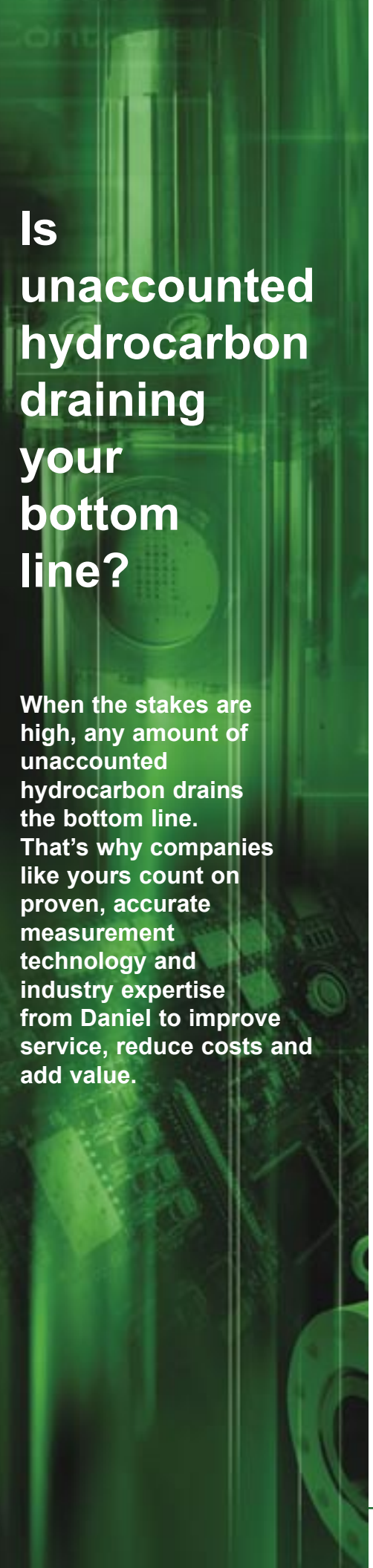
DANIEL®

Daniel® Gas Ultrasonic Flow Meter Brochure

SeniorSonic™ and JuniorSonic™ Flow Meters

EMERSON™
Process Management



Daniel® Company Overview

For more than 75 years, Daniel Measurement and Control, Inc. has served the fiscal custody transfer market. Daniel's natural gas and liquid flow measurement products, systems, and services are known around the world in the oil and gas industry. Daniel is synonymous with quality products, industry expertise and reliable and innovative engineering that deliver advanced technology. Daniel is well positioned to serve its customers with locations throughout the world.

Daniel empowers customers to achieve their business objectives by providing excellent service, reduce costs, and add value.

As Daniel continues to innovate and build its product technology and global organization, you can be confident that Daniel is stronger than ever. A subsidiary of Emerson Electric Co. ($15 billion revenue/ NYSE:EMR) and part of the Emerson Process Management group of companies, Daniel has financial strength, staying power and proven history.

Change and continuous improvement means success for Daniel customers. One commitment remains constant - to continue to earn and keep our customers' trust.

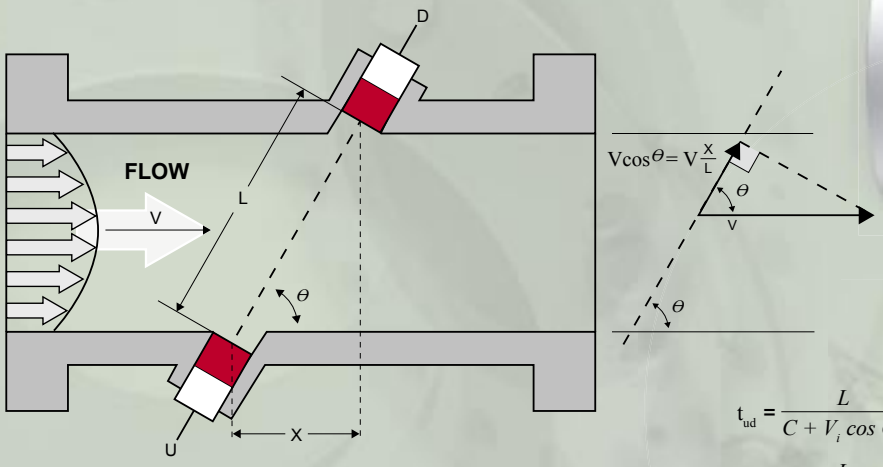
Daniel® Gas Ultrasonic Flow Meters

Daniel® Gas Ultrasonic Flow Meters are natural gas flow measurement instruments that are ideal for fiscal custody transfer applications. Typical installations for Daniel gas ultrasonic flow meters include power plants, industrial users, production, underground storage, offshore, and some wet gas applications. The meters have no moving parts and eliminate pressure loss common to differential measurement. This advanced technology provides higher accuracy and greater rangeabiliy (turndown) than traditional measurement instruments. Ultrasonic meters provide the following advantages over other types of meters:

- **Higher accuracy versus other traditional measurement technologies**
- **Lower maintenance costs with no moving parts**
- **Wealth of diagnostic information**
- **No loss in pressure as with differential measurement**
- **Flow range of 100:1 with flow calibration**
- **Bidirectional measurement**

How a Daniel Ultrasonic Flow Meter Works

Ultrasonic flow measurement is determined by measuring the difference in transit time of ultrasonic pulses. Flow measurement is determined by measuring the time required for an ultrasonic pulse to be transmitted between two transducers that are mounted at an angle relative to the gas flow. When the ultrasonic signal is traveling in the downstream direction, the transit time of the pulse is less than when it is traveling in the upstream direction. The difference between the upstream and downstream transit times is directly proportional to the velocity of the gas.



$$t_{ud} = \frac{L}{C + V_i \cos\Theta}$$

$$t_{du} = \frac{L}{C - V_i \cos\Theta}$$

$$V_i = \frac{L^2}{2x} \cdot \frac{t_{du} - t_{ud}}{(t_{ud})(t_{du})}$$

$$C = \frac{L}{2} \cdot \frac{t_{du} + t_{ud}}{(t_{ud})(t_{du})}$$

t_{ud} transit time from transducer U to D

t_{du} transit time from transducer D to U

L path-length between transducer faces U and D

X axial length between transducer faces

C velocity of sound in the gas in still condition

V_i mean chord velocity of the flowing gas

Θ acoustic transmission angle

Daniel SeniorSonic™ Gas Flow Meter

The Daniel SeniorSonic™ Gas Flow Meter utilizes Mark III™ Electronics, Customer Ultrasonic Interface software, and optional features for exceptional flow measurement in critical applications such as custody transfer. It measures transit times of ultrasonic pulses passing through the gas on four parallel planes. This is often referred to as a "chordal" design. Daniel carefully chose path locations to optimize measurement accuracy for a variety of piping and operational conditions.

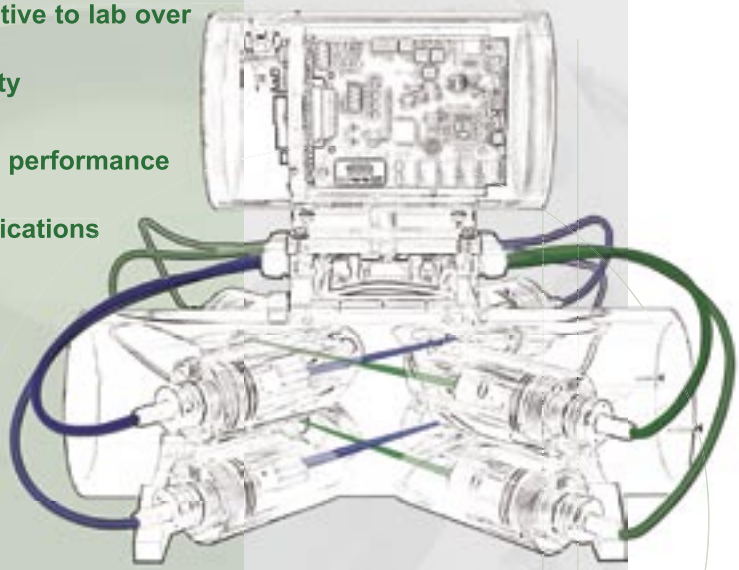
Measuring transit times directly from transducer to transducer (chordal design) increases measurement integrity. The direct chordal path provides virtual immunity to changes in pipe wall roughness and upstream installation effects.

Additionally, the chordal design permits the verification of uniform gas temperature within the meter, which also contributes to increased measurement integrity, especially at low flow rates. Considerations of the temperature variance inside the pipe due to convection is important to accurately measure natural gas at low flow rates.

A recent design change puts the path at a 60° angle relative to the pipe axis. The 60° angle shortens the chordal distance inside the pipe, thus improving the meter's ability to read ultrasonic pulses at higher velocities while maintaining accuracy at low flow velocities. Additionally, the design has proven to be more immune to noise, and maintains its superior installation effects performance.

Meter Performance:

- **Flow calibrated accuracy is ± 0.1% of reading relative to lab over entire flow calibration range**
- **Absolute accuracy is 0.3% including lab uncertainty**
- **Repeatability is ± 0.05% from 5 to 100 fps**
- **Velocity Rated to 100 fps. (30 m/s) with over-range performance exceeding 125 fps. (38 m/s)**
- **Meter meets or exceeds AGA9 performance specifications**



Mechanical Ratings:

- **4 – 42 inches**
- **Gas temperature: -4 to +212° F (-20 to +100° C)**
- **Operating pressure range: 150 – 4,000 psig (1030 – 27,579 kPa)**
  Consult factory for lower and higher pressure applications
- **Flange options include raised face and ring joint flange type for 300 – 2500 ANSI classes**

Safety Classifications:

- **UL listed for use in Class I, Division 1, Group D hazardous locations in both the US and Canada (UL E152246)**
- **CE marked to ATEX directive (94/9/EC)**
- **Certified to Eex d ia IIB T4 to standards EN 50014, EN 50018 and EN 50020**
  Please consult Daniel for a complete metrology approvals list

Daniel JuniorSonic™ Gas Flow Meter

The Daniel JuniorSonic™ Gas Flow Meter utilizes Mark III™ Electronics, Customer Ultrasonic Interface software, and optional features for accurate flow measurement in non-custody transfer applications such as production measurement, gas storage and wet gas applications.

The Daniel JuniorSonic Gas Flow Meter measures flow by bouncing a signal across the meter body. While Daniel does not recommend this method for fiscal custody transfer accuracy, it is a convenient method to determine flow rate for applications that do not require high accuracy.

The JuniorSonic Gas Flow Meter uses centerline paths to measure flow rate. Since the gas flow velocity is not the same across the center line of the pipeline, a flow profile correction factor is required to correct for the average velocity across a sectional area of the meter.

This correction sometimes referred to as a Reynold's Number correction, can be applied as a fixed value. Alternatively, a real-time correction can be applied by using pressure, temperature, and gas composition as live inputs. Read more about obtaining live gas composition under the "AGA 10 Speed of Sound Calculations" heading on page 5. Once the corrected mean velocity is determined, the flow rate is calculated by multiplying the average velocity by the cross sectional area of the meter.

Meter Performance

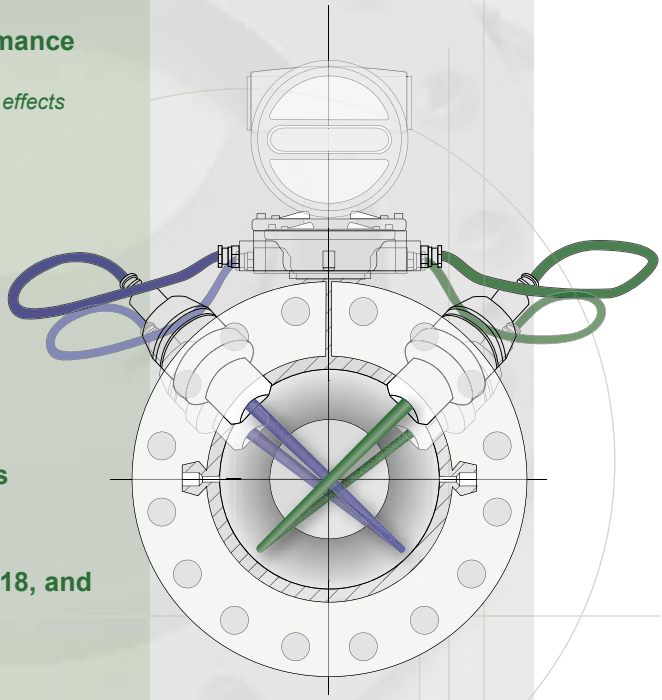
- **Flow calibrated accuracy: ± 0.5% of reading relative to lab***
- **Uncalibrated accuracy is typically ± 1.5% of actual volume flow***
- **Repeatability is ± 0.1% of reading for Qt to Qmax**
- **Velocity Rated to 100 fps. (30 m/s) with over range performance exceeding 125 fps. (38 m/s)**

  ** Does not take into consideration changes in wall roughness and installation effects*

Mechanical Ratings:

- **4 - 42 inches**
- **Gas temperature: -4 to +212° F (-20 to +100° C)**
- **Operating pressure range: 150 - 4,000 psig (1030 - 27,579 kPa)**

  Consult factory for lower and higher pressure applications
- **Flanges: RF for 300/1500 ANSI, RTJ for 600/2500 ANSI.**



Safety Classifications

- **UL listed for use in Class I, Division 1, Group D hazardous locations in both the US and Canada (UL E152246)**
- **CE marked to ATEX directive (94/9/EC) (pending)**
- **Certified to Eex d ia IIB T4 to standards EN 50014, EN 50018, and EN 50020 (pending)**

  Please consult Daniel for a complete metrology approvals list

Daniel Gas Ultrasonic Flow Meter Advantages

Daniel Gas Ultrasonic Flow Meters are preferred by operators of natural gas flow measurement equipment for the following reasons:

- **Best-in-Class Ultrasonic Flow Meter with Mark III™ Electronics**
- **Windows®-Based Customer Ultrasonic Interface Software**
- **Industry-Leading Meter Diagnostics and Audit Logs**
- **Optional Features to Enhance the Meter functionality**
- **Exceptional low flow performance down to 1 fps (0.3 m/s) and below**
- **Exceptional performance (accuracy) with dirty build up inside meter**
- **Multi-point calibration provides ± 0.1% calibrated accuracy, extends rangeability and improves accuracy**

Collectively, these advantages reduce your capital expenses and operating cost. Your Technicians can easily interface with the meter to get important diagnostic information. With these exclusive product features you can be sure that you are fully paid for the gas you sell.

Mark III™ Electronics

Mark III Electronics saves time and assures measurement integrity

Real-time flow measurement has been achieved with Mark III Electronics for Daniel Gas Ultrasonic Flow Meters. This innovative and scalable electronics and software platform increases the speed of data dramatically. All transducers are sampled more than 30 times per second and measurement is updated every ¼ second.

The Mark III Electronics firmware utilizes the Linux® operating system. This cutting-edge operating system moves data fast and is easy to access. The Mark III Electronics platform allows new features to be added easily without changing electronic components.

New Mark III Electronics firmware improves low flow performance and improves the ability to detect and process ultrasonic signals in the presence of high-frequency valve noise.

Mark III Electronics supports the following communications:

- **Two individually configurable 115 Kbps serial communication ports**
- **RS-232 and RS-485 half and full duplex**
- **Optional Ethernet connectivity**
- **Polling from multiple users simultaneously using Ethernet**

Mark III Electronics can pinpoint the date and time of each alarm event, and configuration change in a matter of seconds. This feature saves time when viewing historical measurement data, and gives you confidence in the accuracy of your meter. Mark III Electronics utilizes a single board design for full compatibility with all Daniel transducers and meters. This single board allows you to save money with fewer spare parts in inventory.

Customer Ultrasonic Interface CUI Software

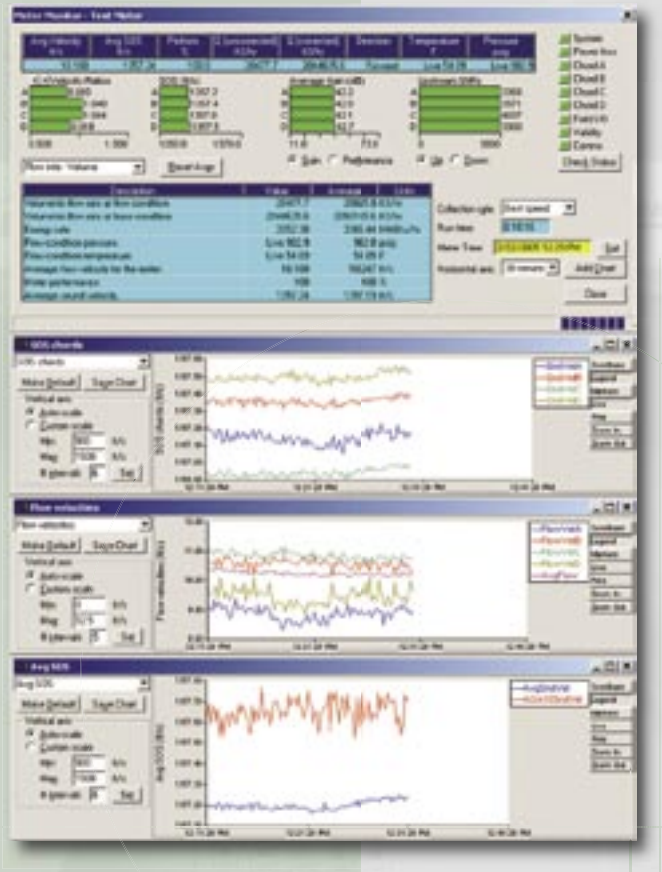
Daniel's Customer Ultrasonic Interface (CUI) software has set the industry standard for real-time ultrasonic flow meter monitoring. Through a single monitor screen, virtually all live data is simultaneously displayed in an easy-to-understand graphical format. Important real-time information is readily viewed, such as alarms, flow profile, speed of sound, signal-to-noise ratio, transducer gain, digital waveforms and much more. Ease of use is further enhanced with several set-up wizards to simplify routine technician tasks.

Industry-Leading Meter Diagnostics

Measurement uncertainty can be expensive. Understanding when and why measurement accuracy changes is of high importance today. The Daniel Ultrasonic Flow Meter provides advanced diagnostics to identify potential problems that may contribute to measurement uncertainty.

The key diagnostic information provided by the Daniel Ultrasonic Flow Meter includes:

- **Speed of Sound**
- **Velocity Profile**
- **Transducer Gain and performance**
- **Signal Quality**
- **Configuration changes**
- **Swirl and Turbulence**
- **Electronics Temperature + Voltages**



The figure shown here highlights the simplicity of the Daniel CUI software. A glance at the meter monitor including the alarm indicator lights, is all that is needed to see that the meter is working correctly. Screens can be added to your desktop to view live graphs that plot information about the meter's health, the flow of fluid, real-time calculations, or any combination of these. Navigation through the software is simple, and it comes with an integrated help menu for added assistance. Embedded macros and set-up screens make CUI easy to use. The diagnostic information can be exported to Excel.

Excel based spreadsheet reporting dramatically reduces meter inspection time, and simplifies trending of data for long-term meter performance verification. Daniel CUI automatically develops file folders and names for all stored data to insure consistency and ease of access for your service technicians.

Optional Features to Enhance the Meter

Series 100 Options Board

The optional Series 100 Options Board provides inputs for pressure, temperature and live gas composition from the Daniel gas chromatograph. This allows the meter to function as a redundant flow computer and calculate speed of sound (SOS) using the AGA 10 algorithm.

The Series 100 Options board attaches to the Mark III Electronics board and includes the following features:

- **Two 16 bit, 4-20 mA full differential analog inputs for pressure and temperature**
- **One 16 bit, 4-20 mA analog output for volume, energy and mass flow rate**
- **One serial RS-232/485 port for live gas composition from the Daniel Gas Chromatograph**
- **Obtains power from the main CPU**
- **Transmitters can be source powered from the Series 100 Options Board or can be externally loop powered**

Live Gas Composition from a Daniel® Gas Chromatograph (GC)

Daniel has established an industry first by integrating flow computer functionality in the SeniorSonic™ and JuniorSonic™ Flow Meters with live natural gas composition information in the meter. This option can significantly reduce overall project costs by eliminating the need for a second, back-up flow computer. If the primary flow computer fails, the meter provides a valuable service as a redundant flow computer.

When used as a redundant flow computer, costs can be further reduced by utilizing the primary pressure and temperature transmitters. This is achieved by transparently looping the primary transmitters through the Series 100 Options Board. This is made possible with the Options Board by utilizing full differential analog inputs. The Series 100 Options Board can also power 4-20 mA pressure and temperature transmitters for stand-alone measurement systems.

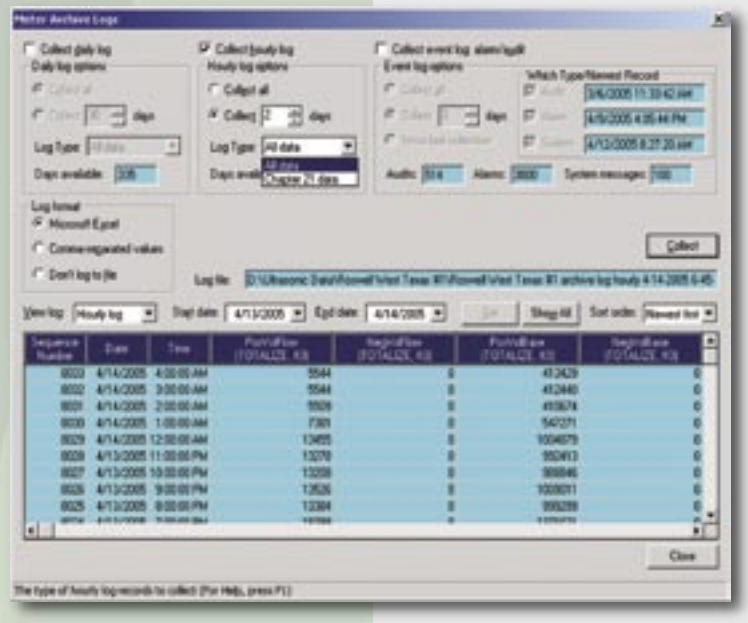
AGA 10 Speed of Sound Calculations

Daniel Ultrasonic Flow Meters can save valuable time with real-time AGA 10 SOS calculations. The Mark III Electronics, using live gas composition, pressure and temperature, calculates the speed of sound every 5 seconds. The AGA 10-calculated and meter-measured SOS values are then each averaged over an hour with the results reported in an hourly data log. This comparison can help identify possible process upsets and helps validate the integrity of the flow meter, gas analysis and analog measurements.

The Daniel Customer Ultrasonic Interface (CUI) software automatically includes the AGA 10-calculated SOS in the inspection reports. This valuable feature prevents manual data entry errors of gas composition.

Optional Features to Enhance the Meter

Archive Data Logs



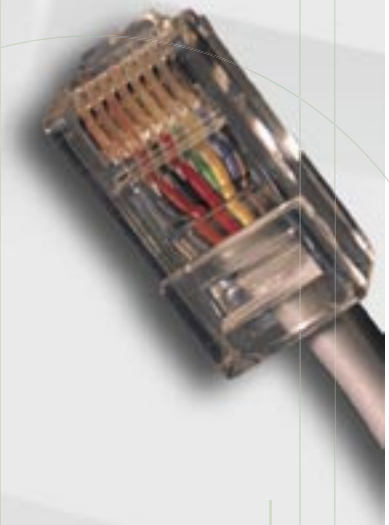
The financial value of natural gas makes historical measurement information very valuable. Daniel Archive Data Logs are easy to use and help validate measurement integrity. They far exceed the requirements of API 21.1 by providing:

- **100 days of hourly measurement data**
- **365 days of daily measurement data**
- **3,000 audit log records**
- **3,000 alarm log records**
- **Automated download of data to Microsoft Excel® using Daniel CUI software**

When a Daniel Ultrasonic Meter is manufactured, metrology information is stored in the meter. This includes meter geometry, delay times, meter calibration factors, and many other parameters that can directly affect measurement integrity. If the meter configuration is changed, accuracy of the meter can be affected. The Daniel Archive Log records changes to the meter configuration and notes alarm information with a time stamp, so you can easily see when events occur. All archive log information is stored in non-volatile memory so you can even see a meter's power fail and restore times.

The Archive Data Log provides the confidence to insure accurate measurement and should problems occur, permits accurate and timely corrections to billing.

Ethernet Connectivity



Securely accessing data quickly and easily via the Internet from anywhere in the world saves time and money. Another valuable Ethernet benefit is providing meter access by multiple, simultaneous users for data collection and routine maintenance.

For applications where remote access is not available, Ethernet remains the preferred method of locally connecting directly to the flow meter. At a speed of 10 Megabits (ten million bits) per second, Ethernet is more than 100 times faster than serial connectivity. This dramatically reduces data collection time while providing transparent meter access to multiple users simultaneously.

Mark III Electronics is Internet[1] enabled. This makes the Daniel Ultrasonic Flow Meter accessible from corporate area intranet and Internet installations, including existing and industry-standard firewalls and access rules.

[1]Note that an external firewall is required for secure access.

Daniel Measurement Services

At Daniel, we are focused on providing superior customer service. Through our ongoing practices of continuous improvement, training and development, and solicitation of customer feedback, Daniel Measurement Services is committed to being the world's leading provider of value–added measurement services.

Daniel Measurement Services is comprised of a specialized group of service engineers, technicians, and training personnel who are dedicated to customer satisfaction. This global team is available to respond to your start-up, training, or service needs twenty-four hours a day. Daniel provides solutions to your every service need, any time, anywhere.

Service offerings include:

- **Start-up and commissioning**
- **Product Repair / Upgrades**
- **Preventive Maintenance**
- **Meter Tube Inspection and Recertification**
- **Educational Services**
- **Remote Diagnostics**
- **Warranty Plus!**
- **Project Management and Intergration**

Daniel Measurement Services also offers a series of educational courses essential to customer success. Courses can be at the factory or the customer's location, and are taught by an accredited engineer, technician or other trainer. Courses include product instruction on proper operation of Daniel Gas Chromatographs, Ultrasonic Meters, Presets, Brooks® Compact Prover™ and other instruments for fiscal flow measurement applications.

Daniel Measurement Services' commitment to being the world's leading provider of value-added measurement services, affirms that the Daniel support of customers has never been stronger.

Daniel Engineered Systems

Daniel Measurement and Control, Inc. is the industry leader in designing, constructing and commissioning of complex oil and gas metering systems to exacting standards.

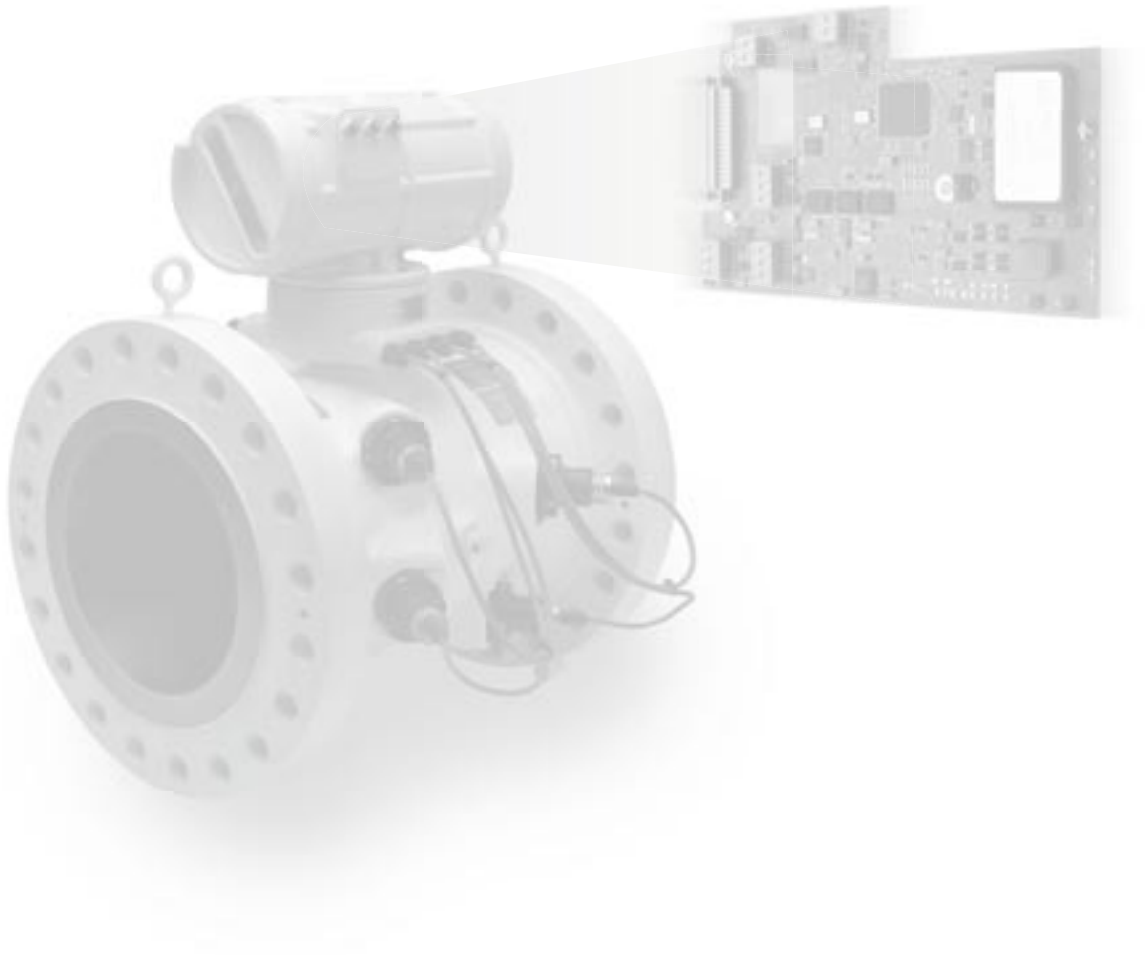
This global organization offers decades of fiscal petroleum flow measurement application experience. Customers rely on Daniel's Engineered Systems Group's international fabrication facilities, customized engineering and success in field-testing and support. From the simplest single-stream skid to complex on-site installations, Daniel delivers both natural gas and liquid petroleum turn-key applications. The Daniel Engineered Systems team designs, constructs and commissions the metering project, blending up-to-the-minute technology with decades of understanding what customers need and expect.

Components of a Daniel Engineered System installation typically include meters, valves, provers, flow-control instruments, instrumentation and read-out equipment, and process management components. Computer software and hardware are integrated with the measurement system. Standard calculation methods include AGA 3 (now API-MPMS-14.3), ISO 5167, AGA 5/7/8, AGA 9 and the API Manual for Petroleum Measurement Standards.

Daniel DMSS-2000 Supervisory Control System utilizes a sophisticated Graphical User Interface, database server, and a dedicated PLC for the metering skid/MOV interface. Redundancy is often used for custody transfer systems and/or when system integrity is essential.

A dedicated project manager and project team are assigned to each measurement system project. This team is responsible for overall system design and project construction from start, to finish. A separate internal QA/QC group reviews all design details, inside and outside fabrication, assembly and system testing.

Whether it is a pipeline, offshore production facility, or a loading facility for ocean-going tankers, Daniel Engineered Systems is a proven, single-source solution for customers throughout the world.



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