Framo
Multiphase Flow Meters
PhaseWatcher Vx

The Choice of the Professional Well Testers
The Multiphase Flow Metering System

We are committed to:

- Maintain the position as industry leader in Multiphase Flow Meter Systems.
- Supply the industry state of the art Multiphase Flow Meters.
- To continuously improve quality and competitiveness based on the best of the previous successful designs.
- To work closely with all our customers through all phases of their field development - from initial reservoir assessment to field abandonment.
- Continue to work with our customers to find the best way to apply our Flow Meters in the interest of improved field economy.
- Maintain a complete focus on details in all phases of design, manufacture, testing and operation of the Framo Flow Meter Systems.
- Continue to develop our organisation and facilities as necessary to serve all existing and future customers to their satisfaction.
- The same high health, safety, environment and ethical standards as our major owners – Frank Mohn A/S and Schlumberger.
A United Team

Framo Engineering and Schlumberger have joined forces in the Multiphase metering.

Through years of research in the jointly owned company 3-Phase Measurements we have developed the PhaseWatcher Vx, the multiphase meter that today is widely recognized by the industry as the leading edge technology. Numerous satisfied customers and user joint industry verification programs have endorsed the product for critical applications such as reservoir monitoring, well testing and allocation measurements.

The success of the PhaseWatcher Vx technology is due to a unique cooperation between the partners, across the international boarders, the area of expertise and the different technological background. 300 man-years of R&D is the partners contribution to the PhaseWatcher Vx success.

The combined Global presence of Framo Engineering and Schlumberger will secure our Customers true technical back-up and support wherever you are.

The reservoir is your most valuable asset –why settle for the 2nd best in the monitoring.
"A multiphase flowmeter does not only provide a more cost efficient well test, it also gives a much higher quality test than a conventional test separator.

The multiphase meter provides real time monitoring of the well performance."

Fully Physical Meter

- Venturi for robust mass flow measurement
- Dual energy gamma meter for fully physical measurement of fractions
- Independent of:
  - Gas volume fractions
  - Water cuts
  - Emulsions
- Complete and fully independent multiphase meter, no other input than fluid properties required
- Low power compact field mounted flow computer for complete flow computations
- Simple independent connection to platform supervisor system
- Unique high frequency gamma scanning has mitigated the criticality of mixing
- Ultra compact meter
Multiphase Flow Measurements by Dual Energy
Gamma fraction measurements and Venturi

The measurement principle combines Venturi and Dual Energy Gamma fraction measurements. The concept consists of two main elements:

- A dual-energy spectral gamma ray detector combined with a radioactive chemical source.
- A Venturi with pressure, temperature and differential pressure sensors.

The dual energy fraction meter provides oil, water and gas hold-ups that are used to determine the fractions of each phase. When the fractions are known, the venturi meter is utilised to measure the total mass flow rate and the individual phase flow rates can be calculated.

Multiphase Flow meter measurements based on dual energy fraction meter in combination with venturi has continued to evolve since Framo Engineering commercially introduced it in 1994. Most significantly, meter reliability and metrological performance have benefited from the extensive field experience gained and ongoing engineering enhancements made since then.

A specific nuclear detector was developed for multiphase flow measurement, drawing on Schlumberger’s forty-year experience in design and manufacture of nuclear sensors. The flow loop and field test results collected during the early years of multiphase meter deployment enabled the creation of superior detector stability and resolution.

The dual-energy gamma measurement uses a single radioactive chemical source, which emits gamma rays at numerous energy levels. A scintillation detector located on the opposite side detects the gamma rays that have not been absorbed by the mixture. A photomultiplier converts the light pulses into electric signals that are digitally processed. The detector records not only the arrival but also the energy level of each photon, building up the energy spectrum given by the source. The source is selected because it has a significant natural peak of energy within specific bands. The technology applied was specifically adapted from nuclear measurements developed for wireline and well logging while drilling resulting in high speed processing.

The attenuation of the gamma rays by the fluid are measured at two different energy levels. A cross plot of the resultant count rates is the basis for the oil, water and gas fraction determination. The mixture attenuations at two energy levels are compared to the attenuations of pure oil, water and gas. From this a variety of parameters can be extracted such as fluid fractions (liquid, gas, oil and water), water-liquid ratio (WLR) and mixture density.

A visual interpretation of the solution is presented in the diagram to the left where the composition triangle corner points are the single-phase attenuations. An operating point example is shown at 50% GVF and 50% WLR. The constant GVF lines are parallel to the water-oil line and the constant WLR lines intersect the gas point.
## PhaseWatcher Vx Range

### PhaseWatcher Vx 88
- **Venturi throat diameter:** 87.5 mm
- **Sour service:** NACE MR-01-75
- **Working pressure:** 0 - 5000 psi (0-345 bar)
- **Temperature rating (process):** -40 to +150°C
- **Ambient temperature (electronics):** -20 to +85°C
- **Ambient storage temperature:** -40 to + 85°C
- **Water-liquid ratio:** 0 to 100%
- **Liquid viscosity:** 0.1 to 2000 cp at line conditions
- **Typical liquid flow range:** 1,000 - 100,000 bpd

### PhaseWatcher Vx 52
- **Venturi throat diameter:** 52 mm
- **Sour service:** NACE MR-01-75
- **Working pressure:** 0 - 5000 psi (0-345 bar)
- **Temperature rating (process):** -40 to +150°C
- **Ambient temperature (electronics):** -20 to +85°C
- **Ambient storage temperature:** -40 to + 85°C
- **Water-liquid ratio:** 0 to 100%
- **Liquid viscosity:** 0.1 to 2000 cp at line conditions
- **Typical liquid flow range:** 400 - 35,000 bpd

### PhaseWatcher Vx 29
- **Venturi throat diameter:** 29.25 mm
- **Sour service:** NACE MR-01-75
- **Working pressure:** 0 - 5000 psi (0-345 bar)
- **Temperature rating (process):** -40 to +150°C
- **Ambient temperature (electronics):** -20 to +85°C
- **Ambient storage temperature:** -40 to + 85°C
- **Water-liquid ratio:** 0 to 100%
- **Liquid viscosity:** 0.1 to 2000 cp at line conditions
- **Typical liquid flow range:** 150 - 11,000 bpd

### Process connection (inlet & outlet hub)
- **8GR67**
- **5GR40**
- **36R23**

### Vertical distance between flanges
- **930 mm**
- **553 mm**
- **467 mm**

### Estimated weight
- **400 kg**
- **240 kg**
- **130 kg**

### Interfaces - electrical, power
- **24 VDC (ref. interconn. diagram)**

### Interfaces - electrical, signal
- **RS-422 MODBUS RTU**

### Hazardous area (electrical)
- **Flameproof Ex d (Zone 1) IIB T4**

For subsea applications, different sizes are also available.

### Built in PVT Models
- API black oil model
- Customized specific PVT
- Project unique oil phase model developed by Framo / Schlumberger

### Applications
The PhaseWatcher Vx provides a cost effective and high quality tool for:
- Well testing
- Production testing
- Reservoir monitoring
- Exploration testing
- Allocation metering
A Meter for every Application

The PhaseWatcher VX replaces conventional separator systems for measurements of oil, water and gas. It can be mounted for continuous monitoring of each individual well or mounted on a test manifold for alternate well testing. Both applications contribute to significantly cost savings in CAPEX and OPEX by eliminating test lines, test separator, manifolds, valves and reduced well testing time.

Topside permanent installation

Test manifold (mounted) meter

Individual well monitoring by Multiphase Meters

Retrievable meter for subsea installation
Subsea Integration

Framo Engineering have developed several different subsea packages of the PhaseWatcher Vx technology. An optimum solution is available for any subsea infrastructure.

Integration in:

- Subsea X-mas tree- Interfaces established for all major XT suppliers / vendors
- Subsea manifolds
- Retrievable modules such as:
  - Choke bridge
  - Flow control modules
  - Customer specified and designed special modules

Retrieval design

Inline design for module integration
Subsea Applications

The Framo Subsea PhaseWatcher Vx has been accepted and used for the following applications:

- Reservoir monitoring
- Well testing
- Resource allocation
- Fiscal allocation

The system architecture of the Framo Subsea PhaseWatcher Vx has been designed for integration to all major subsea control systems.

All the benefits of the 2nd generation PhaseWatcher technology is available in compact subsea packaging.

- Insert retrievable
- Weights comparable to control pods
- Non intrusive design
- Metal to metal sealing philosophy
- Low power requirements
- Independant metering principle
- Remote static calibration
- Built in PVT
- Functional for multiple wells with different fluid characteristics
Framo Commitment

Research & Development

“We are devoted to quality and reliability. We intend to be the leading supplier within our line of business.”

Continuous R & D is therefore an important part of the Framo philosophy. We do not release any new technical solution or product without ensuring that it meets our high quality standards. Extensive and realistic testing is integrated into our R & D programs, in order to continuously improve our products and to remain the leading supplier.

Manufacturing and Testing Facilities

All equipment packages and systems have been developed and qualified by Framo Engineering in close cooperation with major operators.

Prior to delivery of a contract the complete system is fully verified in our unique test facilities.

Through large and continuous investments we offer the best test facilities available in the industry. For our Multiphase Meters all of the following facilities are available to ensure that the end product meets our own, and our clients, requirements for high reliability and availability:

- Probably the largest industrial multiphase flow loop there is
- Full performance testing of the complete system with flow conditions representative to the expected field performance
- Experimental multiphase test loop in several of the Schlumberger facilities (Paris, Cambridge)
- Large assembly and stack-up test facility in conjunction with the unique Test Dock
  - All mechanical stack-up test and interface verification is carried out
  - Direct access to deepwater quay and to our test dock facility ensure optimum material handling in an effective and safe manner
- Subsea Test Dock for underwater verification of all aspects of operation, installation and Intervention:
  - Multiphase operation
  - ROV/Diver intervention
  - Installation/Retrieval with simulated heave
  - Pull-in and Connection operations
  - Guidewire establishment facilities
  - In-house subsea test well with 300 m depth and artificial multiphase flow
Quality

Quality is our trademark. By performing all critical work in-house, from design to delivery, we maintain control throughout each contract. Our products are thoroughly tested before they are released, providing the required quality. The industry acknowledges Framo Engineering as a leader in Multiphase Pump Systems.

Quality is maintained throughout our system engineering and deliveries, by performing all critical work in-house. All work is performed in accordance with our ISO 9001 certified QA system.

Product Line

Framo Engineering provides the oil industry with subsea and topside multiphase booster pump systems, fluid swivels for FPSO’s and subsea and topside multiphase flow meters. The products are engineered, manufactured, tested, installed and commissioned by Framo Engineering and delivered to the customer as turn key systems or modules.

After Sales Service Support

We are available throughout the lifetime of your project. Our association with Frank Mohn Services and Schlumberger, a global service support organisation, secures assistance during commissioning and start-up and provides you with support services during the operational phase.

Our test facilities are second to none.