CASE STUDY: Enabling Multichannel Emissions Sampling

Delivering a Faster, Simpler, and 62% Cheaper Solution in Eight Weeks

Project Snapshot

Industry: Aerospace / Combustion Emissions Testing
Challenge: A high-cost, four-month lead-time design hindered timely emissions measurement upgrades.
Result: Fully functional system delivered in 8 weeks at 38 % of the quoted cost, saving ≈ $50 K per unit and meeting all technical and accuracy requirements.

---

1. Opening Hook – The Challenge

A major combustion test facility needed a **multichannel emissions sampling system** capable of reading from individual exhaust probes and also measuring a **combined total-average sample**. The goal was to quickly connect twelve sampling ports at the exhaust outlet and route each to the emissions analyzer without compromising accuracy of NOx, CO, and CO_2 measurements.

The customer's initial engineering proposal, developed by a third party, quoted an **$80 K system** with a **four-month delivery**, which was unacceptable given the test program schedule. Their target: **complete installation in ≤ 8 weeks** with comparably high measurement fidelity.

---

2. Problem Definition

The proposed design included a **heated box assembly** containing multiple high-temperature solenoid valves to prevent condensation along the sampling lines—a condition believed to distort NOx readings.

Our challenge was twofold:

- **Timeline:** Cut delivery by 50 % (from 16 weeks to 8 weeks).
- **Cost:** Reduce total spend while maintaining thermal integrity and analytical accuracy.

The key assumption driving complexity and cost was that **every section** of each 120-foot sampling line needed to be actively heated to prevent water condensation. We set out to test

assumption.

3. My Approach

We mapped the entire sampling loop—from probe tip at the test vehicle to the central analyzer—and confirmed that most of the line was already **within a heated and insulated test bay**. Only the first ~6 feet of each probe line, near the combustor outlet, would be unheated if we deploy an innovative yet simple solution.

To validate whether heating that short section was necessary, we ran a **controlled experiment**:

- We toggled heating **on and off** for the unheated 6 ft section.
- We measured emission stability and NOx reading deviation.

Result: Measurements remained *identical to the first decimal point* regardless of local heating, confirming that condensation at the entry briefly occurs but the temperature profile along the rest of the line **revaporizes moisture** before the analyzer inlet.

Having proven heat uniformity unnecessary, we designed a **low-complexity system featuring:

- A **scanning valve** connecting up to 16 sample channels.
- A **high-temperature solenoid** for ganged sampling.
- **Check valves and simple piping** assembled without heated enclosures but insulated.

This compact system could perform both **point-by-point** and **total-average** sampling from all channels using a simple control input to the channel selector and the solenoid valve.

---

4. Implementation and Validation

- **Procurement & fabrication:** < 8 weeks total, meeting the accelerated timeline.
- **System design:** Engineered for maintainability with all accessible fittings and minimal wiring.
- **On-site testing:** Demonstrated identical concentration readings across cycles, validating NOx measurement stability and flow repeatability.

The complete **design–build–install** package cost roughly **$30 K**, versus the original **$80 K** concept.

Results and Impact

- **Cost reduction: ~62 %** savings (≈ $50 K per system).
- **Schedule reduction:** Lead time cut from 4 months to 8 weeks (− 50 %).
- **Measurement quality:** Maintained emission accuracy to within standard analytical tolerance.
- **Simplicity:** Reduced system footprint and eliminated complex heated boxes and long procurement chains.

Financial impact: With typical escalation (3 %/yr), a single system's 10-year cost advantage approximates **$67 K**. Scaling this modular design across multiple test rigs multiplies savings further while lowering maintenance overhead.

---

6. Takeaway & Forward Value

This project underscores a critical lesson: **engineering assumptions should always be validated—especially under urgent timelines.** By challenging the notion that "the full sampling line must be heated," we delivered a faster, simpler, and more reliable system at a fraction of the price.

The customer gained confidence to deploy this low-cost emissions sampling architecture across other test cells, demonstrating that **innovation under time pressure often leads to the most elegant results.**

Note: Inflation-adjusted savings calculated using a **3 % annual escalation** compounded for 10 years, equivalent to current-value benefit of ≈ $67 K per installation.