MECHATEST
VYDRAULICS GROUP

Whitepaper

The Critical Importance of Correct Sampling System Design for FPSOs

1. Introduction

Sampling in the process industry is a critical step in ensuring accurate process control, quality assurance, and regulatory compliance. Yet, despite its importance, **sampling is often underestimated.** Poorly designed sampling systems lead to inaccurate data, compromised product quality, and costly production inefficiencies. This paper outlines how **incorrect sampling system design -** especially in high-pressure applications such as FPSOs - **can result in significant errors and delays**, and offers guidance on achieving best-in-class sampling performance.

---

2. Sampling Systems: More than Just Valves on a Panel

It's a common misconception that sampling systems are merely a couple of valves bolted to a panel. In reality, a **well-designed sampling system** is an engineered solution **tailored to the process conditions**, the nature of the sampled fluid, and the operational constraints. The system must maintain the sample's integrity **from the take-off point to the analyser or laboratory vial.** A failure in any component of this system can compromise the entire sample. **Without the right sampling background knowledge it's so simple and there are so many ways to destroy the sample.**

---

3. The Impact of Taking the Wrong Sample

Incorrect sampling—whether due to poor system design, improper probe selection, or inadequate sample conditioning—can have severe consequences:

- **Misleading laboratory results**
- Out-of-spec process operation
- **Discrepancies between lab samples and online analysers values**
- Incorrect operational decisions
- Production loss or product quality issues
- Regulatory compliance risks

Studies show that 60% to 80% of sampling and analysis errors are caused by field sampling issues, not laboratory techniques. This highlights the urgent need to address sampling at the system level.

---

4. Sample Probes: Not Just Part of the Piping Spec

Sample probes are often treated as an extension of the process piping, but this is a dangerous oversimplification. A correctly designed sample probe must:

- Withstand high pressures (e.g., up to 10,000 psi / 690 barg on FPSOs)
- Suit the phase of the fluid (gas, liquid, or multiphase)
- Minimize dead volume
- Provide first-stage filtration for particles or fallback condensates
- Reduce lag time by optimizing the sample transport distance and volume

Incorrect probe selection results in excessive lag time, leading to:

- Sampling of "old" fluid, but also bad mixing by too-low velocities
- Inaccurate lab results
- Operator confusion and distrust in sample data
- Process control errors

Operators won't tolerate delays, they will not wait 10 minutes or much longer at every sample point for a valid sample.

---

5. Sample Transport Line Design: A Hidden Risk

After the probe, the next critical component is the sample transport line. Lag time—the delay between a process change and the detection of that change in the sample—is heavily influenced by:

- Inner diameter of the tubing
- Length and routing of the tubing
- Sample phase and pressure
- Flow rate (often very low in sampling systems)

Rule of thumb: Avoid using large-diameter piping for gas samples. A wide-bore probe or tubing in high-pressure gas systems can cause lag times of up to 1 hour.

---

6. FPSO Case Study: The High-Pressure Challenge

On offshore FPSOs (Floating Production Storage and Offloading units), sample conditions can be extreme:

- Well fluids: Up to 10,000 psi (690 barg) – vapour/liquid mixtures
- Process hydrocarbons: Liquids or gases up to 380 barg (2500#)

Using standard 2" process nozzles, combined with standard DB&B valves and thick-walled probes, leads to oversizing. This not only increases weight and risk but also causes unacceptable lag times.

Our recommendation: Use narrow-bore, custom-designed probes, matched to the process conditions. This reduces lag time, improves response, and maintains the sample's representativeness.

7. Why Use a Probe: Four Core Benefits

- First filtration effect: Repel particles before they enter the transport line
- Condensed gas fallback: Prevents contaminant migration
- Faster response: Reduces lag time for quicker data
- More representative samples: Improves correlation with process conditions

8. Design Guidance: Smart Selection = Better Sampling

To design a reliable sampling system, apply the following principles:

- Start at the sample take-off point and work downstream
- Select a probe based on process phase, pressure, and compatibility
- Design transport lines with minimal internal volume and length
- Use sample conditioning to stabilize pressure and temperature if needed
- Match the flow rate to the sampling requirements (low flow systems!)

BAD DATA LEADS TO BAD DECISIONS In the process industry, this translates to lower efficiency, higher costs, and increased risk. Sampling systems must be engineered—not copied or improvised. From probe to panel, every component matters. **The cost of a poor design is not just time - it's trust, safety, and profit.**

Well-designed sampling systems start from the take-off point to the analyser or laboratory vial and **brings a lot of additional business values:**

- **Taking representative samples** and get better results
- Quality control, **reducing costs by process optimization**
- **Significantly reduces waiting time for process operators**. This allows operators to take more accurate samples faster, make quicker process decisions, and avoid unnecessary delays productivity and operational efficiency.
- **Preventing production loss**
- Zero emission, **safe for your health & environment**
- **No pollution**, prevent emission and/or damage claims

- And most important, **Happy process operators !!**

Sampling Is Time-Consuming Work - Lag Time Multiplies the Burden

Manual sampling is already a time-consuming task for process operators. With long lag times at each point, the workload grows significantly - especially on FPSOs, where 100 or more sample points are common. Without optimized sampling systems, valuable operator time is lost, and process responsiveness suffers.

Lag Time Comparison for a gas sample @ 250 barg – 3 Scenarios @ 10 L/min Sample Flow

SAMPLE SYSTEM DESIGN SEGMENTS	CASE A: **STANDARD (OVERSIZED) DESIGN**	CASE B: **BETTER DESIGN**	CASE C: **OPTIMIZED DESIGN**
PROCESS PRESSURE (BAR G)	250	250	250
1" PROBE LENGTH (MM)	300	300	300
1" PROBE ID (MM)	**25**	**6**	**4**
1" PROBE VOLUME (L)	0.147	0.0085	0.004
2" DB&B VALVE LENGTH (MM)	220	220	220
2" DB&B VALVE ID (MM)	**49**	**49**	**8**
2" DB&B VALVE VOLUME (L)	0.414	0.414	0.011
SAMPLE LINE LENGTH (M)	10	10	10
SAMPLE LINE ID (MM)	**15 (1/2" NPS)**	**6 (Tubing)**	**4 (Tubing)**
SAMPLE LINE VOLUME (L)	1.77	0.283	0.126
SAMPLE FLOW RATE (L/MIN)	10	10	10
FLUSH TIME (MIN)	**58.5**	**17.7**	**3.5**
SAMPLE SYSTEM LAG (MIN)	0.2	0.2	0.2
TOTAL LAG TIME (MIN)	**59 min**	**18 min**	**3.7 min**

9. Conclusion

- Case A: **Designing sampling probes to match piping schedule specifications is a fundamental design error.** These oversized probes create excessive internal volume and **extreme lag time measured in tens of minutes or even hours.**
- Even a large 2” piping schedule DB&B valve alone (Case B) **causes a 4× longer lag time** than fully optimized.
- **Full optimization (Case C) reduces lag time by over 90% compared to standard setups.**
- Lag time depends non-linearly on internal diameter - **small reductions in ID lead to big improvements in lag time.**
- Oversized components combined with low sample flow result in low velocities within the sampling system segments, leading to poor mixing and unrepresentative samples.

- **Smart design means small probe ID, custom small-bore DB&B valves and narrow transport tubing - especially critical for high-pressure gas sampling.**

About the Author / Company

Andre van Roon, Manager of the Doedijns Sampling Group (Mechatest Sampling Solutions), is one of the few globally certified Industrial Sampling Systems Engineers following an intensive 36-week training program led by sampling expert Tony Waters.

With decades of experience and deep technical knowledge, Andre and his team are recognized worldwide for delivering high-quality, innovative sampling solutions for demanding process environments. Their focus on accuracy, safety, and reliability has positioned Mechatest at the forefront of the global sampling systems industry.

Contact information: Phone +31 (0)88-0912705 - Email: sales@mechatest.com