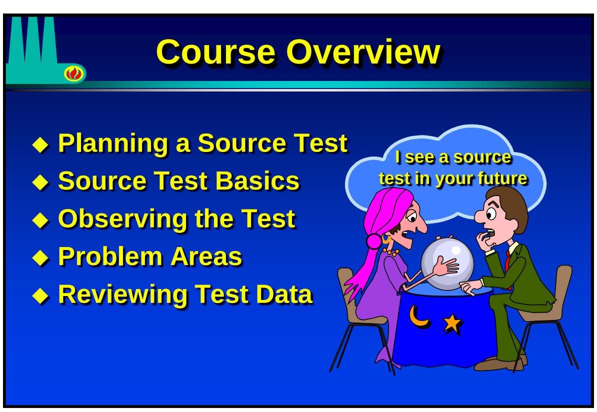
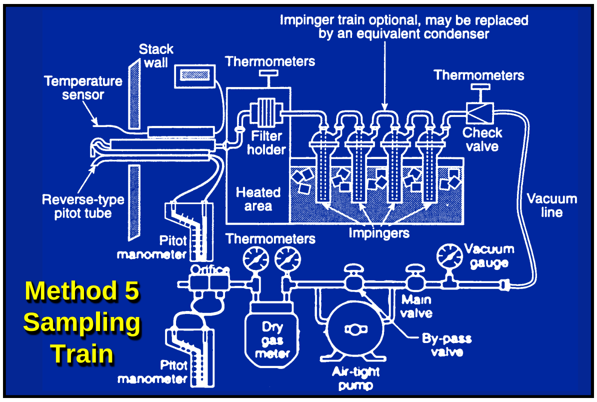

OBSERVING SOURCE TESTS

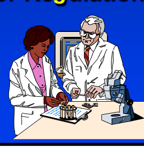

NACT Course # 224


Course Overview
◆ Planning a Source Test
◆ Source Test Basics
◆ Observing the Test
◆ Problem Areas
◆ Reviewing Test Data
I see a source test in your future



Purpose of Source Testing

- **For the Agency :**
  - Provide Data to Evaluate Compliance
  - Provide Data to Formulate Control Strategies
  - Provide Data for Regulation Development

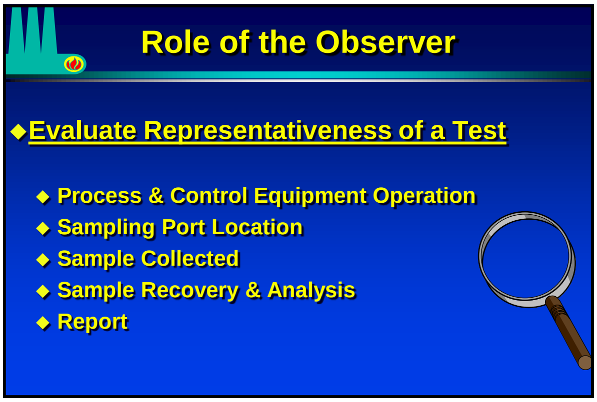


Purpose of Source Testing

- **For the Facility :**
  - Provide Data to Evaluate Compliance Status
  - Meet Permit-To-Operate (PTO) Conditions
  - Provide Info. on Control Device Efficiency
  - Provide Info. for Design of New Processes
  - Provide Info. on Process Operation
  - Certify CEMs
  - Certify PEMS


Federal & State
Regulations


Authority Req. Source Testing
◆ Federal : NSPS, NESHAP, Acid Rain Req.
◆ State : California H & SC
◆ ARB
◆ District Enforcement & Permitting Program Adequacy
◆ District Rules
◆ Permit Provisions
◆ Toxics


Role of the Observer
◆ Evaluate Representativeness of a Test
◆ Process & Control Equipment Operation
◆ Sampling Port Location
◆ Sample Collected
◆ Sample Recovery & Analysis
◆ Report

Role of the Observer

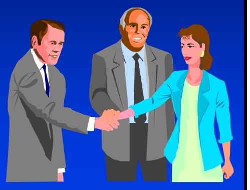
- Represent the Interests of Agency
  - Tests Satisfy the Needs of the Agency
  - Planning & Pretest
  - During the Test
  - Post Test
- QA/QC Officer

Role of the Observer

- Is the Source Test Legally Defensible?
  - Evaluate the Test Activities
  - Evaluate the Test Company/Team Qualifications & Competence
  - Evaluate the Laboratory Qualifications & Competence
  - Reliable & Appropriate Test Methods
  - Chain-of-Custody

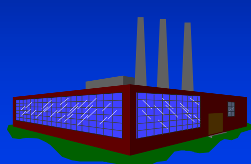
Role of the Observer

- Observer Behavior
  - Test is Successful
  - Cooperate with Both Facility & Testers
  - Specific & Firm Requests
  - DO NOT Intrude or Interfere Unnecessarily



Test Protocol

- Name & Location of Test Facility
- When is the Test - Adequate Notification?
- Purpose of the Test
- Testing Contractor
- Facility Description
- Process Description
- What is to be Tested?



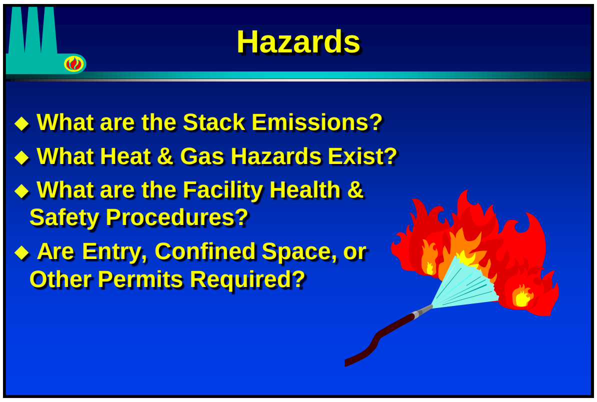
Test Protocol

- Regulatory Requirements
- Test Methods to be Used
- Schedule of the Test
- Test Location Configuration & Type
- Number & Size of Test Ports
- Process Rate to be Tested
- Report Requirements
- Unusual Requirements

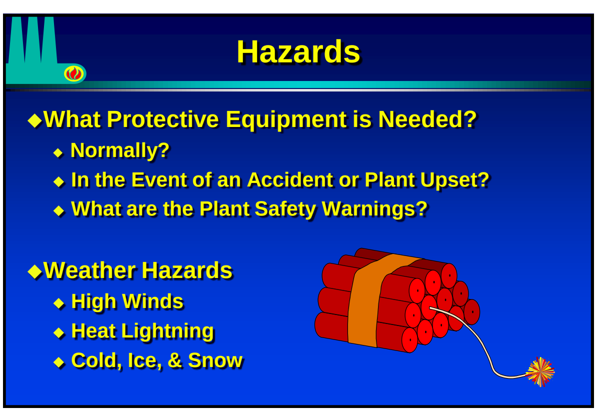
Testing Access

- <u>Access to the Stack</u>
  - Getting Equipment to the Stack, Vehicle Access
  - How far up is the Testing Platform?
  - Getting Personnel & Equipment up the Stack
  - Is the Platform Secure?
- <u>Logistics</u>
  - Are there Electrical Outlets at the Stack?
  - What Load will the Electrical Circuits Hold?
  - Explosion Proof Electrical Equipment Required?

Observing Source Tests


Hazards
◆ What are the Stack Emissions?
◆ What Heat & Gas Hazards Exist?
◆ What are the Facility Health & Safety Procedures?
◆ Are Entry, Confined Space, or Other Permits Required?

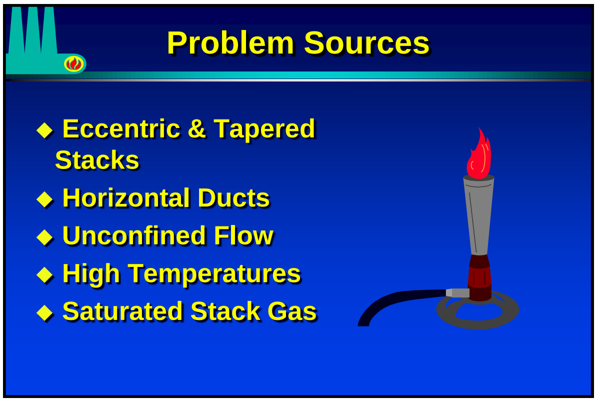

Hazards :
Heat, Gas
Weather


Hazards
◆What Protective Equipment is Needed?
◆ Normally?
◆ In the Event of an Accident or Plant Upset?
◆ What are the Plant Safety Warnings?
◆Weather Hazards
◆ High Winds
◆ Heat Lightning
◆ Cold, Ice, & Snow


Plant
Malfunction

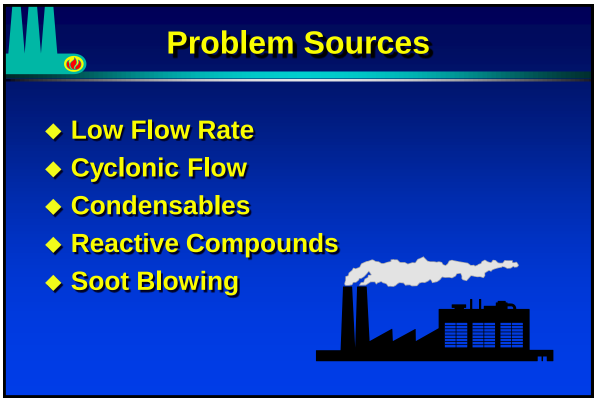

Height & Falling Object Hazards


Protective Safety Equipment


Problem Sources
◆ Eccentric & Tapered Stacks
◆ Horizontal Ducts
◆ Unconfined Flow
◆ High Temperatures
◆ Saturated Stack Gas


Saturated Exhaust


High Temp. Exhaust


Problem Sources
◆ Low Flow Rate
◆ Cyclonic Flow
◆ Condensables
◆ Reactive Compounds
◆ Soot Blowing


High Pressure Steam


Stack Access

Observing the Source Test

- Physical Inspection Points
- Procedural Inspection Points
- Calculation Inspection Points
- Preliminary Data Collection
- QC Audits

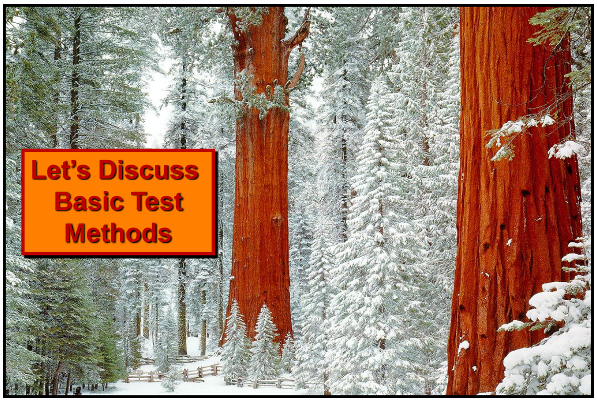
Documentation

- What Process & Control Room Data Area Available?
- What Data Are Required for the Test?
- What Data Are Required to Document Process Conditions?
- What Data Are Required to Document Continued Compliance?
- Is Any Control Room Data Confidential?

Checklists

- Ensure All Inspection Points Are Covered
- Ensure All Data Points Are Properly Collected

- Should Be Reviewed & Modified for the Source Being Tested



Basic Test Methods

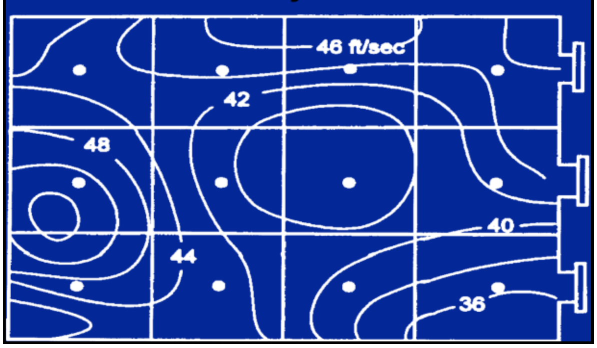
- Method 1 - Sampling Point Location
- Method 2 - Stack Gas Velocity
- Method 3 - Dry Molecular Weight
- Method 4 - Moisture Content of Stack Gases
- Method 5 - Particulate Emissions
- Method 6 - Sulfur Dioxide Emissions
- Method 7 - Nitrogen Oxide Emissions
- Method 10 - Carbon Monoxide Emissions

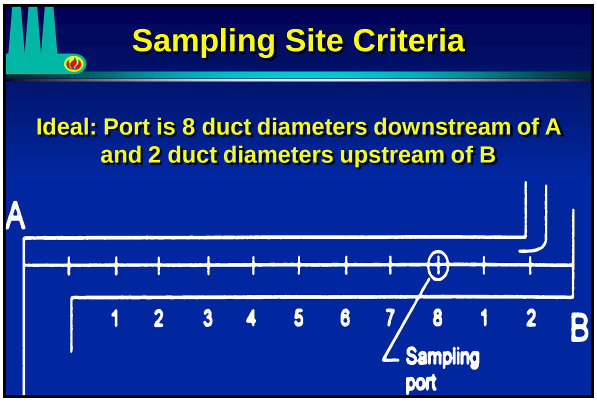
Method 1

Sample & Velocity Traverses for Stationary Sources

- Specifies Both the Sampling Site Location & the Location of the Sampling Points
- The More Convoluted the Ductwork, the More Points that Will Need to be Tested

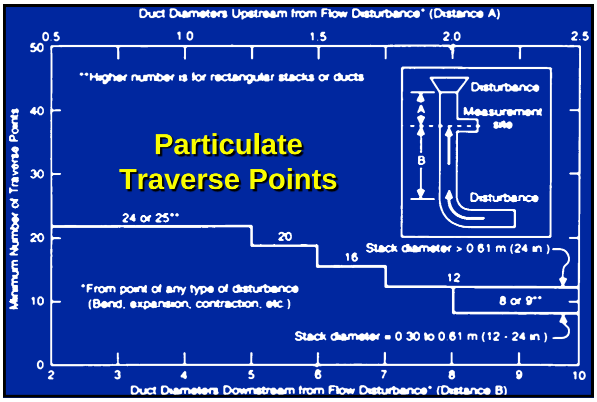
Stack Velocity Stratification




Sampling Site Criteria
Ideal: Port is 8 duct diameters downstream of A and 2 duct diameters upstream of B
A
1 2 3 4 5 6 7 8 1 2
B
Sampling port

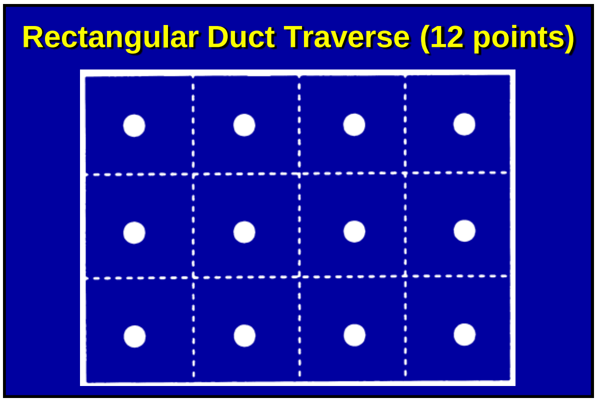

Blackfoot River Taproom
Beer To Go
On Tap Today
By the Glass
Thank You All
Sampling Criteria


Sampling Criteria



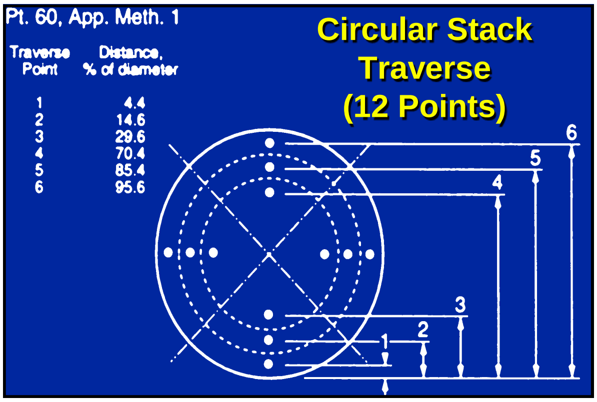
Rectangular Duct Cross-Section Layout

# of Traverse Points	Matrix
9	3 x 3
12 (example on next slide)	4 x 3
16	4 x 4
20	5 x 4
25	5 x 5
30	6 x 5
36	6 x 6
42	7 x 6
49	7 x 7

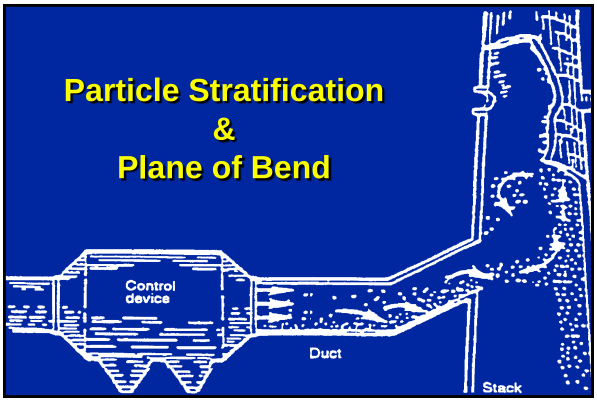


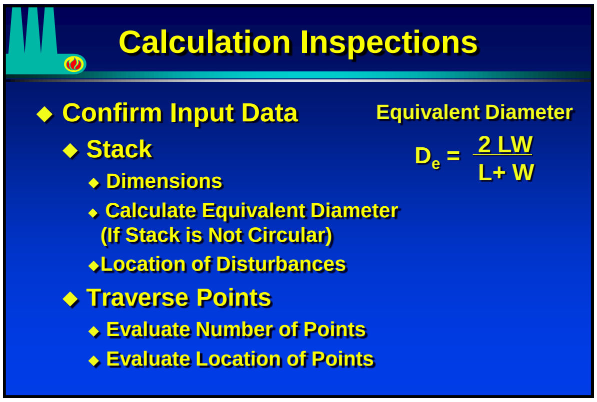
Location of Traverse Points in Circular Stacks

Traverse Point #	2	4	*6	8	10	12	14	16	18	20	22	24
	Number of traverse points on a diameter											
1	14.6	6.7	4.4%	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.6%	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.6%	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.4%	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.4%	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6%	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8				96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10					97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.8	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9



Observing Source Tests



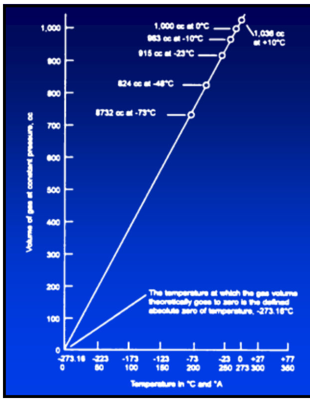


Method 2

Determination of Stack Gas Velocity and Volumetric Flow Rate

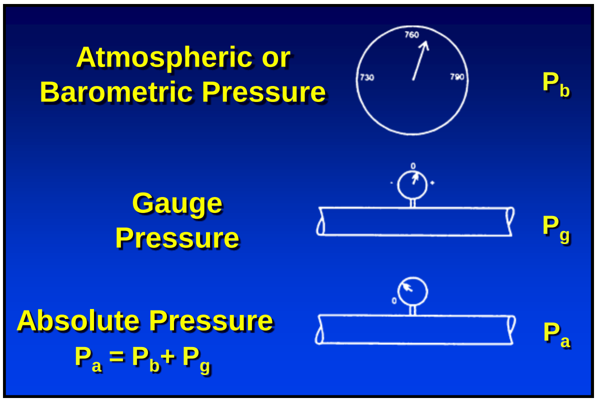
- Method Uses Type S Pitot Tube
- Method Also Used to Certify Flow Monitors

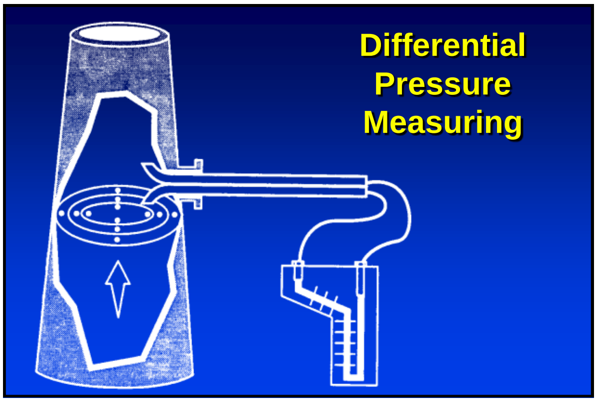
Stack Volumetric Flow Rate : $Q_s = A_s V_s$

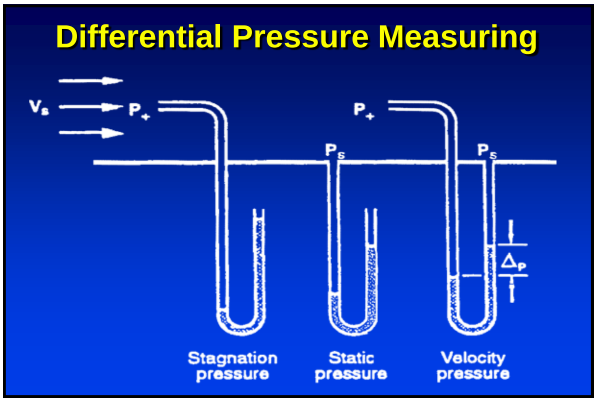


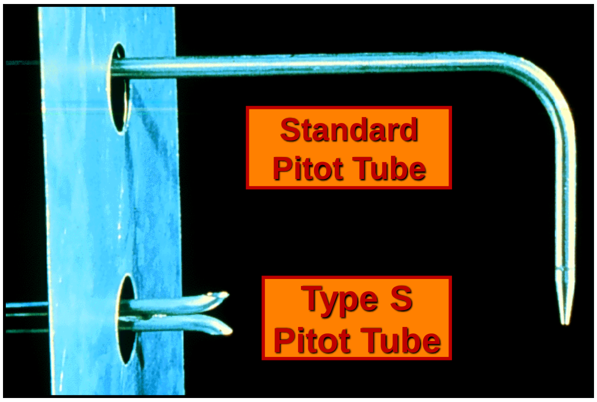
Volume of a Gas vs. Absolute Temperature

Absolute Temperature
Degrees Rankine: R
R = °F + 459.49
Degrees Kelvin: K
K = ° C + 273.16


Atmospheric or Barometric Pressure
760
730
790
P_b
Gauge Pressure
0
P_g
Absolute Pressure
$P_a = P_b + P_g$
0
P_a


Differential Pressure Measuring


Differential Pressure Measuring
V_s
P_+
P_+
P_s
P_s
Δ_p
Stagnation pressure
Static pressure
Velocity pressure



Physical & Procedural Inspections

- Pitot tube
  - Construction & Condition
  - Alignment (Bent, etc.)
  - Orientation & Attachment to Probe
  - Calibration
  - Leak Checked (Both Sides)
- Pressure Instruments
  - Oil Manometer Leveled & Zeroed
  - Magnehelic Gauge Calibrated
- Cyclonic Flow Checked

Calculation Inspections

- Confirm Input Data
  - Stack Pressures
  - Stack Temperature
  - Calibration Factors

Stack Gas Velocity

$$v_s = K_p C_p \sqrt{\frac{T_s \Delta p}{P_s M_s}}$$

$$P_s = P_b + \frac{p_s}{13.6}$$

Δp - Velocity pressure

The difference between the two pressure taps of a pitot tube (determined by averaging the square roots of all the Δp readings. Note -- DO NOT take average of readings and then take the square root).

Stack Gas Velocity

- $C_p = 0.84$
- $t_s = 345^oC$
- $T_s = 345^oC + 273^oC$
- $\Delta p = 38.1$ mm H_2O
- $P_b = 680$ mm Hg
- $M_s = 28.2$ g/mole
- $p_s = 35$ mm H_2O
- $K_p = 34.97$ (metric)

$$v_s = K_p C_p \sqrt{\frac{T_s \Delta p}{P_s M_s}}$$

$$32.5 \text{ m/s} = 34.97 \times 0.84 \sqrt{\frac{(345+273) \times 38.1}{(680+35/13.6) \times 28.2}}$$

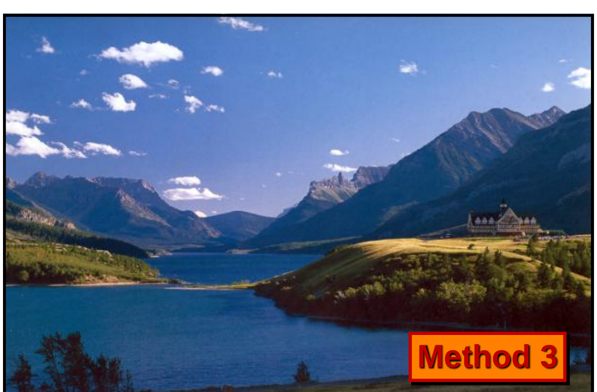
Calculation Inspections

- Stack Volume
  - Stack Area
  - Flow

Stack Gas Volumetric Flow Rate $Q_s = A_s V_s$

$$Q_s = A_s K_p C_p \left(\frac{T_s \Delta p}{P_s M_s}\right)^{1/2}$$

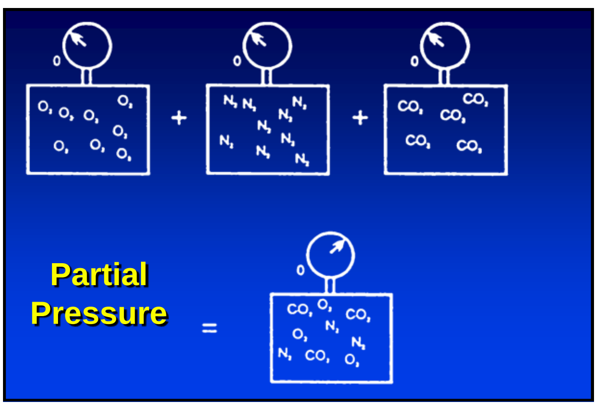
$$Q_{sd} \text{ (ft}^3\text{/hr)} = 3600 \times (1 - B_{WS}) A_s V_s \frac{T_{STD} P_s}{T_s P_{STD}}$$

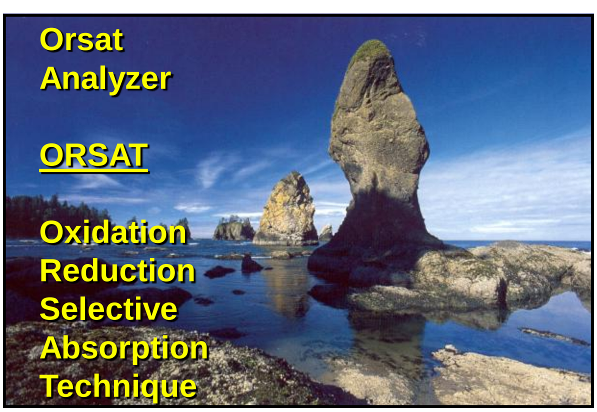


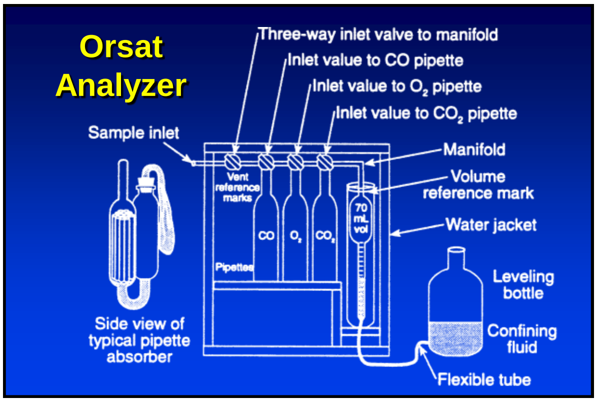
Method 3

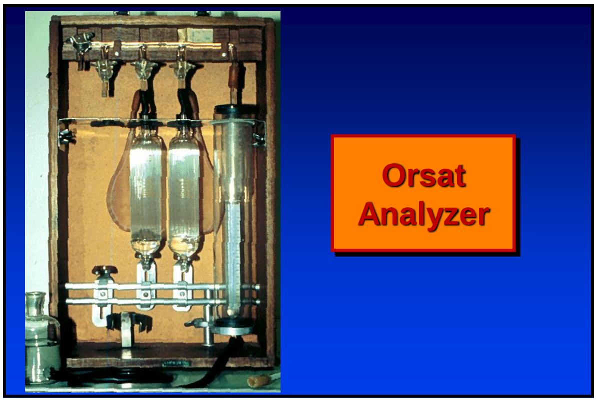
Gas Analysis for Determination of Dry Molecular Weight

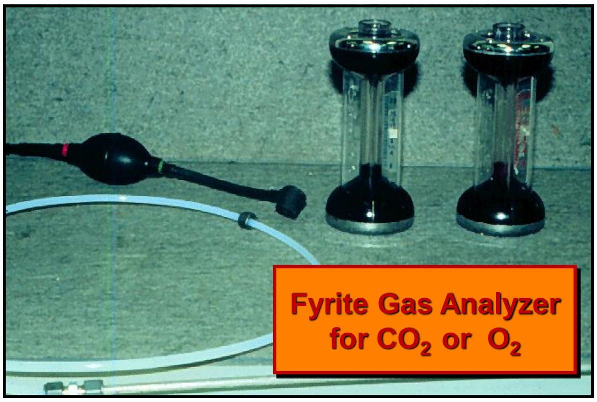
- Determines $\%CO_2$, $\%O_2$, & CO
- Balance is N_2
- Needed for Both Pitot Tube Equation & Isokinetic Rate Equation

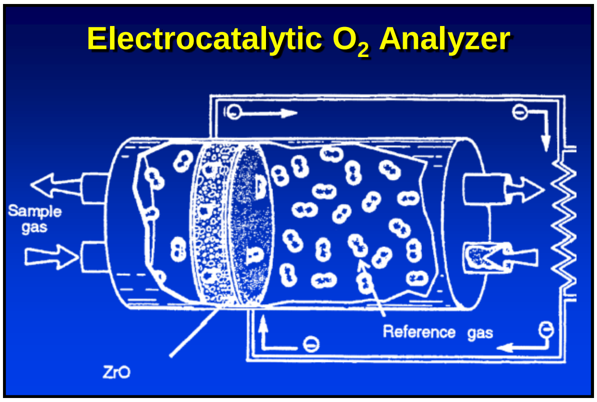


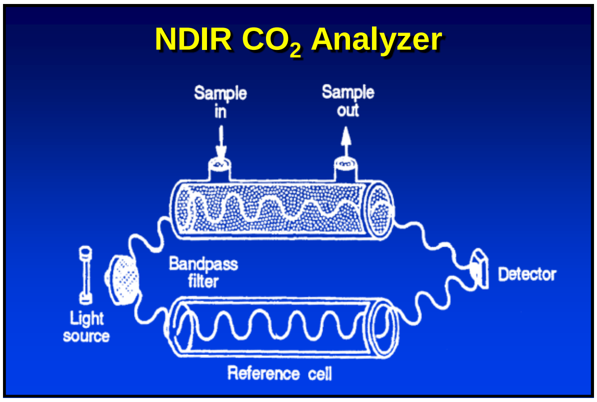



Orsat Analyzer
Three-way inlet valve to manifold
Inlet value to CO pipette
Inlet value to O_2 pipette
Inlet value to CO_2 pipette
Sample inlet
Manifold
Vent reference marks
Volume reference mark
CO
O_2
CO_2
70 mL vol
Water jacket
Pipettes
Leveling bottle
Confining fluid
Side view of typical pipette absorber
Flexible tube


Orsat Analyzer


Fyrite Gas Analyzer for CO_2 or O_2


Electrocatalytic O_2 Analyzer
Sample gas
Reference gas
ZrO


NDIR CO_2 Analyzer
Sample in
Sample out
Bandpass filter
Detector
Light source
Reference cell


INFRARED GAS ANALYZER
CO_2 Analyzer
CO
NOX
SO_2

Molecular Weight by Mole Fraction

- O_2 = 55 mm Hg (8.1%)
- CO_2 = 65 mm Hg (9.6%)
- CO = 8 mm Hg (1.1%)
- N_2 = 552 mm Hg (81.2%)
- P_b = 680 mm Hg

$$M = \Sigma B_i M_i$$

$$\frac{55}{680} \times 32 + \frac{8}{680} \times 28 + \frac{65}{680} \times 44 + \frac{552}{680} \times 28$$

= 30.0 g/mole

F Factors

Fuel Type	F_d		F_w		F_c		F_o
	dscm/J ($\times 10^{-7}$)	dscf/10^6 BTU	wscm/J ($\times 10^{-7}$)	dscf/10^6 BTU	scm/J ($\times 10^{-7}$)	scf/10^6 BTU	
Coal:							
Anthracite	2.71	10,100	2.83	10,540	0.530	1,970	1.016-1.130
Bituminous	2.63	9,780	2.86	10,640	0.484	1,800	1.083-1.230
Lignite	2.65	9,860	3.21	10,950	0.513	1,910	1.016-1.130
Oil:	2.47[1]	9,190[1]	2.77[1]	10,320[1]	0.383[1]	1,420[1]	1.260-1.413[2]
							1.210-1.370[3]
Gas							
Natural	2.43	8,710	2.85	10,610	0.287	1,040	1.600-1.836
Propane	2.34	8,710	2.74	10,200	0.321	1,190	1.434-1.586
Butane	2.34	8,710	2.79	10,390	0.337	1,250	1.405-1.553
Wood	2.48	9,240			0.492	1,830	1.000-1.120
Wood Bark	2.58	9,600			0.516	1,920	1.003-1.130
Municipal Waste	2.57	9,570			0.488	1,820	

ORSAT Analysis Check by F_o

- O_2 = 8.1%
- CO_2 = 9.6%

$$F_o = \frac{20.9 - \%O_2}{\%CO_2}$$

$$F_o = \frac{20.9 - 8.1}{9.6} = 1.33$$

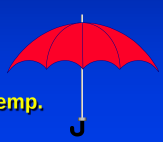
Table value for oil combustion = 1.260 - 1.413

ORSAT analysis is OK

Method 4

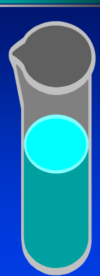
Determination of Moisture Content in Stack Gas

- Needed for Both Pitot Tube Equation & Isokinetic Rate Equation
- 4 Methods Can be Used
  - Saturation Pressure: T_{GAS}
  - Psychrometry: Wet & Dry Bulb Temp.
  - Adsorption: Silica Gel Tubes
  - Condensation: Impingers (Vol of H_2O ÷ Vol of Gas)



Calculation & Procedural Inspections

- Recovery
  - No Spillage
  - Measured Correctly
- Moisture
  - Preliminary
  - Final
  - Dry *vs* Wet Molecular Weight



$$M_{saturated} = M_{dry} (1 - B_{ws}) + 18B_{ws}$$

Wet Basis Molecular Weight

- M_d = 30.0 (dry)
- B_{ws} = 15%

$$M_s = M_d\,(1 - B_{ws}) + 18B_{ws}$$

$$M_s = 30.0\,(1 - 0.15) + 18 \times 0.15$$

$$= 28.2 \text{ g/mole}$$

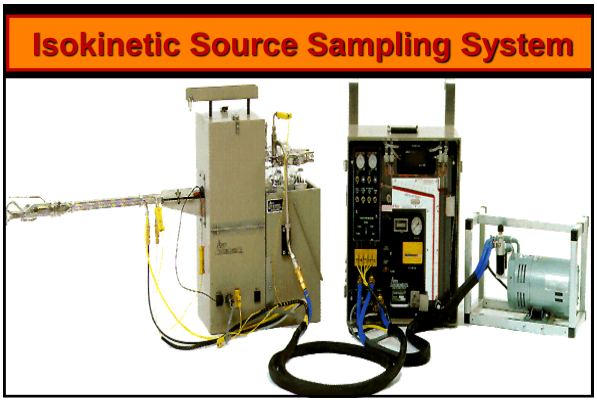
B_{ws} = Vol of H_2O ÷ Vol of Gas

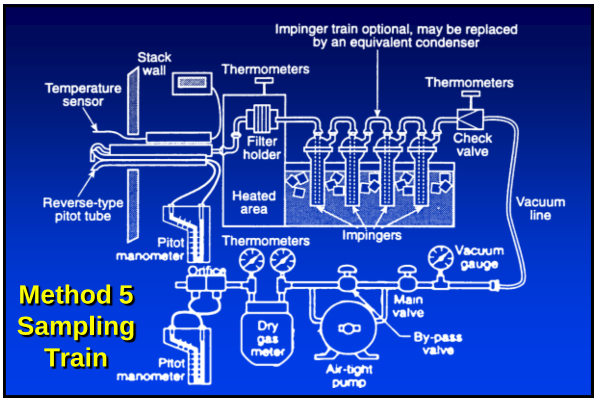
Method 5

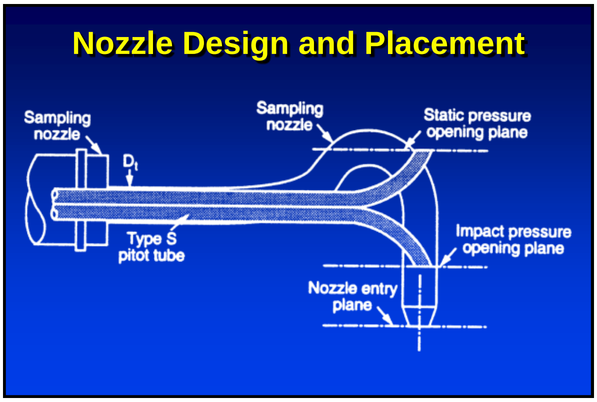
Determination of Particulate Emissions from Stationary Sources

- Isokinetic Sampling -- The sample is drawn into the probe nozzle at the same rate as it is moving in the flue gas.


Iso : Same as
Kinetic : Motion


Isokinetic Source Sampling System


Impinger train optional, may be replaced by an equivalent condenser
Stack wall
Temperature sensor
Thermometers
Thermometers
Filter holder
Check valve
Heated area
Reverse-type pitot tube
Vacuum line
Impingers
Thermometers
Pitot manometer
Vacuum gauge
Orifice
Method 5 Sampling Train
Main valve
Dry gas meter
By-pass valve
Pitot manometer
Air-tight pump

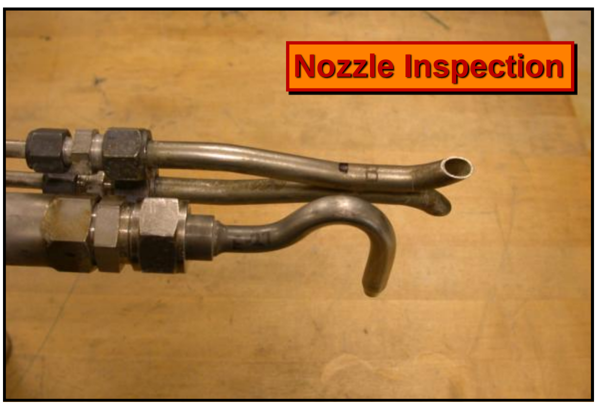

Nozzle Design and Placement
Sampling nozzle
Sampling nozzle
Static pressure opening plane
D_t
Type S pitot tube
Impact pressure opening plane
Nozzle entry plane


Sample Nozzles


Sample Nozzles

Physical Inspections

- Nozzle
  - Construction (SS or Glass)
  - Alignment & Installation on the Probe
  - Dents, etc.
  - Calibration
  - Rinsed During Sample Recovery



Calculation Inspections

- Nozzle Diameter

$$D_n = \sqrt{\frac{K_D Q_m P_m}{T_m C_p (1-B_{ws})} \sqrt{\frac{T_s M_s}{P_s \Delta p_{est}}}}$$

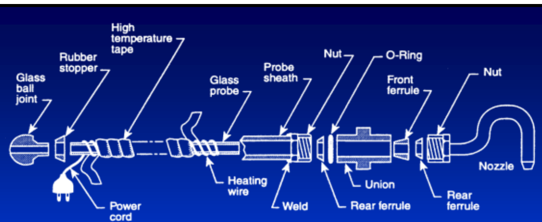
K_D = 6.07 (0.0358 English units)

Nozzle Diameter

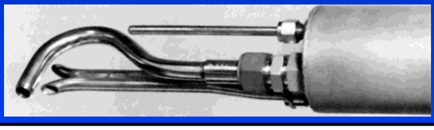
- $K_D = 6.07$
- $Q_m = 0.021\ m^3$
- $P_m = 683.6$ mm Hg
- $T_m = 28^oC$
- $C_p = 0.84$
- $B_{ws} = 0.15$
- $T_s = 345^oC$
- $M_s = 28.2$ g/mole
- $p_s = 35$ mm H_2O
- $\Delta\ p_{est} = 38$ mm H_2O

$$D_n = \sqrt{\frac{6.07x0.021x683.6}{(28+273)x0.84x(1-0.15)}}\sqrt{\frac{(345+273)x28.2}{(680+35/13.6)x38}}$$

$D_n =$ 0.576 cm

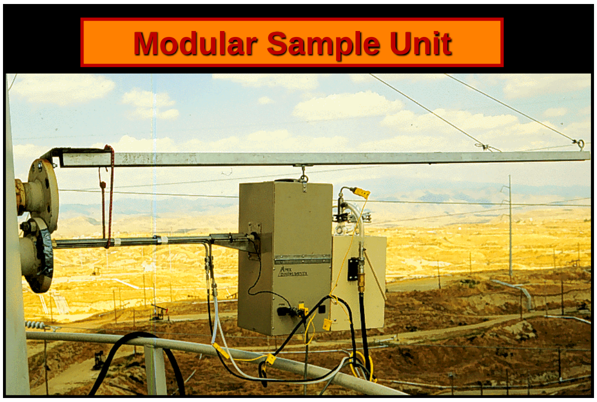


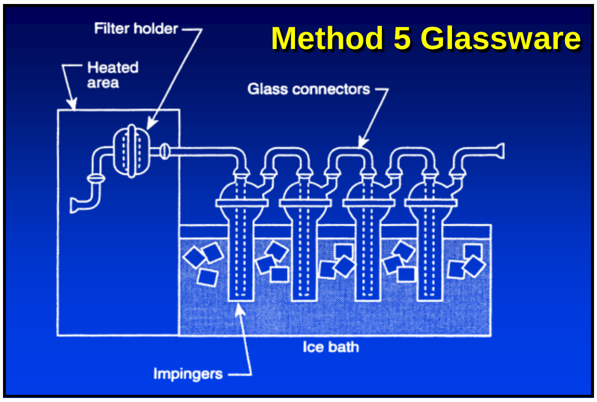
Probe Assembly

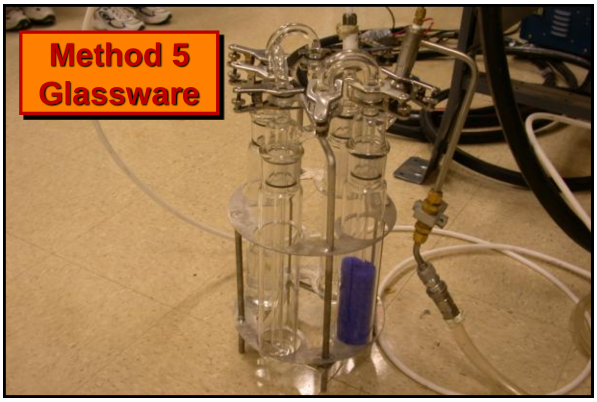


Physical Inspections

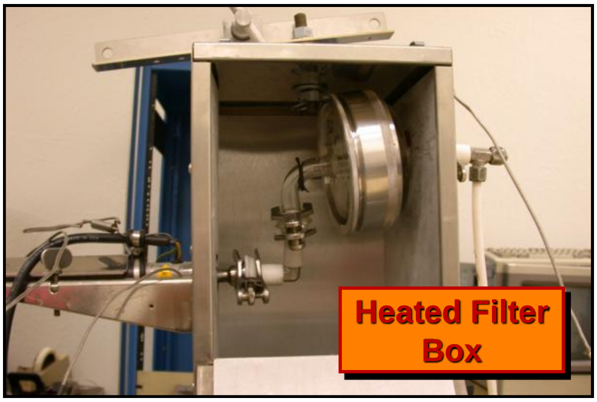
- Temperature Probe
  - Condition
  - Calibrated
- Probe
  - Long Enough to Reach, Not Too Long
  - Heated
  - SS or Glass Liner
  - Marked (Heat Resistant) for Traverse Points
  - Rinsed During Sample Recovery


Modular Sample Unit


Method 5 Glassware
Filter holder
Heated area
Glass connectors
Ice bath
Impingers

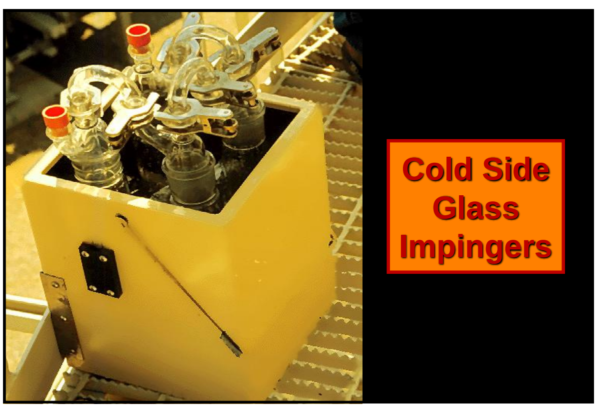

Method 5 Glassware

Observing Source Tests



Physical Inspections

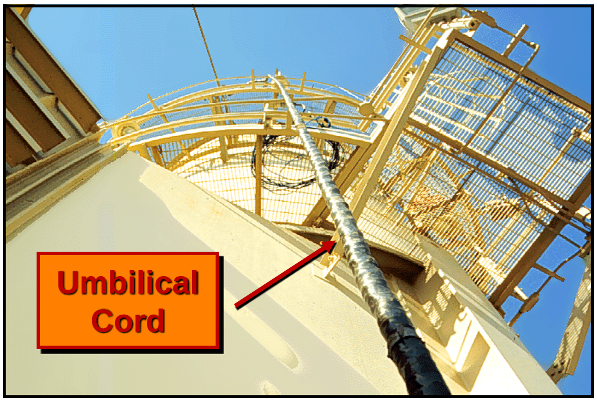
- Sampling Case - Hot Side
  - Heated (Check Method for Proper Temperature)
    - Temperature Gauge Installed
  - Glassware Properly Assembled

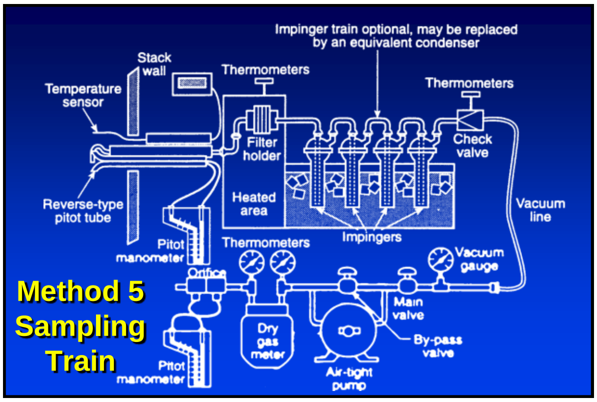


Physical Inspections

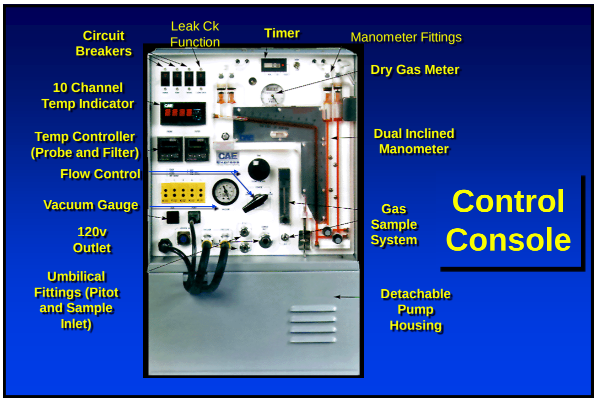
- Sampling Case - Cold Side
  - Glassware Properly Set-Up
  - Proper Solutions in Impingers
  - Ice & Water Bath - Exit Temperature

Observing Source Tests




Impinger train optional, may be replaced by an equivalent condenser
Stack wall
Temperature sensor
Thermometers
Thermometers
Filter holder
Check valve
Heated area
Reverse-type pitot tube
Vacuum line
Pitot manometer
Thermometers
Impingers
Vacuum gauge
Orifice
Method 5 Sampling Train
Main valve
Dry gas meter
By-pass valve
Pitot manometer
Air-tight pump


Isokinetic Control Console

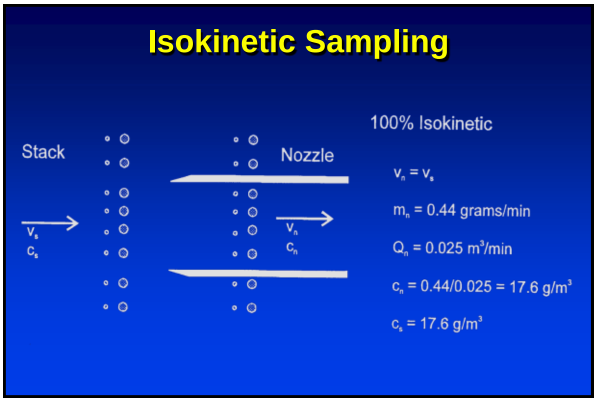

Circuit Breakers
Leak Ck Function
Timer
Manometer Fittings
Dry Gas Meter
10 Channel Temp Indicator
Temp Controller (Probe and Filter)
Dual Inclined Manometer
Flow Control
Vacuum Gauge
Gas Sample System
Control Console
120v Outlet
Umbilical Fittings (Pitot and Sample Inlet)
Detachable Pump Housing

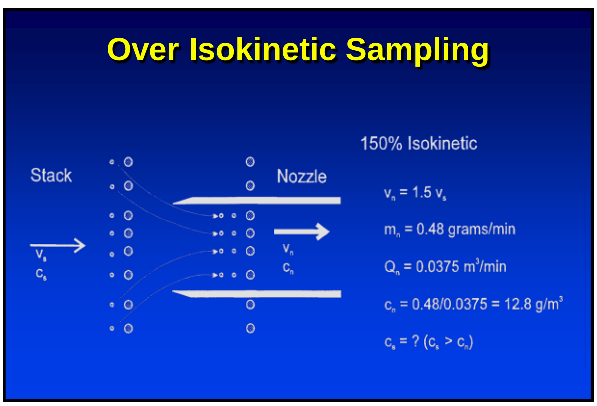
Physical Inspections

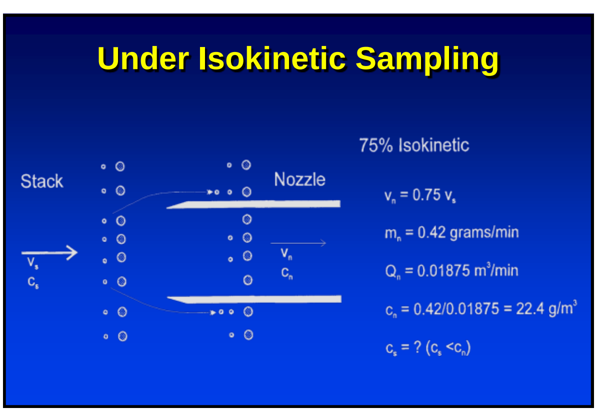
- Pump
  - Non-reactive and leak free
- Dry gas meter
  - Leak free
  - Calibrated
- Orifice meter
  - Calibrated

Sampling Rate

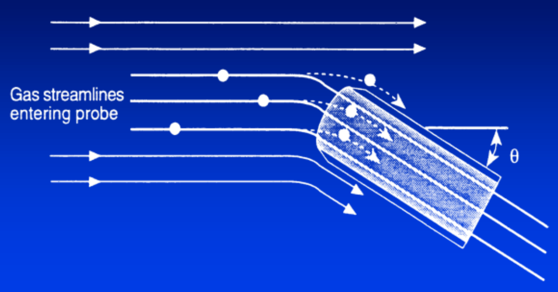
- Constant Rate
- Proportional
- Isokinetic


Isokinetic Sampling
Stack
Nozzle
100% Isokinetic
$v_n = v_s$
m_n = 0.44 grams/min
Q_n = 0.025 m^3/min
c_n = 0.44/0.025 = 17.6 g/m^3
c_s = 17.6 g/m^3
v_s
c_s
v_n
c_n


Over Isokinetic Sampling
Stack
Nozzle
150% Isokinetic
$v_n = 1.5\ v_s$
m_n = 0.48 grams/min
Q_n = 0.0375 m^3/min
c_n = 0.48/0.0375 = 12.8 g/m^3
c_s = ? ($c_s > c_n$)
v_s
c_s
v_n
c_n


Under Isokinetic Sampling
Stack
Nozzle
75% Isokinetic
$v_n = 0.75\ v_s$
m_n = 0.42 grams/min
Q_n = 0.01875 m^3/min
c_n = 0.42/0.01875 = 22.4 g/m^3
c_s = ? ($c_s < c_n$)
v_s
c_s
v_n
c_n

Nozzle Misalignment



Calculation Inspections

- Orifice Meter (Sample Flow Rate) Settings

$$\Delta H = \underbrace{K_H D_n^4 \Delta H_@ C_p^2 (1-B_{ws})^2 \frac{M_d T_m P_s}{M_s T_s P_m}} \Delta p$$

K factor - used for rapid calculation of ΔH

K_H = 0.803 (846.72 English units)

K Factor and ΔH

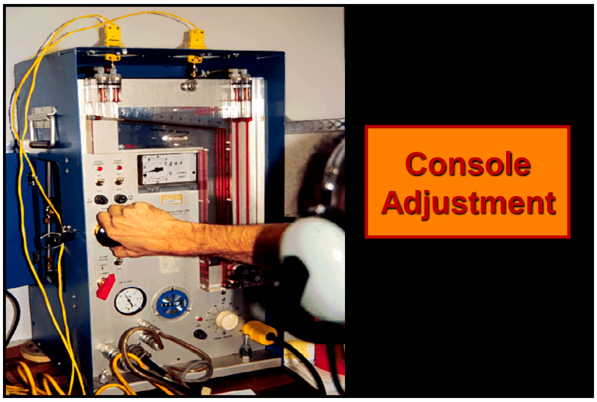
- K_H = 0.803
- D_n = 0.576 cm
- $\Delta H_@$ = 49.3 mm H_2O
- C_p = 0.84
- B_{ws} = 15%
- Δp = 38.1 mm H_2O
- M_d = 30.0 g/mole
- M_s = 28.2 g/mole
- T_m = 28°C
- T_s = 345°C
- p_s = 35 mm H_2O
- P_m = 683.3 mm Hg

$$\Delta H = 0.803x(0.576)^4x49.3x0.84^2(1-0.15)^2 \frac{30.0x(28+273)x(680+{}^{35}/_{13.6})}{28.2x(345+273)x683.3} \text{ x } 38.1$$

K Factor = 1.15

Δp = 38.1

$\Delta H = K \text{ x } \Delta p = 43.81$



Procedural Inspections

- Sampling Points
  - Properly Laid Out
  - Move Between Points on Time
  - Move Between Points Quickly
  - Data Read & Recorded Quickly & Accurately
  - Delta H Calculated & Adjusted Quickly
- Dry Gas Meter
  - Start/Stop Times & Volume Readings Accurately Recorded
  - Sampling Times & Volume Requirements Met

Calculation Inspections

- Percent Isokinetic

$$\%I = 100\ \frac{T_s[V_{lc}K + V_m/T_m\,(P_b + {}^{\Delta H}/_{13.6})]}{60\ \Theta\ A_n\ V_s\ P_s}$$

K = 0.003454 mm Hg m³/ml K
(0.002669 in Hg ft³/ml °R)

Percent Isokinetic

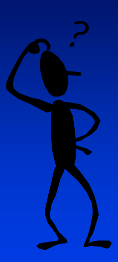
- T_s = 345°C
- Θ = 48 min
- V_{lc} = 113 ml
- V_m = 1.008 m^3
- T_m = 28°C
- P_b = 680 mm Hg
- ΔH = 43 mm H_2O
- A_n = 2.6x10^{-5} m^2
- V_s = 32.5 m/s
- p_s = 35 mm H_2O

$$\%I = 100\,\frac{(345+273)[113\times0.003454+1.008/(28+273)(680+43/13.6)]}{60\times48\times2.6\times10^{-5}\times32.5\times(680+35/13.6)}$$

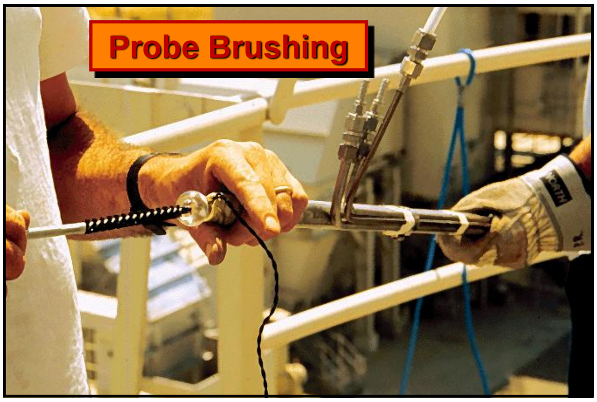
%I = 99.7%

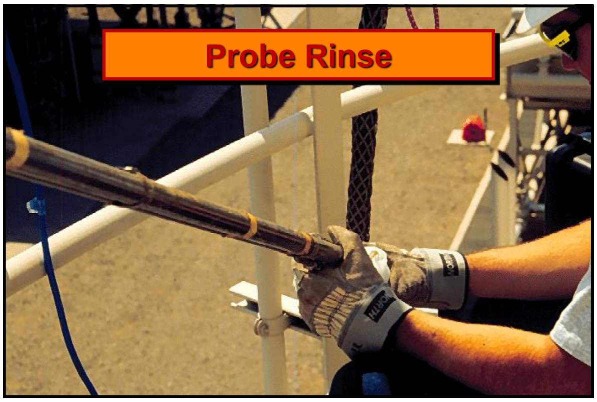
Procedural Inspections

- Sample Recovery
  - Sampling Completion Procedure
  - Leak-Check
  - Cool-Down
  - Probe & Glassware Cleanup
  - Impinger Recovery
  - Filter Recovery

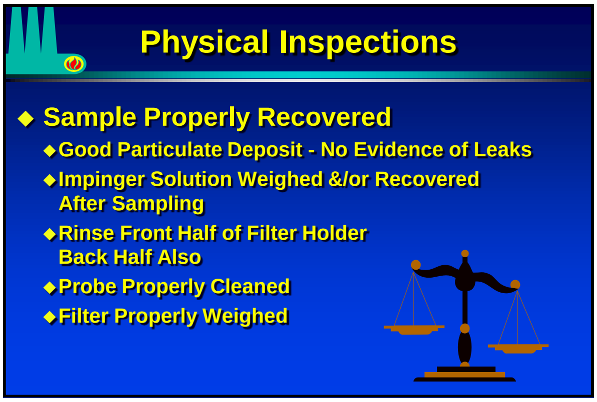



Sampling Train Leak Test

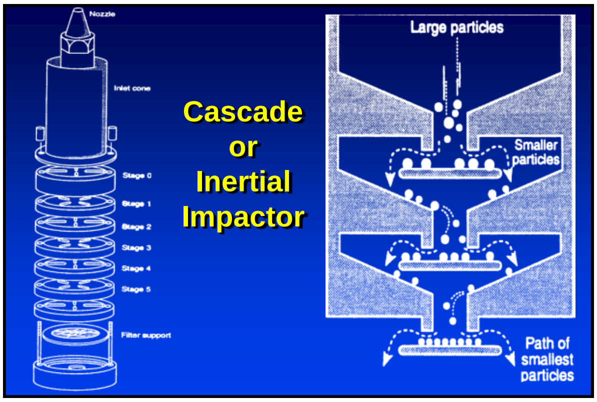

Probe Brushing

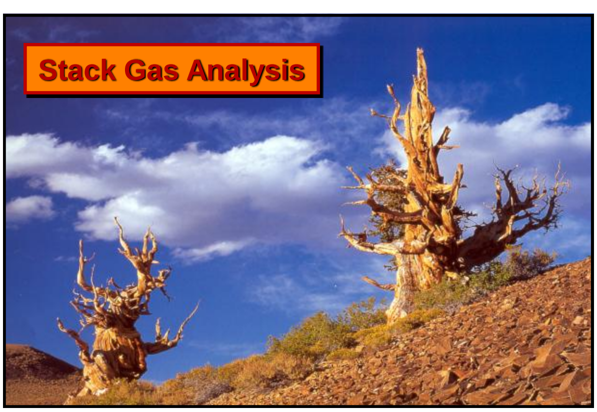

Probe Rinse

Observing Source Tests



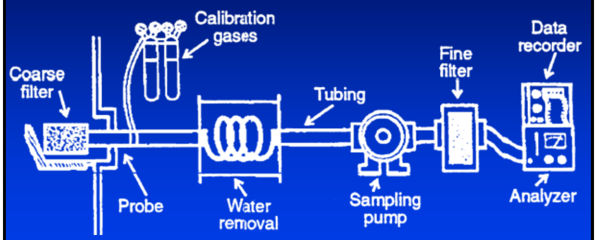
Observing Source Tests





Observing Source Tests

Basic Extractive System

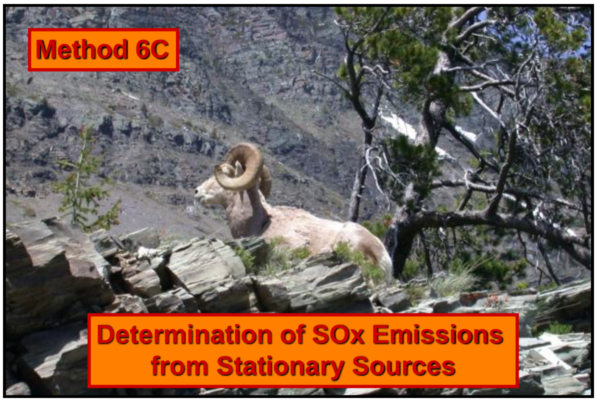


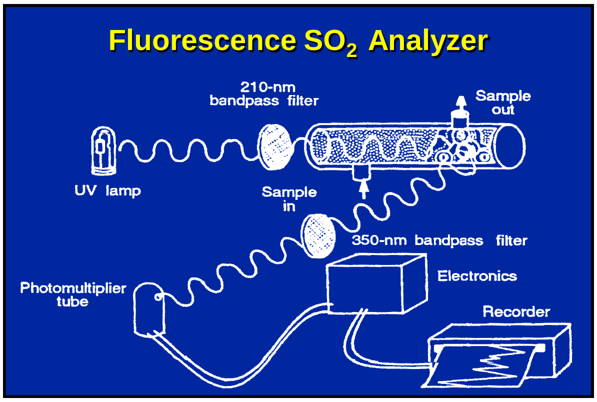
Source Test Analytical Techniques

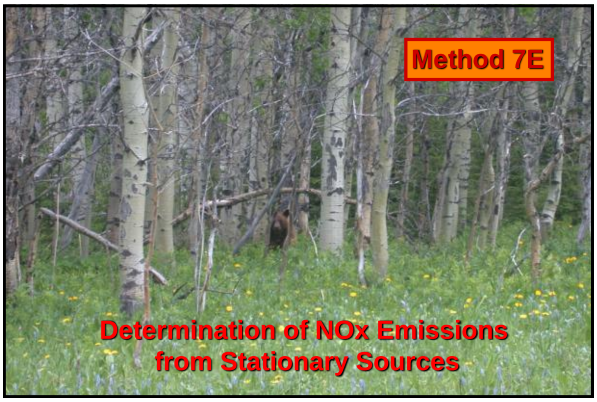
- Infrared Methods
  - Differential Absorption
  - Gas Filter Correlation
  - Fourier Transform Infrared
- Ultraviolet Methods
  - Differential Absorption
  - Second Derivative Spectroscopy
- Visible Light
  - Scattering & Absorption

Source Test Analytical Techniques

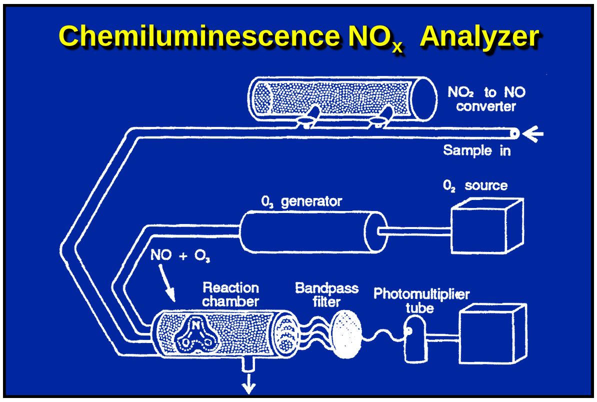
- Luminescence Methods
  - Fluorescence
  - Chemiluminescence
  - Flame Photometry
- Electroanalytical Methods
  - Polarography
  - Electrocatalytic
  - Paramagnetism
  - Conductivity

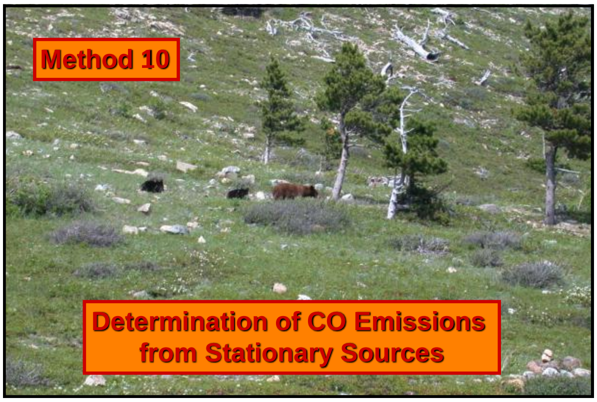

Method 6C
Determination of SOx Emissions from Stationary Sources


Fluorescence SO_2 Analyzer
210-nm bandpass filter
Sample out
UV lamp
Sample in
350-nm bandpass filter
Electronics
Photomultiplier tube
Recorder

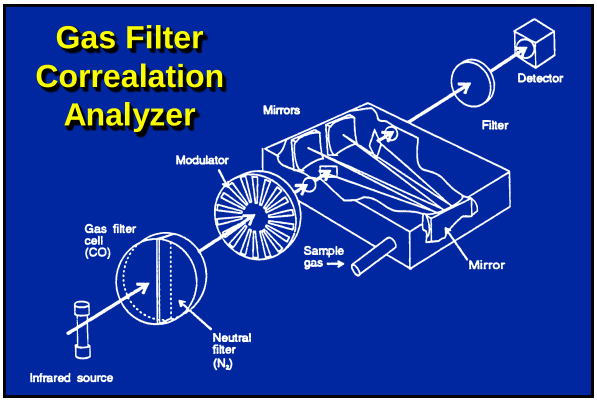

Method 7E
Determination of NOx Emissions from Stationary Sources

Observing Source Tests



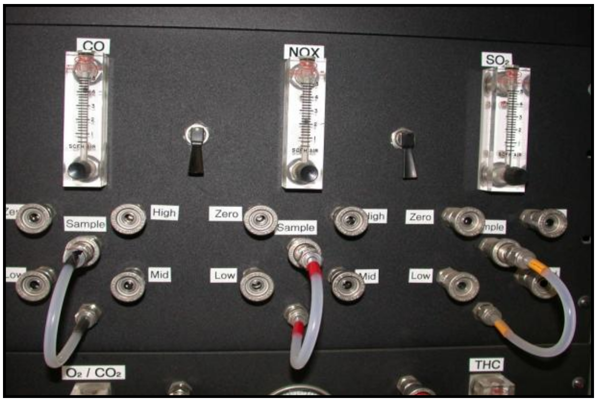


Observing Source Tests



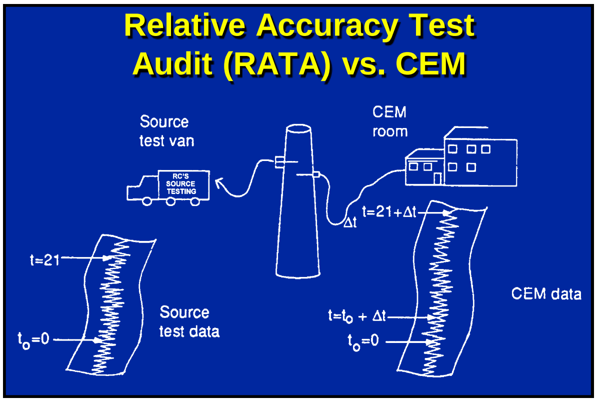
Instrument Inspections

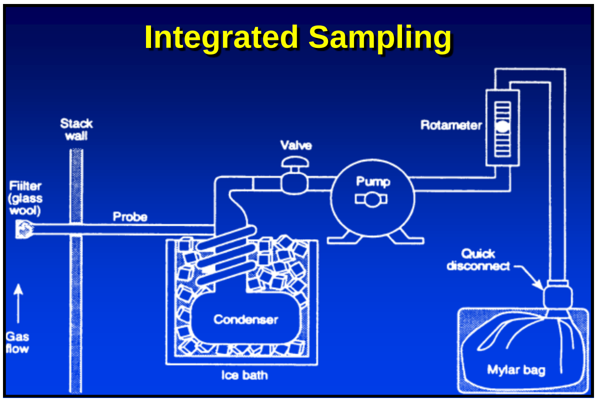
- Always Check Applicable Method & Subpart
- Instrument Span
- Calibration Error
  - <+/- 2 % of Span for Zero, Mid, & High Range Gases
- Sampling System Bias
  - <+/- 5% of Span for Zero & Mid or High Range Gases
- Zero Drift & Calibration Drift
  - <+/- 3% of Span Over the Period of Each Run
- Interference Check



Cal Gas Certificate Points

- Cylinder ID Number
- Balance Gas
- Cylinder Pressure
- Certification Date
- Expiration Date
- Lab & Analyst ID
- Reference Standard Data
- Statement of Procedures
- Certified Concentration
- Gas Analyzer ID & Cal Date
- Analyzer Readings & Calc Used
- Chronological Cert Record

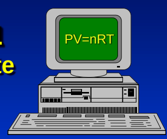

Relative Accuracy Test Audit (RATA) vs. CEM
Source test van
CEM room
RC'S SOURCE TESTING
t=21+Δt
Δt
t=21
Source test data
CEM data
t=t$_o$ + Δt
t$_o$=0
t$_o$=0


Integrated Sampling
Stack wall
Rotameter
Valve
Filter (glass wool)
Pump
Probe
Quick disconnect
Condenser
Gas flow
Mylar bag
Ice bath


Grab Sample Case

Procedural Inspections

Data Recording

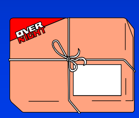


- Timely, Accurate, & Complete
- Standardized Form Used
- Computer Data Entry:
  - Automatic - Computer Controlled Equipment
  - On Site After Sampling or During Sample (Computer Data Entry Form)
  - After Sampling Completed

Procedural Inspections

Sample Conservation

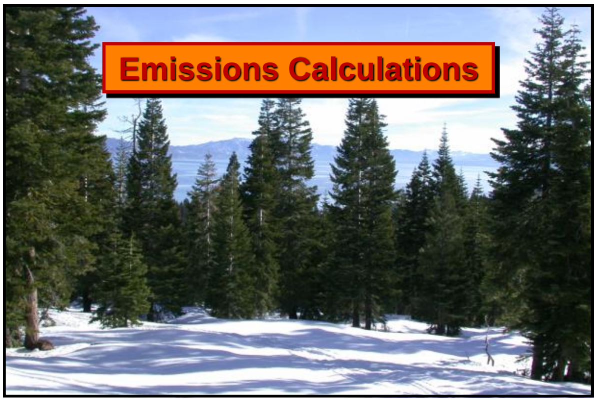
- Container Material Must be Compatible with Sample
- Storage Conditions
  - Refrigerate the Samples if Held Overnight
- Blanks Properly Prepared & Shipped with Field Samples
- Sample Container Must be Labeled
- Shipping
- Chain-of-Custody



Procedural Inspections

Analysis

- On Site
  - Weights & Volumes
  - Some Simple Titration's & Chemical Analysis can be Done on Site
  - Work Area Conditions must be Consistent with Good Laboratory Procedures
- Off Site
  - Analytical Lab Should be Certified
- QA Samples



Emission Calculations

Emission rates

- Concentration (c_s) : (ppm, g/dscm, gr/dscf)
- Pollutant mass rate (pmr_s) : (kg/hr, lb/hr)
- Process rate (E) : (ng/J, lb/10^6 BTU, lb/ton)
- Flow rates or F factors

Emissions

$$E = \frac{pmr_s}{Q_H} = \frac{c_s Q_s}{Q_H} \qquad E = c_s F\left(\frac{20.9}{20.9 - \%O_2}\right)$$

Calculation Inspections

- Normalized to Diluent Gas
  - O_2
  - CO_2

Conditions

$12\%\ CO_2$

$$c_{s\ 12\%} = c_s \frac{12}{\%CO_2}$$

$6\ \%\ O_2$

$$c_{s\ 6\%} = \frac{15\ c_s}{21 - \%O_2}$$

Effects of Errors

Impact of Errors on the Sample

- What is the Data to be Used for?
- What is the Direction & Magnitude of the Error?
- What is the Acceptable Bias Before Rejecting the Sample?

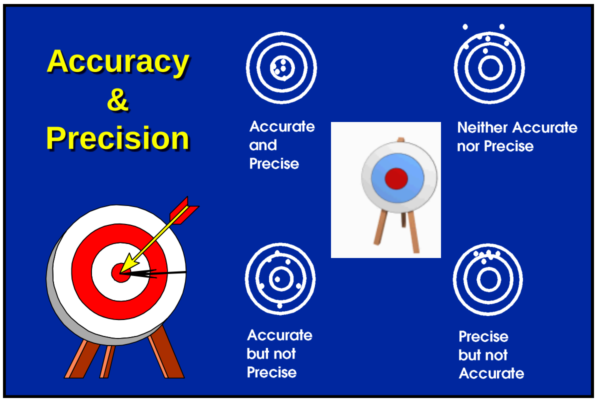
Effects of Errors

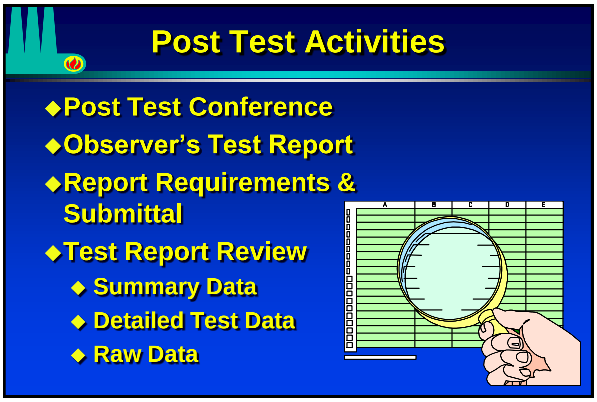
Accuracy

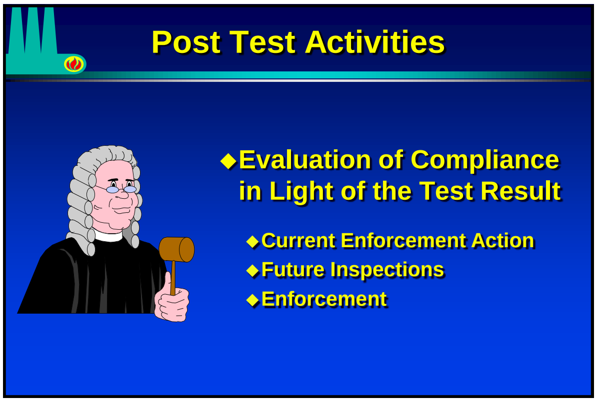
→ Compares Well with the Correct Value

Precision

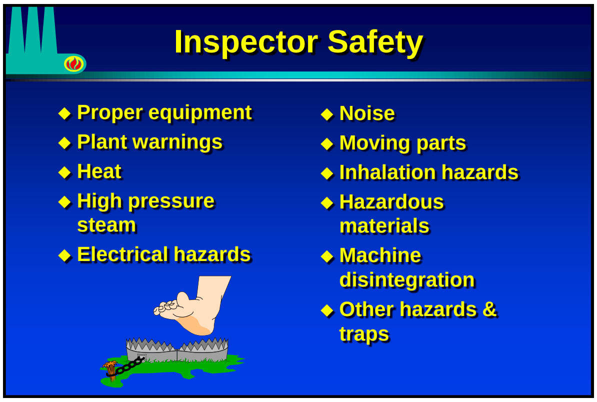
→ Repeated Tests Give the Same Results

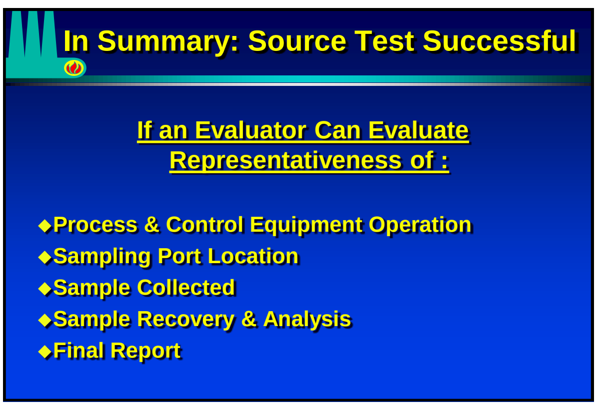

Accuracy
&
Precision
Accurate
and
Precise
Neither Accurate
nor Precise
Accurate
but not
Precise
Precise
but not
Accurate

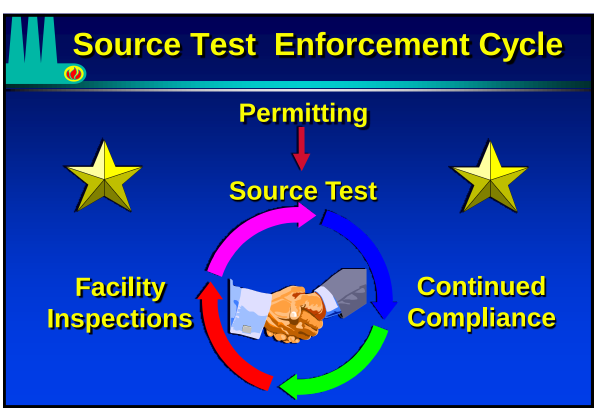

Post Test Activities
◆Post Test Conference
◆Observer's Test Report
◆Report Requirements &
Submittal
◆Test Report Review
◆ Summary Data
◆ Detailed Test Data
◆ Raw Data


Post Test Activities
◆Evaluation of Compliance
in Light of the Test Result
◆Current Enforcement Action
◆Future Inspections
◆Enforcement

Observing Source Tests







Observing Source Tests