Qualitative Particulate Monitoring

- "Bag Leak Detectors" and/or "Particulate Matter Detectors"
- Various Monitoring Applications in MACT Standards, such as:
  - Secondary Lead
  - Portland Cement
  - Hazardous Waste Combustors
  - Lime Manufacturing

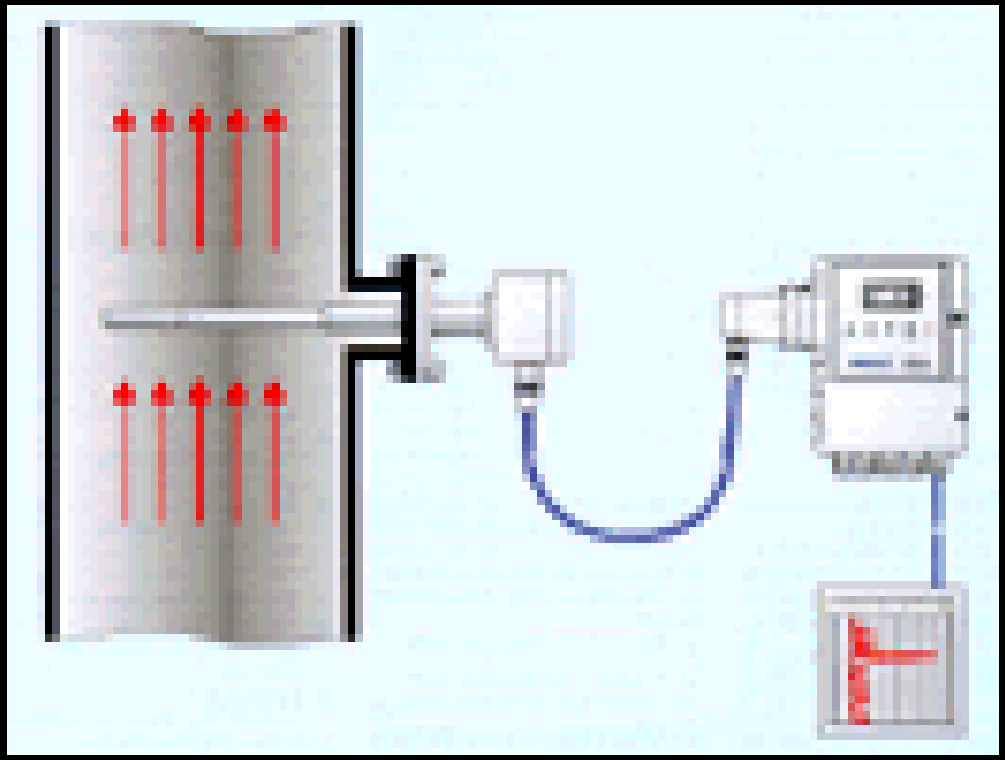
BLD Specifications

- No typical Performance Specification
- Requirements promulgated April 5, 2002 with Portland Cement Direct Final Rule Amendments
- Similar requirements in Lime MACT Standard signed Aug. 27, 2003
- More requirements and new alarm limit procedure in HWC rules April 20, 2004

Summary of Typical BLD Requirements

- Certified by manufacturer to be capable of detecting 10mg/m^3 (0.0044grains/acf)
  - HWC regulations demand 1 mg/m^3
- Output relative to PM concentration
- Alarm activated when there is significant increase in PM
- Operated in accordance with manufacturer's written instructions
- Baseline, range, and alarm set according to manufacturer's recommendations

Filter Watch D-FW-230
Triboelectric Particualte Monitor



EPA's HWC Approach

- Set alarm level at value observed during PM tests during comprehensive performance test
- No tolerance or uncertainty allowance
- Debate about sensitivity requirement (1 versus 10 mg/acm
- Sources typically operate at 10-20% of standard!

ASTM D 7392-07
Standard Practice for Certification of "PM Detectors" and "Bag Leak Detectors" and Its Challenges

James W. Peeler, Emission Monitoring

Richard Myers, Teledyne Monitor Labs

May 20, 2009

International Thermal Treatment Technologies Hazardous Waste Combustor

Particulate Test Method for Real-Time Particulate Concentration Measurements

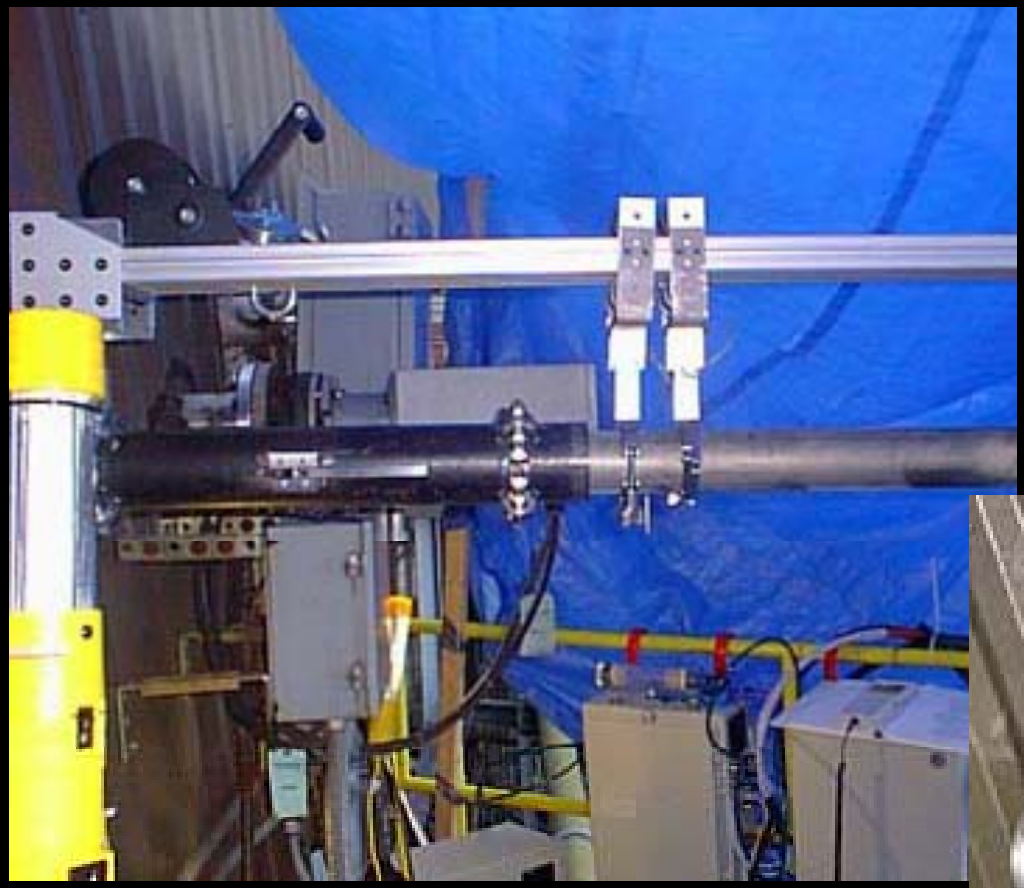
- Tapered Element Oscillating Microbalance
- TEOM Series 7000 Source Particulate Monitor
- Uses technology from contemporary ambient measurements modified for source testing
- Includes PM concentration, flow rate, O_2, CO_2 and H_2O

TEOM Series 7000

- ASTM D6831-02 Method
- EPA Method 301 Tests at Coal Fired Sources
  - Approved by EPA for coal-fired combustion sources and cement kilns
  - Approved by EPA for wet stacks

TEOM Series 7000 Source Part Monitor

Installation at a Test Location



On the platform

Boom support system
on the duct

TEOM Series 7000 Source Part Monitor

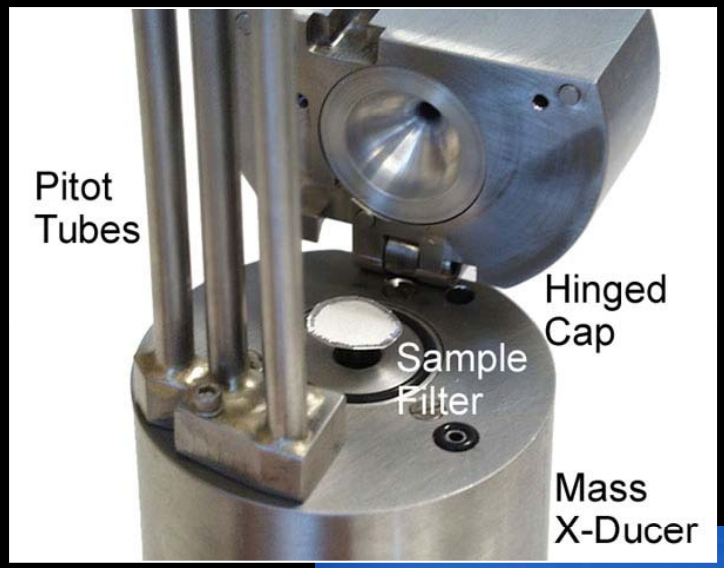
Inlet System on Mass Transducer

- Purge flow for in-situ filter equilibration, dilution and intermittent sampling
- Thermocouple and pitot tubes for isokinetic flow control
- Exchangeable nozzles for different stack velocity ranges
- Purge air heated to stack temperature

TEOM Series 7000 Source Part Monitor

Mass Transducer

- Filter-based sampling
- In-situ mass measurement using high-temperature TEOM mass transducer
- Continuous or intermittent sampling modes
- Exchangeable filter for post-collection analysis
- Sample collection temperature maintained at or above flue conditions

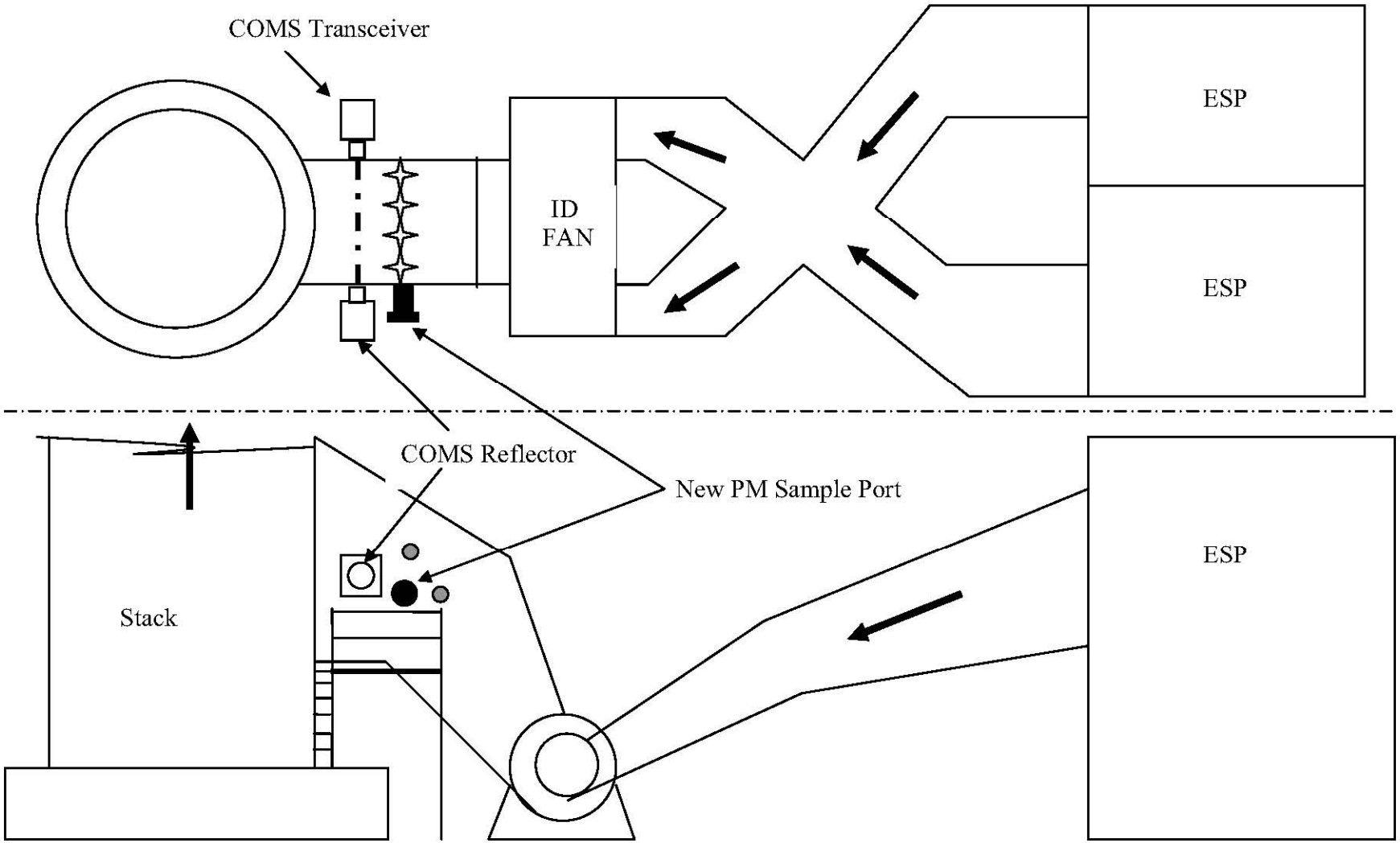


TEOM Series 7000 Source Part Monitor

Tapered Element

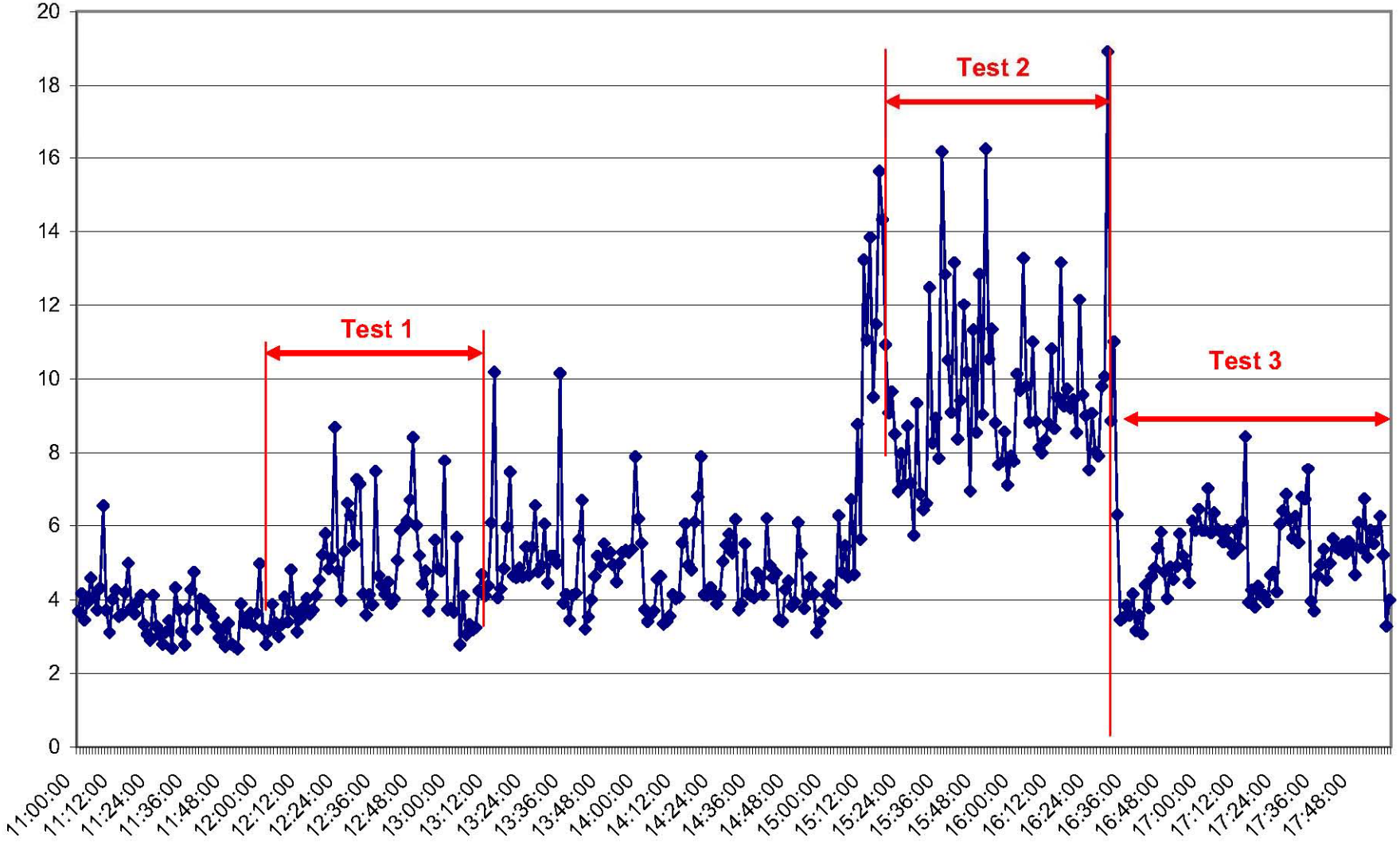
- Tapered element oscillates at its natural frequency
- Particulate matter collects on filter as sample stream passes through
- Frequency decreases with accumulation of mass
- *Direct* relationship between mass and frequency change

Tapered Element



Sampling Location Schematic

Opacity Minute Averages



RESULTS OF LINEAR CORRELATION

Facility: **Artesia** **Emission Unit:** **Kiln**
Location: **Artesia MS** **Test Dates:** **38574**

Variable	Equation	Value
n	Number of data points =	9
$\tilde{x}$	x~ = 1/n*(Sum of (x_i)) =	30.01
S_{xx}	S_{xx} = Sum((x_i-x~)^2) =	968
$\tilde{y}$	y~ = 1/n*(Sum of (y_i)) =	15.55
S_{yy}	S_{yy} = Sum((y_i-y~)^2) =	370
S_{xy}	S_{xy} = Sum((x_i-x~)(y_i-y~)) =	589.0
b_0	b_0 = y~-b_1x~ =	-2.716
b_1	b_1 = S_{xy}/S_{xx} =	0.608
S_L	S_L = SQRT(1/(n-2)(Sum(y_i^-y_i)^2)) =	1.285
$y^{\wedge}_{mean}$	y^ at mean x value =	15.545
t_f	t_f from table =	2.365
CI	CI = t_f*S_L*SQRT(1/n) =	1.013
EL	Emission Limit =	34.6
CI%	CI% =CI/EL*100% =	2.93%
n'	n' = n =	9
v_f	v_f from table =	1.797
$u_{n'}$	$u_{n'}$ from table =	1.203
k_T	k_t = u_n'*v_f =	2.162
TI	TI = k_t*S_L =	2.777
TI%	TI% = TI/EL*100% =	8.0%
S_y	S_y = SQRT(S_{yy}/(n-1)) =	6.800
r^2	r^2 = 1-(S_L^2/S_y^2) =	0.964
r	r = SQRT((1-S_L^2/S_y^2)) =	0.982

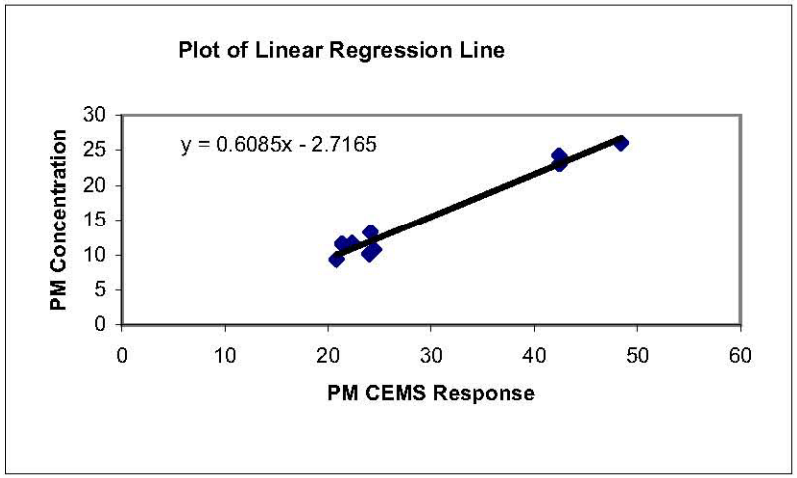
* Indicates correlation coefficient is undefined.

Correlation equation: **y = -2.716 + 0.608 x**

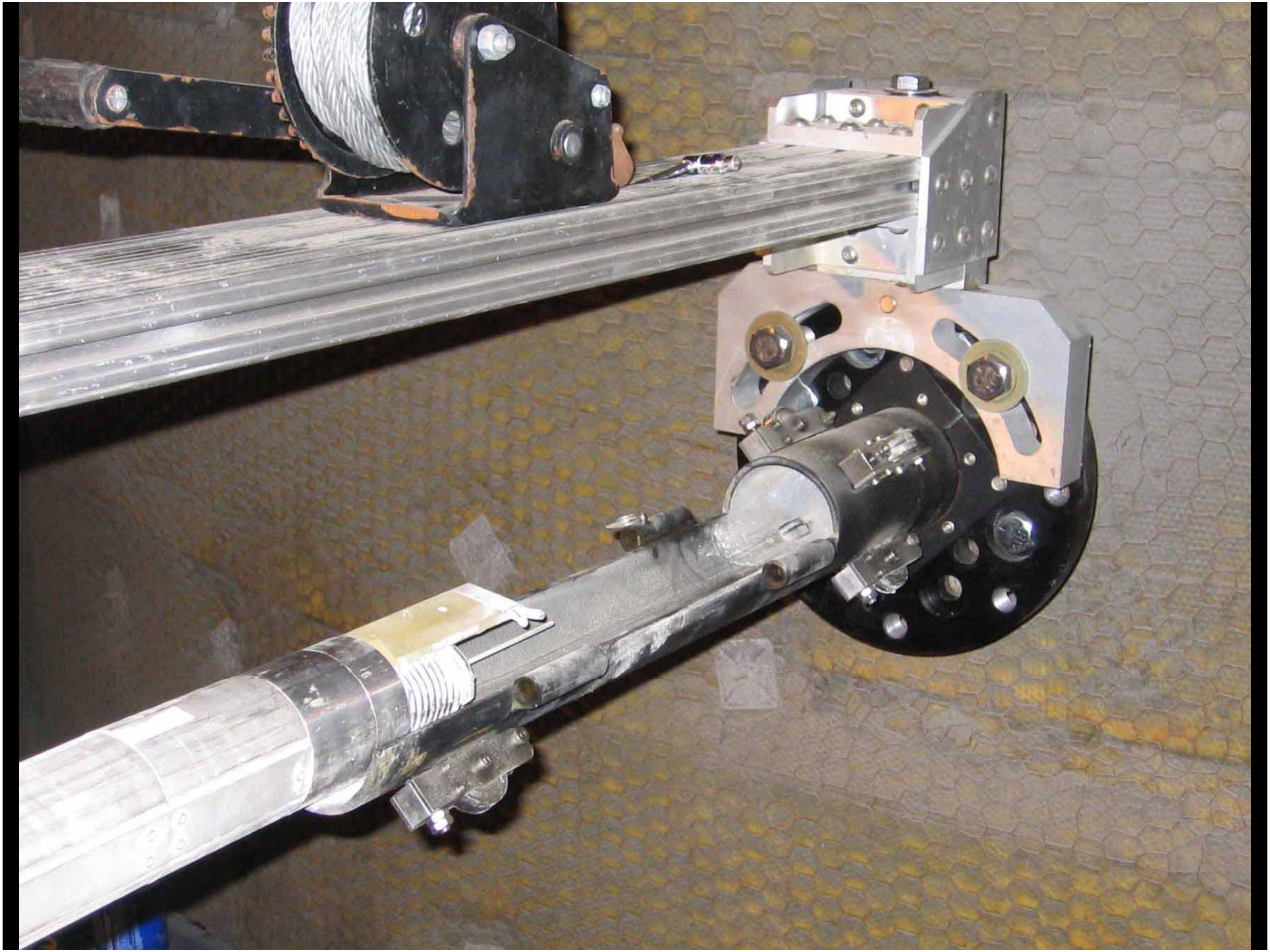
Summary of Acceptance Criteria for PS-11

Criterion	Actual	Allowable	Acceptable?
Correlation coefficient	0.982	≥ 0.85	yes
Confidence interval	2.93%	≤ 10%	yes
Tolerance interval	8.0%	≤ 25%	yes

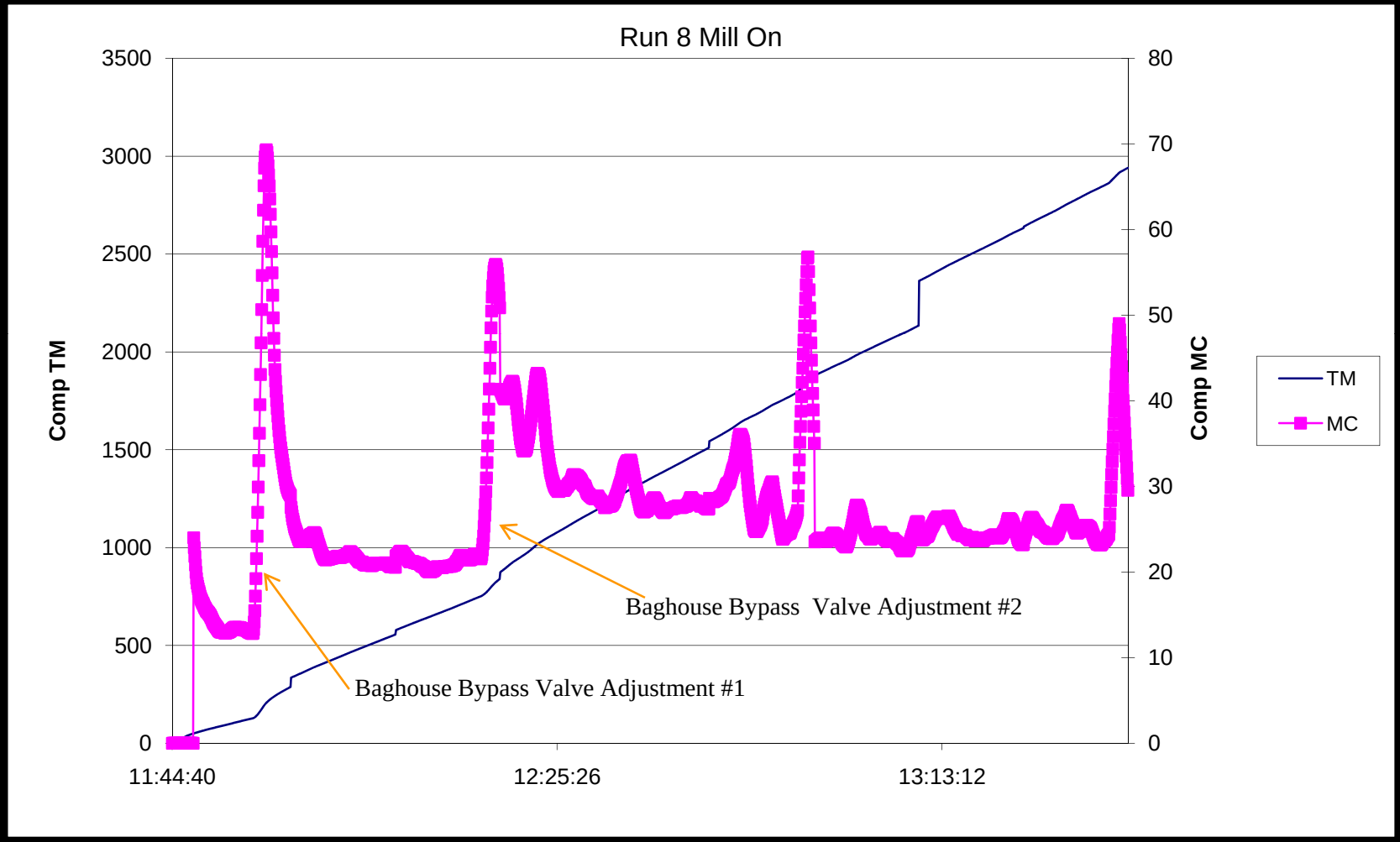
* Indicates correlation coefficient is undefined.



PS-11 Correlation Test
Calculation Spreadsheet
Version 2-6 10/25/04




TELEDYNE
INSTRUMENTS
Monitor Labs


Run 8 Mill On
Comp TM
Comp MC
3500
3000
2500
2000
1500
1000
500
0
80
70
60
50
40
30
20
10
0
11:44:40
12:25:26
13:13:12
TM
MC
Baghouse Bypass Valve Adjustment #1
Baghouse Bypass Valve Adjustment #2

New Technology?

- Thermo Fisher Scientific has Active R&D Program to Develop “Self Validating” Hybrid PM CEMS
  - Includes two light scattering devices
  - Includes internal TEOM for periodically calibrating both light scattering devices
  - Monitoring light scattering output ratio detects potential changes in particle size, refractive index, etc. and triggers TEOM recalibration
  - Potential simplification or elimination of correlation testing with manual reference methods
- 2010 -2011 Field tests and work with EPA may provide a superior alternative approach before PC MACT deadline