Proposed Tentative Standard Update - GPA WG77 / GPA 8126 Multi-Path Ultrasonic Metering of Gas at or Near Dew Point

2026 CEESI Gas USM User's Conference

Duane Harris
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CEESI
An ABS Company

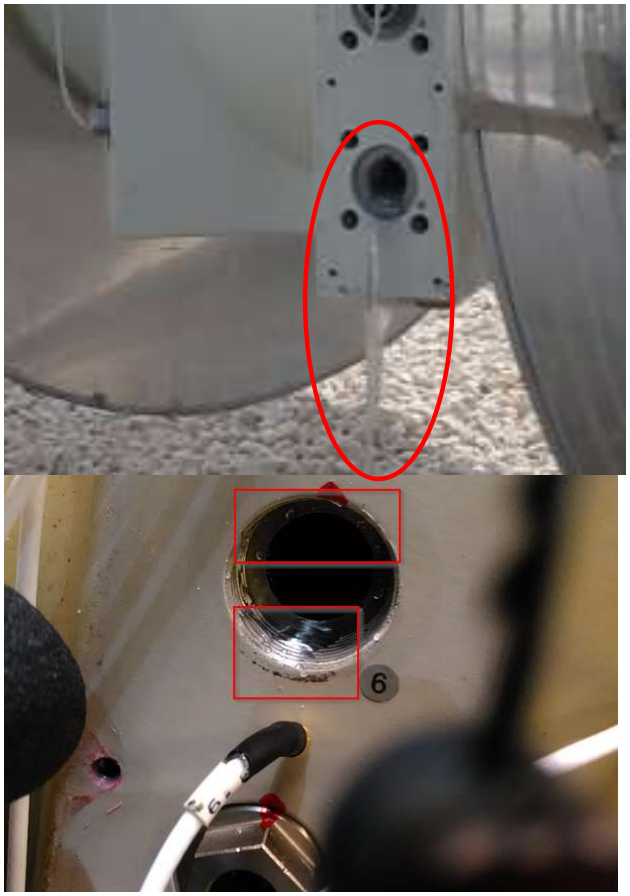
Topic Agenda

- Introduction
- Industry Challenges
- WG77 Team Update
  - Timeline
  - Proposed Tentative Standard Update
  - Next Steps
- Q & A

Introduction

Classic Upstream application

Wet Gas measurement is still one of the most challenging applications to measure natural gas accurately with the presence of oil, water, dirt, dust and mechanical particles that differs from point to point and field to field throughout an organization.



Industry Challenges

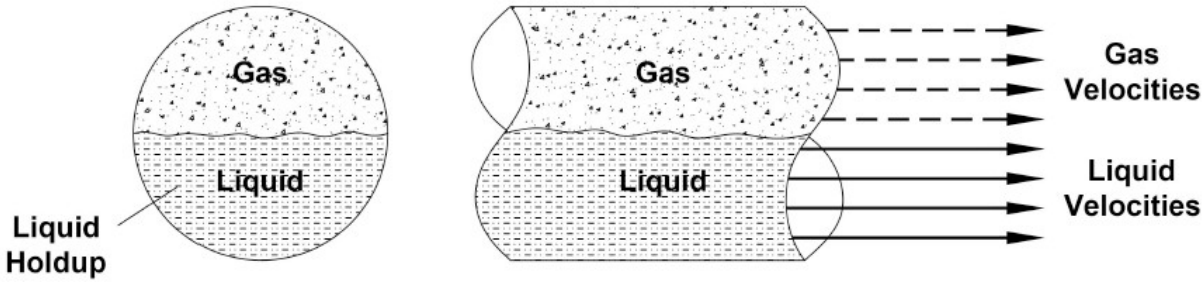
Wet Gas Ultrasonic Meter Standard Challenges & USM Industry Standards

- **API MPMS 20.1 (R2016) Allocation Measurement of Oil and Natural Gas: Allocation Measurement**
  - Natural Gas Measurement – Orifice Meters / USM
- **AGA Report No. 9 Measurement of Gas by Multipath Ultrasonic Meters - Fourth Edition (2022)**
  - Custody Transfer Multipath USM Standard
  - Clean & Dry / Pipeline Quality Gas
- **AGA Report No. 9 XU – Extended Uncertainty (LVUSM - Low Volume USM) Standard Update**
- **API MPMS 14.10 – Natural Gas Fluids Measurement – Measurement of Flow to Flares**
- **API MPMS 22.3 – Testing Protocol for Flare Gas Metering**

Wet Gas Short Theory Basis

Theory overview. GVF/LVF. Gas Velocity

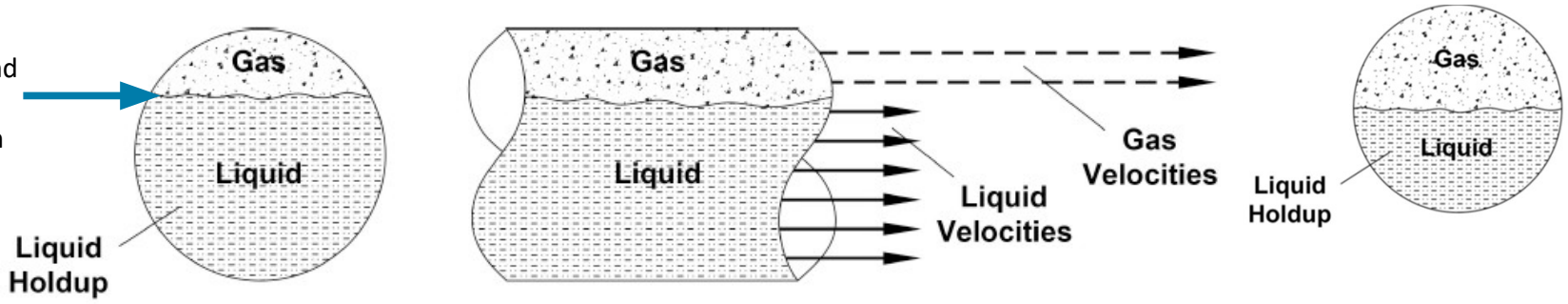
Imagine the pipe with 50% gas and 50% liquid (GVF = 50%). How flow velocity profile looks like?



GVF = Gas Volume Fraction (relation of Gas to total Volume)

LVF = Liquid Volume Fraction (relation of Liquid to Total Volume)

Notice how "higher" the liquid line in second example
but GVF is 50% in both cases!

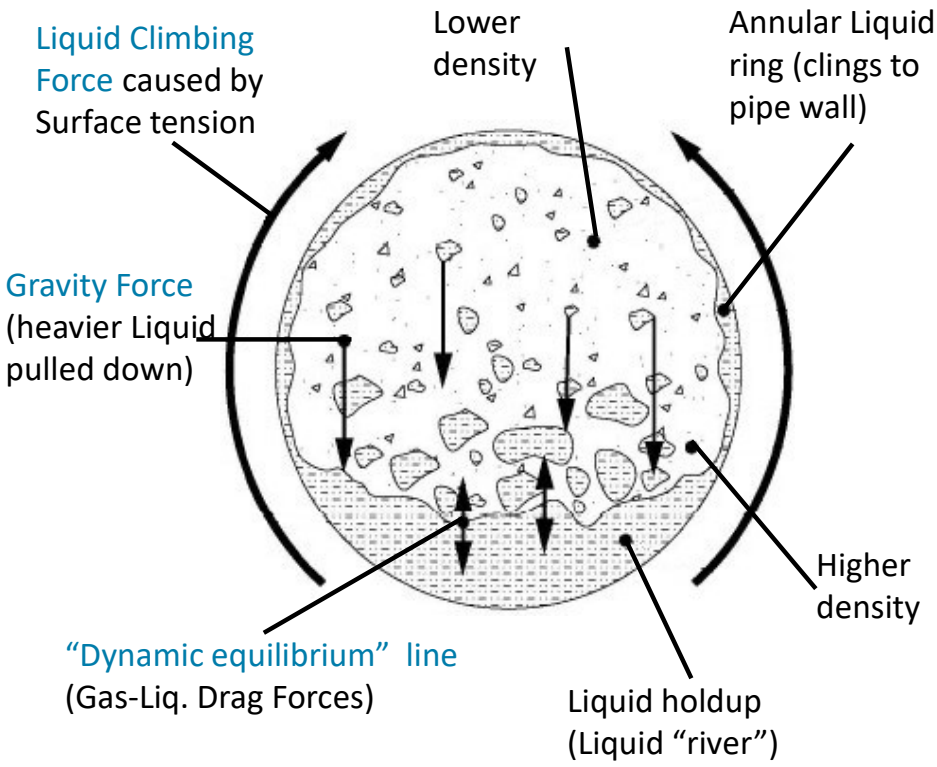


Liquid is uncompressible vs Gas. Gas is less dense and has a lower viscosity than liquid. It "Slips" on the liquid → V_{gas} is higher than V_{liqiud}
Second picture is closer to reality. But how do you think is it a final variant?

Wet Gas Short Theory Basis

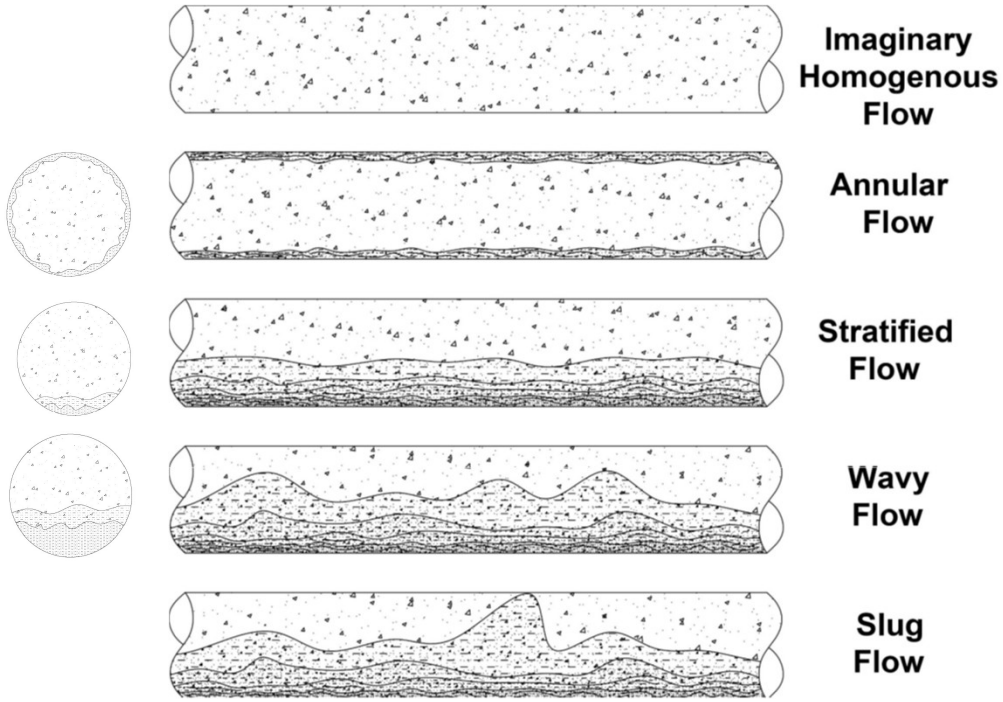
Theory overview. Wet gas Forces and Regimes

Forces in wet gas flow



Wet gas flow regimes

depends on Velocity, density of gas and liquid and relation of densities, pipe diameter, viscosity, surface tension, pressure, temperature, etc. Approximate regimes presented below.



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Wet Gas Ultrasonic Meter Standard Timeline

- **GPA Working Group 77 - Multi-Path Ultrasonic Metering of Gas at or Near Dew Point**
- **Kicked off February 2023**
  - Goal to create a Tentative Standard
  - Subgroups were created in April 2023 and met biweekly through November 2023.
  - The combined WG77 document was distributed to the team on 12/28/2024 and comments were due back by mid January 2024.
  - An in-person review team met February 20th & 21st, 2024 in the Woodlands (Western Midstream)
  - The In-person team have been meeting bi-weekly on and off since February 2024 with additional in person meetings in 2024 and 2025.
  - The document was sent out for ballot in April 2026.
  - The team started working through the 133 comments that were submitted and then received additional 67 comments for consideration. The team also received an additional listing of comments for consideration. The team plans to reconvene on June 22nd to work through the additional comments. Our goal is to work through the comments and publish the standard in 2026.

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Wet Gas Ultrasonic Meter Tentative Standard Team

- **GPA WG77 / GPA 8126 - Multi-Path Ultrasonic Metering of Gas at or Near Dew Point**
- **GPA Working Group 77 Team**
  - Duane Harris – E+H, Trevor Morrison - Western Midstream, Fred Young – Enterprise, Jim Wright – Targa Resources, Eric Harman – CEESI, Hunter Ward - TMCO USA, Mason Flannery – E+H, Rolf Sonderkamp – E+H, Danny Carnahan – Western Midstream, John Lansing – Lansing LLC, Martin Schlebach – Emerson, Joey Raskie – Emerson, Rick Spann – ONEOK, Amy Bolon – Enterprise, Keith Fry – Howard Measurement, Lonna Dickenson – Emerson, Manny Atencio – KGM, Joel Clancy – CEESI, Don Sextro – Targa Resources, Matt Holmes – X-Treme Measures, Casey Hodges - Scale-Measurement, Stormy Phillips – TMCO USA, Brandon Buquet – OXY, Jeff Tilden – Transus Instruments, Cesar Martinez – E+H, Kolt Decker - X-Treme Measures, Paul Stockwell – Process Vision, Richard Steven - CEESI
- **In-Person Review Team**
  - Duane Harris – E+H, Trevor Morrison - Western Midstream, Fred Young – Enterprise, Jim Wright – Targa Resources, Eric Harman – CEESI, Hunter Ward TMCO USA, Mason Flannery – E+H, Rolf Sonderkamp – E+H, Danny Carnahan – Western Midstream, John Lansing – Lansing LLC, Martin Schlebach – Emerson, Joey Raskie – Emerson, Rick Spann – ONEOK, Amy Bolon – Enterprise, Keith Fry – Howard Measurement

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1. Scope

- Whenever natural gas is measured at or near its dewpoint, the term “Wet Gas” is used. Wet Gas describes a condition where the dominant fluid is gas and liquids are present. This is commonly found in production, gathering, underground storage, vapor recovery units (VRU), and upstream gas measurement.
- The increased interest in accurate upstream and midstream measurement has led to the need for improved Wet Gas meters. This document addresses the principles and guidelines for using Ultrasonic Meters (USMs) in Wet Gas applications.
- Even well-designed gas measurement systems are subject to liquid droplets, mist, and/or other contaminants. This tentative standard provides cautionary details regarding liquid droplets, mist, and/or other contaminants and their potential impact on USM flow measurement.
- This tentative standard focuses on applications where the Gas Volume Fraction (GVF) ranges from 100% to 98.0%, (a Liquid Volume Fraction (LVF) ranges from 0% to 2.0%). GVF values below 98.0% (LVF above 2.0%) are beyond the scope of this tentative standard. This tentative standard covers multipath USMs with wetted transducers installed in level, horizontal pipe installations only. Clamp-on USMs are beyond the scope of this tentative standard.
- Determining the GVF and LVF at a field USM location is beyond the scope of this document.

4. USM Meter Requirements - Minimum requirement from the USM – I/O, Diagnostics, Serial Communications

- **4.4.2 Associated Flow Computing**
- **The flow computations may be performed by an external device or be directly integrated into the USM's SPU. For bi-directional flow applications, separate flow rates should be calculated and recorded for each direction.**
- **For applicable flow computer requirements, the designer should reference API MPMS Chapter 21.1/ AGA Report No.13, Flow Measurement Using Electronic Metering Systems – Electronic Gas Measurement.**

Calculations

- **Volume measurement is commonly reported at base conditions (Qb). Flowing conditions are also known as actual or line conditions. To convert from flow rate at flowing conditions (Qf) to flow rate at base conditions (Qb), correction for pressure, temperature, and compressibility is required and shown in the equation below.**

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4.4.2 Calculations

The equations used in a flow computer for a USM are described in AGA Report No. 7, “Measurement of Natural Gas by Turbine Meters.” These equations correct for pressure, temperature and compressibility of the flowing gas. The required calculations are summarized in the following expressions:

$Qb = qf\ (Pf / Pb)\ (Tb / Tf)\ (Zb / Zf)$

$V_b = \int Q_b\, dt$

Where:

Q_b = *Flow rate at base conditions*

q_f = *Flow rate at flowing conditions*

P_b = *Absolute base pressure (e.g.14.73, 14.65, 15.025, 14.696 PSIA)*

P_f = *Absolute static pressure of gas at flowing conditions from meter tap*

T_b = *Absolute base temperature (e.g. 60 °F + 459.67)*

T_f = *Absolute temperature of gas at flowing conditions*

Z_b = *Compressibility factor of gas at base conditions*

Z_f = *Compressibility factor of gas at flowing conditions*

V_b = *Accumulated volume at base conditions*

$\int$ = *Integrated over time*

dt = *Integration increments of time, typically one second*

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5. Design and Installation Considerations

- **Meter Piping: Consult the USM manufacturer to determine the optimal Meter Package design for your specific application. Be aware that when free liquids are present, large pressure drops can occur due to the fluid dynamics of the entrained liquids in the gas stream. Consult the USM manufacturer to determine if the use of a flow conditioner is recommended based on the proposed process conditions. The internal diameters of the USM flange and associated meter piping should be within 3% of each other.**
- **Bi-directional applications: USMs are inherently bi-directional. The user should specify if bi-directional measurement is required so the manufacturer can properly configure the meter. The flow computer used should be compatible with bidirectional flow. Both flow directions require an appropriate amount of piping for the proper development of the flow profile.**
- **Probes and Protrusions: The protrusion of probes into the flow stream, when installed upstream of the meter, may have a negative effect on the flow profile. If a meter is utilized more often in one flow direction than the other, temperature probe(s) and other protrusions should be located downstream of the meter relative to this direction. It is not necessary to install temperature measurement on both sides of the meter.**

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5. Design and Installation Considerations - continued

- **Ambient Conditions: Before installation, the user should consult with the manufacturer to determine if either the ambient temperature or flowing temperature is not within the meter's specified range. If the ambient temperature is lower than the meter's specified range, heating, insulation, sheltering, or similar installation should be considered. The solution should include adequate upstream pipe and secondary measurement equipment to ensure the meter operates within its specified temperature range. Insulation, heating, cooling, or sheltering may be needed for adverse climate conditions.**
- **Pipe Supports: Adequate pipe supports may be required to minimize the effects of vibration, stress on the meter, and prevent sagging of the meter tube (where liquid might collect).**
- **Access requirements: Access requirements should be considered for maintenance and other activities (e.g., do personnel have adequate space to service the meter?).**
- **Today - This standard addresses horizontal installations only.**

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7. Meter Performance

- **Several parameters can impact the meter's accuracy including GVF, velocity, gas and liquid density, liquid viscosity, etc. As the gas deviates from 100% GVF, accuracy of the USM degrades. The end user should validate the test parameters that cover the expected operating conditions. Type Testing is required to determine the influence of GVF and other parameters on USM accuracy.**
- **The meter manufacturer shall conduct Type Testing for at least 5 gas velocities across meter's wet gas qualification range, or the range of the test facility (e.g. 5, 10, 30, 60, and 80 fps), and at two test pressures based on the meter's pressure rating (e.g. 200 and 800 PSIG for class 600) over the GVF values listed below. Meter size shall be considered in determining which meter(s) should be Type Tested. Note, the wet gas qualification range may be further limited by the wet gas test facility's operational limits.**
  - **Meter accuracy at 100% GVF (Shall be within 2% from Qt to Qmax)**
  - **Meter accuracy at 99.5% GVF.**
  - **Meter accuracy at 99.0% GVF.**
  - **Meter accuracy at 98.5% GVF.**
  - **Meter accuracy at 98.0% GVF.**

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8. Operation and Maintenance / Commissioning

Operation and Maintenance

- **Follow the meter and accessory equipment manufacturers' recommendations regarding proper operation and maintenance practices.**
- **Section 7 and Annex D (Informative): USM Commissioning and Verification Checklists are provided courtesy of AGA Report No. 9 Measurement of Gas by Multipath Ultrasonic Meters Fourth Edition 2022**

Commissioning

- **Commissioning is the process of the initial verification and documentation ensuring the USM is installed and functioning according to its specification, design, and regulatory/contract requirements. Installation verification may include, but is not limited to, electrical wiring, signal outputs, data mapping, and mechanical installation. Verify the meter configuration parameters are correct and have not been altered from the manufacturer or flow calibration values. If the meter configuration parameters have been altered, ensure these changes are valid.**
- **During commissioning, an initial diagnostic logfile should be created and saved. If the meter has been flow calibrated, the calibration diagnostic logfile should be compared to the logfile created during commissioning.**

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9. Auditing and Reporting Requirements - General

- **It shall be possible for the end user to obtain the meter's configuration parameters referenced in Section 4.4.6.**
- **Provisions shall be made to prevent an accidental or undetectable alteration of those parameters that affect the performance of the meter. Suitable provisions may include a sealable switch or jumper, permanent programmable read-only memory, or a password in the SPU.**
- **An SPU shall be capable of establishing an audit trail by internally compiling and retaining sufficient data and information for the purpose of verifying measurement constants and configuration parameters. This documentation shall include units of measure for all reported values.**
- **The audit trail shall include, but is not limited to, configuration logs, event logs, and inspection/maintenance report(s) The records and reports in this section may be created onsite or off-site, or a combination of both, and shall include units of measure where applicable.**
- **Unique identifiers shall be provided to identify the version of the firmware used in the SPU. Version documentation should include the calculation standards and their revision dates.**

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9. Auditing and Reporting Requirements - Documentation

- **Documentation regarding the performance of the USM at the GVFs as specified in the Performance section of this document shall be provided by the manufacturer and available upon request.**
- **Documentation around translating event and alarm codes provided to flow computers shall be provided by the manufacturer and available upon request.**
- **If a flow calibration is performed, calibration adjustments shall be documented and available for inspection.**
- **Inspection/maintenance reports shall be retained and available for review for at least 6 months. Contracts, regulations, or company policies may stipulate longer retention periods. Refer to the Operations and Maintenance section of this document for more information.**

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9. Auditing and Reporting Requirements - USM Cyber Security and Access

- **SPUs shall be designed to deny unauthorized access for the purpose of altering any configuration parameters and data that may affect measurement. The USM system operator should consider assigning unique codes or security measures to individuals to ensure all parties gaining access are identifiable and accountable.**
- **All audit trail records within the USM, as required in this tentative standard, shall be stored in such a way that they cannot be altered.**
- **The firmware version that contains the algorithm in the SPU used to calculate quantities shall be protected from alterations. Each firmware version shall have a unique identifier (e.g. revision number and checksum) that is retained in the SPU.**
- **The SPU device shall provide nonvolatile memory capable of retaining all data in the unit's memory.**

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10. Diagnostics

- **This Section discusses the various diagnostic parameters that are available from today's gas ultrasonic meter (USM). The recording and historical trending of USM diagnostics provides a valuable tool in identifying changes to meter performance and flowing conditions in the pipe throughout the life of the facility. USMs are required to use multiple acoustic paths to comply with this document. Each acoustic path utilizes a pair of wetted transducers that send high frequency sound pulses back and forth, at an angle relative to flow, across the meter body. The meter measures the transit-time for the sound pulses in both directions. The difference in times is used to determine gas velocity for each path. By combining all pairs of transducer readings into one average bulk gas velocity, the USM then determines the actual flow rate by multiplying this velocity by the meter's cross-sectional area. As a minimum, the USM shall provide an updated flow rate at least once per second, and the diagnostics described below for each path:**
- Automatic Gain/Power Control
- Transducer Performance
- Path Velocity
- Speed of Sound (SOS)
- Signal-to-noise ratio (SNR)
- Turbulence

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10. Diagnostics - Continued

- **Additional diagnostic parameters may include the following:**
  - **Profile Factor**
  - **Symmetry**
- **This following sections briefly discusses each of these diagnostic parameters under normal “dry gas” conditions. Understanding what each of these are, helps the user to recognize changes that occur when the gas is not clean and dry, and the impact liquids may have on these eight diagnostic parameters.**
  - Wet Gas Automatic Gain / Power Control
  - Wet Gas Transducer Performance
  - Wet Gas Signal-to-noise ratio (SNR)
  - Wet Gas Path Speed of Sound (SOS)
  - Wet Gas Path Velocity
  - Wet Gas Turbulence

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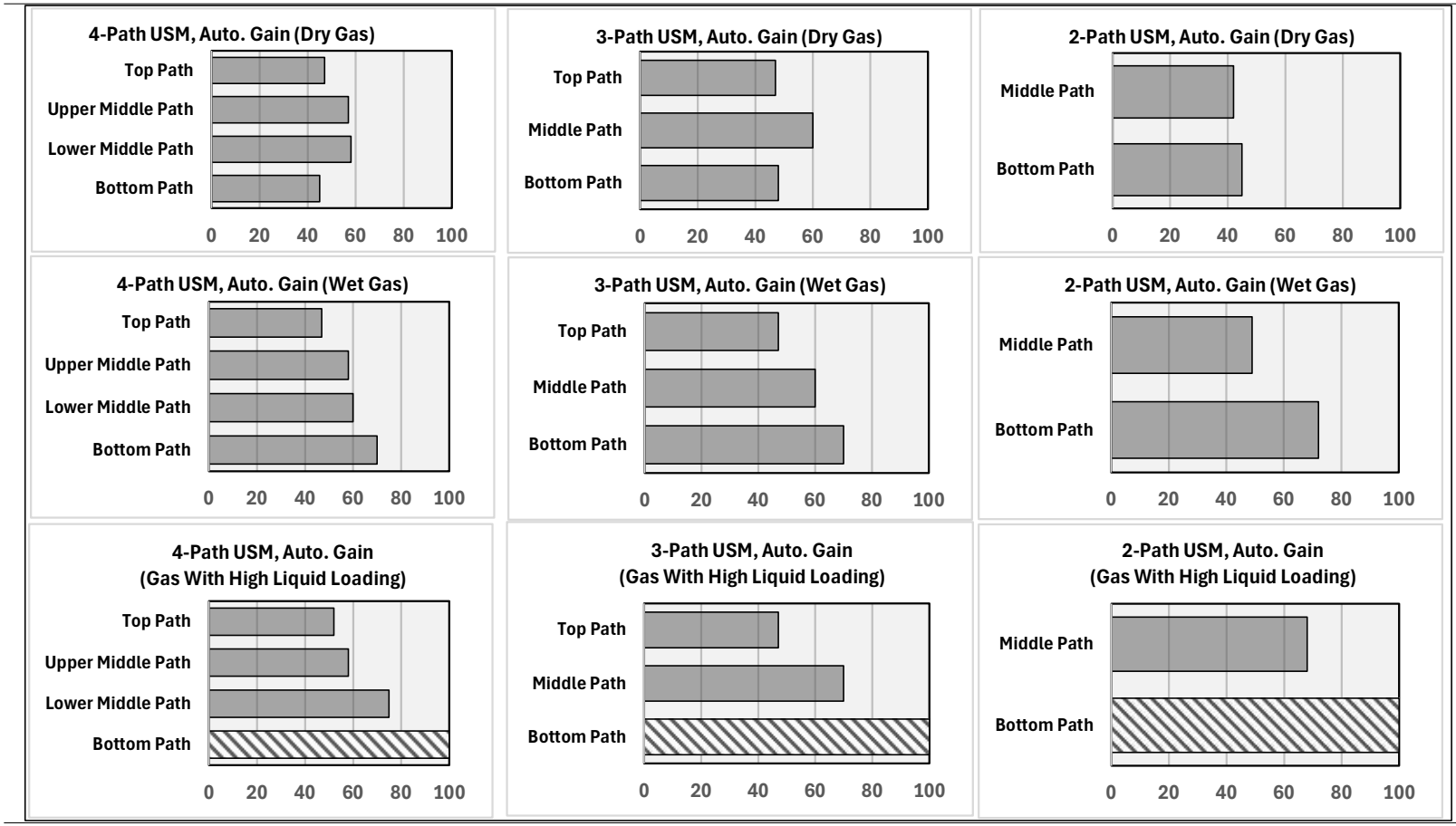
10. Diagnostics - Continued

Automatic Gain/Power Control (dB)

Dry vs. Wet Gas vs. Gas with High Liquid Loading Bar Graphs for 4-Path, 3-Path, 2-Path USMs



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Next Steps

- **Finalize WG77 / GPA 8126 Proposed tentative Standard Verbiage**
  - Process through the all the comments. The 133 comments that were initially submitted combined with the additional 67 comments received this week. The team also received an additional listing of comments for consideration. The team plans to reconvene on June 22nd to work through the all comments.
- **Our goal is to work through the comments and publish the standard in 2026.**

GPA WG77 Update
Multi-Path Ultrasonic Metering at or Near Dew Point of Natural Gas

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