



## FCI flow calibration laboratory

Leading the process  
industry with  
state-of-the-art  
calibration facilities

**With constant demand for higher  
instrument performance, FCI has  
dedicated over 40 years of flow research  
and development into the construction  
and operation of the process industry's  
leading flow calibration facility.**





## **FCI. The process industry measurement standard.**

Fluid Components International is recognized across the process control industry for precision calibration services and highly reliable flow metering instrumentation. From early designs, FCI has focused closely on replicating field conditions in a controlled laboratory environment.

This assures the highest installed accuracy and minimum metering uncertainty. Today, we operate a state-of-the-art flow calibration laboratory with versatility to quickly transition through a wide range of calibration fluids, line sizes, and process connections. We proudly feature extensive automation and data collection capabilities that offer unmatched proprietary calibration solutions that balance throughput efficiency with traceability and reliability.

### **NIST ISO 9001:2000 and AS9100 Certification**

FCI calibrations are performed utilizing only NIST National Institute for Standards and Technology traceable equipment and instrumentation. We pride ourselves on meeting MIL-STD-45662A, ANSI/NCSS Z-540 requirements and for continuously maintaining ISO 9001:2000 and AS9100 certification.

Always extending flow lab facilities to meet new field conditions, FCI features gas flow calibration capabilities ranging as low as 0.001 SCFM (.00017 NCMH) to ranges that exceed 5000 SCFM (8500 NCMH) and higher for line sizes in excess of 10 inches

(250 mm). Calibrations for applications with temperature ranges from -100 to +1000°F (-73 to +538°C) and pressure ranges from 0 to 1000 psig (0 to 68 atmospheres) are commonly performed for many fluid services.



### **AVAL sizing software and instrument selection services**

FCI has developed sizing and specification software to make selection of thermal mass and Coriolis mass flow instruments quick and reliable. Since process parameters, fluid compositions and installation constraints can limit ideal performance, FCI *AVAL* and *ASAP* software will ensure customers are fully aware of process conditions that can potentially produce installed uncertainty. *AVAL* application evaluation software is a proprietary FCI service designed from years of fluid testing and installation experience. Using *AVAL* software, FCI models an installation with straight run variations and obstructions. All fluid process conditions are input

to run a suitability evaluation. When a complete evaluation is performed, an output report clearly defines expected "installed" accuracy or offers recommendations for improvement. Different from other sizing software, FCI relates laboratory calibrations to true installed field performance. *ASAP* configuration software matches specific process conditions and makes appropriate configuration recommendations for each flow meter application prior to purchase.

## **Reference metering technologies**

Due to the wide range of operating conditions, FCI has selected and utilizes proven reference flow standard technologies that provide the maximum reliability and flexibility needed for a particular range of process conditions and fluids.

For maximum reliability in both air and gas applications, sonic nozzles or critical venturis (CVs) are utilized for both low flow and small line size applications. When combined with high accuracy pressure standards, sonic nozzles deliver industry leading accuracy and repeatability. Since turndown is limited on sonic nozzles, FCI utilizes a sonic nozzle sizing rack to perform calibrations for wide flow range applications up to 1000:1 turndown.

FCI utilizes a portable metrology cart designed to travel to each production flow stand and to service scheduled metrology activities and calibration cycles. Accordingly, all flow laboratory reference meters are traceable directly to the nozzle standards, or for elevated ranges are traceable to third party laboratory affiliates. In all cases, every flow reference standard is directly traceable to NIST. For optimum mass flow measurement in liquid applications, FCI utilizes Coriolis type standards. The inherent “mass flow” capability of Coriolis technology assures no need for auxiliary process measuring instruments in order to achieve high accuracy mass flow indication. Flow laboratory accuracy of 0.10% of reading is attainable depending on fluids and process conditions.

In large line gas applications such as stacks and air ducts, turbine meters are selectively utilized as flow stand reference meters. Turbines are incrementally selected on bypass sections such that only the linear output range is utilized. Narrowing the useable range enables the highest accuracy calibrations. Turbine meters are combined with dual temperature and

pressure instrumentation to derive and output real-time mass flow.

**Sonic nozzle primary meters**



## **Automation and data acquisition database**

FCI's Test Engineering group is continuously developing new methods for reducing uncertainty, improving data collection and recall, expanding rangeability, developing automation routines and designing new calibration test stands.

Automation activities are done with three mandated objectives outlined and managed before each improvement is initiated:

- ➊ Automation activities must improve calibration accuracy and stand stability. Software is developed to optimize settling time and to integrate real time measurement and equipment inputs. As automation continues, human error is designed out of the data collection process.
- ➋ Automation must service throughput improvements. Customers no longer accept long waits for instrument calibrations no matter how complex the application. Equally important, customers can not sacrifice instrument reliability for turnaround.
- ➌ Improved access to critical calibration data, parameters, flow conditions and instrument variables. Whether a factory service technician is



in the field or whether a customer needs specific instrument details, every calibration variable and instrument detail must be immediately and reliably accessible.

### **Electronic calibration library**

At FCI, all instrument calibration records are maintained in FCI's electronic calibration library. Every flow meter has a calibration finger print that can be accessed either by performing an instrument inquiry using software contained in the meter or by calling up a serial number address on the world wide web and accessing complete calibration files.

### **Certified calibrations**

Computer generated and electronically stored calibration documents describe specific instrument details and can be easily sorted by instrument serial number, tag number or customer purchase order. Process conditions, calibration fluid, line size and other relevant calibration specifics are detailed for each calibration. A certified flow curve table is provided that matches instrument current outputs with scaled units of flow.

All NIST traceable equipment utilized during instrument calibration is identified along with the calibration history on all reference equipment. ISO calibration procedures followed during the instrument calibration are listed and certified by the performing calibration technician.

### ***Benefits to customers***

Automation initiatives have continued to deliver the following benefits for FCI customers:

- FCI is able to offer high value "actual fluid and field condition" calibrations at prices comparable to fluid equivalency calibrations offered by others.
- Technicians simultaneously operate multiple calibration stands to provide faster instrument throughput and timely calibration turnaround.
- Automated processes result in consistent calibrations free of human error.
- Storing all data in a database means quicker access and facilitates process analysis tools.
- Improved customer service response times.

### **Exclusive calibration documents**

FCI customers are provided certified calibration documents that summarize all calibration parameters, indicate actual instrument performance during system to system validation, and provide detailed setup information useful for troubleshooting or field calibration adjustments. This data is additionally accessible via FCI's website and can be viewed and printed by registered customers.



The image shows a screenshot of a document titled "FCI Calibration Summary and Output Chart". It contains a table with multiple columns of data, including flow rates and calibration parameters. The table is organized into several sections, with headers indicating different types of data being presented.

### **Calibration summary and output chart**

#### ***Records:***

- Application conditions
- Instrument ID
- Computer generated flow curve look up table

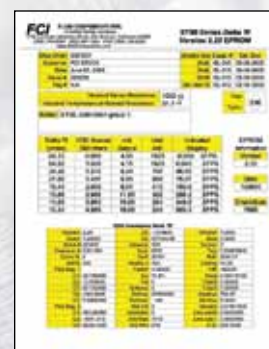


The image shows a screenshot of a document titled "FCI Calibration Certificate". It contains a table with multiple columns of data, including flow rates and calibration parameters. The table is organized into several sections, with headers indicating different types of data being presented.

### **Calibration certificate**

#### ***Records:***

- Applicable NIST traceable equipment
- Calibration procedures
- Technician certified stamp



The image shows a screenshot of a document titled "FCI Delta R data sheet". It contains a table with multiple columns of data, including flow rates and calibration parameters. The table is organized into several sections, with headers indicating different types of data being presented.

### **Delta R data sheet**

#### ***Records and enables:***

- Raw and processed outputs
- Calibration verification
- Tolerance limits

## **Accurate data acquisition systems**

All FCI data collection instruments feature NIST traceable calibrations and are systematically checked to verify calibration cycle compliance. FCI flow stands use independent meters for data collection and signal processing. This ensures that incoming signals are isolated from any potential PC produced noise effects.

In addition, all instruments are installed with careful isolation from line induced or radiant type electrical and RFI interferences. All measured signals are wired to multi channeled data collection devices. All devices interface digitally with the data acquisition systems to eliminate transfer or conversion errors. The result is uncompromised reliability in data generation.

### ***Fail safe calibrations***

Automated data collection provides all inputs for real time calculation of pressure, temperature and mass flow. If any of the signals or corresponding digital calculations fall outside of the limits retrieved from the database, calibration is stopped until corrected. The second function of the software is to automatically find a target flow rate and efficiently bring the stand to stable equilibrium.

### ***Virtual data conveyer belt***

After installing the flow meter into the flow stand, a qualified test technician electronically retrieves test parameters and flow stand setup instructions to begin the calibration process. The flow stand directly communicates with the instrument being calibrated to download initial settings for the application. Data is

then automatically collected over the selected flow range.

Individual programs at each step in the calibration cycle add information to the calibration record much like a virtual data conveyer belt. Following data collection, the flow stand performs a curve fit linearization routine then downloads coefficients into the calibrated instrument memory. After the data download phase

is completed, a NIST compliant system-to-system flow check is performed. As the newly calibrated flow meter passes the final verification flow check-points, all calibration data is then sent electronically to a retrievable database and calibration documents are generated.

## **VORTAB® solves straight run deficiencies**

Ideally, both process flow measurement and actual flow meter calibration should be performed under conditions where pipe straight run is available. Actual installations with inadequate pipe diameters will usually experience flow profile disturbances that directly result in degraded instrument accuracy. Often piping practices are dictated more by

limited plant space than by instrumentation needs. As a result, to assure that calibration laboratory accuracy is transferred to the field installation, flow conditioning may be recommended. To eliminate inaccuracies associated with velocity profile distortions, FCI has partnered with VORTAB flow conditioners to isolate flow irregularities and to provide a swirl free symmetric flow profile that is reliably transferred from the lab to the field. FCI also features laminar, flat, turbulent and custom profile calibrations.

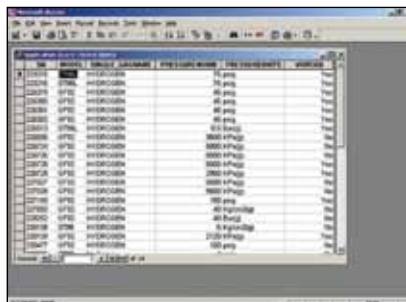




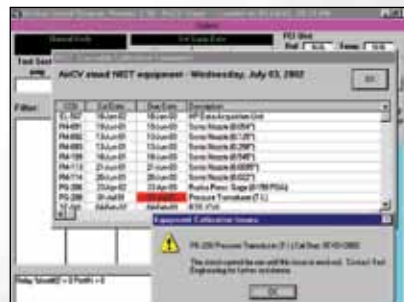
Gas sonic nozzle stand



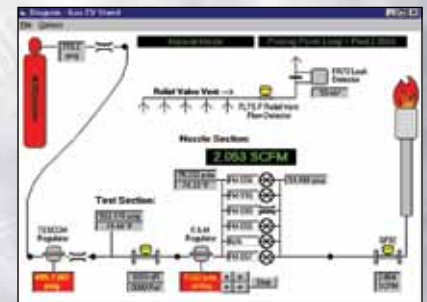
## Proprietary software equals reliability and repeatability



Customer application data and flow meter performance results are easily queried from the calibration database. Analysis of this information leads to constantly improving products and test facilities.



Automated software guarantees that all flow stand equipment is up to date and NIST traceable.



The FCI gas sonic nozzle stand is operated remotely from a separate control room. Computerized process control allows fully automated calibrations and efficient product development testing.



**Pressurized gas loop stand**



**Air sonic nozzle stand**



**Air high temperature stand**





## **European Calibration Center**

FCI offers complete calibration solutions to service European customer needs for quick turnaround and high reliability. FCI's Service and Calibration Center located in our Tilburg (Netherlands) facility features local European access to traceable flow stations and is ideal for validation testing, recalibration services and cycle audits.

## **Web enabled trouble shooting**

Database management is a constantly improving area. With the application versatility available on the world wide web, FCI can setup individual instrument addresses and can perform remote flow meter diagnostic routines directly from the factory. For flow meters installed in the field without web addresses, access to calibration records is available to password protected customers for parameter "read only" access thus making field data collection and performance comparisons available around the clock.

## **Field calibration services**

Where extreme or challenging installation conditions exist, FCI provides reliable "in situ" calibration services with highly qualified field calibration engineers. For customers who are mandated to perform annual calibration validations, FCI features mobile audit and certification services designed to meet customer compliance cycles.

## **Productivity equals customer benefits**

Through stand automation and flexible fixturing, throughput at each station is continually optimized. Automated data entry maximizes processes speed and accuracy. On-site liquid and gas reserves means minimal waiting for either basic fluids or complex mixed gas calibration compositions. Self checking calibration stands prevent out of tolerance calibrations. By combining application evaluation services with accurate, reliable throughput, FCI continues industry leadership with state-of-the-art calibration services and facilities.

**Liquid hydrocarbon stand**



**Sanitary liquid stand**



## Customer Applications



### FCI laboratory test stands matched to customer applications

	Open Loop Air (4 stands)	Air Medium Temp	Air High Temp	Air Sonic Nozzle	10" Wind Tunnel (3 stands)	Portable Metrology Stand	Pressurized Gas Loop (2 stands)	Gas Sonic Nozzle	Water Flow (2 stands)	Fuel /Oil Flow (2 stands)	Liquid Temp Comp (2 stands)	Special Setups
<b>Air Metering Applications</b>	Air Flow						Gas Flow		Liquid Flow		Any	
HVAC	•	•	•	•	•							
Compressed Air				•		•	•					•
Cooling Air	•	•		•								
Hot Air Exhaust	•	•	•			•	•					•
Large Air Duct		•			•							•
Aeration	•	•										
<b>Gas Metering Applications</b>	Air Flow						Gas Flow		Liquid Flow		Any	
Hydrogen Cooling							•	•				•
Methane, Propane, Other Flammable							•	•				
Argon, Nitrogen, CO <sub>2</sub> , other Inert							•	•				
Oxygen and Ozone	•*			•*			•*	•*				•
Hazardous or Toxic Gases	•*			•*			•*	•*				
<b>Gas Mixture Metering Applications</b>	Air Flow						Gas Flow		Liquid Flow		Any	
Natural Gas							•	•				
Flare Gas							•	•				•
Flue Gas	•*	•*	•*		•*		•	•				•
Landfill Gas	•*	•*		•*			•	•				
Digester and Biogas	•*			•*			•	•				
<b>Liquid Metering Applications</b>	Air Flow						Gas Flow		Liquid Flow		Any	
Water									•		•	•
Water Drain Lines (partially full line)												•
Oil and Hydraulic Fluid										•	•	•
Coolant Fluid									•	•	•	•
Fuels and Fuel Oils										•	•	•
<b>Flow Switch Applications</b>	Air Flow						Gas Flow		Liquid Flow		Any	
Pump Protection									•	•	•	•
Oil and Hydraulic Fluid										•	•	•
Water and Coolants									•		•	•
Air or Nitrogen	•	•	•	•			•	•				
Gas and Gas Mixtures							•	•				•

Six additional flow stands available in Europe. \*Applications may be done using fluid properties equivalency.

## Applications

The FCI calibration laboratory features an evolving flow measurement facility. This one of a kind flow laboratory services the widest range of fixed station and modular calibration rigs. Each calibration bench is designed to dynamically service a wide range of calibration parameters.

We are unique among flow service providers because of our ability to perform in a wide range of gases, gas mixtures, liquids, temperatures, pressures, line sizes, and process connections. Above are samples of common applications serviced in our facility. Many other fluid service capabilities are available along with special calibration setups.



## Flow Stand Capabilities

### Air Stand Capabilities

Stand	Media	Test Section NPS / DN	Flow Range	Temp Range	Pressure Range
Open Loop Air, High Flow	Air	1.5 – 6 inch 40 – 150 mm	1 – 150 SFPS 0.3 – 46 NMPS	Ambient	Ambient
Open Loop Air, Low Flow	Air	1.5 – 6 inch 40 – 150 mm	0.25 – 110 SFPS 0.08 – 33.5 NMPS	Ambient	Ambient
Open Loop Air, Medium Flow	Air	1.5 – 6 inch 40 – 150 mm	1 – 135 SFPS 0.3 – 41 NMPS	Ambient	Ambient
Aerospace Open Loop Air	Air	1.5 – 8 inch 40 – 200 mm	1 – 150 SFPS 0.3 – 46 NMPS	Ambient	Ambient
Air Medium Temperature	Air	2 – 4 inch 50 – 100 mm	15 – 100 SFPS 4.6 – 30.5 NMPS	-50 – +180°F -46 – +82°C	Ambient
Air High Temperature	Air	6 inch 150 mm	200 – 750 SCFM 340 – 1274 NCMH	Amb – 1000°F Amb – 538°C	Ambient
Air Sonic Nozzle	Air	1/2 – 4 inch 15 – 100 mm	0.03 – 300 SCFM 0.051 – 510 NCMH	Ambient	0 – 100 psig 0 – 7 Bar(g)
10" Wind Tunnel, "D"	Air	10 inch flat profile 250 mm flat profile	2 – 150 SFPS 0.61 – 46 NMPS	Ambient	Ambient
10" Wind Tunnel, "E"	Air	10 inch flat profile 250 mm flat profile	2 – 150 SFPS 0.61 – 46 NMPS	Ambient	Ambient
Portable Metrology Stand	Air	1/2 – 10 inch 15 – 250 mm	0.03 – 500 SCFM 0.051 – 850 NCMH	Amb – 500°F Amb – 260°C	0 – 100 psig 0 – 7 Bar(g)

Note: SFPS, NMPS, SCFM, NCMH referenced to 70°F & 14.7 psia (21.1°C & 1.01325 Bar Abs.)

### Gas Stand Capabilities

Stand	Media	Test Section NPS / DN	Flow Range	Temp Range	Pressure Range
Pressurized Gas Loop	Inert Gas, Flammable Hydrocarbons & Mixtures	1 – 8 inch 25 – 200 mm	1 – 800 SFPS 0.3 – 244 NMPS	32 – 180°F 0 – 82°C	0 – 100 psig 0 – 7 Bar(g)
Bypass Pressurized Gas Loop	Inert Gas, Flammable Hydrocarbons & Mixtures	4 inch 100 mm	0.5 – 800 SFPS 0.15 – 244 NMPS	0 – 180°F -18 – +82°C	0 – 100 psig 0 – 7 Bar(g)
Gas Sonic Nozzle Stand	Inert Gas, Flammable Hydrocarbons	1/2 – 4 inch 15 – 100 mm	0.03 – 200 SCFM 0.051 – 340 NCMH	Ambient	0 – 1000 psig 0 – 69 Bar(g)

Note: SFPS, NMPS, SCFM, NCMH referenced to 70°F & 14.7 psia (21.1°C & 1.01325 Bar Abs.)

### Liquid Flow Stand Capabilities

Stand	Media	Test Section NPS / DN	Flow Range	Temp Range	Pressure Range
High Flow Water	Water	1 – 3 inch 25 – 80 mm	0.35 – 150 GPM 1.32 – 568 LPM	35 – 200°F 1.7 – 93°C	0 – 100 psig 0 – 7 Bar(g)
Low Flow Water	Water	1/8 – 2 inch 6 – 50 mm	0.2 – 20 GPM 0.76 – 76 LPM	Ambient	0 – 60 psig 0 – 4 Bar(g)
Fuel / Oil Flow	Coolants, Oils, Flammable Hydrocarbons	1/2 – 3 inch 15 – 80 mm	0.1 – 100 GPM 0.38 – 380 LPM	-40 – +220°F -40 – +104°C	0 – 100 psig 0 – 7 Bar(g)
Water Temp Comp	Water	2 inch 50 mm	2 ft/sec 0.61 m/sec	40 – 150°F 4.4 – 66°C	Ambient

Contact FCI for other custom configurations.



Bypass gas loop



Air Medium Temperature



10" wind tunnel "D" and "E"



Gas flow facility

## Flow calibration test stand parameters

FCI maintains and operates a wide range of calibration test stands in order to perform calibrations that closely match a diverse range of customer applications. Each instrument and all calibration equipment utilized in the laboratory or located on the calibration stand is placed under a metrology program

that ensures scheduled traceability verification. Lock-out software has been developed to pre-test every calibration stand with a start up interrogation that validates current flow stand compliance and proper stand operation. Operators may only perform calibrations when all test stand instrumentation is within its traceable calibration cycle.

Air flow facility



Headquartered in San Marcos, California, FCI is near San Diego's high tech and biomedical industrial centers with excellent airport, freeway and sea transportation to support its global customer base.



**HART**  
COMMUNICATION PROTOCOL

**PROFI**<sup>®</sup>  
PROCESS FIELD BUS  
**BUS**

**NIST Net**

**ETHERNET**  
*configured*