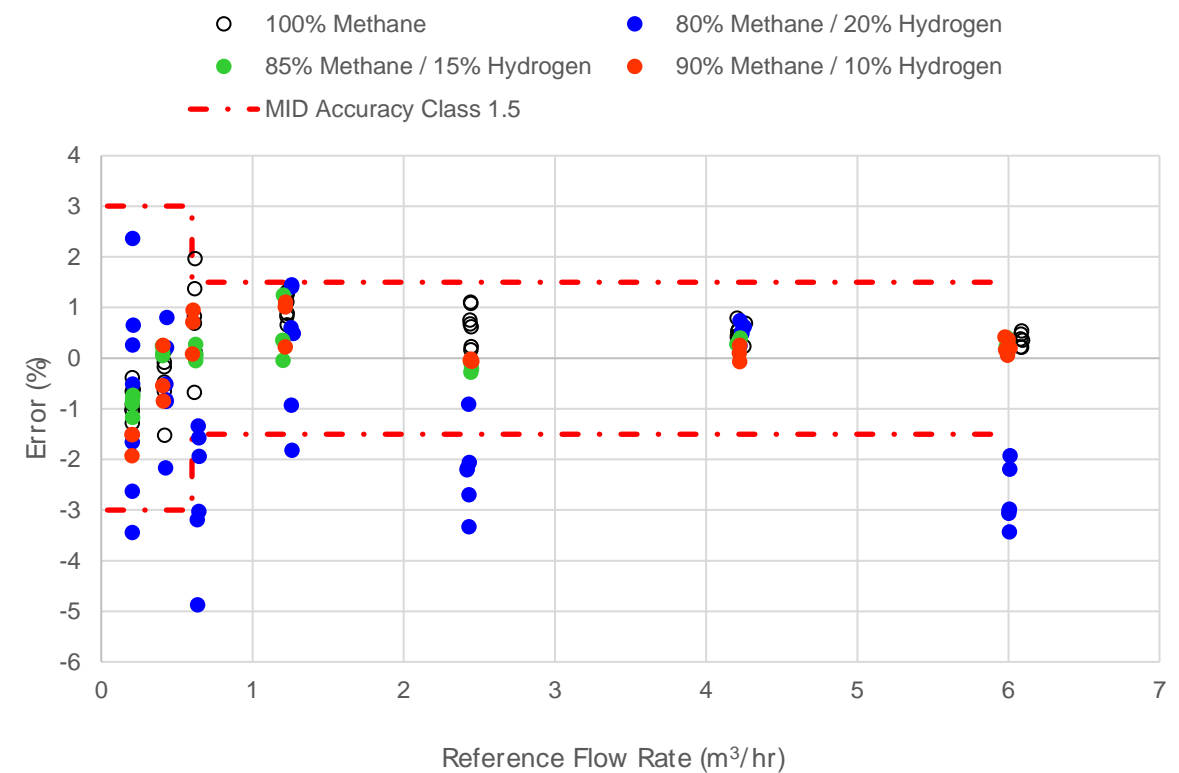
# Ultrasonic Meter Results

## Older Meters from Gas Networks, first installed 1999

### Meter G1

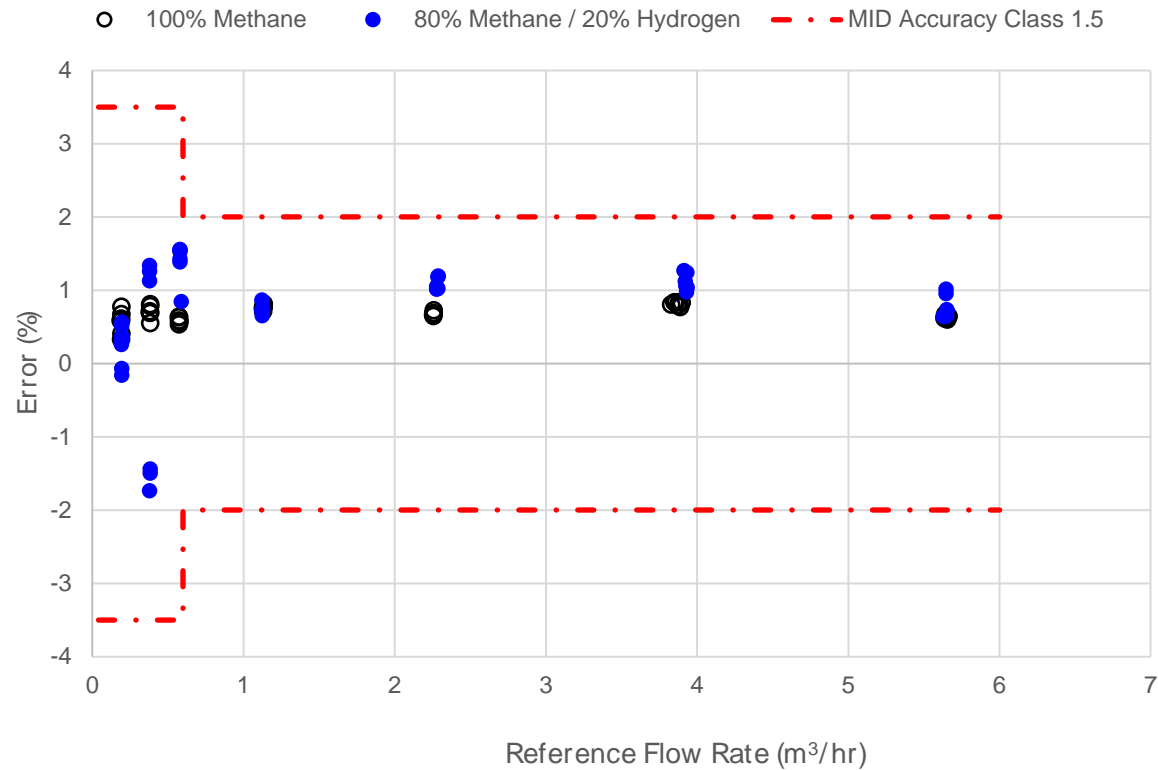


### Meter G2



# Thermal Mass Meter Results

## Meter H1



## Meter H2



# Conclusions

- Total of 18 domestic gas meters tested, 11 diaphragm, 5 ultrasonic, 2 thermal mass
- Diaphragm meters results
  - Methane and blend results generally agreed within 0.3%
  - Only 1 meter exceeded Class 1.5 MPE limits
  - Durability effects were not studied in detail, but 2 diaphragm meters included which previously metered 12 000 – 15 000 m<sup>3</sup> of 20% H<sub>2</sub> blend. Errors consistent with other meters of the same model.
- Ultrasonic meter results
  - E1 and E2 all results within 1.5% error. Errors for methane and H<sub>2</sub> blend agreed within 0.3% at >0.6 m<sup>3</sup>/h, agreement is worse at lower flow rates
  - F1 performed well considering age and condition of the meter, manufactured in 1997.
  - Intermittent shifts in error with blend for Meter G1 and G2, only observed for hydrogen content above 15% by volume. Similar age and condition to Meter F1.
- Thermal Mass results
  - were within Class 1.5 MPE, but greater scatter for the blend
  - Some points using hydrogen blend did not meet MID stability criteria.
  - Agreement between methane and blend usually within 0.5%, but worse at certain flow rates
- Overall results are good, several flow meter models performed consistently with methane and the hydrogen blend



# Planned Activities

- EMPIR NEWGASMET (2021/22)
  - Testing domestic gas meters with 100% hydrogen
  - Facility intercomparison with PTB, VSL, CMI, MeterSit using N<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub>
- NEL internal projects
  - Hydrogen primary standard for flow rates up to 8 kg/h (100 Sm<sup>3</sup>/h)
    - Target Uncertainty of <0.1%
    - Also operating with N<sub>2</sub>, air, CH<sub>4</sub>, CO<sub>2</sub>...
    - Calibration of reference nozzles for domestic meter facility



**NewGasMet**

<http://newgasmeter.eu>