Appendix 10

Conceptual Measurement, Accounting and Reporting Plan
GERMAIN EIA
CONCEPTUAL MEASUREMENT, ACCOUNTING AND REPORTING PLAN

NOVEMBER 2011
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## 1 General Information

Laricina Energy Ltd.
Germain Project Expansion EIA
AEPEA Approval – TBD
ERCB Approval – TBD

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### 1.1 General Scheme/Process Description and Location

Laricina Energy Ltd. (Laricina) plans to expand the Oil Sands Conservation Act (OSCA) approved Germain Commercial Demonstration (Phase 1) Project with the proposed Germain Project Expansion (the Project) which will integrate the Phase 1 project with the three additional phases of development – Phase 2, Phase 3 and Phase 4.

The Phase 1 project is a thermal solvent in-situ oil sands facility with ten Solvent Cyclic-Steam Assisted Gravity Drainage (SC-SAGD) well pairs producing up to a design rate of 4,770 m³/day (5,000 bbl/d). The Central Processing Facility (CPF) of Germain Phase 1 Project is located 50 km northeast of the community of Wabasca-Desmarais in Sections 3 and 4, Township 85, Range 22 W4M. The Phase 1 project has received regulatory approval under AEPEA Approval 242701-00-01 and ERCB Approval 11509B. The proposed Project Expansion will be located east of the Phase 1 project.

Laricina plans to utilize either SC-SAGD or SAGD technology in Phase 2 of the Project. This application presents two facility designs to facilitate flexibility for steam requirements. The first facility design is based on SC-SAGD with a steam-oil ratio (SOR) of 2.2 (SC-SAGD-2.2) and the second facility design is based on adding steam capacity to allow for operations based on an SOR of 3.3 (SC-SAGD-3.3) should Laricina choose to employ SAGD technology.

Phase 2 of the Project will incorporate the addition of 60 well pairs on six pads for SAGD with a steam-oil ratio (SOR) of 3.3 operations or 38 well pairs on four pads for SC-SAGD (SOR 2.2) operations, and additional process facilities for steam generation and injection, solvent injection
and recovery, water treatment, production handling, waste disposal and dilbit exporting (via pipeline / Lease Automatic Custody Transfer (LACT) and truck loading). This expansion will increase the total capacity of the Project to approximately 16,900 m³/d Cold Water Equivalent (CWE) dry steam, up to 1,000 m³/d of diluent and up to 550 m³/d of propane for 5,120 m³/d bitumen production based on the more conservative installed SOR of 3.3.

Phase 3 of the Project will incorporate the addition of 100 SC-SAGD well pairs on nine well pads, and additional process facilities for steam generation and injection, solvent injection and recovery, water treatment, production handling, waste disposal and dilbit exporting (via pipeline / LACT and truck loading). This expansion will increase the total capacity of the Project to approximately 44,450 m³/d CWE dry steam, up to 3,800 m³/d of diluent/pentane and up to 1,400 m³/d of propane for 16,550 m³/d bitumen production.

Phase 4 of the Project will incorporate the addition of 100 SC-SAGD well pairs on five double well pads, and additional process facilities for steam generation and injection, solvent injection and recovery, water treatment, production handling, waste disposal and dilbit exporting (via pipeline / LACT and truck loading). This expansion will increase the total capacity of the Project to approximately 73,250 m³/d CWE dry steam, up to 6,200 m³/d of diluent/pentane and up to 1,400 m³/d of propane for 26,750 m³/d bitumen production.
2  Process and Measurement Drawing

Appendix A contains the Process and Measurement Drawings for each phase of the expansion. For Phase 2, the drawings reflect the SC-SAGD-3.3 case, as it is the more conservative of the two facilities. Drawing series GER-X1-44-SCH-0001-01 shows the oil and gas streams and drawing series GER-X1-44-SCH-0001-01 shows the water streams. The emulsion streams are shown on both drawings.

The following is an index of all drawings included in Appendix A:

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<th>Drawing Number</th>
<th>Detail</th>
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<tr>
<td>GER-21-44-SCH-0001-01</td>
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<td>GER-21-44-SCH-0001-02</td>
<td>Germain Commercial Demonstration Phase 1 - Water</td>
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</tr>
<tr>
<td>GER-51-44-SCH-0001-02</td>
<td>Germain Project Expansion Phase 4 - Water</td>
</tr>
</tbody>
</table>

Note that these drawings are based on presently known information and subject to change.
3 Description of Proposed Operating Procedures

3.1 Calibration and Proving

Laricina’s overall metering objective is to ensure that it has properly installed, commissioned, and configured the flow and level meters required to accurately determine the volumes of all products entering and leaving the facility. Laricina will install additional metering which will balance groups of meters against each other, thereby verifying their accuracy “online”. Accuracy balances will be calculated on an hourly and daily basis. Errors outside of normal operating limits will be reported to operations and maintenance. Calibrations and calibration history, where possible, will be performed with the assistance of an online Asset Management System (AMS). The majority of the instrumentation is expected to communicate to the AMS (via HART protocol), which when used as part of the calibration procedure, will simplify and improve overall accuracy of calibration results and record keeping. This database will be available for regulatory inspection at any time, and records will be maintained and backed up for a minimum of 6 years.

In order to reduce visual inspection requirements, Laricina has made an effort to select “smart” meters that the ERCB will recognize as having “built-in diagnostics to continuously monitor the condition of the primary element” in accordance with Directive 017, Section 2.6. The intent of this is to reduce or eliminate the requirement for visual inspections for meters such as coriolis, magnetic, and ultrasonic. It is expected vortex meters will be removed from service and visually inspected tri-annually (every three years). On-board diagnostics on smart meters will be used between inspections to monitor the flow element health. If at any time the meter diagnostics indicate a flow element issue, the meter will be removed from service and inspected.

All required calibrations will be performed according to the manufacture’s recommendations and will meet the requirements of the ERCB Directive 017 – Measurement Requirements for Upstream Oil and Gas Operations.

Laricina will also install the required primary and secondary metering as required in ERCB Directive 017, section 12.4.6.
4 Accounting Calculations and Reporting

4.1 Facility PRA Configuration and Reporting

The facility will be reported to the Petroleum Registry as a Type 344 *In Situ* Oil Sands Battery and a Type 506 *In Situ* Oil Sand Injection / Disposal Facility, as well as the associated production, injection, source water and water disposal wells. Facility delineation is indicated on the conceptual measurement schematics in Appendix A.

Each phase of the Project will be an expansion of the existing reporting facilities, and will not be reported as separate facilities.

4.2 Volume Reporting

All volumes will be reported in metric units at standard temperature and pressure (STP) of 101.325 kPa absolute and 15.0 °C.

The following units will be used for volumetric reporting:

- Gas ........... Se³ m³
- Liquid ......... Sm³
- Steam .......... Sm³ c.w.e. (cold water equivalent)

4.3 Volume Calculations

All volumes reported to the petroleum registry will be calculated and corrected for deviation from standard temperature and pressure using industry standard volume calculation and compensation algorithms.

Due to the high operating temperatures found in an *in situ* bitumen recovery scheme, all metered volumes will be compensated for operating temperature to facilitate volume balancing and troubleshooting.

4.4 Facility Receipts & Dispositions

The battery will regularly receive shipments of diluent for use in the bitumen treating process. Primarily diluent will be trucked into the facility, with future plans to install a diluent pipeline to the facility.
A truck unloading station, complete with volume and density will be installed to unload diluent from the trucks. When the future pipeline is completed, diluent receipts will be metered at the LACT meter station.

The battery will also receive propane shipment for use as injection solvent during the solvent injection production phases. Propane receipts will be reported via truck tickets and reconciled against solvent inlet metering and change in inventory.

Battery bitumen production will be primarily transported via pipeline. All dispositions to the pipeline will be measured via a LACT meter station installed at the battery outlet.

A small fraction of bitumen production will be transported via truck. A truck loading station, complete with volume and density will be installed to load bitumen onto the trucks. All truck loading data will be reconciled monthly against receipt point truck tickets.

4.5 Well Production Proration

Total battery bitumen production and water production will be prorated to the production wells based on regular well test results. Laricina will be using coriolis meters at each wellhead. Laricina will operate the producer wellhead at a pressure slightly higher than the bottom hole pressure to mitigate the potential measure problems with entrained gas. A white paper “Entrained Gas Handling in Micro Motion Coriolis Flowmeters”, explaining how accurate emulsion flow rates will be achieved is attached as Appendix B. It should be noted that if entrained gas does create problems, Laricina will be manually entering a density of the emulsion into the coriolis meter based on lab test data. This will allow the meter to give an emulsion flow reading unaffected by entrained gas. The online density reading from the coriolis meter will be representative of the entrained gas.

A test separator is not provided but provisions for a future test header with a water-cut meter are included in the design.

Total battery gas production will be measured using the produced gas meters and a chromatograph compositional analysis. The total battery produced gas will be allocated to the production wells based on their individual prorated oil production, resulting in a gas proration factor of 1.000.
5 Appendices
Appendix A – Conceptual Measurement Drawings
Appendix B – Entrained Gas Handling in Micro Motion Coriolis Flowmeters
Entrained Gas Handling in Micro Motion® Coriolis Flowmeters

Introduction

This white paper discusses the measurement problems caused by process fluids that contain bubbles of air or other gas, and describes how Micro Motion® sensor and transmitter technology can be used to overcome those problems. This white paper also presents suggestions for minimizing measurement problems by improving application design.

Although the most common term applied to this problem is “entrained air,” in fact the bubbles may contain any gas. This white paper uses the term “entrained gas” rather than “entrained air” in order to address the broader topic. Other frequently used terms include “two-phase flow” and “slug flow.”

Historical perspective

Micro Motion products were originally developed for the chemical industry, where most applications contain very little entrained gas, and Micro Motion’s product vision focused on high measurement accuracy in clean fluids. As Coriolis technology has moved into other applications and other industries, the issue of entrained gas has become more significant. While, in fact, more than 95% of applications do not have a problem with entrained gas, entrained gas handling is critical for those few applications that do.

The entrained gas problem

Micro Motion’s Coriolis sensor technology produces direct measurements of mass, density, and temperature. When gas is present in a liquid stream, it occupies volume. It is important to understand that entrained gas does not cause primary measurement errors in mass flow measurement: Coriolis technology measures any fluid mixture in the tubes. However, because the density measurement is a ratio of mass to volume, if some of the volume is occupied by gas, which is less dense than liquid, then the overall density of the mixture must decrease. Because most applications need to know the density of the liquid only (the liquid fraction) rather than the density of the mixture, the density value reported by the meter will not be incorrect, but will be low for application purposes. Until Coriolis meters can reach beyond measuring “just what is in the tubes” and distinguish fluid phases, this deviation will not be correctable.1

Micro Motion technology

Existing Micro Motion technology can be used with good results in applications that contain entrained gas, if the correct products are used and configured appropriately. In addition, certain application characteristics can improve measurement. These application characteristics are discussed in the section entitled “Application recommendations.”

Sensor technology

For two-phase flow, the best measurement is provided by dual-tube sensors with a low tube frequency. If a sensor with high tube frequency is used, the two-phase fluid does not vibrate with the tube, resulting in large measurement errors for flow. Micro Motion’s ELITE® sensors are recommended for applications with entrained gas. F-Series and R-Series sensors meet application requirements in certain situations. Because the single-tube T-Series sensors have a high operating frequency, they are not recommended for applications with entrained gas.

Transmitter technology

In general, analog signal processing, as used by Micro Motion’s RFT9739 and earlier transmitters, is not flexible enough to measure two-phase flow. There is no way to change or optimize the signal processing chain for a specific application.

1. Because Coriolis meters use density data to calculate volumetric flow, the density deviation will cause a proportional error in the volumetric flow indication.
Micro Motion’s MVD™ technology employs digital signal processing (DSP). This allows the transmitter software to apply algorithms to the raw sensor data to compensate for specific conditions. In the case of entrained gas, the transmitter must remove or “look through” the noise imposed by the two-phase flow, and report only the “real” flow measurement of the liquid. The DSP algorithms in the MVD electronics very effectively filter the noise and provide an excellent measurement.

Transmitter configuration

For two-phase flow, two transmitter configuration parameters are central:

- “Special mode” is used to increase the rate at which sensor data is reported to the transmitter. This allows the transmitter to filter, process, and report compensated density data almost instantaneously.
- “Fault action” is used to control the behavior of transmitter outputs under certain process conditions such as two-phase flow. The factory default setting for fault action is to drive outputs to fault levels, which means that they no longer report process data. When fault action is set to “none,” outputs continue to report process data during two-phase flow conditions.

In current Micro Motion products, these parameters are set by activating the “Entrained Gas” option. In the next generation of Micro Motion products, special mode will be activated automatically and alarm handling has been changed to allow user configuration of fault severity levels. When two-phase flow alarms are set to a lower severity level, outputs will report process data during conditions of two-phase flow, but will still report all alarms configured for higher severity levels. The transmitter can optionally log the two-phase flow alarms.

Transmitter zero

Unstable fluid conditions (e.g., air separation from the liquid at low or zero flow) can cause significant measurement errors. For this reason, performing an auto-zero under unstable fluid conditions is highly discouraged. If the field zero is suspect, return the meter to the factory zero or the prior zero. Depending on your product, either or both of these is saved in transmitter memory.

Application recommendations

The most important application factor in improving two-phase flow measurement is bubble distribution. For best measurement results, the gas bubbles in the process fluid should be distributed as evenly as possible between the two sensor tubes, and should move through the tubes at the same rate that they entered the tubes. The following factors contribute to even bubble distribution:

- **Straight pipe runs.** The swirl imposed by elbows in the piping can cause gas to enter the sensor tubes unevenly, causing measurement errors.
- **Higher flow rates.** If flow rate is sufficiently high, bubbles move through the sensor tubes at approximately the same rate at which they entered the tubes, counteracting the effects of bubble buoyancy (produced by gravity) and low-viscosity fluids as discussed below. When it is known that entrained air is present, Micro Motion recommends a flow rate no lower than 1/5 (one fifth) of full scale.
- **Vertical pipe runs with upward flow.** Especially at lower flow rates, bubble buoyancy tends to result in bubble collection at high spots in the sensor tubes (see Figure 1a). In Figure 1b, bubble buoyancy works with the flow to move bubbles through the tubes.
- **Viscosity.** High-viscosity fluids tend to hold the bubbles in suspension better than low-viscosity fluids, maintaining their original position and distribution and therefore moving them through the sensor with the liquid. Also, in high-viscosity fluids bubbles are more likely to stay dispersed, while in low-viscosity fluids small bubbles may coalesce into large bubbles that are more likely to collect.

In laboratory testing, batches with a duration of one minute or longer tended to be immune to the transient errors caused by gas remaining in the sensor tubes. As shown in Figure 2, repeatability improves as batch duration increases. Field experience has demonstrated that if the meter fill time is less than 0.1 seconds and the batch time is greater than 2-3 seconds, good Empty-Full-Empty batching can be achieved.
performance can be expected with mass repeatability well below 0.1%. Meter fill time is a function of meter size and flow rate.

Figure 2. Effects of batch duration on repeatability

Summary
With appropriate product selection, installation, and configuration, Micro Motion's dual-tube Coriolis sensors paired with MVD technology minimize or overcome the measurement problems caused by entrained gas. As a result, the benefits of Micro Motion's Coriolis technology are available to an expanded set of applications in a broader range of industries, providing highly accurate measurement of mass flow, density, and volume flow with a single low-maintenance low-installed-cost device.

About the author
Tim Patten has been with Micro Motion, Inc. since 1989, in various engineering and marketing roles. He holds an M.S. in Mechanical Engineering from Worcester Polytechnic Institute in Massachusetts. He is currently the Measurement Director.
Micro Motion supports PlantWeb® field-based architecture, a scalable way to use open and interoperable devices and systems to build process solutions of the future.

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Micro Motion® Enhanced ELITE Meters Eliminate System Faults Caused by Entrained Air

**BENEFITS**

- Reduced operation and maintenance costs by $100,000 in 10 months
- Improved safety and efficiency of the control system operation
- Allowed operators more time to focus on other demanding tasks

**PROCESS**

In 2004, a large-scale chemical manufacturer in China installed and commissioned 107 Micro Motion ELITE and R-Series Coriolis mass flow meters in their production process for two of their main products, 160KT Acrylic Acid (AA) and 70KT Acrylic Ester (AE). A majority of the flow meters were used in the process control applications, while the remaining meters were installed in the custody transfer applications.

**CHALLENGE**

In August 2006, the chemical manufacturer discovered that a number of the meters used in process control were producing abnormal results. The process variable outputs were showing sudden disruptions — either up or down — causing an alarm in the DCS system. The process control valve responded to this alarm with an automatic shut down of the system. After some troubleshooting to recover the system, the operators realized they had to switch from automatic operation to manual operation of the production process to determine what was causing the alarm. After monitoring the operation for a period of days, the operators found that the disruptions were caused by the presence of entrained air or bubbles in the process fluid. In most cases, the problem installations were associated with R-Series Coriolis flow meters being mounted close to a control valve.

**SOLUTION**

The chemical manufacturer contacted Micro Motion Field Service support to address the issue. After working with the customer’s operation team at the site, the Field Service technicians verified the

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For more information:
www.EmersonProcess.com/solutions/chemical
www.micromotion.com
CHEMICAL

Meter error reading in the R-Series meters was caused by air entrainment. They found that during normal operation the actuation of the control valve caused air bubbles and slugs to be introduced into the process fluid. These upset conditions caused the disruptions in the meter readings from the Micro Motion meters.

To address this issue, Micro Motion upgraded the problem meters with the latest configuration of electronics for the meters. This configuration change required that the new software feature, Entrained Gas mode (EG mode), be enabled. Once the customer implemented the configuration change, the amount of fault conditions decreased by 67% (see Table 1 on page 1). The remaining faults were caused by extended periods of slug flow or air bubbles that overwhelmed the compensation capabilities of the EG mode. For the meters still experiencing faults, Micro Motion suggested an upgrade to a new Enhanced ELITE sensor and electronics that incorporates a second-generation digital signal processor with built-in entrained gas capabilities.

In August 2007, the chemical manufacturer upgraded two of its problem flow meters with the new Enhanced ELITE sensor and electronics technology. After several weeks of operation, the customer realized a complete elimination of errors at these two meters. With these results (see graph below), the customer chose to upgrade the remaining problem installations to the second-generation Micro Motion Coriolis meters.

Since the replacement, the manufacturer’s system is operating more safely and efficiently. Also, the system operators have had more time to work on other demanding tasks as the lines are essentially never down. With the cost of Acrylic Acid being more than $1500 per ton and the average system down time of 12 hours per month, the chemical manufacturer estimates a savings of at least $100,000 in 10 months of reduced operation and maintenance costs.

Results of meter handling of entrained gas in the process line. After the installation of the ELITE meters, the meter readings showed a complete elimination of the sudden disruptions in the flow.

Date at which the new Enhanced ELITE meters were installed in the process line