

Mercury CEMS

**Significant Technical Issues
And Recent Results**

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Trimble Hg CEMS Population Update

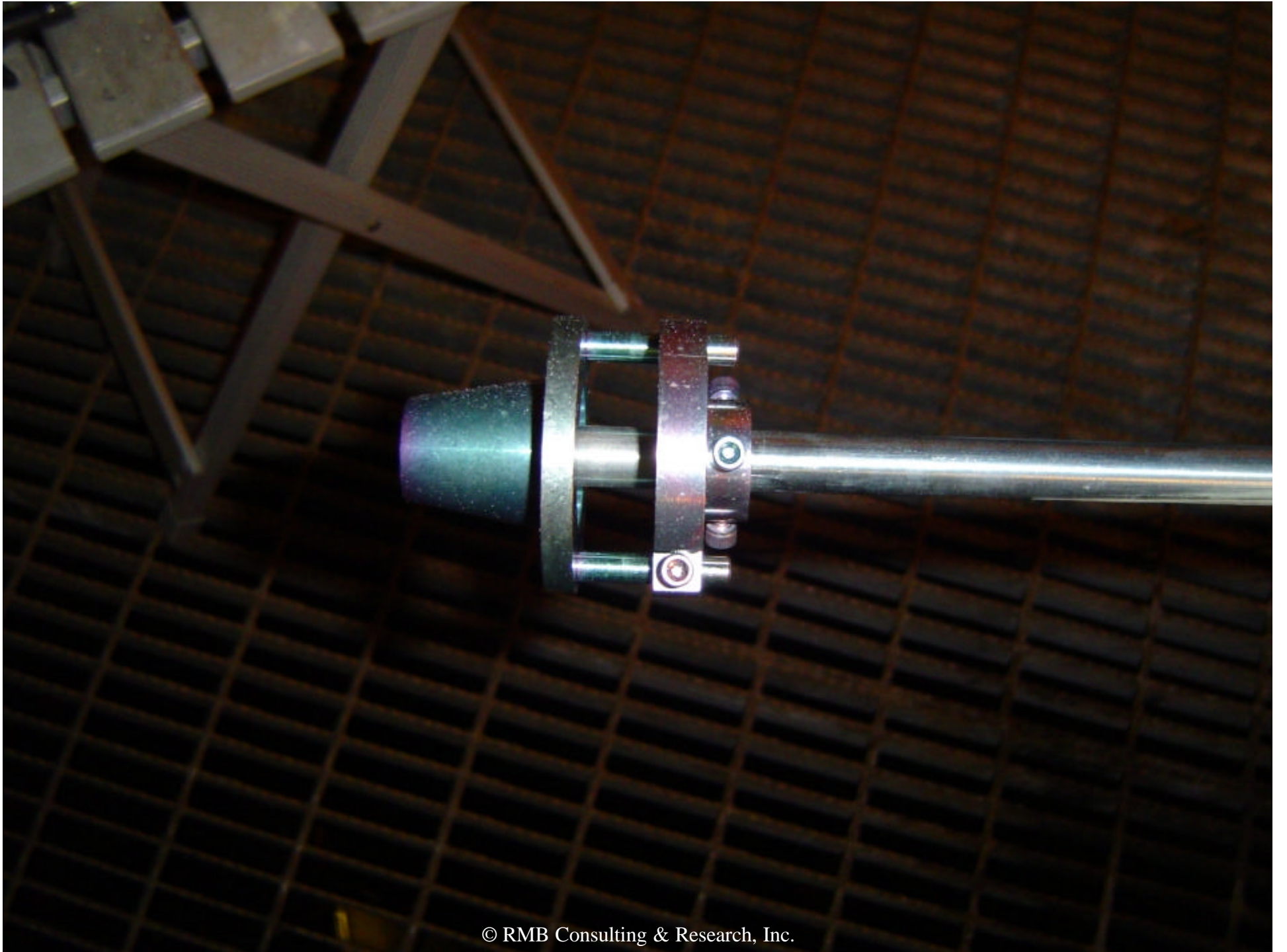
- ◆ Thermo Inertial
- ◆ Tekran Inertial
- ◆ Thermo “Game Cube”
- ◆ Tekran M&C
- ◆ Sick Maihak
- ◆ Ducon
- ◆ Opsis

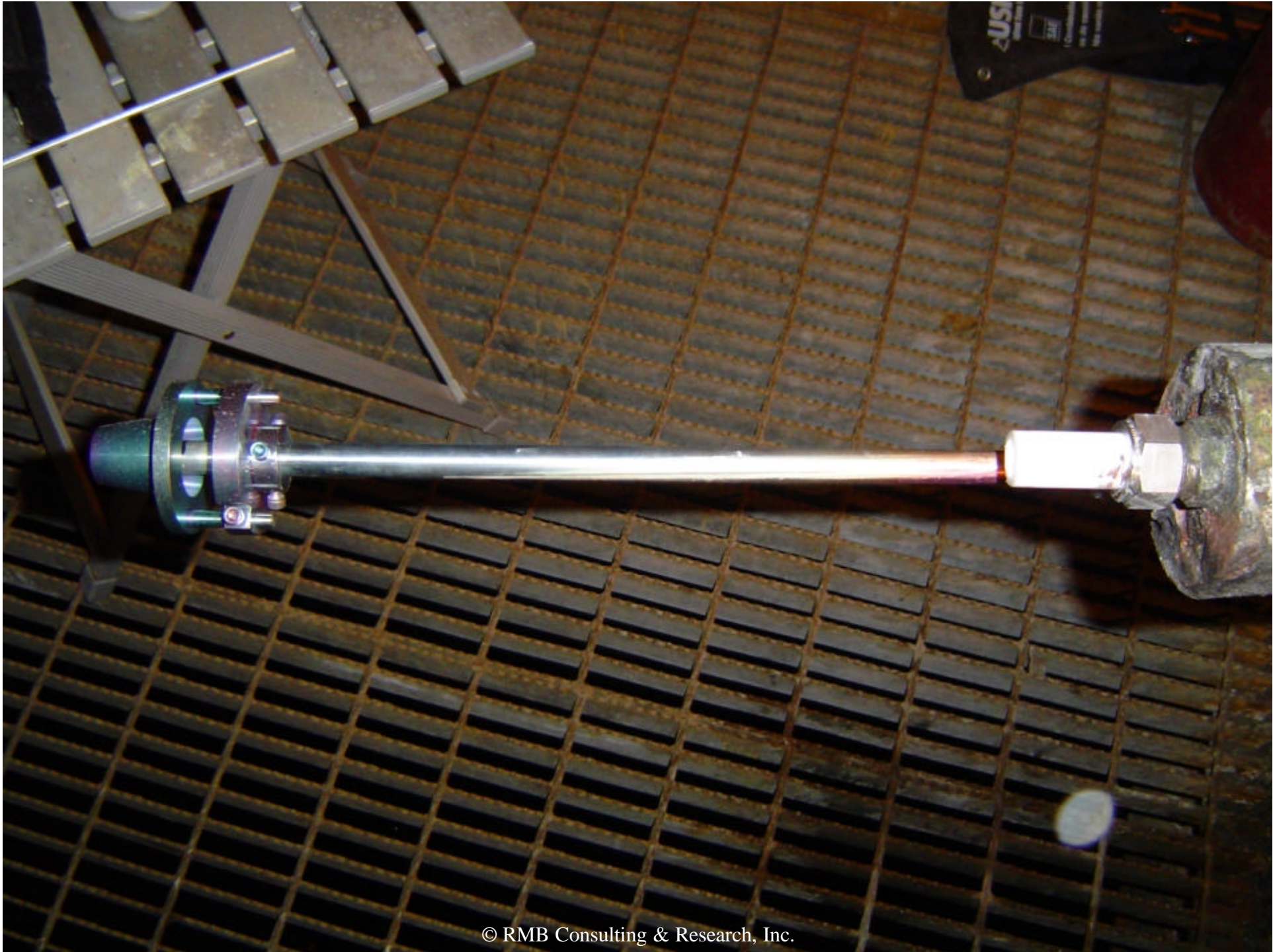
Subjects For Today

- ◆ Lessons Learned
- ◆ Regulatory Issues
- ◆ IRM Issues
- ◆ Calibration Issues

Lessons Learned

**If You Put Stainless In A Wet Stack,
It Will Not Be There
When You Return!**





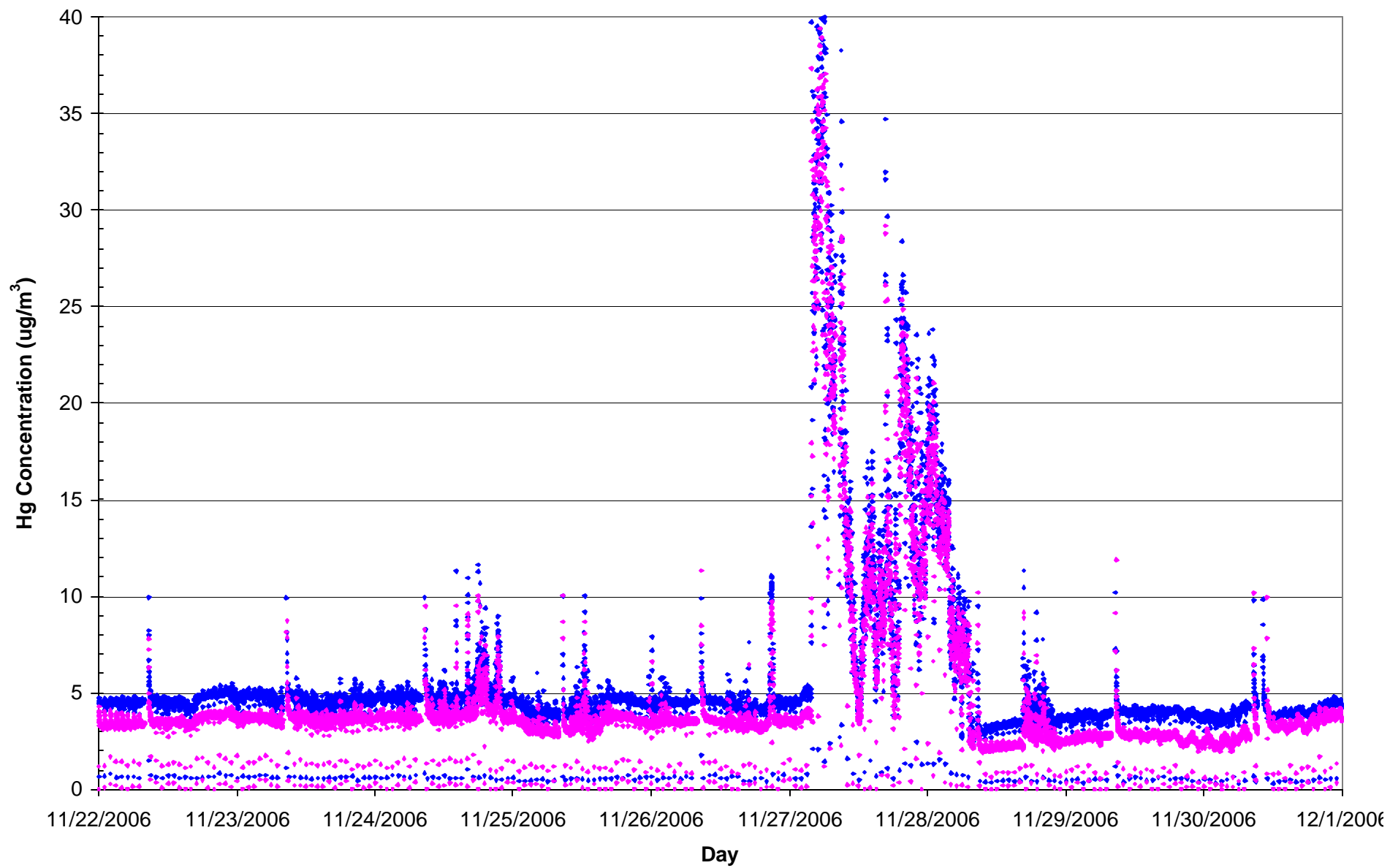


Lessons Learned

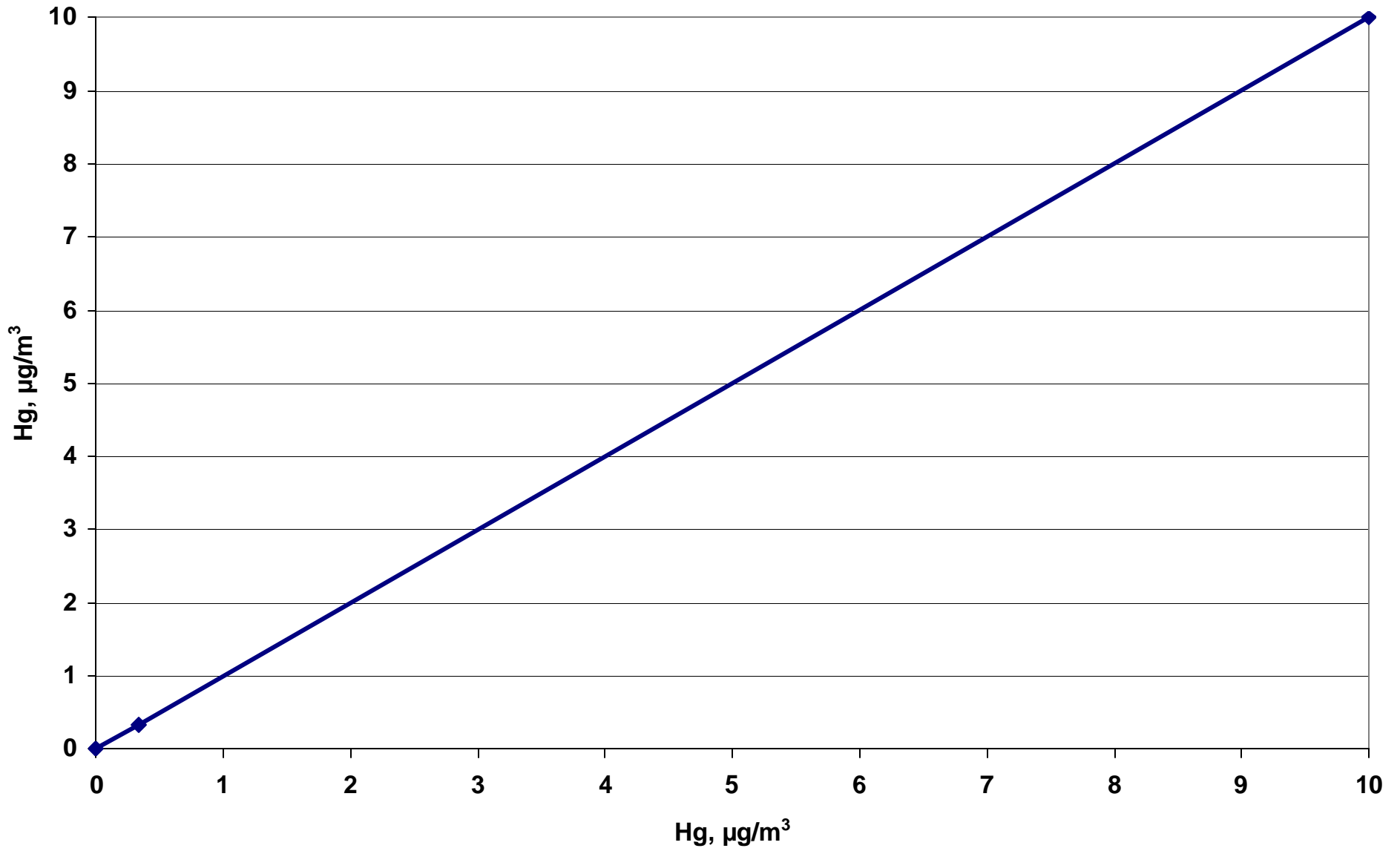
- ◆ Loss Of Probe Heater Trips Are Essential
 - Current or Temperature
 - Otherwise, Days of Acid Cleaning
- ◆ Operating Without An Oxidized Calibrator Tells You Nothing
- ◆ Ditch The 4-20 ma Signals
 - Sets up an Artificial Range - BAD

Regulatory Issues

- ◆ Range And Span Rule Language Obsolete
 - Modern Digital Analyzers Don't Have Ranges
 - 4-20 ma Creates an Artificial Range
- ◆ How Do We Handle 10/50-1 Hg Excursions?
- ◆ There Are Alternatives If One Understands How Hg CEMS And Calibrators Work



Example Hg Analyzer/System Calibration

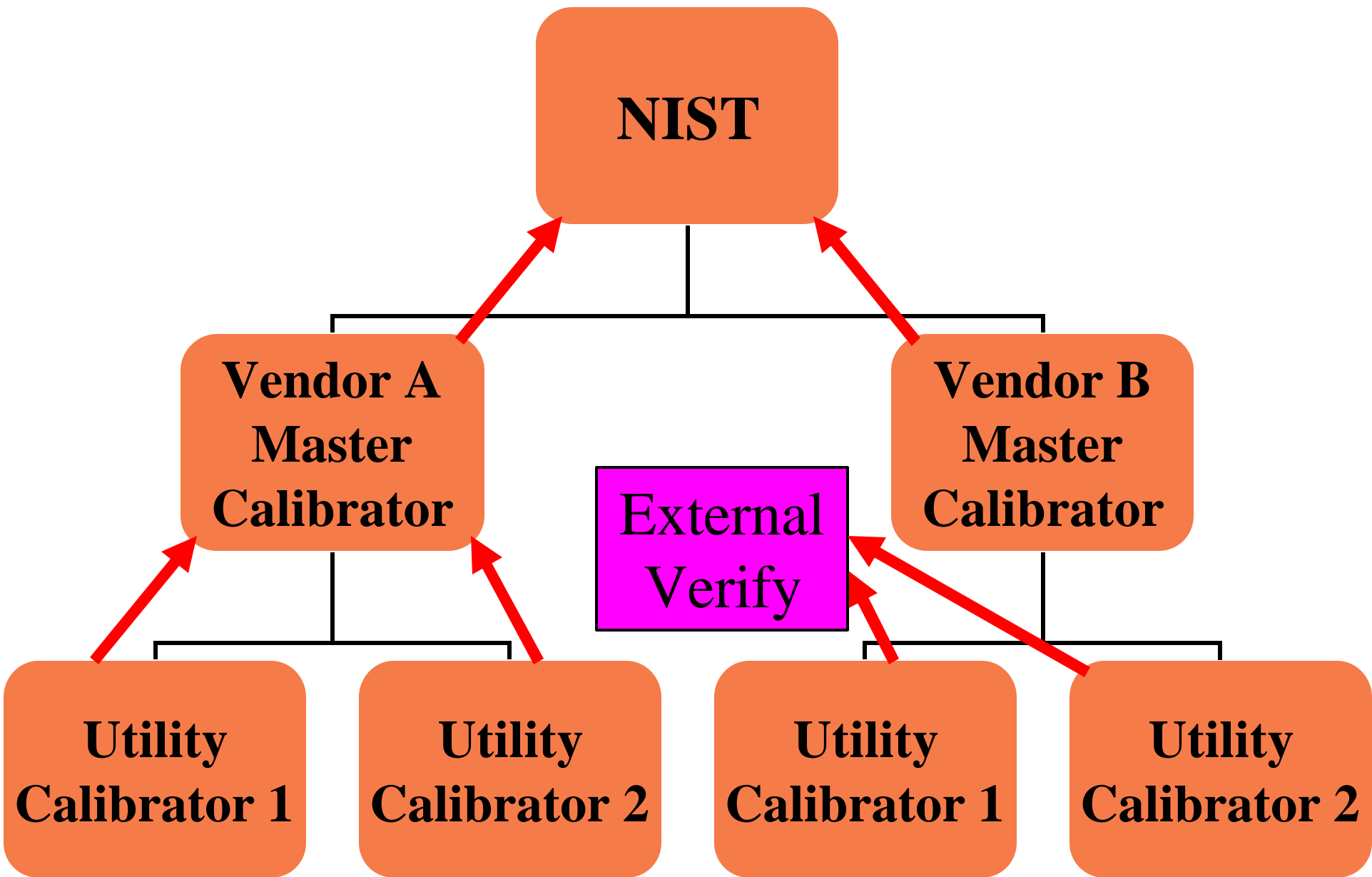


Range And Span

- ◆ Experiments Are Being Conducted To Illustrate The Wide Range Capability Of Hg CEMS
- ◆ Initial Experiments Are Very Encouraging

Regulatory Issues II

- ◆ NIST Traceable Elemental & Oxidized Hg Standards
- ◆ Traceable Elemental Calibrators Promised By Sept 2006
- ◆ No Vendor Has Even One
- ◆ No Traceability Protocol
- ◆ Little Oxidized Work Done



IRM Issues

- ◆ Conceptual IRM Is Very Complex
- ◆ Equipment Is Very Expensive
 - ~\$200,000
- ◆ Extremely Time Consuming
 - 3-4 Days Minimum
- ◆ Are All The Requirements Necessary?

IRM Requirements I

- ◆ 3-Point Elemental Calibration
 - 2% of span or $\pm 0.2 \mu\text{g}/\text{m}^3$ criteria
- ◆ 3-Point Oxidized Calibration
 - 5% of span or $\pm 0.5 \mu\text{g}/\text{m}^3$ criteria
- ◆ Pre-test Dynamic Spike – 2 levels, 3 runs
 - $100 \pm 5\%$ Recovery plus $\leq 5\%$ RSD, or if either failed, alternatively $\leq 0.2 \mu\text{g}/\text{m}^3$ difference between theoretical and actual spike

IRM Requirements II

- ◆ Make Sample Runs
 - Nominally 30-Minutes Each Run
- ◆ Single Level System Integrity Test
 - Minimum of every 4 runs
 - 5% of span or $\pm 0.5 \mu\text{g}/\text{m}^3$ criteria
- ◆ Post-test Dynamic Spike, 2 levels, 3 runs
 - $100 \pm 10\%$ Recovery plus $\pm 5\%$ RSD, or if either failed, alternatively $\pm 0.2 \mu\text{g}/\text{m}^3$ difference between theoretical and actual spike

IRM Tests At Trimble

- ◆ ***Installed*** Tekran Used As IRM
- ◆ Was Used To Evaluate Calibration/Spiking Requirements
- ◆ Also Used To Conduct RATAs On Two ***Installed*** Thermos and PSA/GE
- ◆ 50-foot Sample Lines

Trimble IRM Results

- ◆ All Pre and Post IRM Calibration And Spiking Tests With Tekran Passed IRM Specifications
- ◆ Both Thermos and PSA/GE Passed RATA Requirement of $\pm 1.0 \mu\text{g}/\text{m}^3$ Of The Mean Reference Method Value

IRM Tests At Yates

- ◆ ***Installed*** Thermo Used To Conduct IRM
 - Custom Built Thermo Probe Designed For Spiking – No Cost, Thanks Thermo
- ◆ Used To Conduct RATA On ***Installed*** Tekran
- ◆ 200-ft Sample Lines
- ◆ Ontario Hydro And Carbon Traps Also Done

Yates IRM Results

- ◆ Pre-test Calibration and Dynamic Spikes Completed With Difficulty
 - Miscellaneous Problems and Varying Stack Concentration
- ◆ Only 5 IRM Runs Completed – Only 3 Met IRM Specifications
- ◆ Hovaquick Zapped By Static Discharge

Yates RA Results

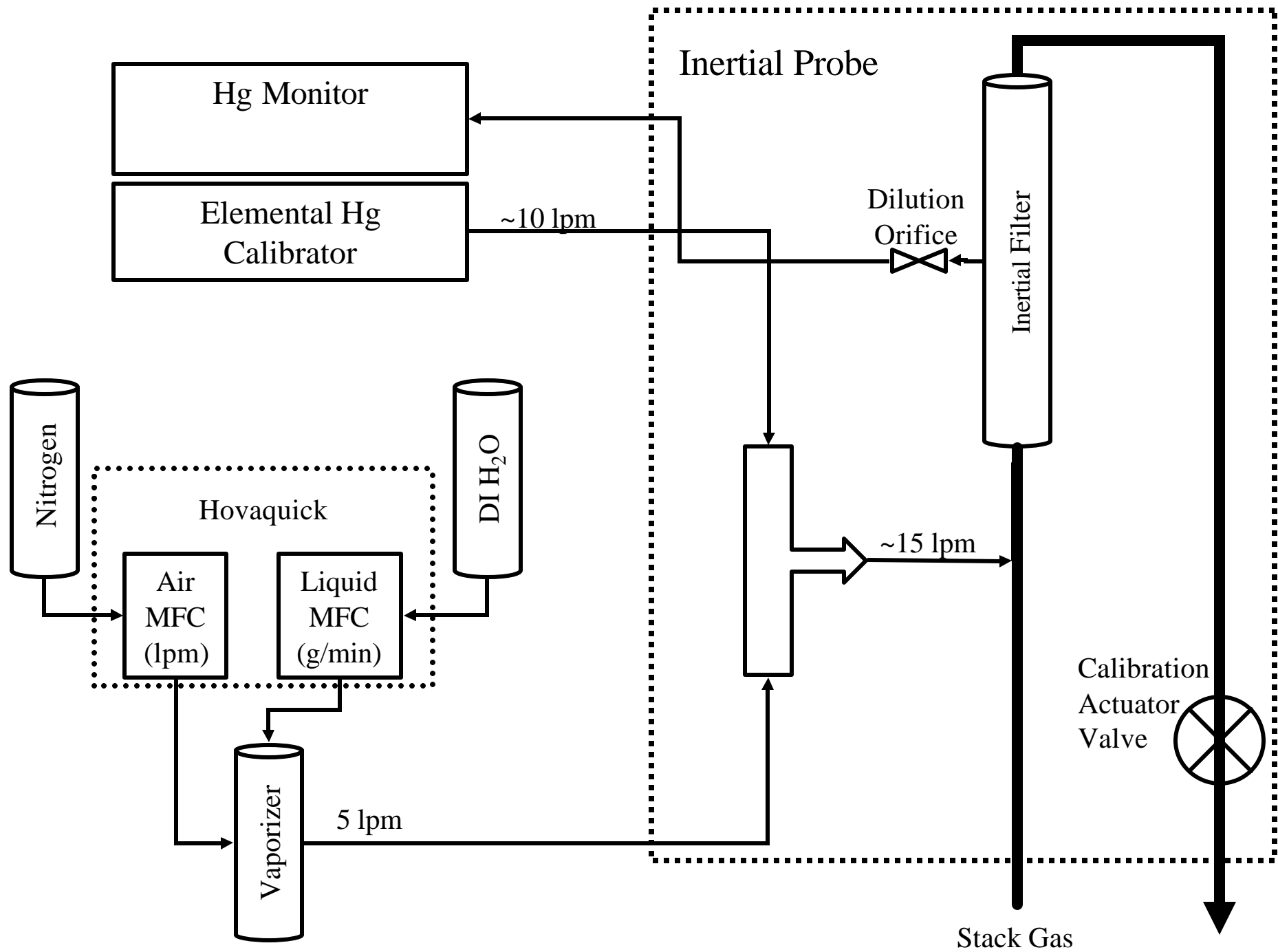
Analyzer	Rel Accuracy (%)	Rel Diff ($\mu\text{g}/\text{m}^3$)
Tekran	10.8	0.08
Thermo	14.0	0.07
App K	30.4	0.74

IRM - What Can Be Eliminated?

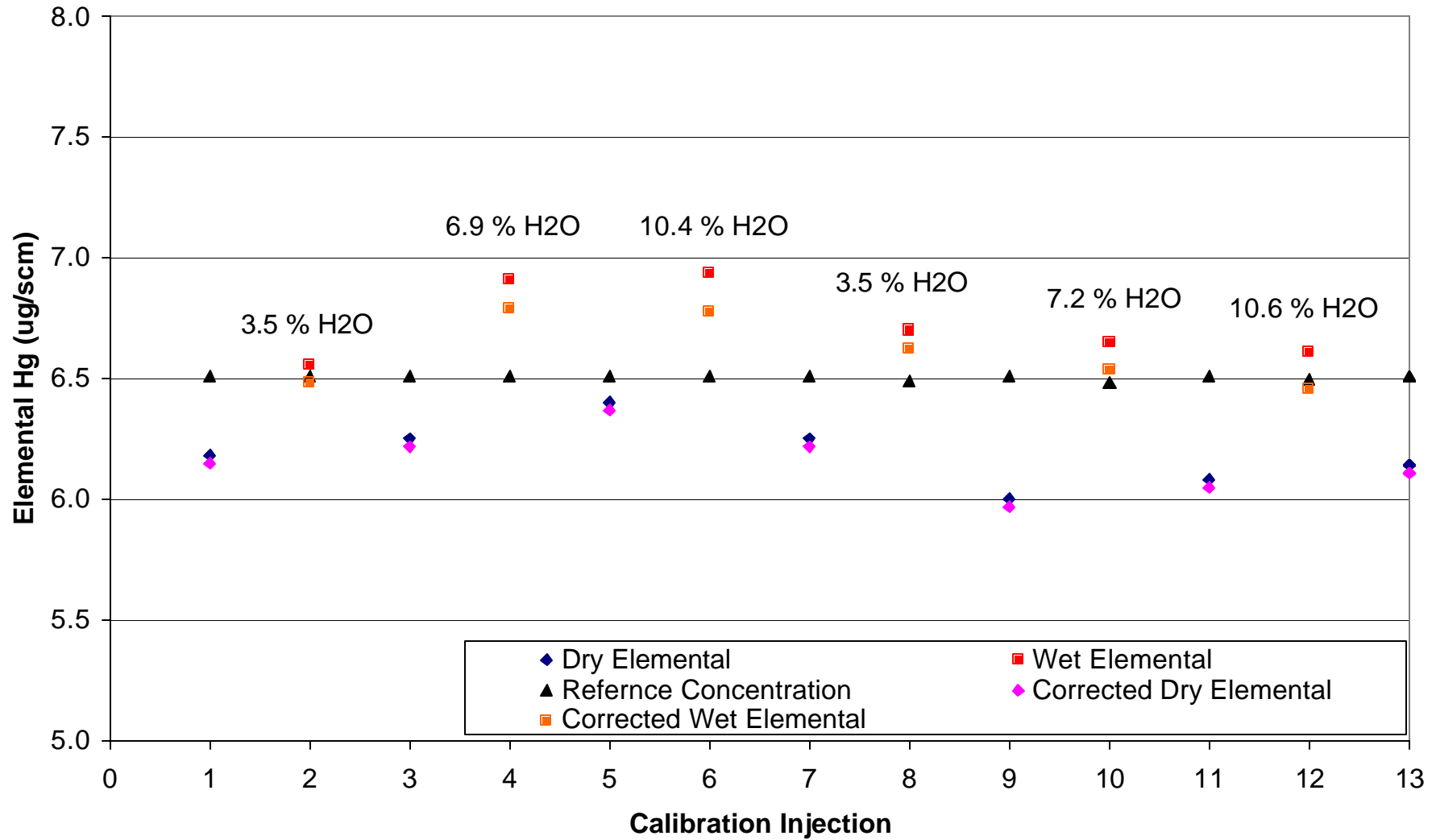
- ◆ Pretest Elemental Calibration
 - Not Needed In Addition To Oxidized Calibration
- ◆ All Spiking – Only Adds Time And Cost
 - Not Telling Us Anything Except That The Spiking Equipment Did Not Work Or That The Stack Hg Concentration Had Changed
 - There Has Never Been Any Evidence Of Stack Matrix Or Spectral Interference

Calibration Problems

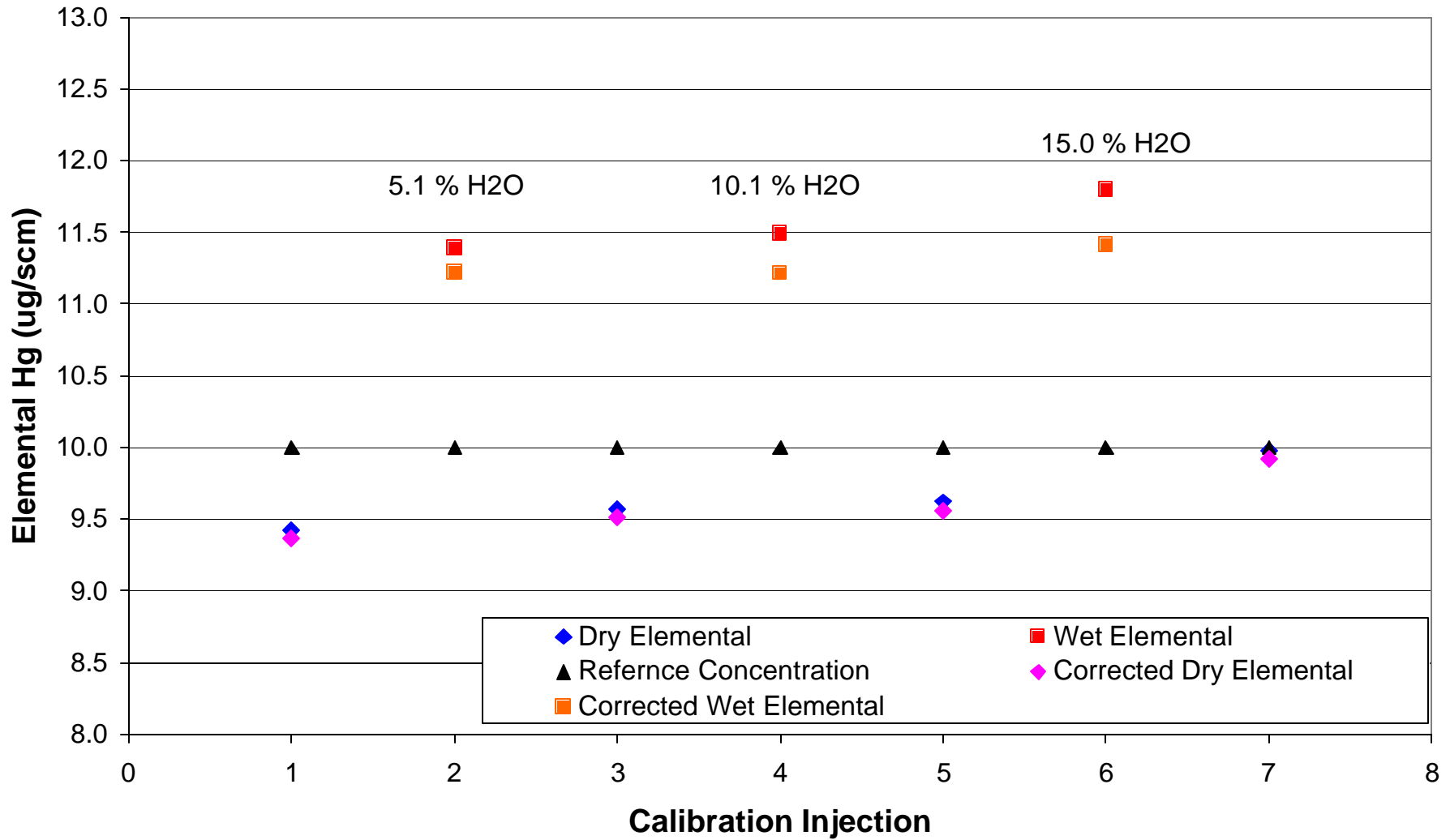
- ◆ Daily/Weekly QA/QC Checks Have Been Unreliable – Frequent Failures
- ◆ Consistent Difference in Dry Hg^0 and Wet Hg^{+2} Calibration Checks
 - Changed From Day-to Day
 - Delta Increased Over Time
- ◆ Experiments Were Designed To Evaluate The Calibration Problem



Response Elemental Calibration Gas - System A



Response Elemental Calibration Gas - System B



Elemental Calibration – Bottom Line

- ◆ Dry Elemental Calibration Is Not Quantitative On Inertial Probes
- ◆ Need To Add 7-10% Moisture
- ◆ Need To Correct Dilution Ratio For Wet Calibration
- ◆ Additional Experiments are Planned For Non-Inertial Probes