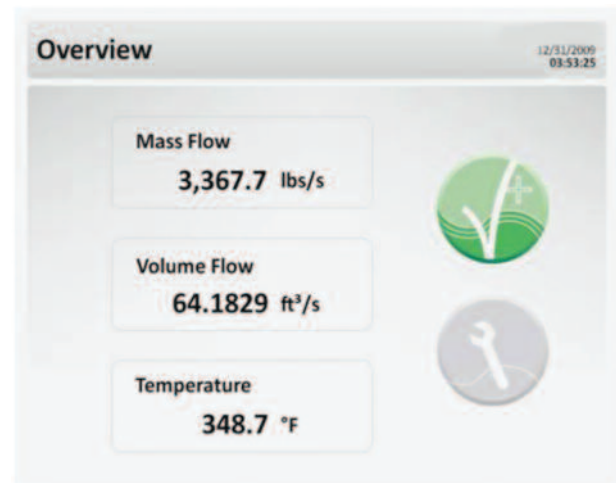
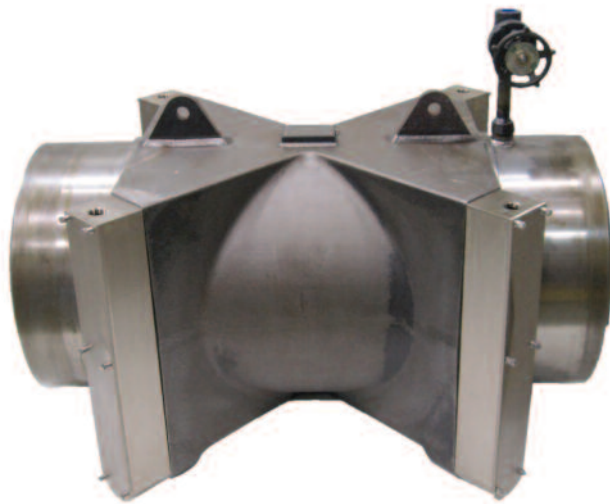


CALDON®

LEFM® CheckPlus

Ultrasonic Flow Meters for Nuclear Power Plant Feedwater



Increase plant revenue while improving safety by installing a Cameron LEFM CheckPlus Flowmeter System. Measurement Uncertainty Recapture (MUR) uprates up to 1.7% based on LEFM CheckPlus Systems have been approved by the U.S. Nuclear Regulatory Commission (NRC) and other nuclear regulators in over 50 nuclear plants worldwide. The LEFM CheckPlus is the only measurement system approved by the NRC for MUR uprates to 1.7%, which allows for typical payback of equipment costs within months, and of total project costs within 1 to 2 years.

The LEFM CheckPlus system also enhances plant safety by reducing the uncertainty in the calculation of power, thereby reducing the probability that the plant will operate at power levels exceeding those used in the accident analysis. The LEFM CheckPlus safeguards against measurement errors through its unique ability to verify its measurements on-line and continuously – an important consideration of nuclear regulating authorities when approving the uprate concept.

Supports MUR Uprates up to 1.7% – representing millions of dollars per year in additional revenue

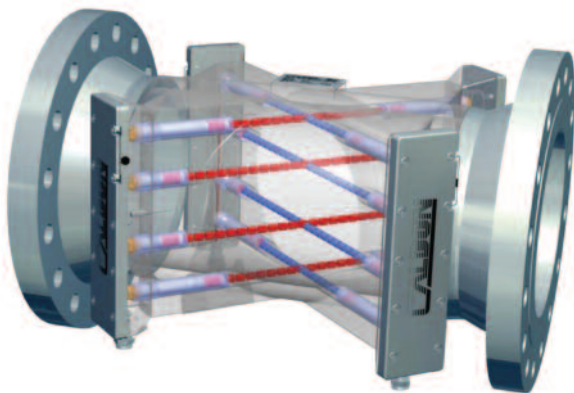
Continuous, on-line diagnostics improve safety and minimize likelihood of over-power operation

Cameron's 20+ years of experience in the nuclear industry streamline the licensing process

Highest Accuracy Means More Revenue

In most cases the LEFM CheckPlus will achieve mass flow accuracy better than 0.3% when installed. In all cases, Cameron provides a bounding analysis defining uprate expectations at the start of a project. This accuracy justifies up to a 1.7% MUR power uprate, which translates into over \$7 million dollars per year in additional revenue for a typical 1000 MWe plant. Cameron provides a site-specific uncertainty analysis, a Certificate of Compliance at the conclusion of final commissioning, and licensing documentation as part of every project.

LEFM CheckPlus systems use well-proven ultrasonic transit-time technology in an 8-path, crossed-plane configuration, which automatically compensates for cross-flow or swirl caused by upstream hydraulic disturbances. That means that the LEFM CheckPlus system can be installed almost anywhere in the plant and still maintain the highest accuracy.



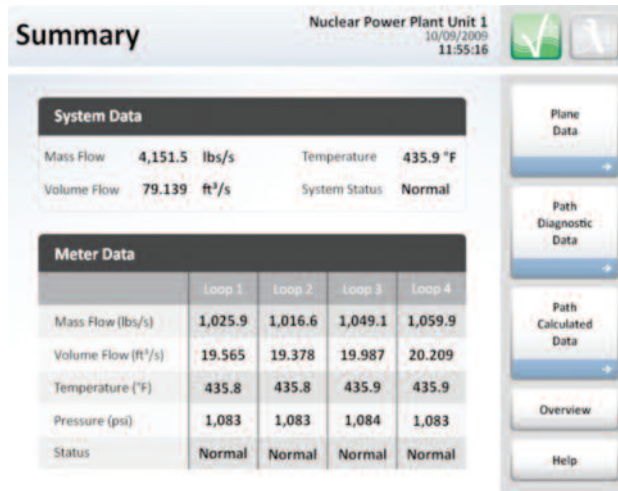
The picture above illustrates the 8-path, crossed-plane design of the LEFM CheckPlus meter spool piece. Every LEFM CheckPlus flow meter is calibrated at a certified calibration facility with piping layout modeling conditions in the plant in which it will be installed. The picture at the right shows an LEFM metering spool installed downstream of several out-of-plane elbows.

Chordal transit-time technology also maintains accuracy through the full range of plant flows. At normal operating conditions above 25% power, temperature is determined from speed of sound, calculated from the transit time measurements. A separate RTD provides additional temperature data for the 32° to 250°F (0° to 121.1°C) range where temperatures based on speed-of-sound calculations are indeterminate.

LEFM CheckPlus meters do not foul or drift over time, and internal circuitry supplies continuous verification of operation within calibrated standards, providing additional assurance that power calculations are based on accurate feedwater flow data.

Continuous Verification Means Increased Safety

On-line verification - The LEFM CheckPlus continuously outputs volumetric flow, temperature, and calculated mass flow via ModBus TCP/IP or RS-485. LEFM CheckPlus circuitry and software verify that the system is operating within its design accuracy, with continuous on-line display of verification of system status on the system touch screen/display. Extensive diagnostics screens provide individual path data, system set-up, and diagnostics screens to simplify troubleshooting.



Summary Nuclear Power Plant Unit 1
10/09/2009 11:55:16

System Data

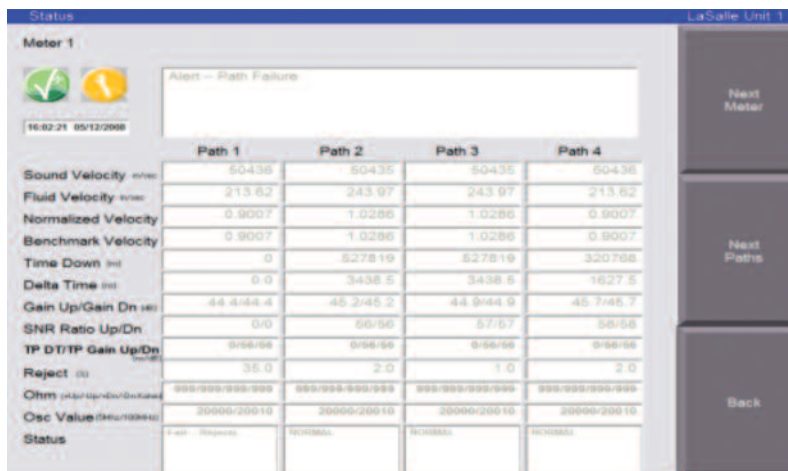
Mass Flow	4,151.5 lbs/s	Temperature	435.9 °F
Volume Flow	79.139 ft³/s	System Status	Normal

Meter Data

	Loop 1	Loop 2	Loop 3	Loop 4
Mass Flow (lbs/s)	1,025.9	1,016.6	1,049.1	1,059.9
Volume Flow (ft³/s)	19.565	19.378	19.987	20.209
Temperature (°F)	435.8	435.8	435.9	435.9
Pressure (psi)	1,083	1,083	1,084	1,083
Status	Normal	Normal	Normal	Normal

Buttons: Plane Data, Path Diagnostic Data, Path Calculated Data, Overview, Help

Detailed displays accessed through the touch screen provide extensive system information and troubleshooting capability.



Status LaSalle Unit 1

Meter 1

Alert - Path Failure

	Path 1	Path 2	Path 3	Path 4
Sound Velocity m/s	504.36	504.35	504.35	504.36
Fluid Velocity m/s	213.62	243.97	243.97	213.62
Normalized Velocity	0.9007	1.0286	1.0286	0.9007
Benchmark Velocity	0.9007	1.0286	1.0286	0.9007
Time Down ms	0	5278.19	5278.19	320768
Delta Time ms	0.0	3438.5	3438.5	1627.5
Gain Up/Gain Dn %	-44.4/-44.4	-45.2/-45.2	-44.9/-44.9	-45.7/-45.7
SNR Ratio Up/Dn	0/0	56/56	57/57	56/56
TP DT/TP Gain Up/Dn	0/0/06	0/0/06	0/0/06	0/0/06
Reject %	35.0	2.0	1.0	2.0
Ohm (kV up/down)	999-999-999-999	999-999-999-999	999-999-999-999	999-999-999-999
Osc Value (kV up/down)	20000-20010	20000-20010	20000-20010	20000-20010
Status	Fail - Stop	NOISSUE	NOISSUE	NOISSUE

Buttons: Next Meter, Next Paths, Back

Redundancy - Total system redundancy – 8 acoustic paths, two transmitters, and two CPUs per loop - ensures that a measurement signal from the LEFM CheckPlus is available 100% of the time. Cameron provides an assessment of accuracy both for normal operation and with any single failure.

Advanced Features Mean More Security

Changes in any software input must be made at the electronics cabinet and are easily traced through system outputs and displays. An audit trail, available through system software, provides additional assurance of continuous operation without changes. LEFM CheckPlus systems can also be configured to indicate an alarm when any of the system electronics is accessed.

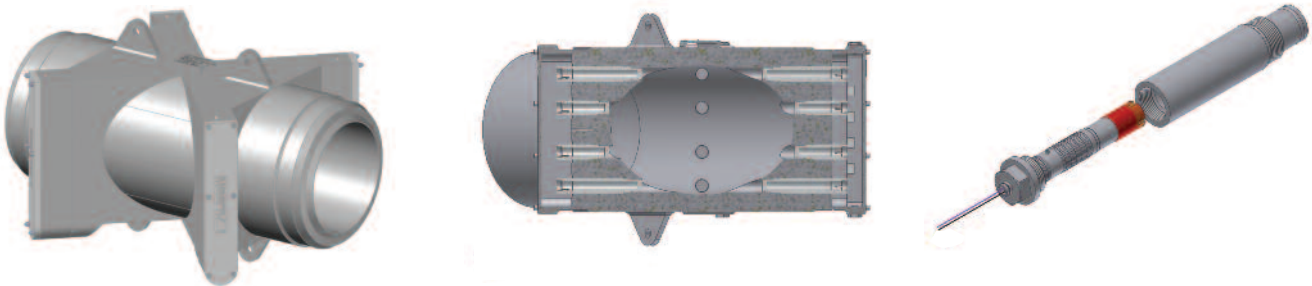
Quality Components and Cameron Experience Mean System Reliability

Cameron has been supplying high-quality systems to the nuclear power industry since 1991. Cameron's Quality Assurance Program is certified to ANSI/ISO/ASQC Q9001 and 10CFR50 Appendix B. Hardware and software components comply with numerous codes and standards defining quality assurance requirements for nuclear power plant applications.

Metering Sections

LEFM CheckPlus meters are manufactured to exacting standards, to ensure that uncertainties associated with system geometry are minimized. Each spool piece is calibrated at a NIST-traceable facility with an upstream piping configuration model of the specific plant geometry. Parametric tests are made to bound the meter's hydraulic sensitivity.

Ultrasonic transducer assemblies are installed in housings that form the pressure boundary on each spool piece and are removable for maintenance or replacement without interrupting flow. All pressure boundaries are welded, inspected by certified NDE inspectors, and hydraulically tested. The Mark III flow element and sensor are shown below.



The center picture is a cut away of the meter body shown at the left, and illustrates the location of the welded transducer housings. The transducer inserts into the transducer housing as shown in the picture at the right.

Electronics

LEFM CheckPlus systems contain precision signal detection and timing circuits to perform the transit-time measurements on which velocity, flow rate, temperature and mass flow calculations are based. Continuous self-checking circuits provide confirmation that the internal clock remains within acceptable parameters and that the quality of received signals is acceptable for use.

Software

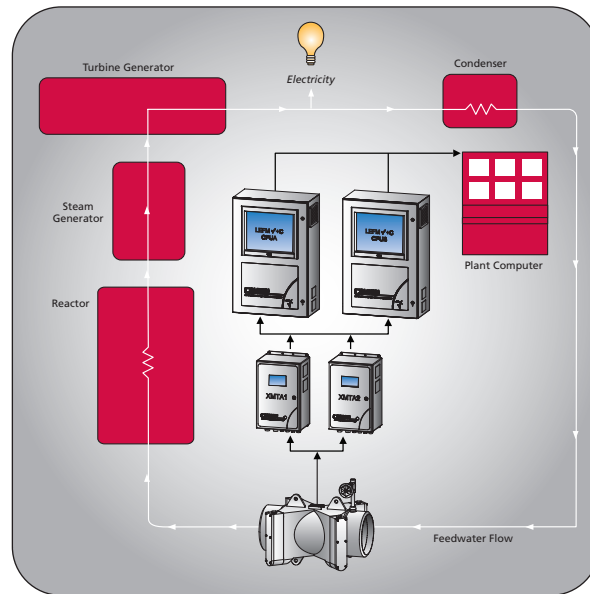
LEFM CheckPlus C software is developed and maintained under a Verification and Validation (V&V) program consistent with ASME NQA-1-1994 and revision control consistent with 10CFR50 Appendix B.

Cameron Experience

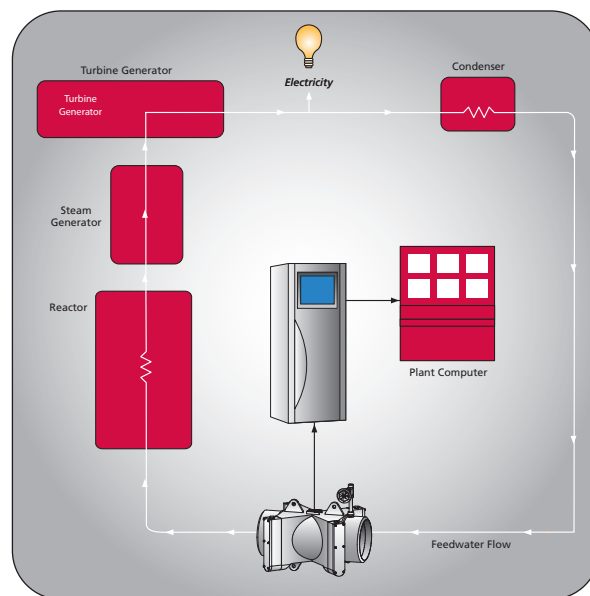
Cameron has installed LEFM CheckPlus systems in feedwater lines at over 50 PWR and BWR nuclear plants world wide. Operators report 99.95% system availability over the last seven years. Contact Cameron to discuss how we can help you increase safety and revenue at your plant using an LEFM CheckPlus system.



LEFM CheckPlus Configurations



LEFM CheckPlus C – distributed electronics minimizes cable runs by terminating transducer cables at the local transmitters and allowing separate system displays at remote locations, connected to transmitters by LEFM System ETHERNET link.



LEFM CheckPlus M – centralized electronics provides access to all system electronics at a single location.

Maximize New Plant Power with "LEFM CheckPlus Control" System

In new plant construction, the LEFM CheckPlus Control System can completely replace conventional orifice plate, venturi tube, or flow nozzle measurements. Analog 4-20mA outputs from the LEFM CheckPlus Control unit allow the use of three-element control throughout the plant's approved power range. This is a significant improvement over other flow measurement methods, which are ineffective for flow control at low power. The LEFM CheckPlus systems provide the following advantages for plant control:

- Eliminate trips caused by extreme fluctuations in steam generator (or reactor) water level at low power
- Reduced time required at low power during start-up
- No single failure causes loss of feedwater flow measurement

PTC-6 Performance Verification and Monitoring

The LEFM CheckPlus System also meets mass flow measurement requirements of ASME Performance Test Code 6 (PTC-6) without modifications, providing significant cost savings at time of plant start-up. The benefits extend well beyond the compliance test, since the system allows continuous monitoring of the power conversion system for the life of the plant.

Other Cameron Ultrasonic Products for Optimizing Nuclear Plant Operation and Efficiency

LEFM 2010FE measures flow to $\pm 1.0\%$ in feedwater lines, without cutting the pipe for installation

LEFM 2010SG measures steam generator blowdown flow for improved thermal power calculation

LineWatch Void Detector continuously monitors emergency cooling system pipes for gas voids and alerts plant personnel as soon as they develop

RCS Temperature Monitor provides accurate bulk average temperature in the hot and cold legs, even in pipes with thermal stratification

FlowWatch V4 General Purpose Flow Meter measures flow in 2" to 12" (5.1 cm to 30.5 cm) lines within $\pm 0.75\%$ without site specific calibration and without upstream flow conditioning

Moisture Separator Drain Flow Meter monitors drain flow for use in calculating moisture separator efficiency

For more information contact: CALDON® Ultrasonics Technology Center

Tel: 724.273.9300 • www.c-a-m.com/caldon

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