CALDON® ULTRASONICS TECHNOLOGY CENTER

Calibration Laboratory

- World class hydrocarbon calibration laboratory
- Broadest capability in North America
- Accredited to ISO 17025
- Traceable to international standards
- Uncertainty certified by NMi

Filling/Draining System

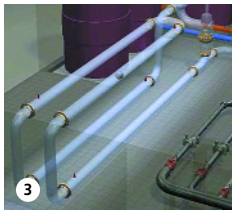
Hydrocarbon liquid from any one of the three storage tanks fills the laboratory piping using the automated valve system ***(Photo 1)***. One, two, or all three available liquids may be used to calibrate a particular flow meter over a Reynolds number range that approximates that of the actual process. Once filled with liquid, a pressurizer ***(Photo 2)*** can increase the laboratory piping pressure up to 75 psi.

- Three 12,000 gallon storage tanks hold Exxsol D80 and two mineral oils
- Vents ***(black piping shown in Photo 3)*** are opened as the system is filling to eliminate air
- Drains ***(blue piping shown in Photo 3)*** and vents empty into a sump network ***(Photo 4)***. Liquid in the sump is pumped back into the appropriate storage tank.

Ball Prover

A calibration run is initiated when the prover ball ***(Photo 1)*** is launched by the operator ***(Photo 2)***. The ball drops down and is carried by the flow into the prover piping. A glass view of the prover piping that illustrates the ball in motion ***(Photo 3)***. The position of the ball is monitored by a series of four detector switches ***(Photo 4)***.

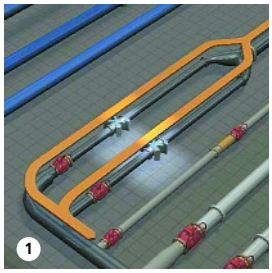
- 20-inch, 10 m^3 Ball Prover with a capacity of 40 m^3/hr to 2200 m^3/hr
- Four detectors, 3.3 m^3 between two consecutive detectors
- Used to calibrate all size meters between 4-inch and 10-inch
- Uncertainty 0.043%

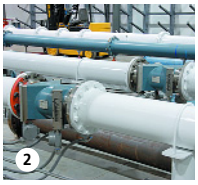


Master Meters

Flow can pass through one or both master meter lines and then into any of the calibration lines as shown by the yellow arrow ***(Photo 1)***.

- Two 10-inch LEFM 280C master meters
- Used to calibrate meters 10-inch and larger (flows greater than 2200 m^3/hr)
- Uncertainty of 0.083%
- Calibrated by ball prover

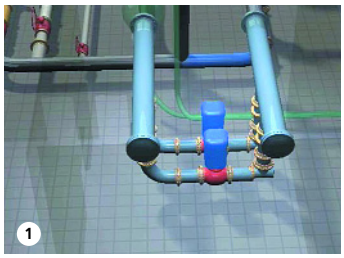


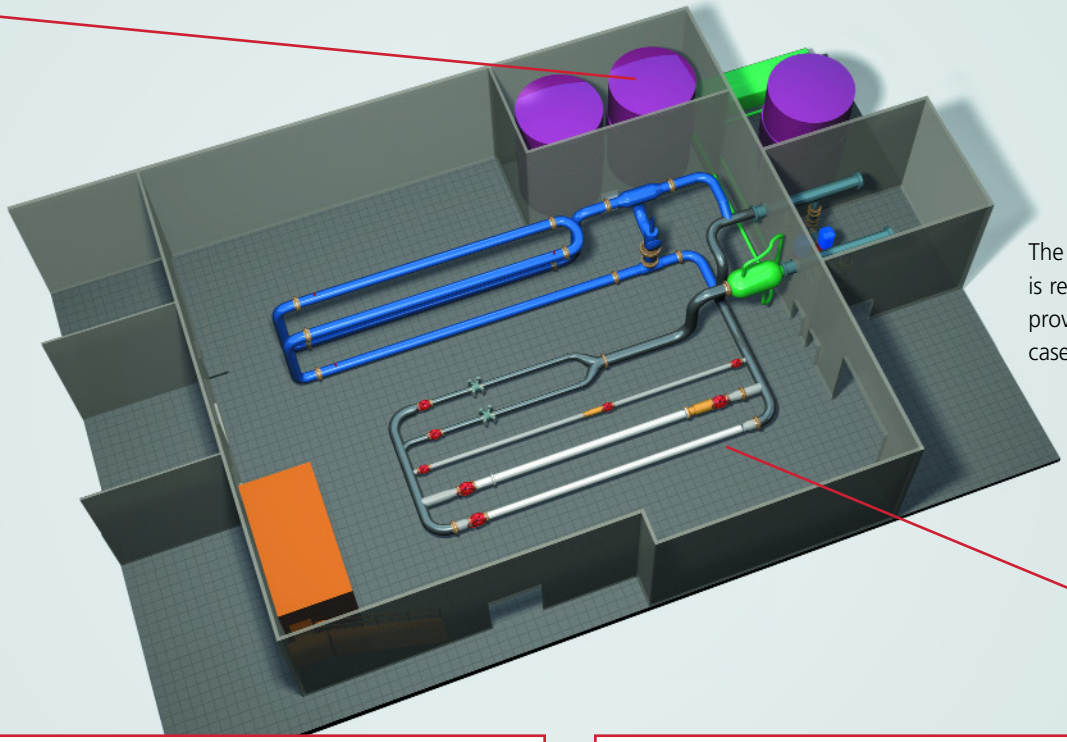


Pump Room

The illustration ***(Photo 1)*** shows the location of the laboratory pumps.
A third pump can be added in the future to expand the capacity of the laboratory.

- Two variable speed 250 HP pumps ***(Photo 2)*** with adjustable frequency A.C. drives ***(Photo 3)***
- Maximum flow rate of 3600 m^3/hr





The floor of the laboratory is recessed 7 inches to provide containment in case of a possible spill.

Control Room

- Data from all instruments, PLC's and meters are transmitted to two computers in the main control room
- Visitors can observe calibrations from here
- Two control room computers gather and process all calibration data and print final report

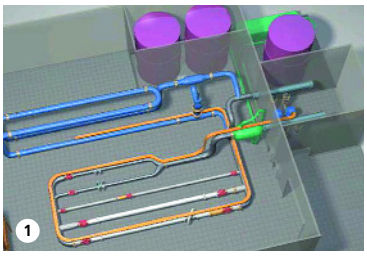
Main Floor Control Panels

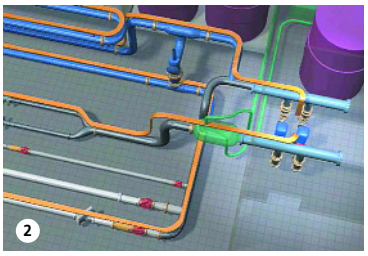
One of two control panels ***(Photo 1)*** with sample display screens ***(Photo 2 & Photo 3)***.

- Two panels with touch screen displays permit control of all laboratory operations from the main floor
- There are emergency stop buttons on the two panels, as well as seven (7) other strategic locations in the laboratory

One Large Closed Loop

When using the prover, flow goes from the pump room, through one of the master meter lines, into the feed header, into one of the calibration lines, into the return header, and then into the prover *(Photo 1)*. Flow continues through the prover and back into the pump room *(Photo 2)*.

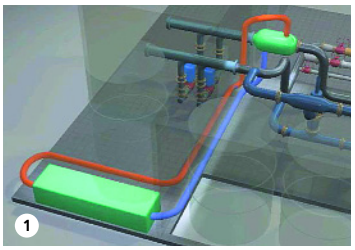


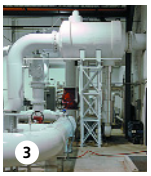


The laboratory has a temperature control system that stabilizes liquid temperature at a desired value during a calibration run. This system removes heat added to the liquid by the pumps as it circulates through the laboratory piping loop.

Temperature Control

Coolant, shown in blue *(Photo 1)* is pumped from the outside chiller *(Photo 2)* into the shell of the lab's heat exchanger *(Photo 3)*. Heated coolant (orange) is pumped back to the chiller. The desired temperature set-point for the hydrocarbon liquid being used for the calibration is controlled by varying the rate at which coolant flows to the heat exchanger.

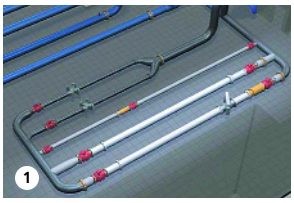


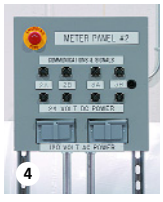


- Fluid temperature is controlled over a range of 60°F to 120°F by the 65-ton chiller system
- Tube and shell heat exchanger contains approx. 2.5 miles of internal tubing
- Temperature control system stabilizes calibration run conditions and permits hydrocarbon viscosity to be varied over a range of 1.5 to 200 centistokes
- Controlling hydrocarbon viscosity allows meters to be calibrated over approximately the same Reynolds number range corresponding to installation conditions

Calibration Lines

Three calibration lines are shown in the illustration *(Photo 1)*. Flow of hydrocarbon liquid can be directed from the feed header *(Photo 2)* into any of the calibration lines. The inner most line is used to calibrate 4-inch to 8-inch meters *(Photo 3)*. The middle calibration line is for 10-inch to 16-inch meters. The third calibration line is designed for meters 10-inch to 24-inch (and larger). Flow meters can be calibrated with customer provided meter runs or with laboratory piping. Meter electronics are connected to one of two panels *(Photo 4)*, which transmits all data to the control room computers.





The Cameron Hydrocarbon Calibration Laboratory

The Caldon Ultrasonic Technology Center is located near Pittsburgh, Pennsylvania. The centerpiece of this facility is the Cameron Hydrocarbon Calibration Laboratory. This flow laboratory is unequalled and sets Cameron apart from other ultrasonic meter suppliers in three distinctive ways.

Each Caldon® LEFM 200 Series ultrasonic flow meter is calibrated in this laboratory over a Reynolds number range that corresponds to the actual Reynolds number range the meter will encounter in the field, when possible. This process ensures that once the meter is installed and operating, performance will be unaffected by changes in flow rate and liquid viscosity. The ability to calibrate in-house will virtually eliminate the need for Cameron to use independent facilities, thereby dramatically reducing delivery cycles.

When you talk about a flow laboratory sooner or later you will come around to talking about accuracy, or as it's called by metrological experts, the laboratory's measurement uncertainty. To calibrate a meter it is necessary to compare its registration to a "known volume", i.e., if 1,000 barrels of oil are passed through the meter, does it register 1,000 barrels? The uncertainty of the flow laboratory deals with the errors that might affect the "known volume" and how it compares to an international standard. When a meter has been calibrated in a flow laboratory with a low measurement uncertainty, its measurement in the field will be more accurate. The uncertainty of the Cameron Hydrocarbon Calibration Laboratory is 0.043%.

The extreme stability of flow rate and temperature achievable at the Cameron Hydrocarbon Calibration Laboratory provides Cameron engineers with an unsurpassed tool for conducting fundamental research. This has contributed to better understanding of the phenomena that affect ultrasonic flow meters.

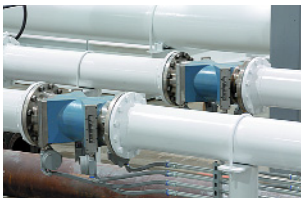
Calibration Laboratory Overview

1. Outside storage tank and chiller

2. Pump room

3. Ball prover

4. Heat exchanger



5. Master meters

6. Calibration lines

7. Mezzanine level control room

Calibration Laboratory Specifications

Laboratory:	Occupies approximately 7,360 ft². Piping is pressurized to up to 75 psi. Flow is circulated and controlled using two pumps.
Pumps:	Two variable speed 250HP pumps located in a separate pump room.
Maximum Flow Rate:	3600 m³/hr
Minimum Flow Rate:	40 m³/hr
Meter Sizes:	4-inch (100 mm) to 24-inch (600 mm) meters can be calibrated using three calibration lines. A 7.5 ton crane is used for handling meters and piping.
Prover:	10 m³ unidirectional prover
Master Meters:	Two LEFM 280C-10 inch meters installed in parallel
Calibration Fluids:	Exxsol D80 and two mineral oils with nominal viscosities of 2 cSt, 15 cSt and 150 cSt. During a calibration, viscosity can be varied and controlled between approximately 1.5 and 200 cSt.
Storage Tanks:	The oils are contained in three, double-walled storage tanks. The tanks are 20-ft. high and 12-ft in diameter with a 12,000 gallon capacity. Two inside tanks are located in a 5-ft deep containment pit. The third tank is located outside.
Temperature Control:	Temperature is controlled within a band of 60 to 120°F using a 65-ton chiller system. Oil passes through a tube and shell heat exchanger as it circulates in the lab. The oil temperature is controlled by adjusting the rate of coolant fed into the shell side of the heat exchanger from the chiller.
Control:	The system is operated from a mezzanine level modular control room with full view of the entire laboratory. The system can also be operated from the laboratory floor via two touch-screen control panels.
Safety:	Goggles and metal tipped shoes are required by personnel on the facility floor
Uncertainty:	0.043% Ball Prover 0.083% Master Meters

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NVLAP

Certificate of Accreditation to ISO/IEC 17025:2005

Cameron Measurement Systems

CALIBRATION LABORATORIES

8. ISO 17025 Certificate

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