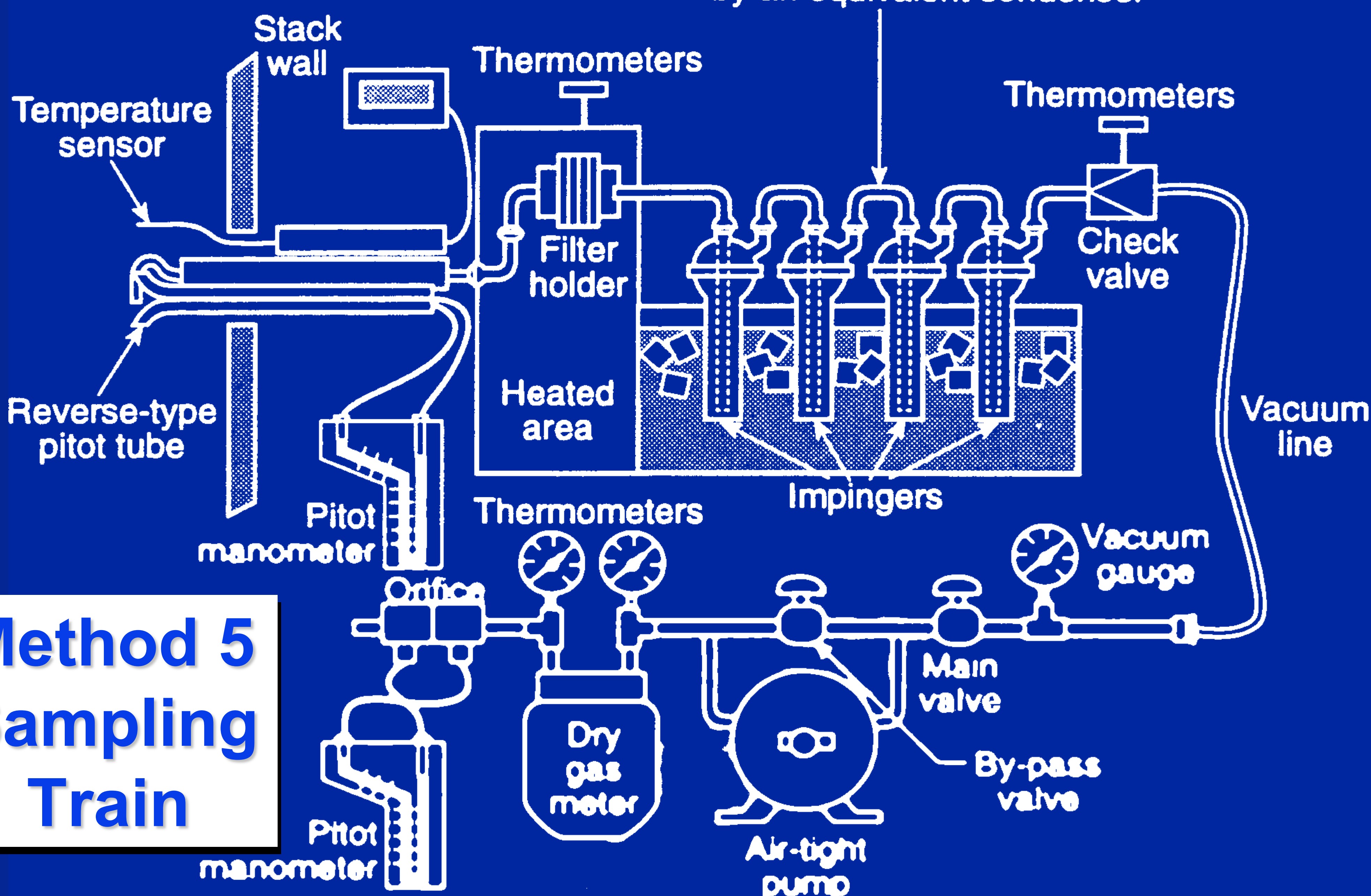
NACT 224

Observing Source Tests

Course Overview

- Planning a Source Test
- Source Test Basics
- Observing the Test
- Problem Areas
- Reviewing Test Data

Method 5 Sampling Train

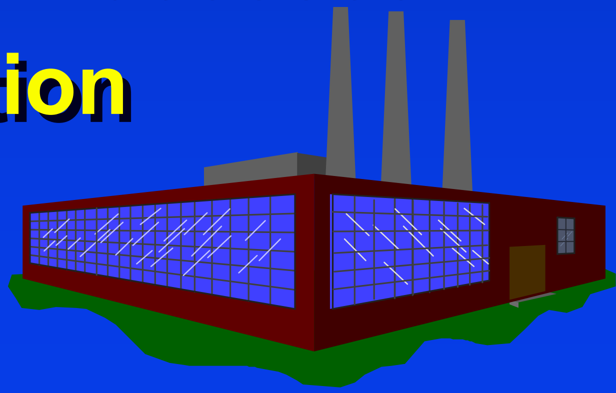


Purpose of Source Testing

- **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

Authorities Requiring Source Testing

- Federal
  - NSPS
  - NESHAP
  - Title V Permits
- State and Local Requirements
  - Enforcement
  - Permitting
  - Emissions Inventory

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

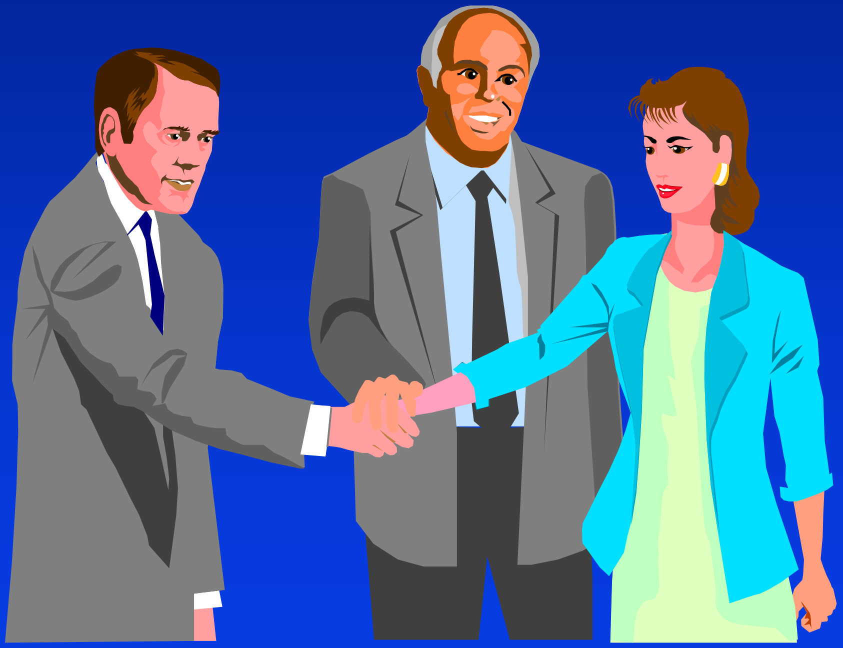
- Represent the Interests of Agency
  - Tests Satisfy the Needs of the Agency
  - Planning & Pretest
  - During the Test
  - Post Test
- QA/QC Officer

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 (Cont'd)

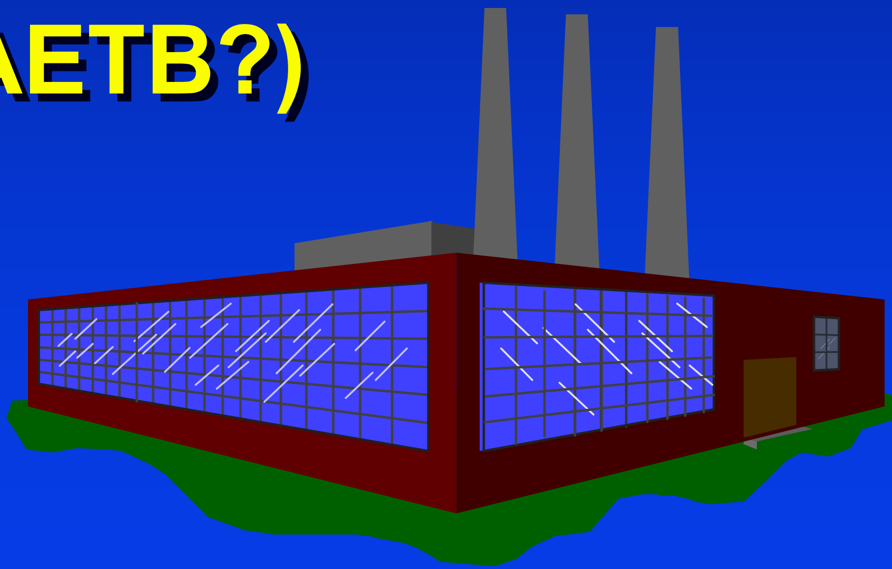
- Observer Behavior
  - Test is Successful
  - Cooperate with Both Facility & Testers
  - Specific & Firm Requests
  - DO NOT Intrude or Interfere Unnecessarily



Test Protocol

Test Protocol

- Name & Location of Tested Facility
- When is Test (Adequate Notification?)
- Purpose of Test
- Testing Contractor (AETB?)
- 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

Firefox

2013 Protocol Gas Verification Progra... | Stack Testing Accreditation Council -...

www.betterdata.org/accreditedorganizations.htm

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STAC
STACK TESTING ACCREDITATION COUNCIL

Stack Testing Accreditation Council

Home Page | Get Accredited | Accredited Organizations | About STAC | Membership | Resources | Training | Contact

Accredited Organizations

Currently Accredited Organizations:

Interim Accreditation

Note: Interim Accreditation confers all the benefits and privileges as Final Accreditation. The only difference being that it requires a successful field audit during the interim period. Presently the field audit procedure is being finalized and an outline and text of early drafts are posted.

- Air Compliance Testing
- Air Hygiene International
- Air Kinetics
- Airtech Environmental Services
- Avogadro Environmental Corporation
- Avogadro Group
- CK Environmental
- Clean Air Engineering
- C.E.M. Solutions
- Dominion Generation
- Energy and Environmental Measurement (EEMC)
- ENTEC Service
- GE International, Inc
- Golden Specialty
- Grace Consulting
- Horizon / AMTest
- Integrity Air Monitoring

Testing Access & Hazards

Testing Access

- Access to the Stack
  - Getting Equipment to the Stack, Vehicle Access
  - How far up is the Testing Platform?
  - Getting Personnel & Equipment up the Stack
  - Is the Platform Secure?

- Logistics
  - Are there Electrical Outlets at the Stack?
  - What Load will the Electrical Circuits Hold?
  - Explosion Proof Electrical Equipment Required?


Stack
Access


Testing
Platform


Stack Access


Stack
Platform

Hazards

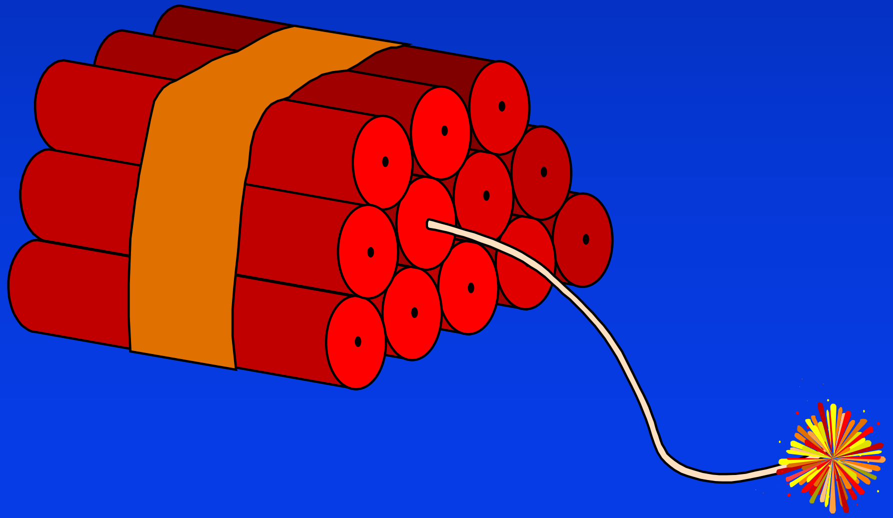
- What are the Stack Emissions?
- What Heat & Gas Hazards Exist?
- What are the Facility Health & Safety Procedures?
- Are Entry, Confined Space, or Other Permits Required?


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



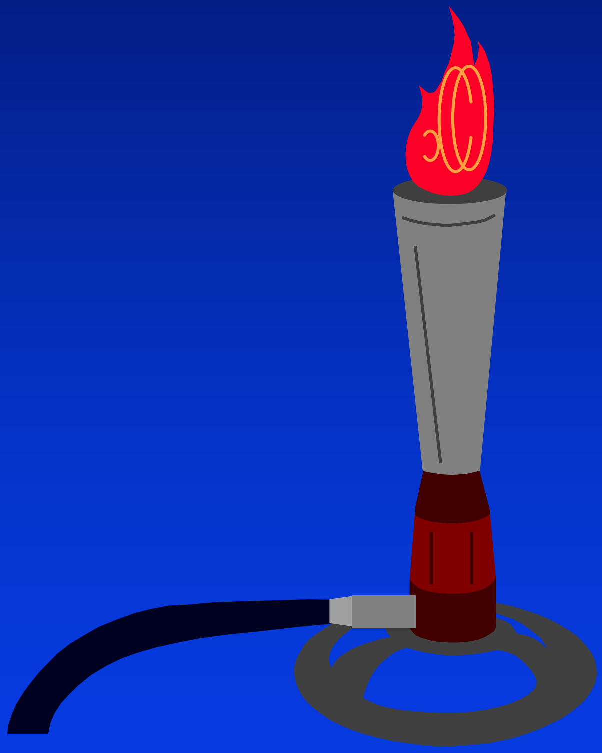
Plant Malfunction

Height & Falling Object Hazards

Protective Safety Equipment

Problem Sources

- Eccentric & Tapered Stacks
- Horizontal Ducts
- Unconfined Flow
- High Temperatures
- Saturated Stack Gas

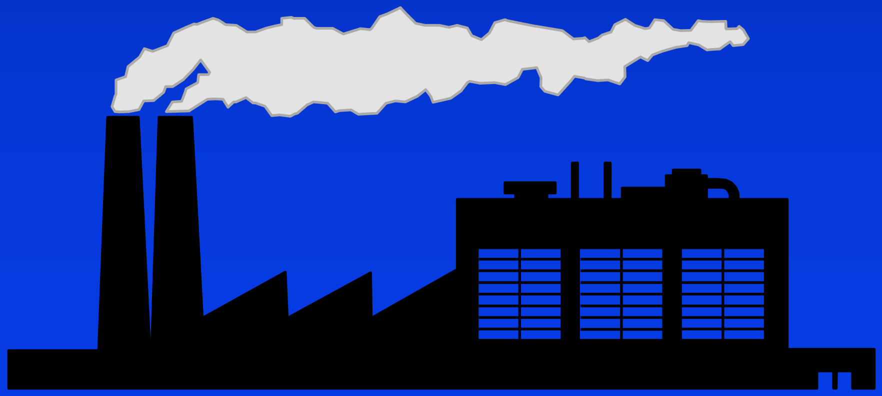



Saturated Exhaust


High Temp. Exhaust

Problem Sources

- Low Flow Rate
- Cyclonic Flow
- Condensables
- Reactive Compounds
- Soot Blowing




High Pressure Steam


Stack Access

Observing the Source Test

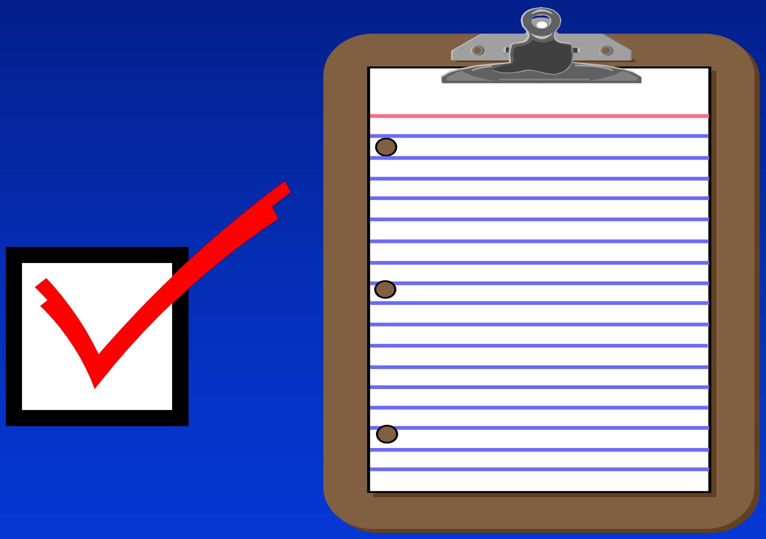
- Physical Inspection Points
- Procedural Inspection Points
- Calculation Inspection Points
- Preliminary Data Collection
- QC Audits

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




Let’s Discuss
Basic Test
Methods

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

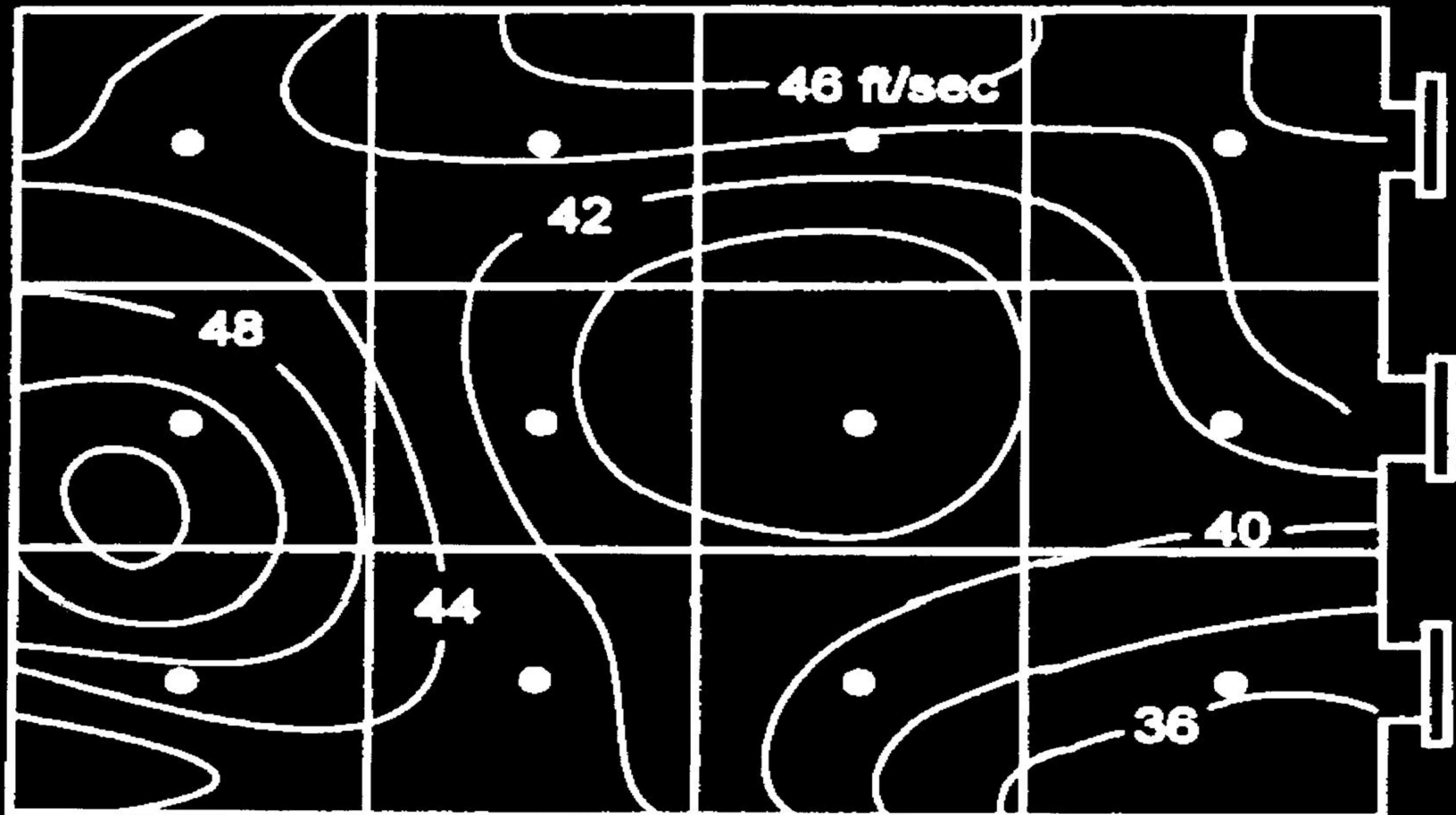

Method 1

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

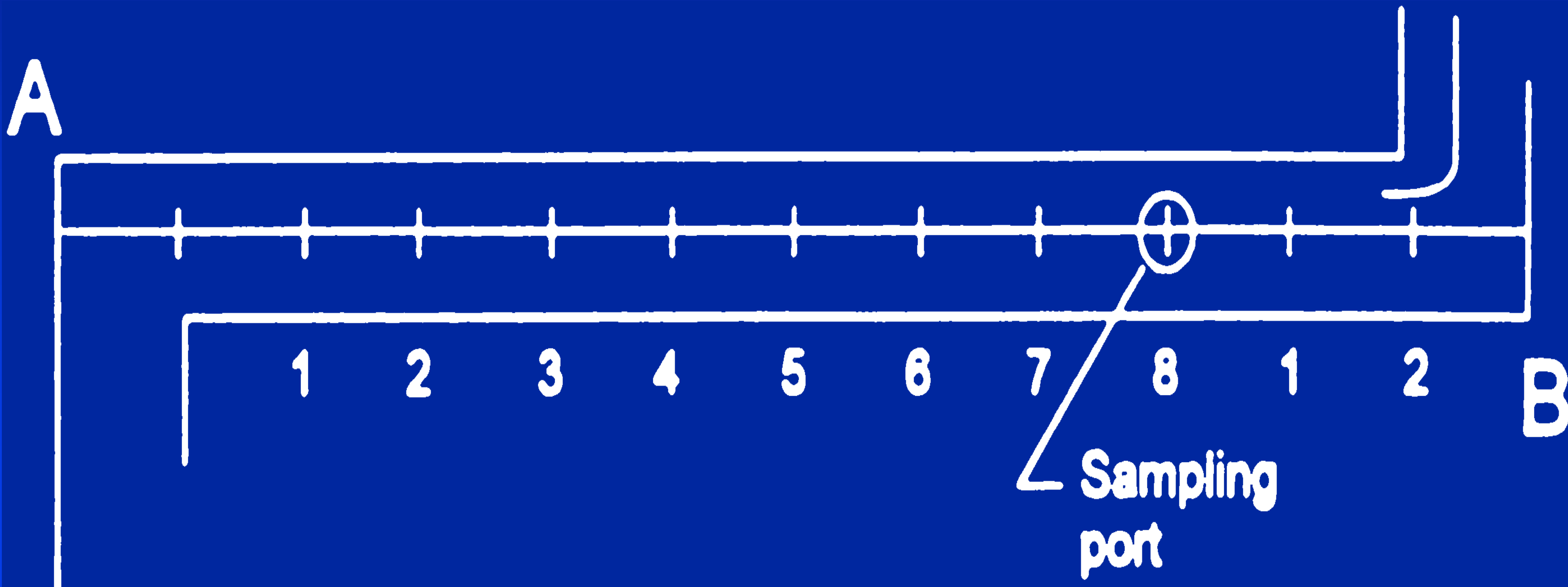
Stack Velocity Stratification




Cyclonic
Flow

Sampling Site Criteria

Ideal: Port is 8 duct diameters downstream of A and 2 duct diameters upstream of B

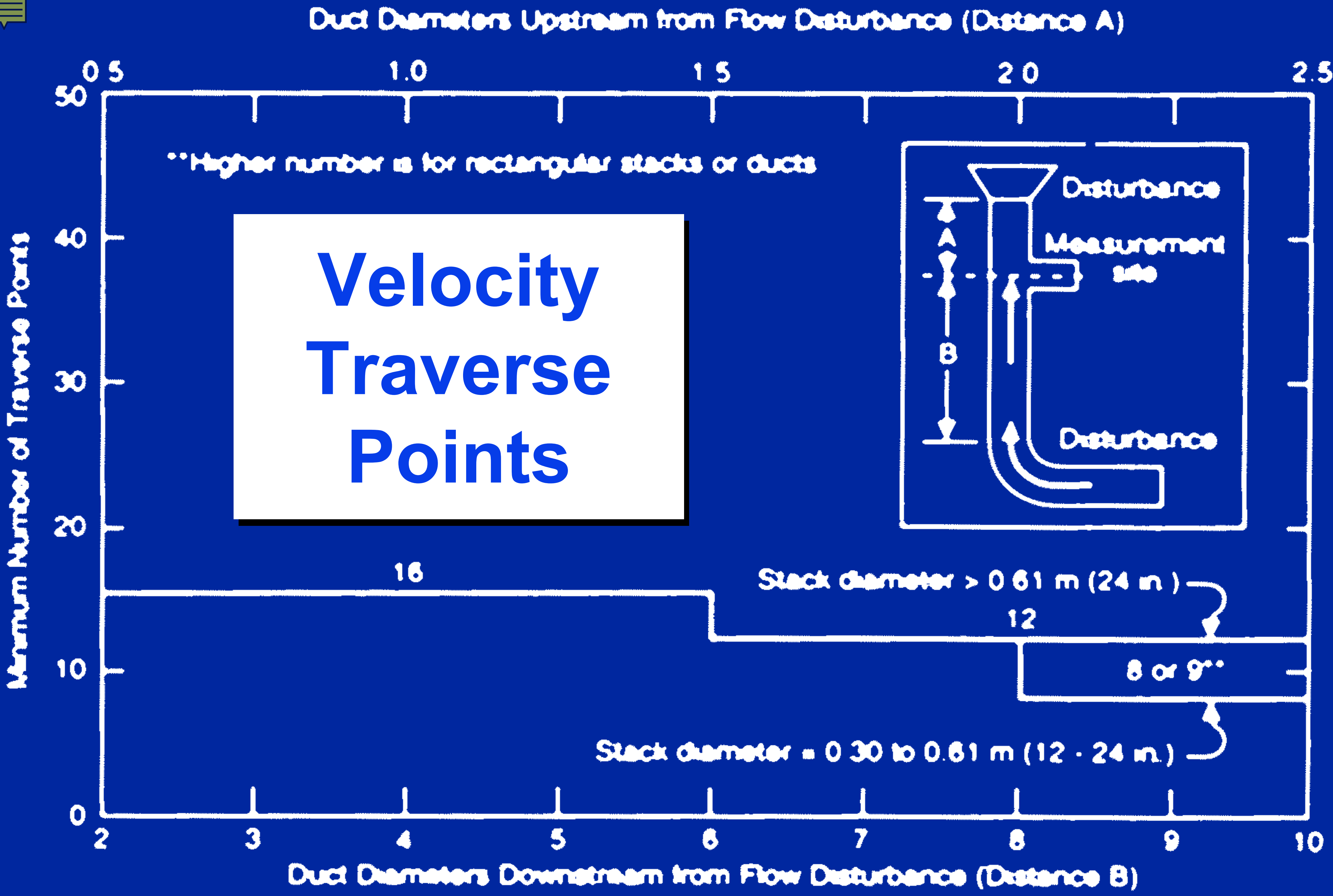


Sampling Criteria

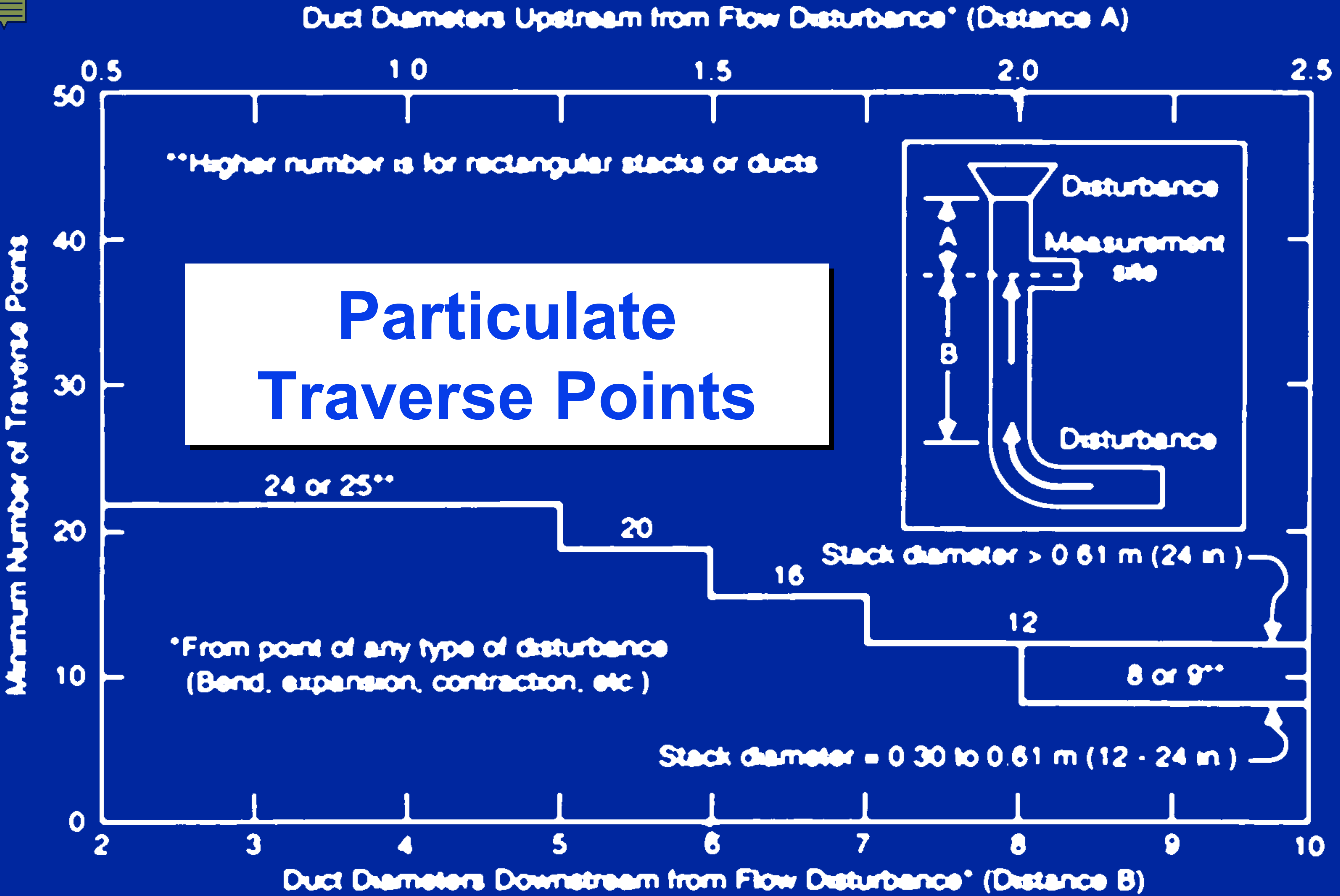
Sampling Criteria


8 & 2
Criteria

Velocity Traverse Points



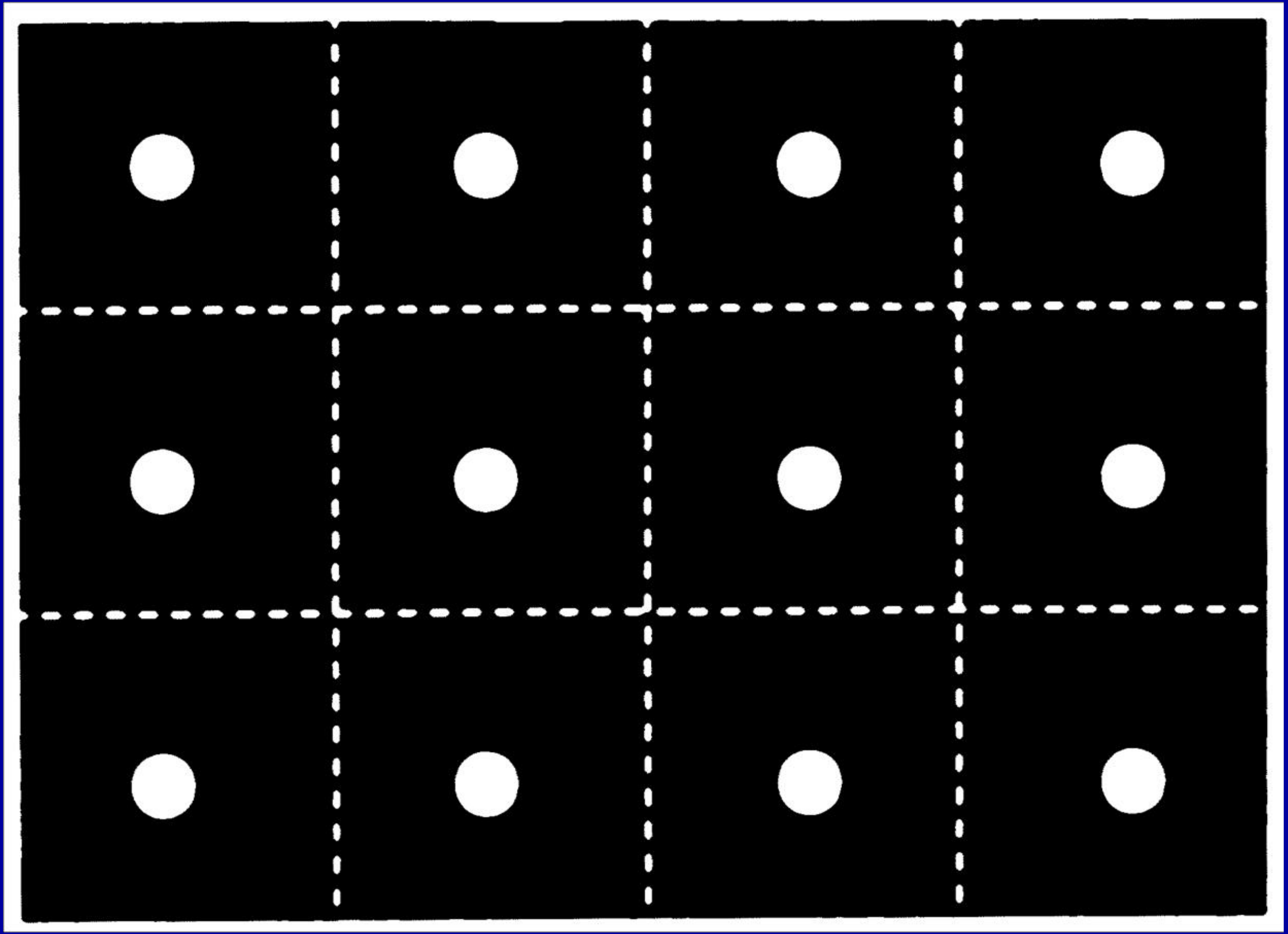
Particulate Traverse Points



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

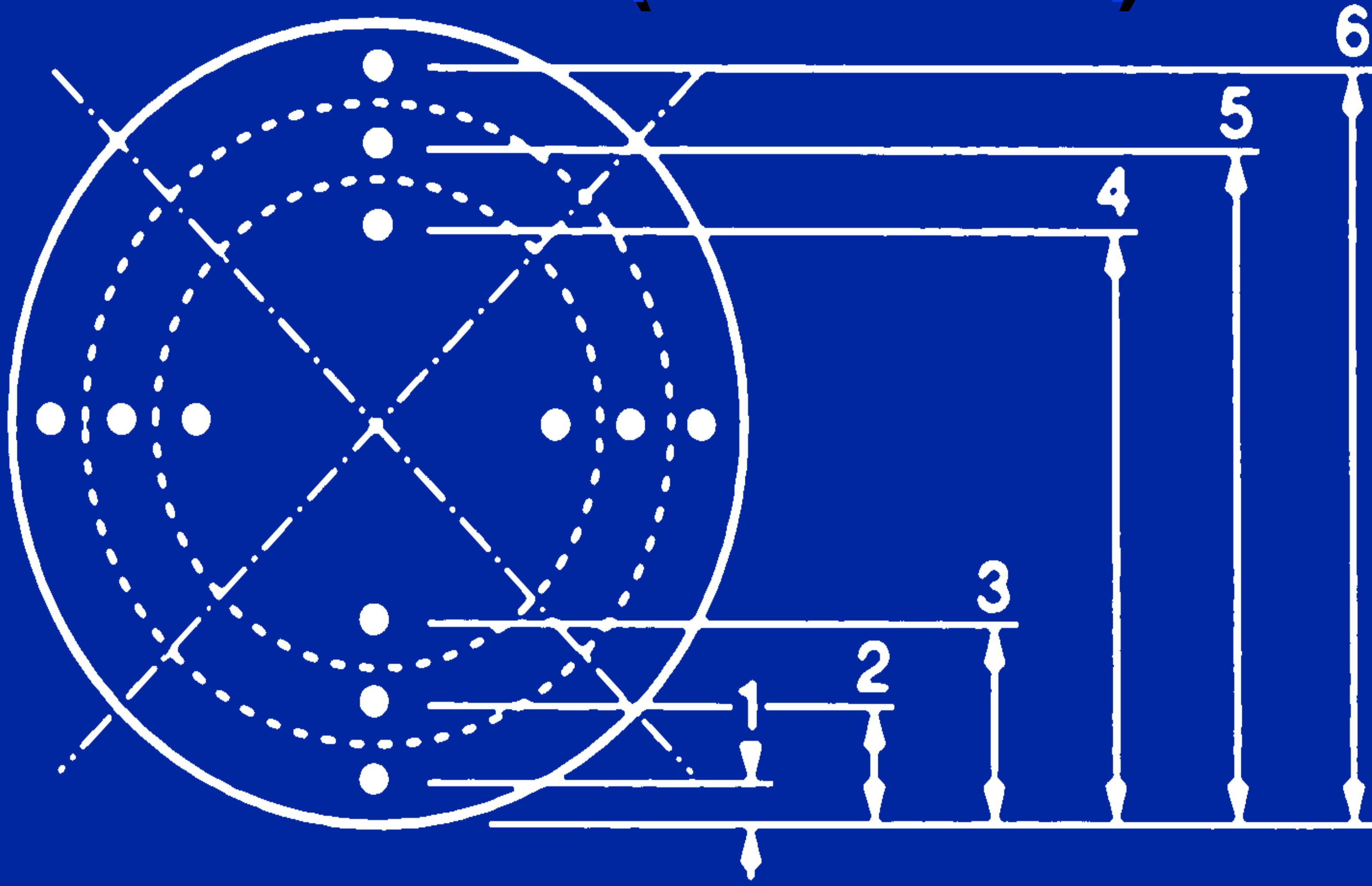
Rectangular Duct Traverse (12 points)



Pt. 60, App. Meth. 1

Circular Stack Traverse (12 Points)

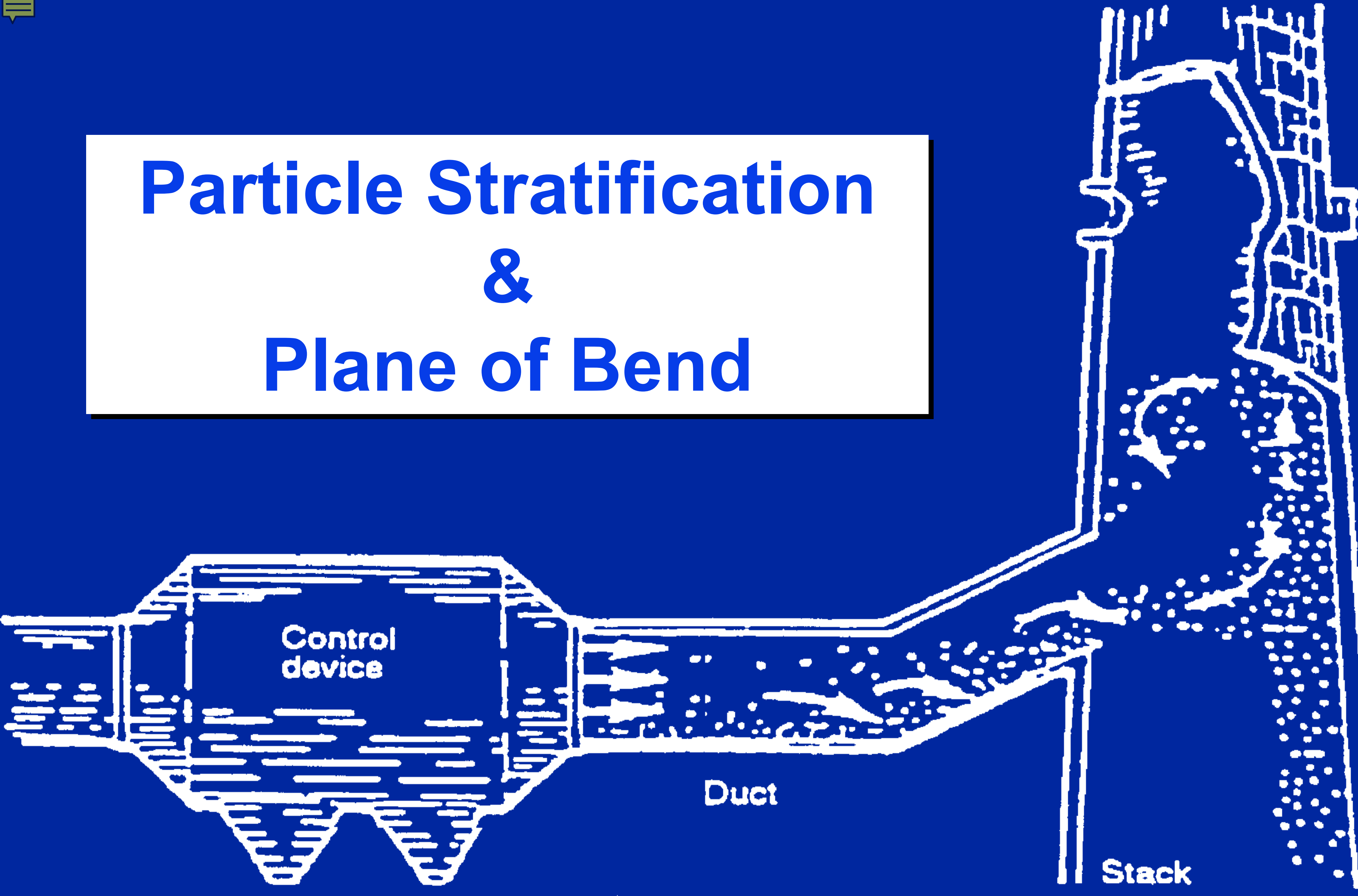
Traverse Point	Distance, % of diameter
1	4.4
2	14.6
3	29.6
4	70.4
5	85.4
6	95.6



Location of Traverse Points in Circular Stacks

Traverse Point #	Number of traverse points on a diameter											
	2	4	*6	8	10	12	14	16	18	20	22	24
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

Particle Stratification & Plane of Bend




Cyclonic
Flows

Calculation Inspections

- Confirm Input Data
  - Stack
    - Dimensions
    - Calculate Equivalent Diameter (If Stack is Not Circular)
    - Location of Disturbances
  - Traverse Points
    - Evaluate Number of Points
    - Evaluate Location of Points

Equivalent Diameter

$$D_e = \frac{2\,LW}{L + W}$$

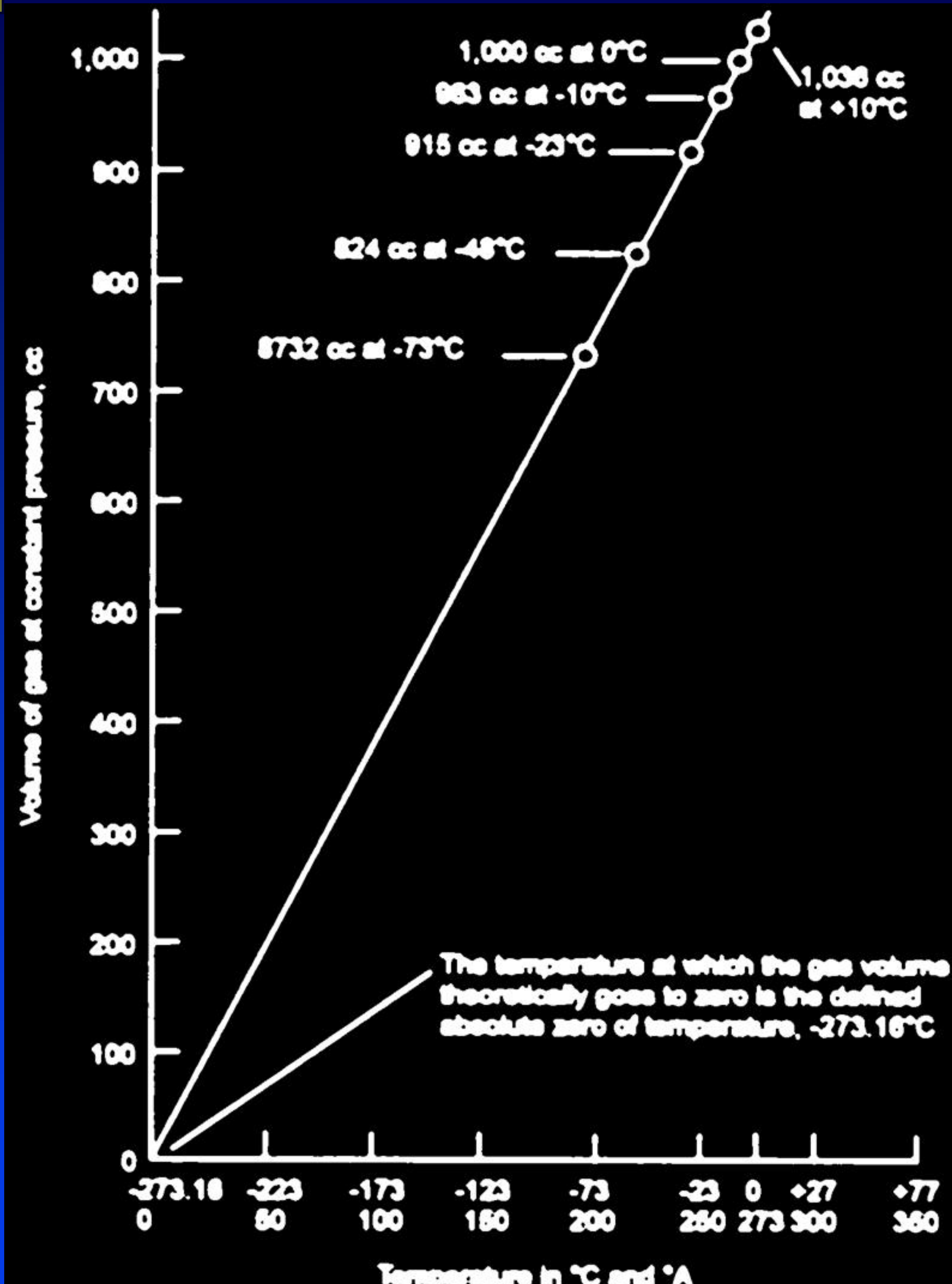

Method 2

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 = ºF + 459.49

Degrees Kelvin: K

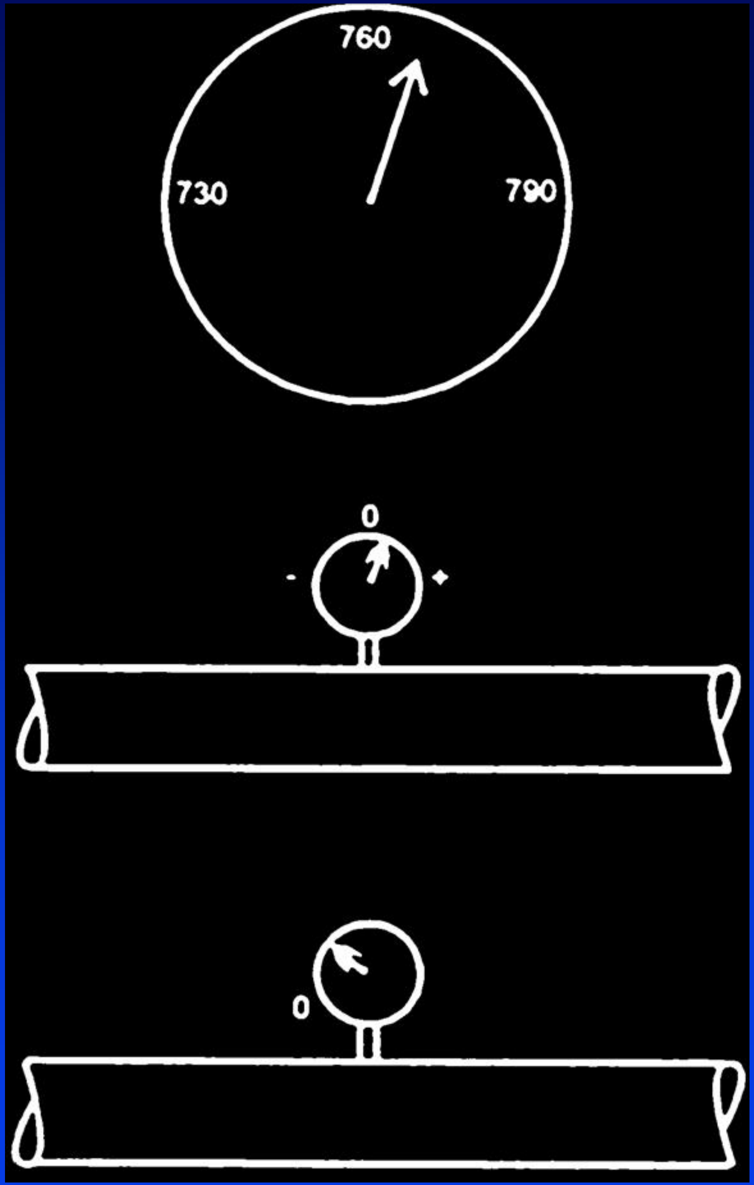
K = º C + 273.16

Atmospheric or Barometric Pressure

Gauge Pressure

Absolute Pressure

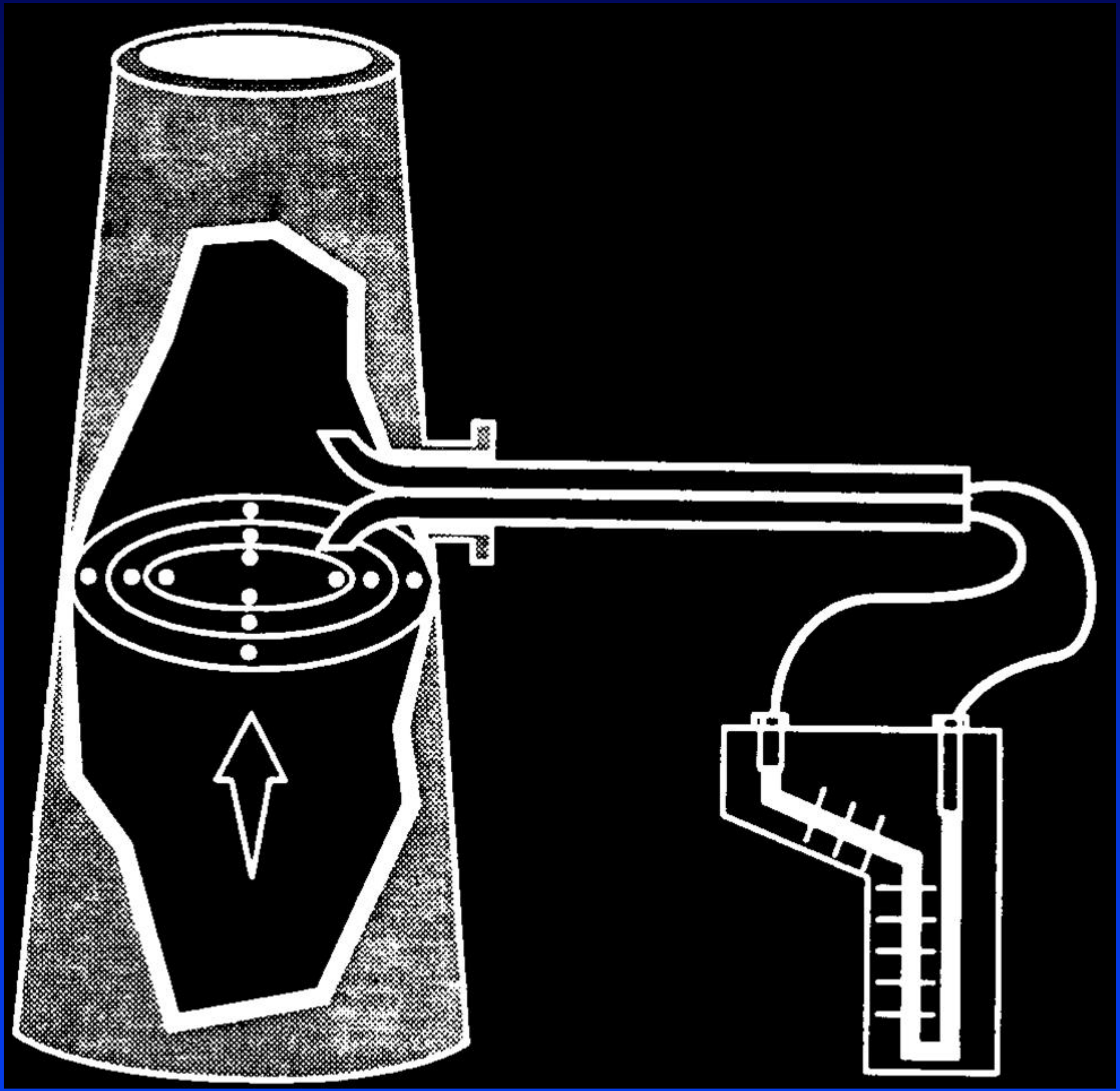
$$P_a = P_b + P_g$$



P_b

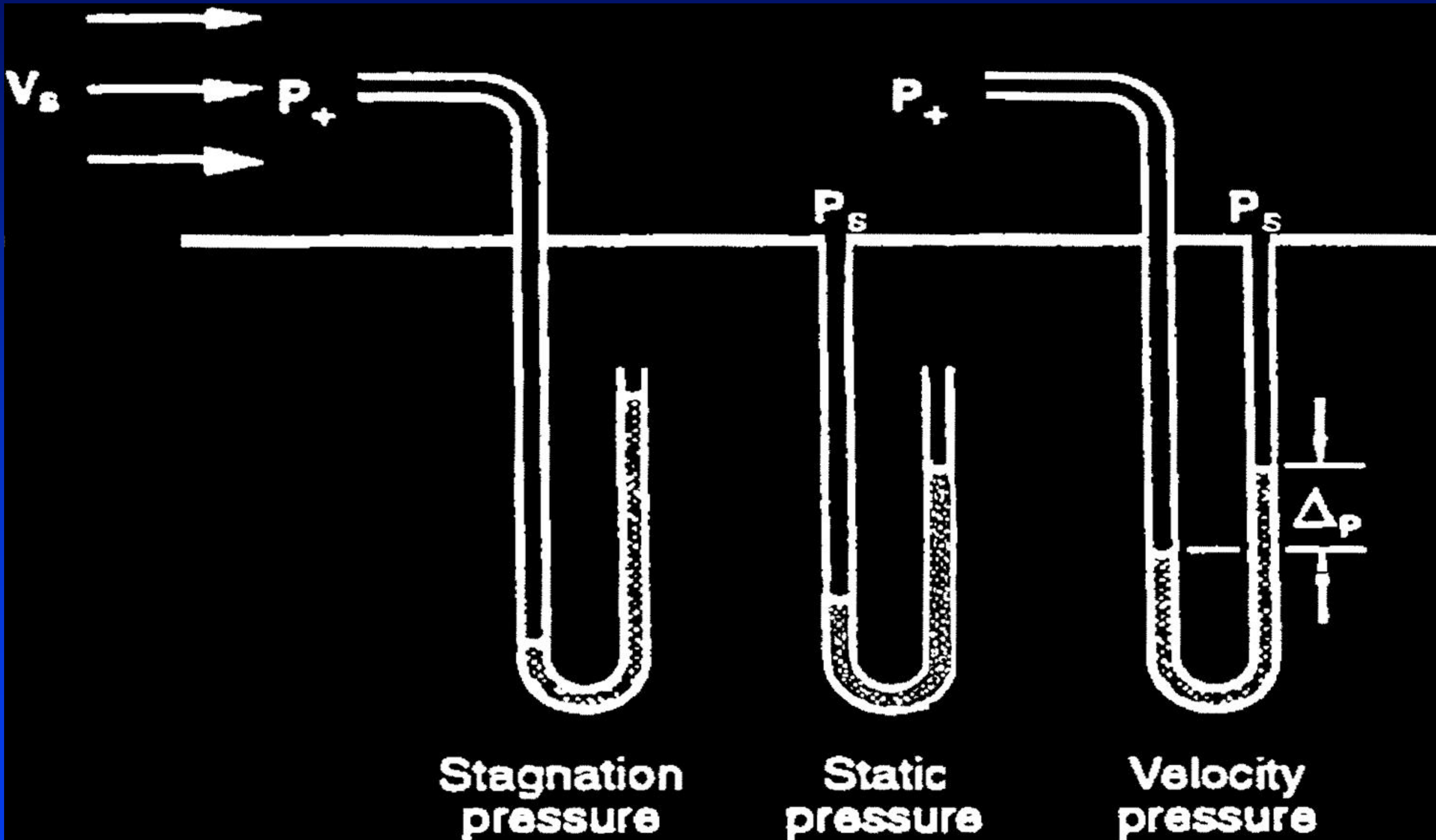
P_g

P_a

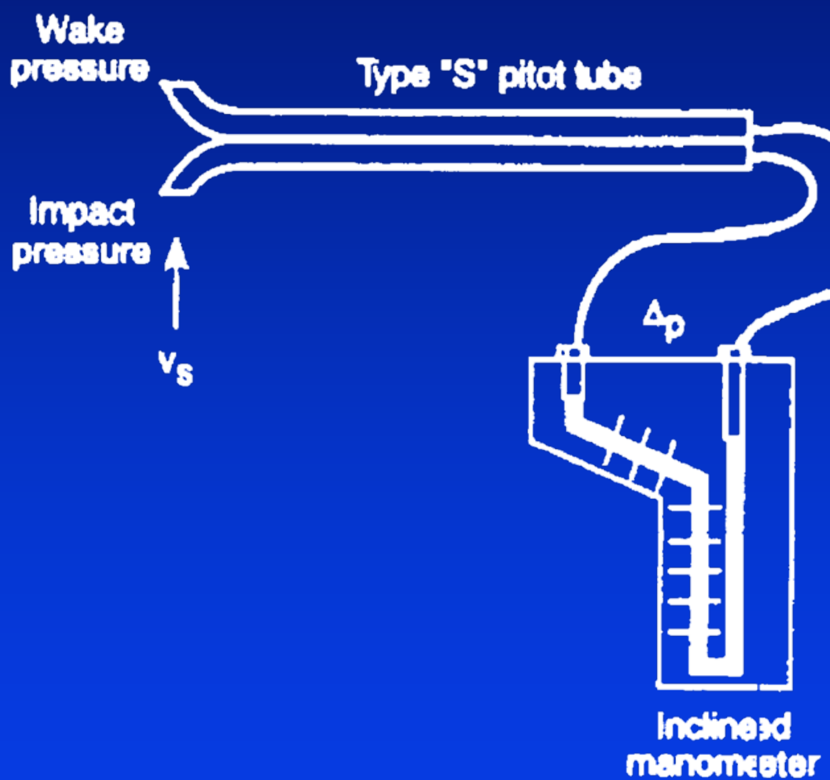


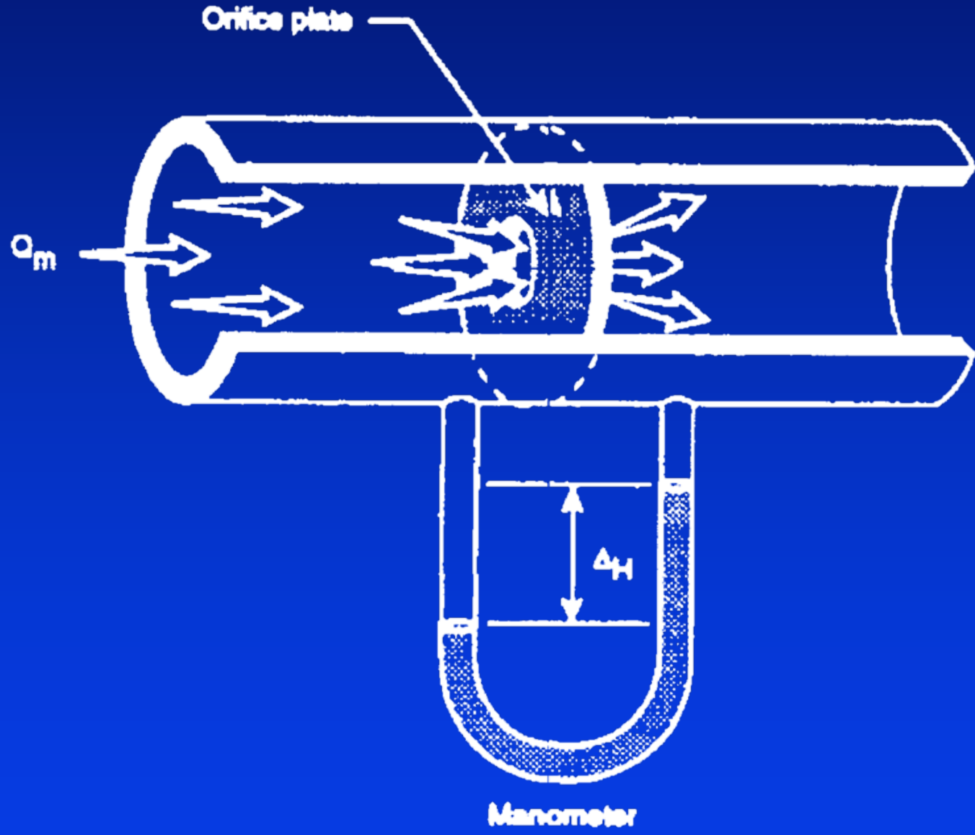
Differential Pressure Measuring

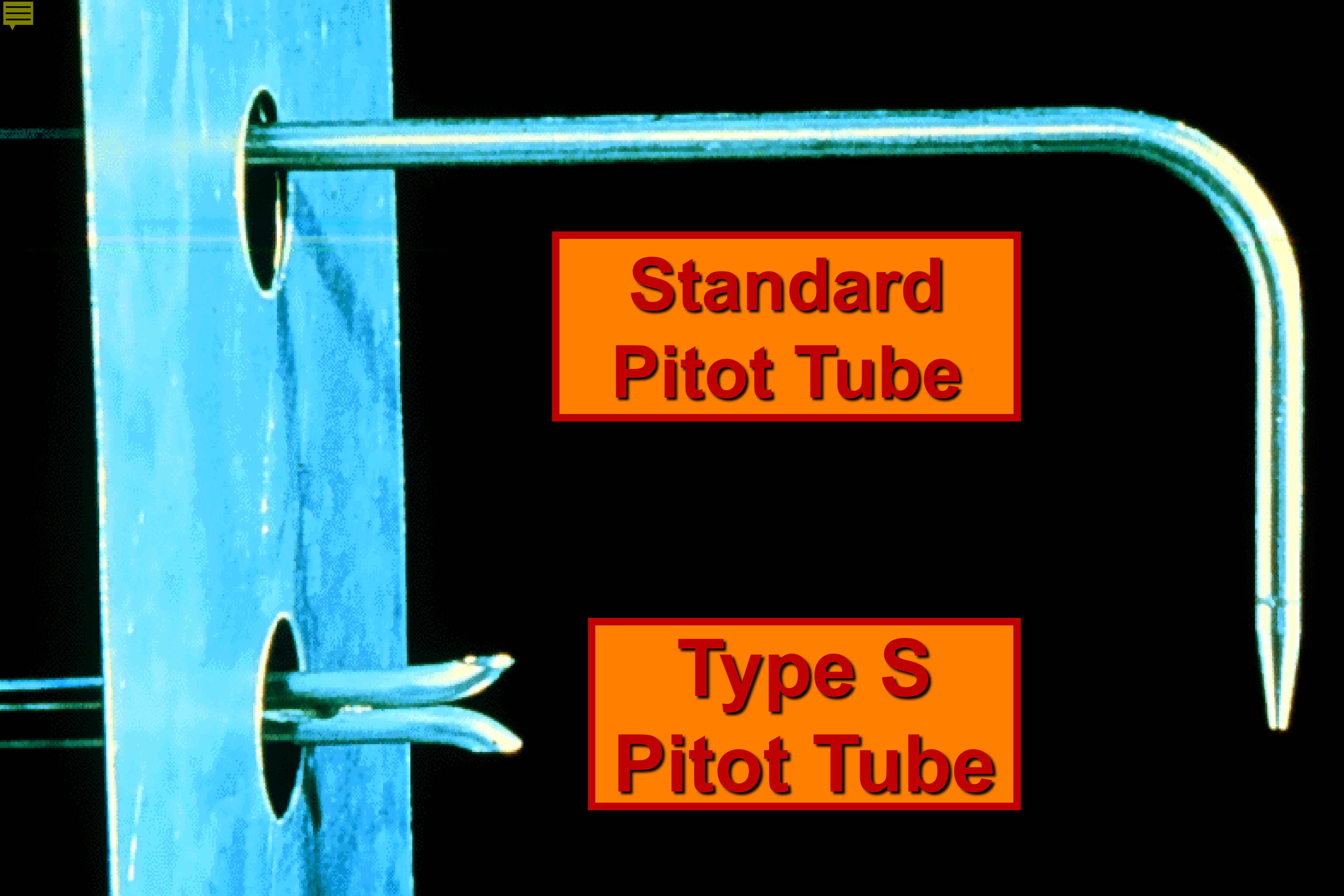
Differential Pressure Measuring



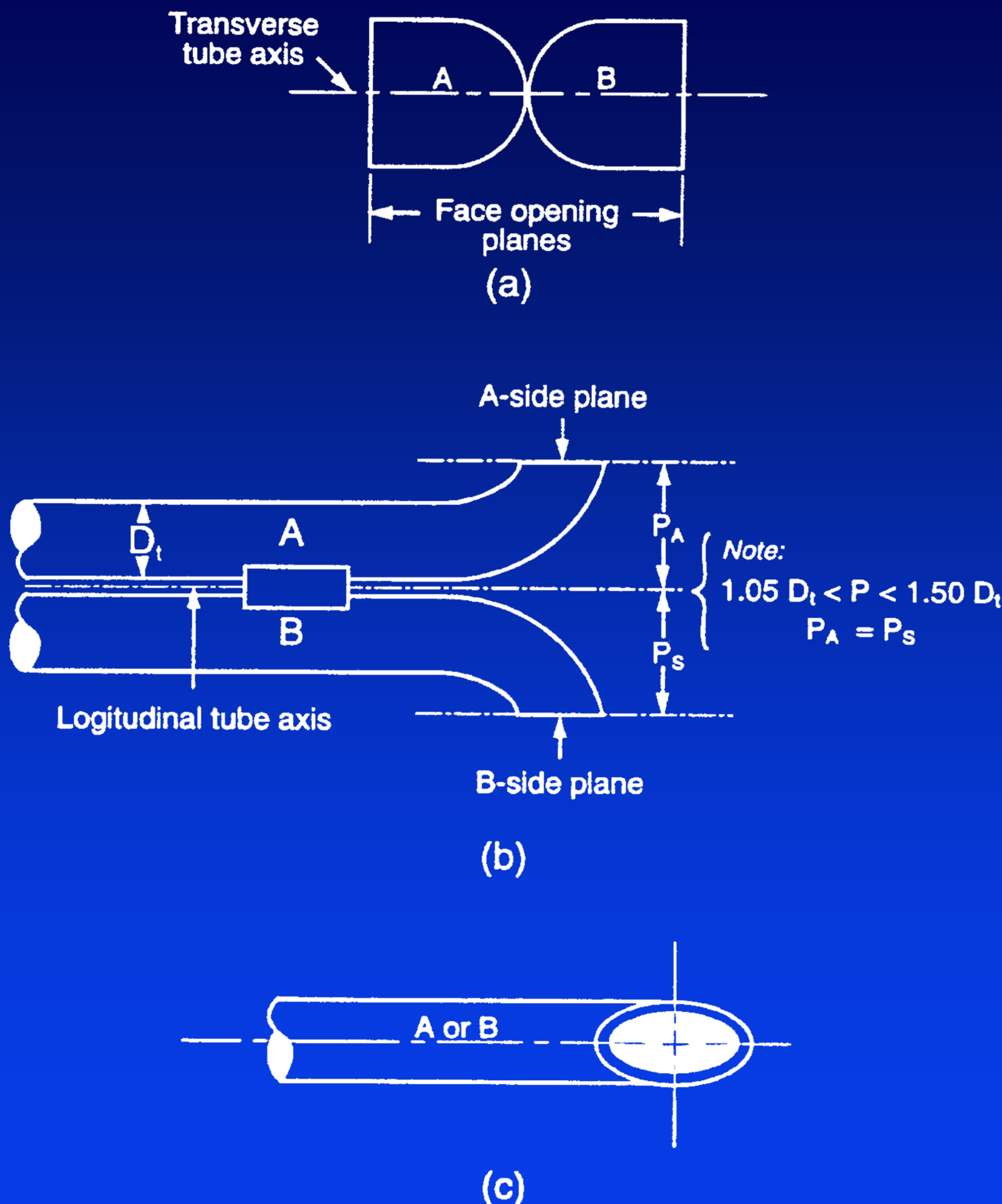
Type "S" Pitot Tube & Orifice Meter






Standard
Pitot Tube
Type S
Pitot Tube

Type S Pitot Tube Construction



Physical & Procedural Inspections

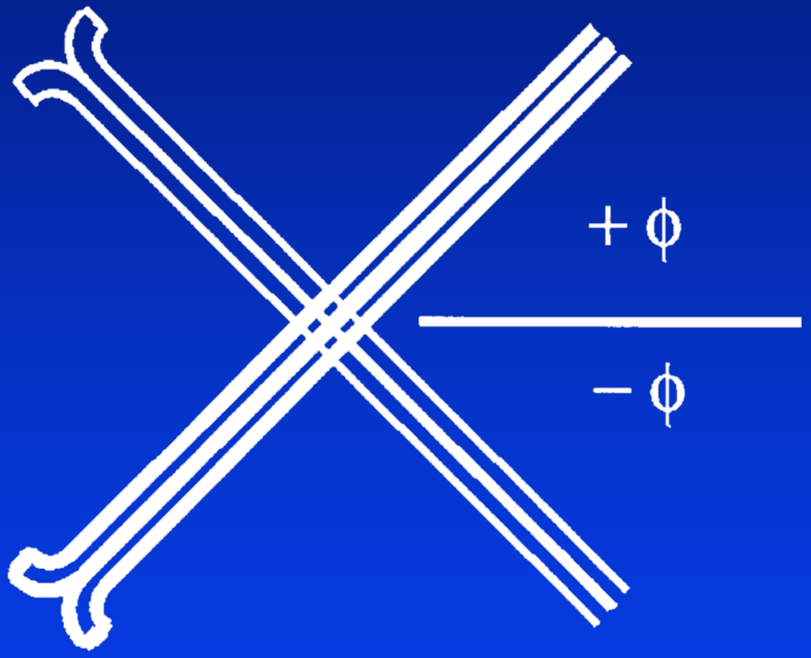
- Pitot tube
  - Construction & Condition
  - Alignment (Bent, etc.)
  - Orientation & Attachment to Probe
  - Calibration
  - Leak Checked (Both Sides)
- Pressure Instruments
  - Oil Manometer Leveled & Zeroed
  - Magnehelic Gauge Calibrated
- Cyclonic Flow Checked

Pitot Tube Roll and Pitch

Roll angle

Rotational

Pitch angle



Vertical

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

- $C_p = 0.84$
- $t_s = 345°C$
- $T_s = 345°C + 273°C$
- $\Delta p = 38.1$ 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 $Q_s = A_s V_s$

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

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

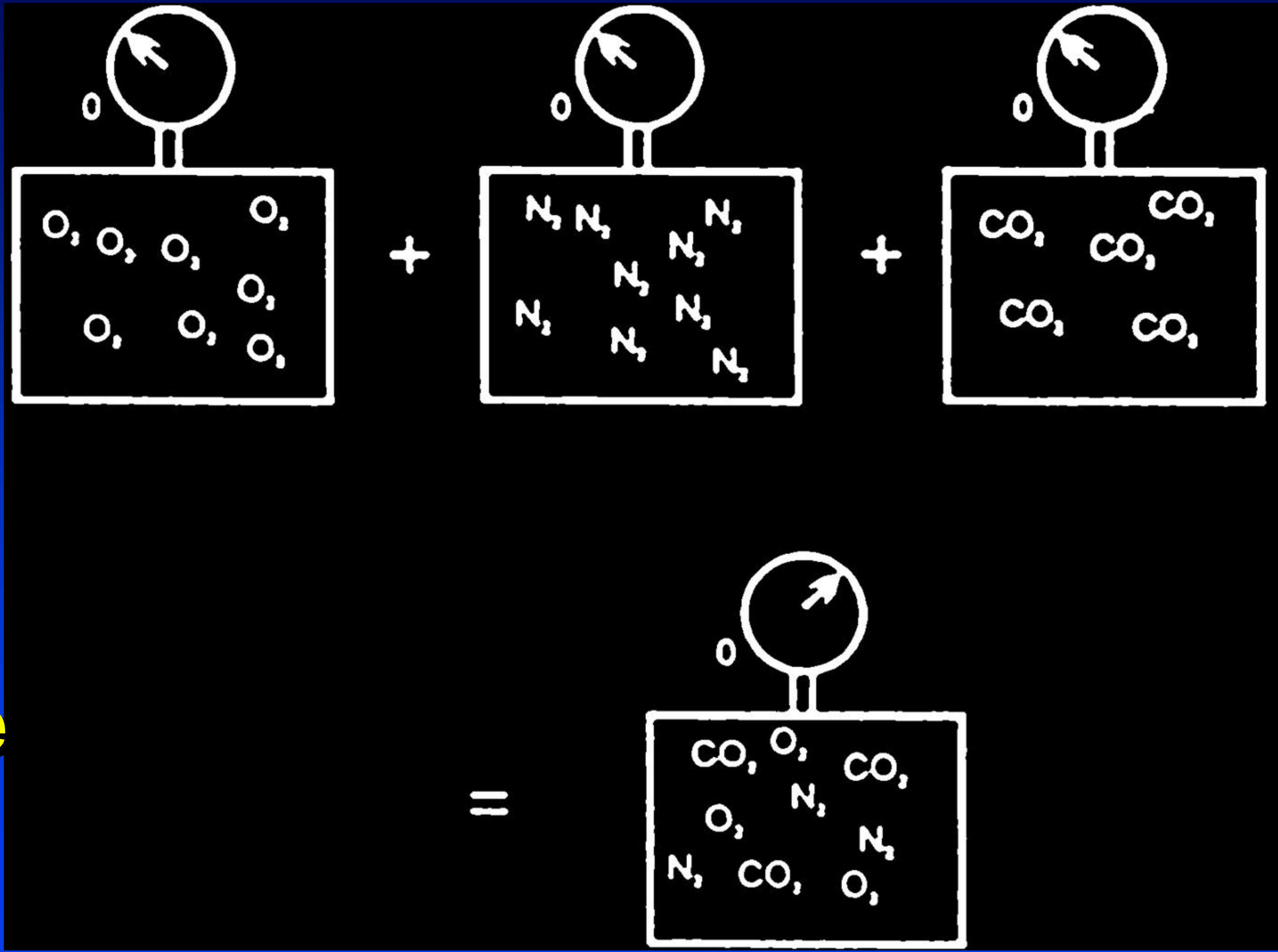

Method 3

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

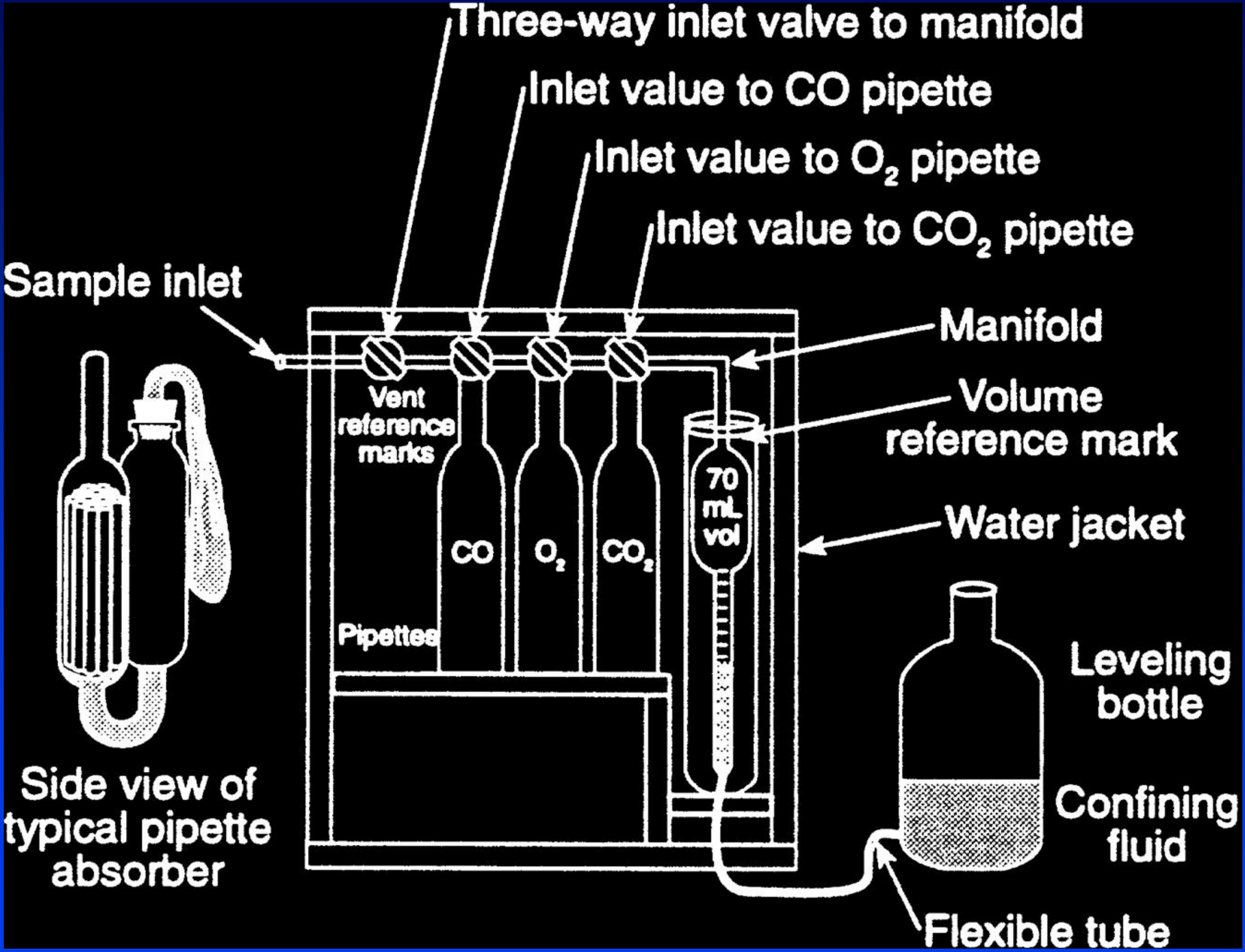
Partial Pressure

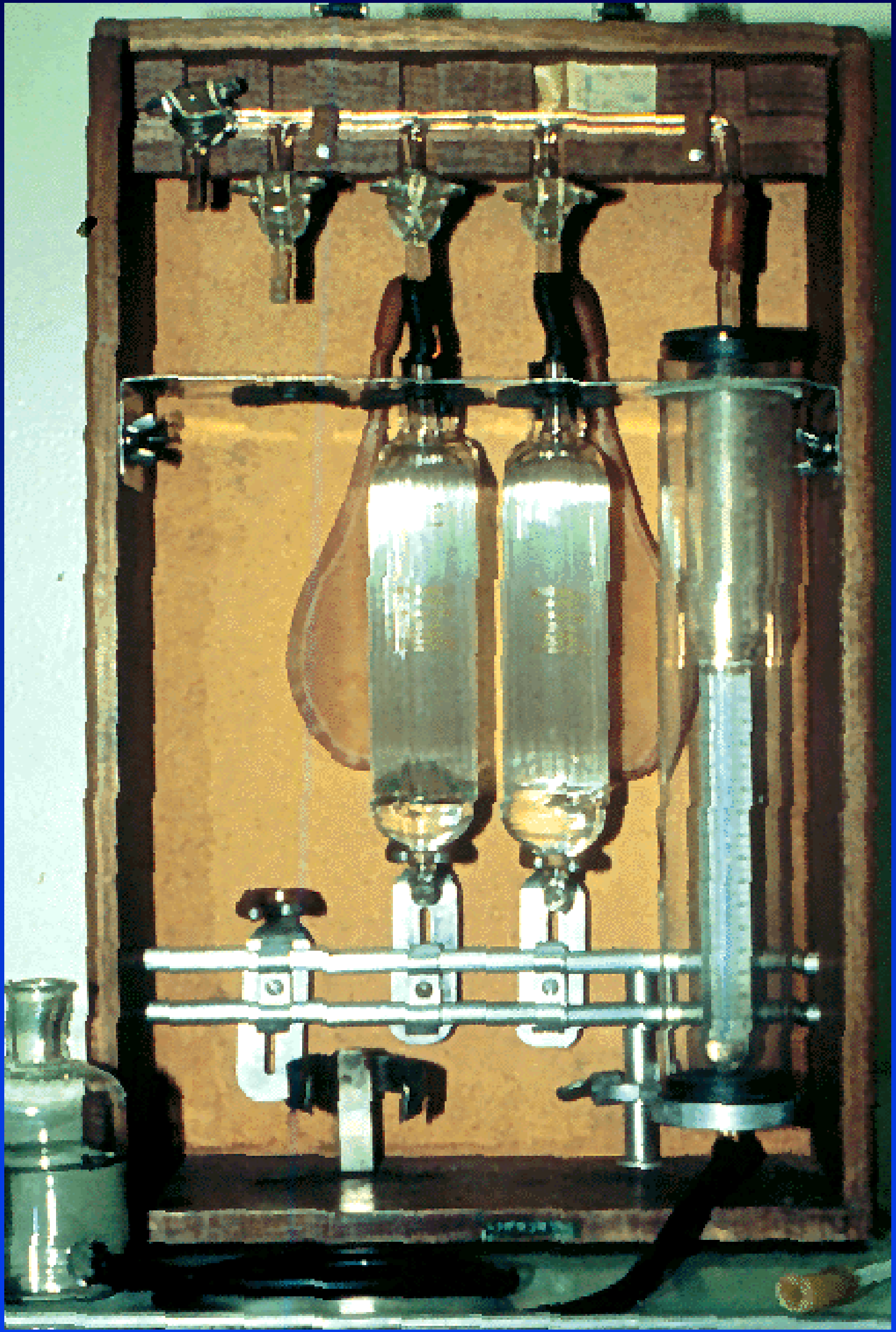


ORSAT Analyzer

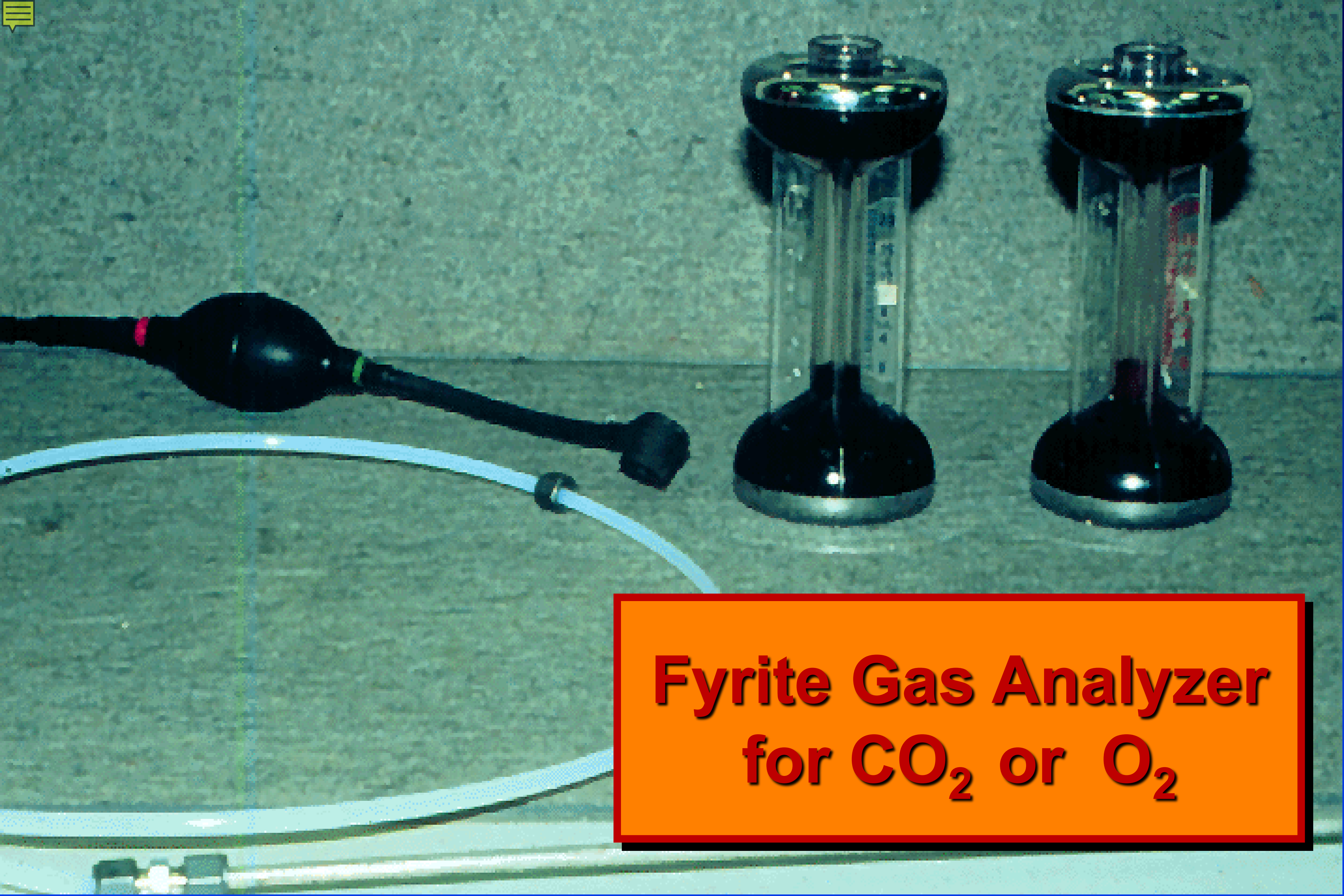
Oxidation
Reduction
Selective
Absorption
Technique

Orsat Analyzer



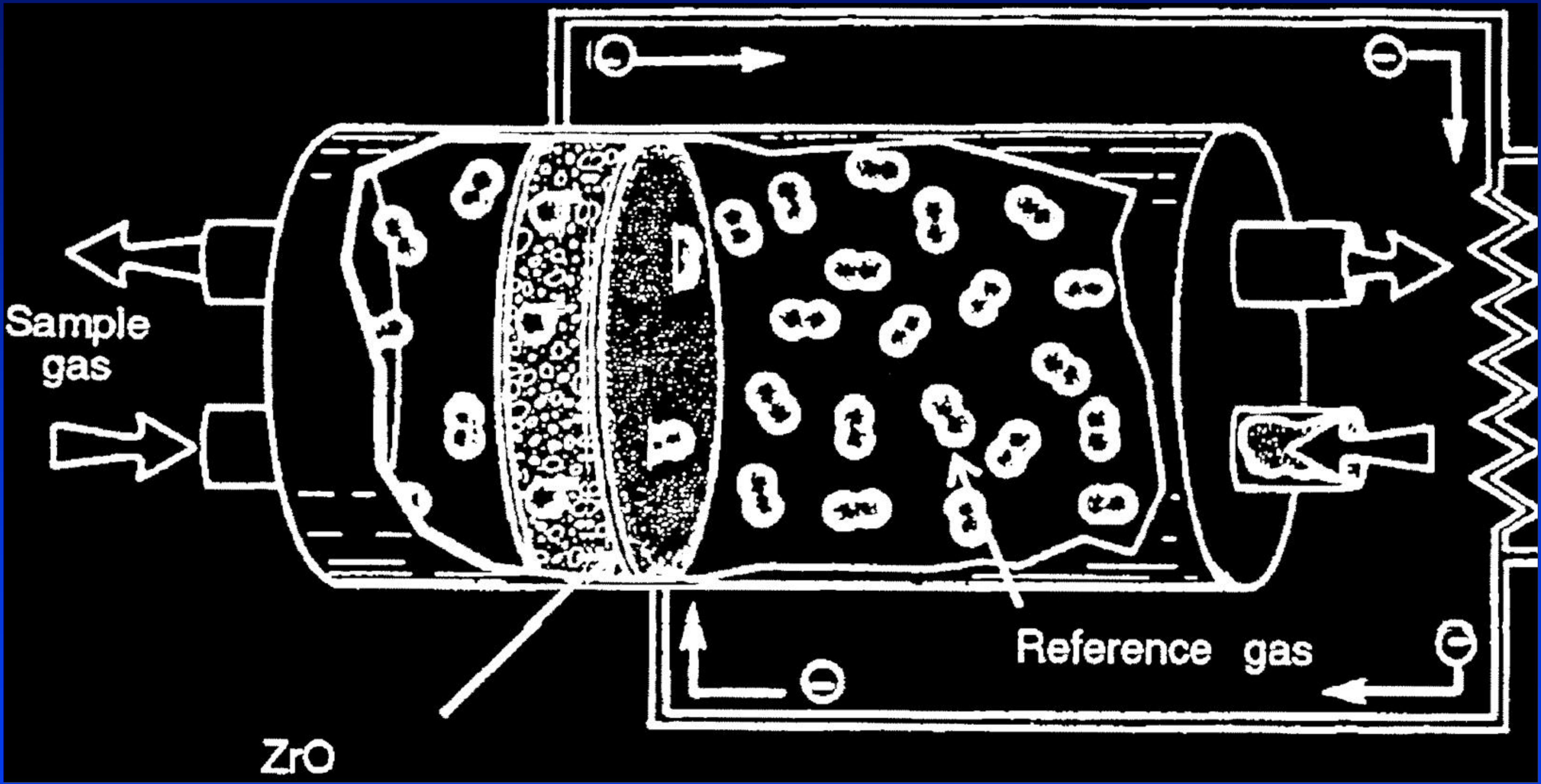


Orsat Analyzer

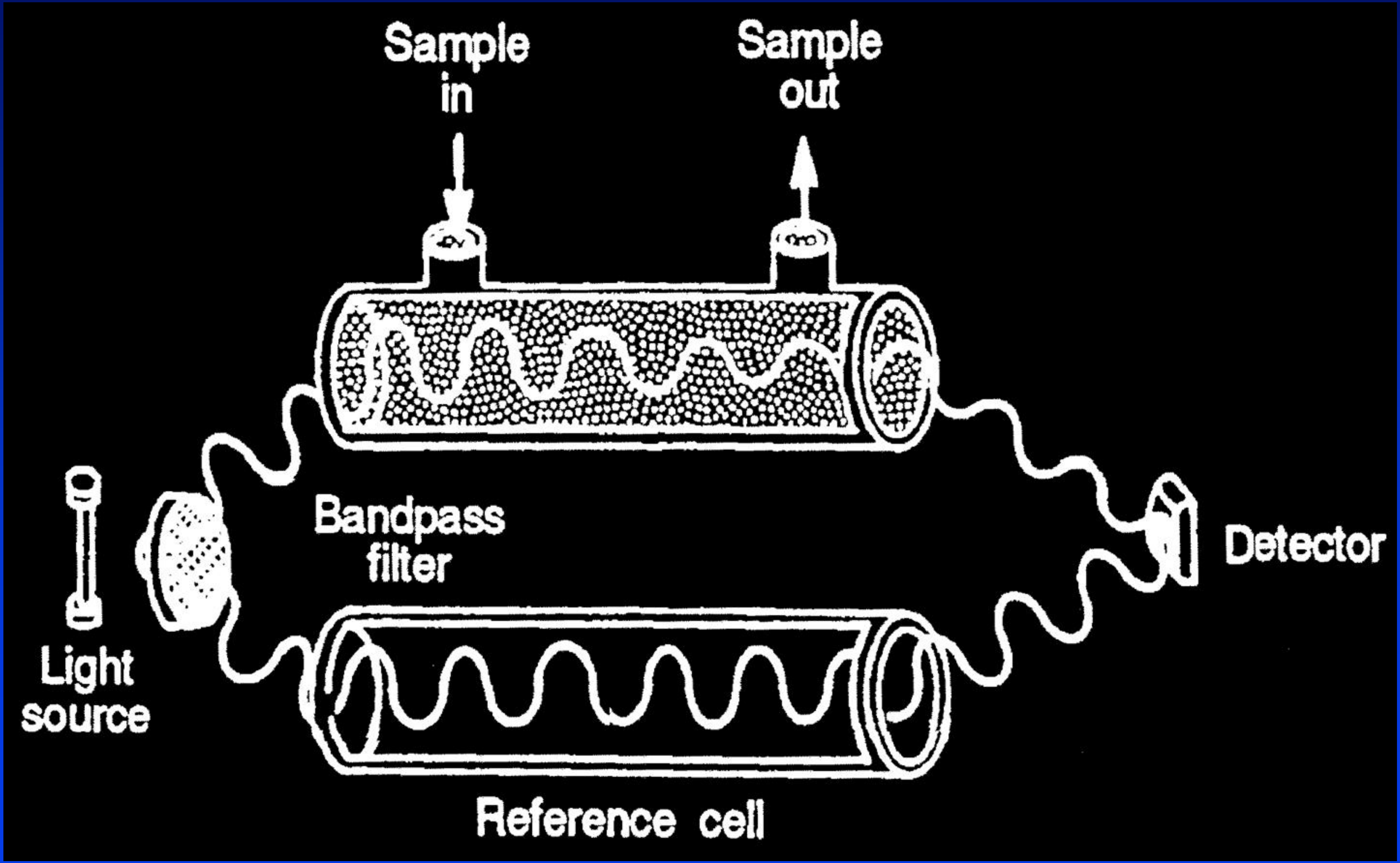


Fyrite Gas Analyzer for CO_2 or O_2

Electrocatalytic O_2 Analyzer



NDIR CO_2 Analyzer



CO_2 Analyzer

Molecular Weight by Mole Fraction

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

$$M = \Sigma B_i M_i$$

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

= 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

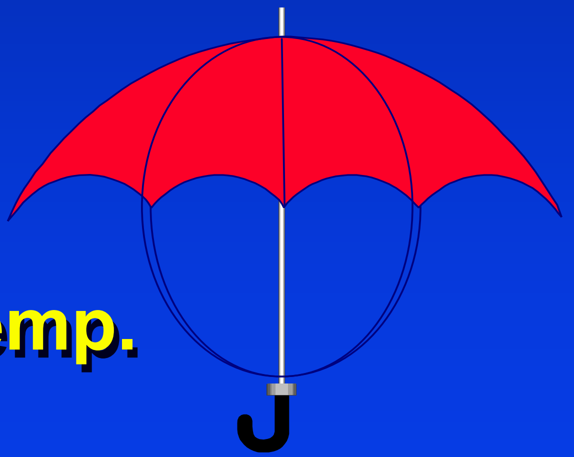
ORSAT analysis is OK


Method 4

Method 4

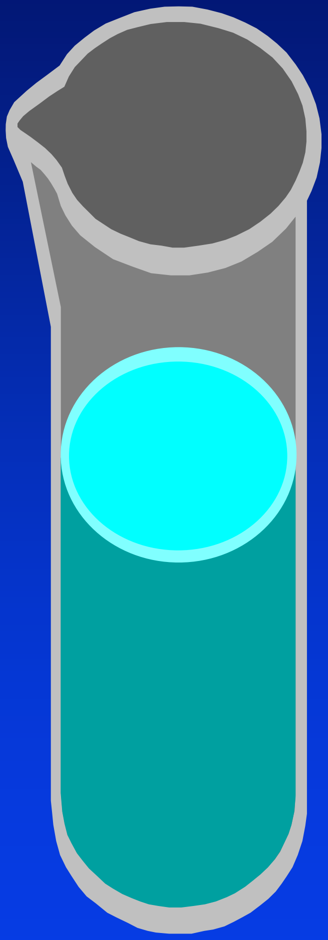
Determination of Moisture Content in Stack Gas

- **Needed for Both Pitot Tube Equation & Isokinetic Rate Equation**
- **<u>4 Methods Can be Used</u>**
  - **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

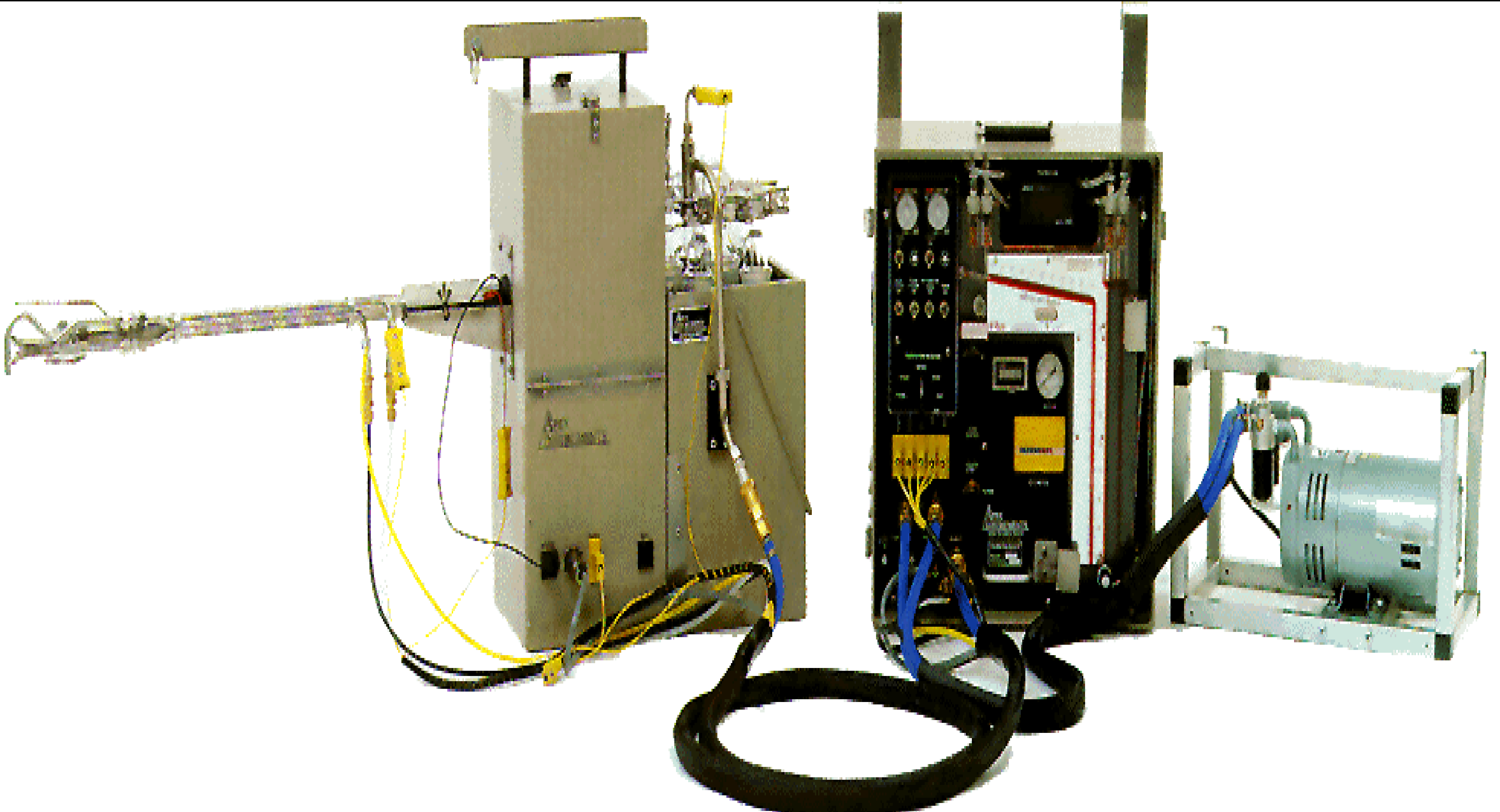
Method 5

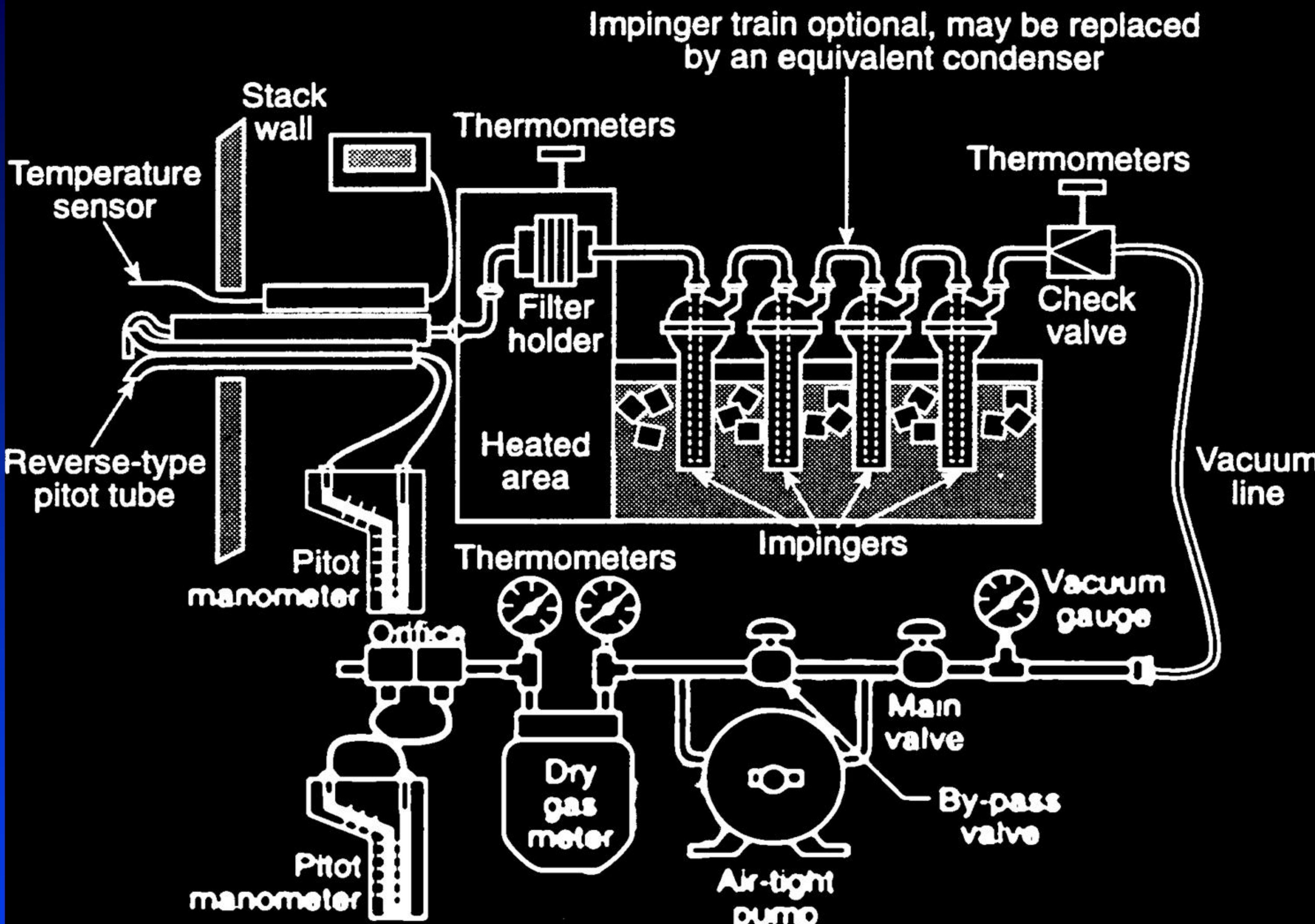
Determination of Particulate Emissions from Stationary Sources

- 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

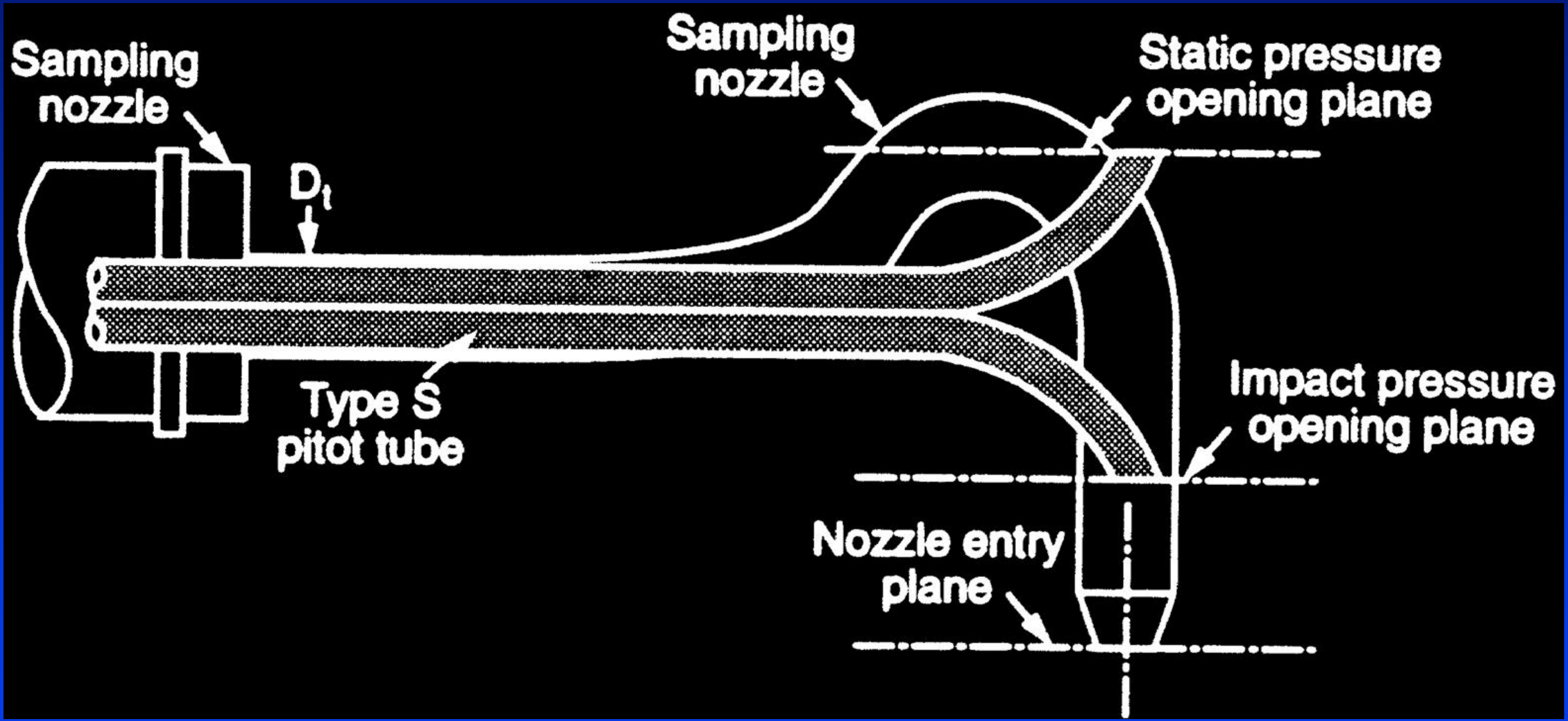
Isokinetic Source Sampling System





Method 5 Sampling Train

Nozzle Design and Placement



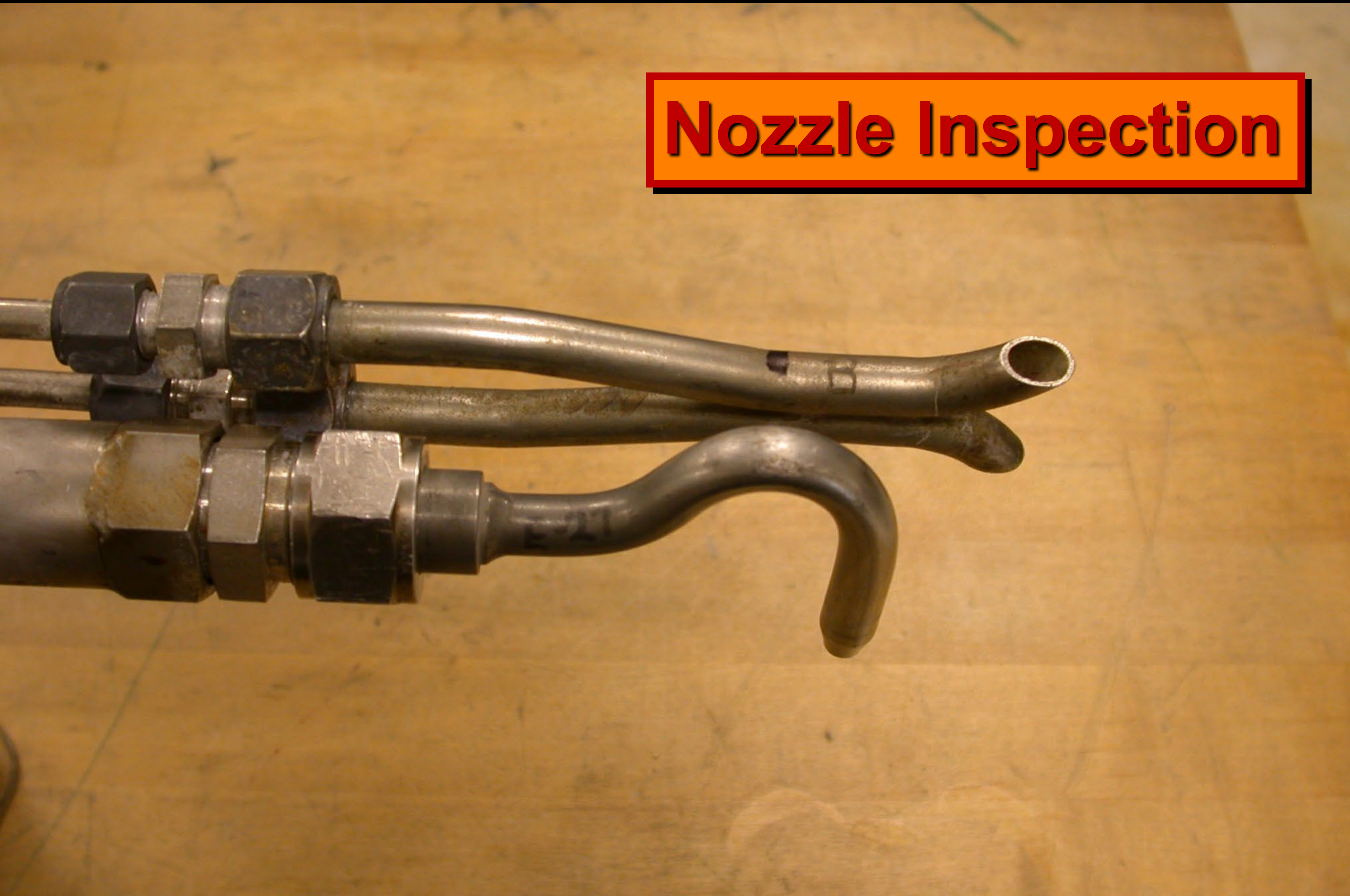
Sample Nozzles

Sample Nozzles

Physical Inspections

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

Nozzle Inspection



Calculation Inspections

- **Nozzle Diameter**

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

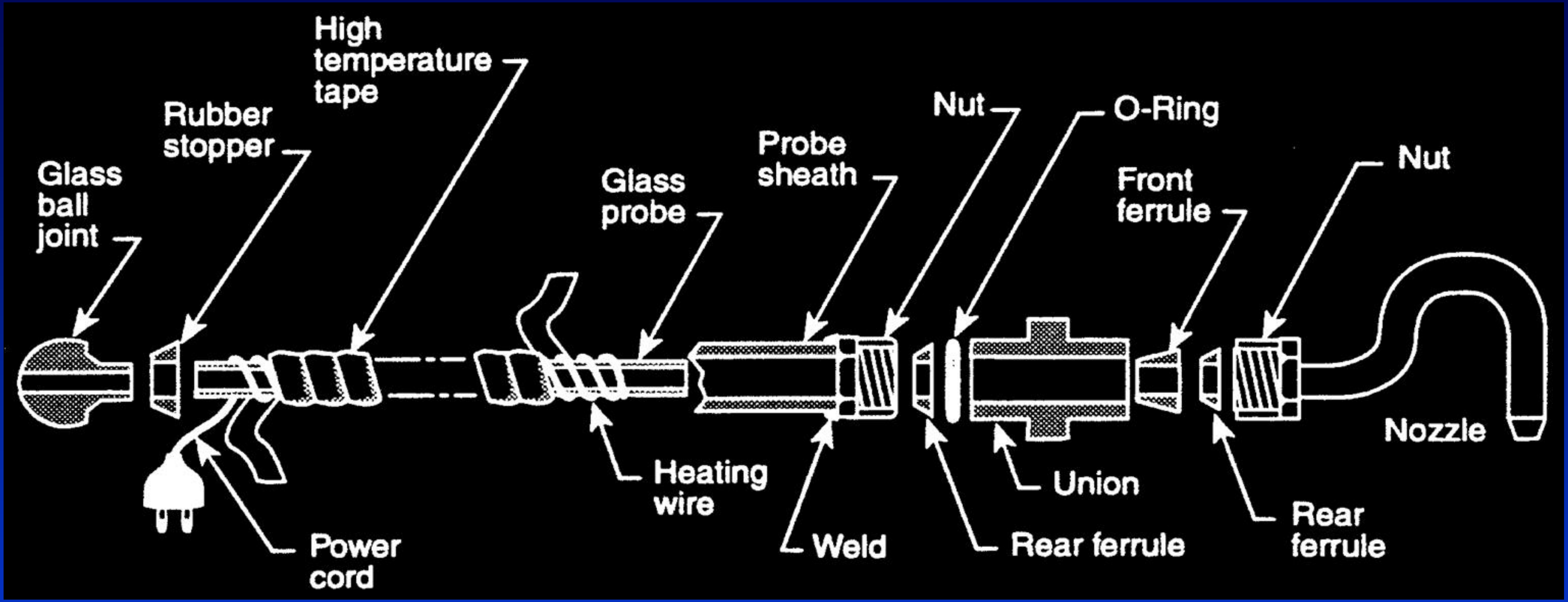
K_D = 6.07 (0.0358 English units)

Nozzle Diameter

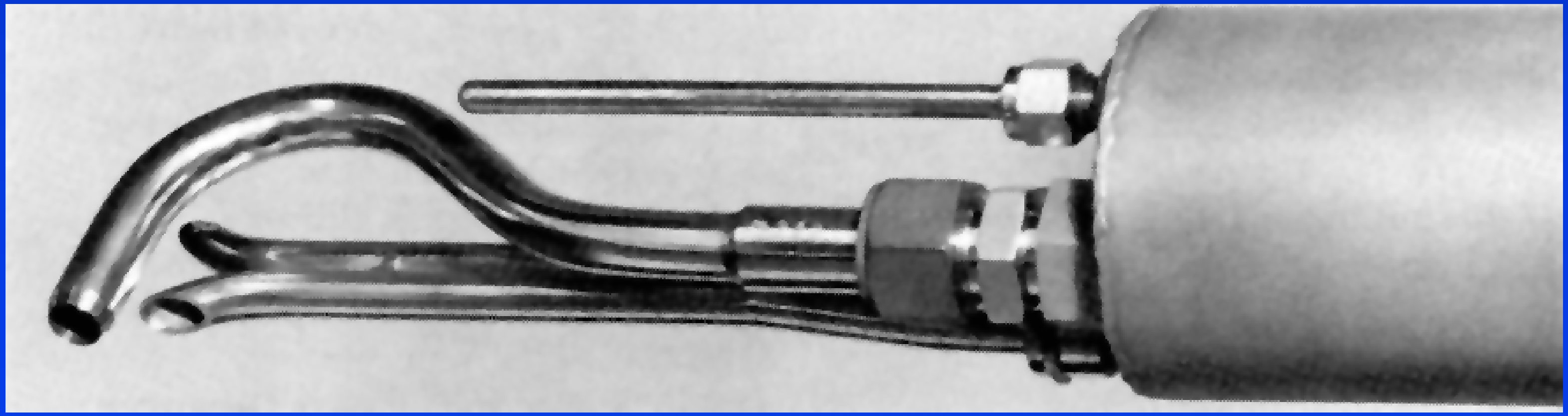
- $K_D = 6.07$
- $Q_m = 0.021\ m^3$
- $P_m = 683.6$ mm Hg
- $T_m = 28^oC$
- $C_p = 0.84$
- $B_{ws} = 0.15$
- $T_s = 345^oC$
- $M_s = 28.2$ g/mole
- $p_s = 35$ mm H_2O
- $\Delta\ p_{est} = 38$ mm H_2O

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

$$D_n = 0.576\ cm$$



Probe Assembly

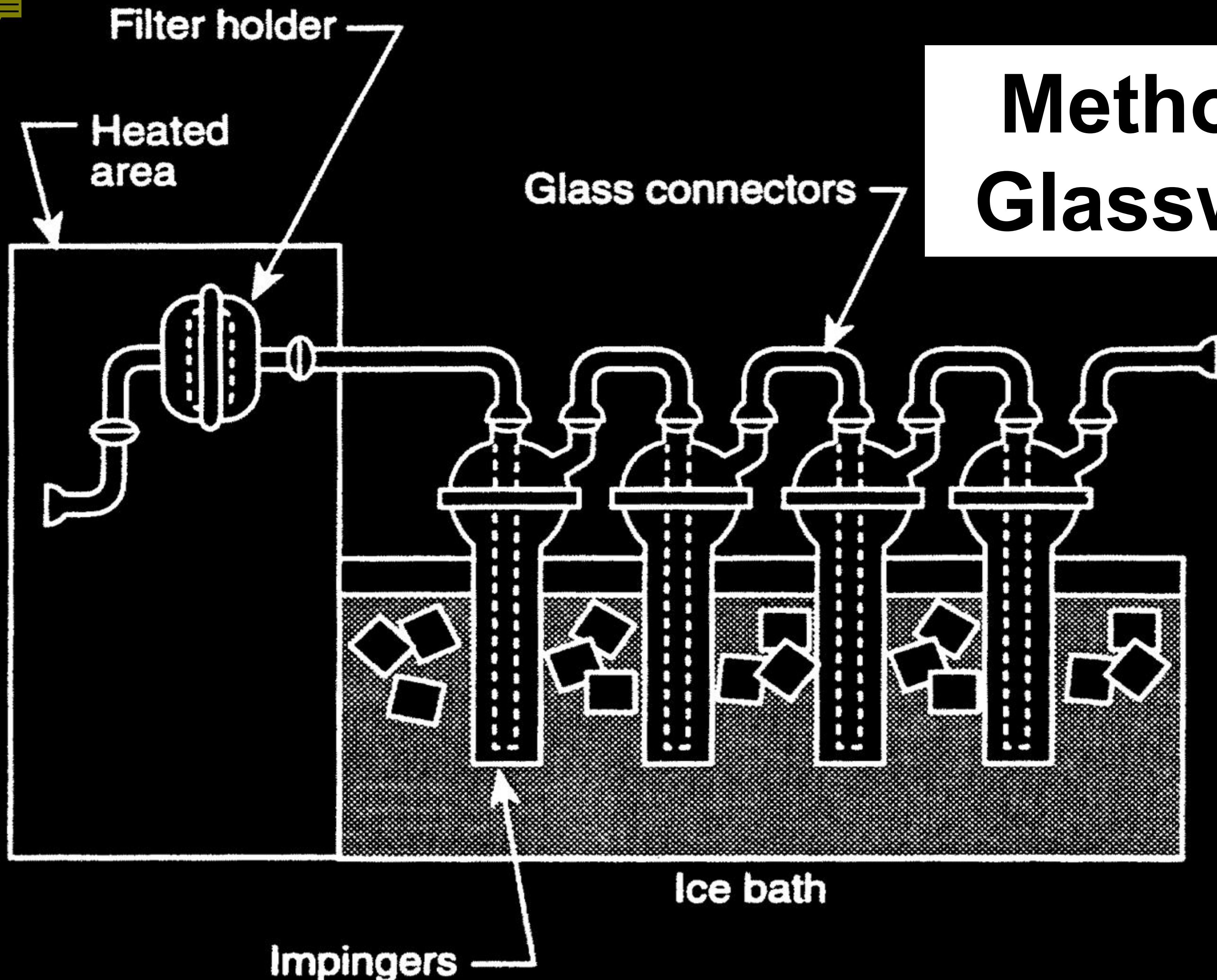


Physical Inspections

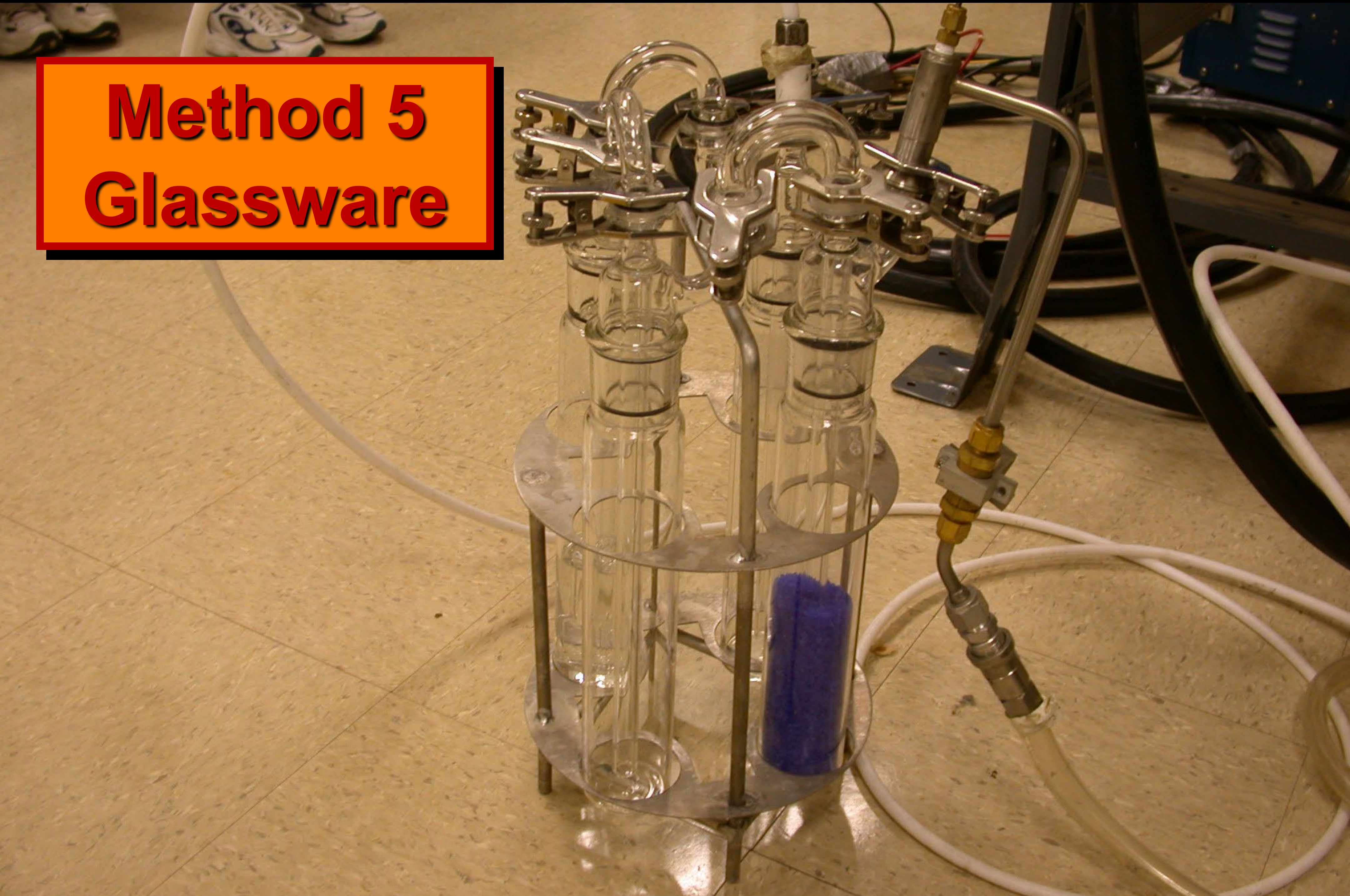
- Temperature Probe
  - Condition
  - Calibrated
- Probe
  - Long Enough to Reach, Not Too Long
  - Heated
  - SS or Glass Liner
  - Marked (Heat Resistant) for Traverse Points
  - Rinsed During Sample Recovery

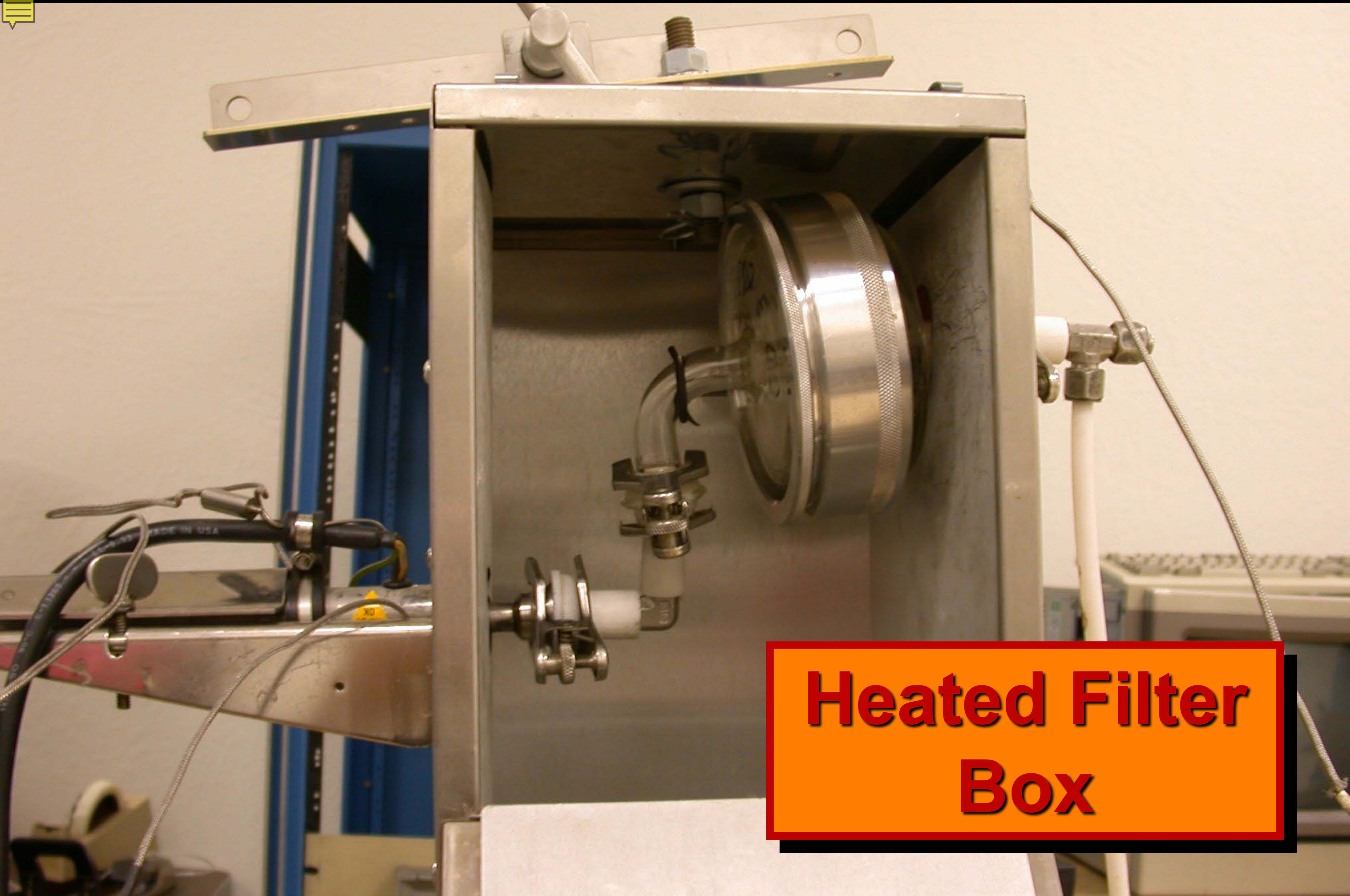
Modular Sample Unit

Method 5 Glassware



Method 5 Glassware



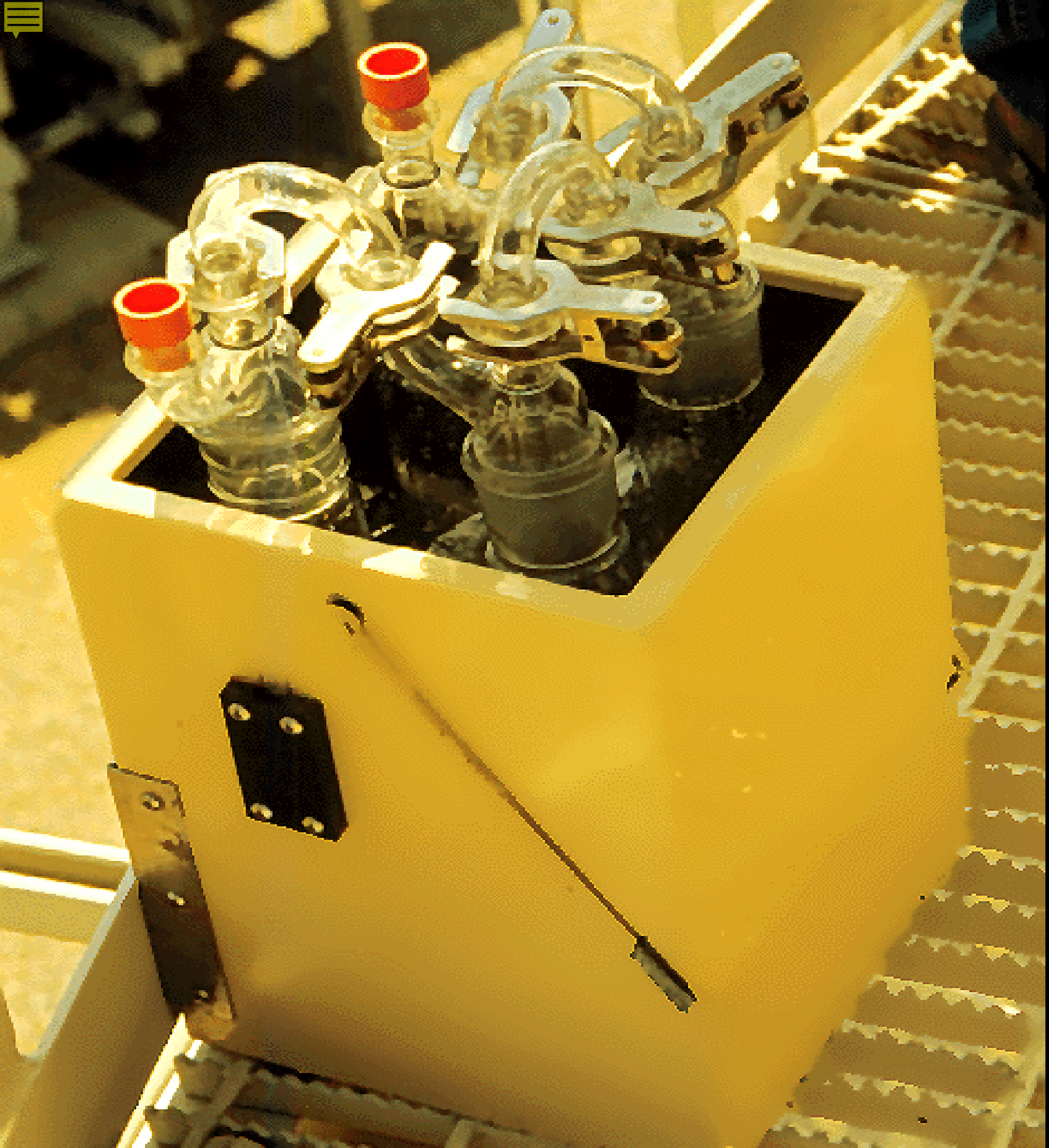

Heated Filter
Box


Filter
Assembly


#2719
47mm quartz
0.12265g
#2716
47mm quartz
0.12305g
#2718
47mm quartz
0.11975g
MILLIPORE
GENERAL
SWISS MADE

Physical Inspections

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



Cold Side Glass Impingers


Impinger Ice Bath

Impinger Ice Bath

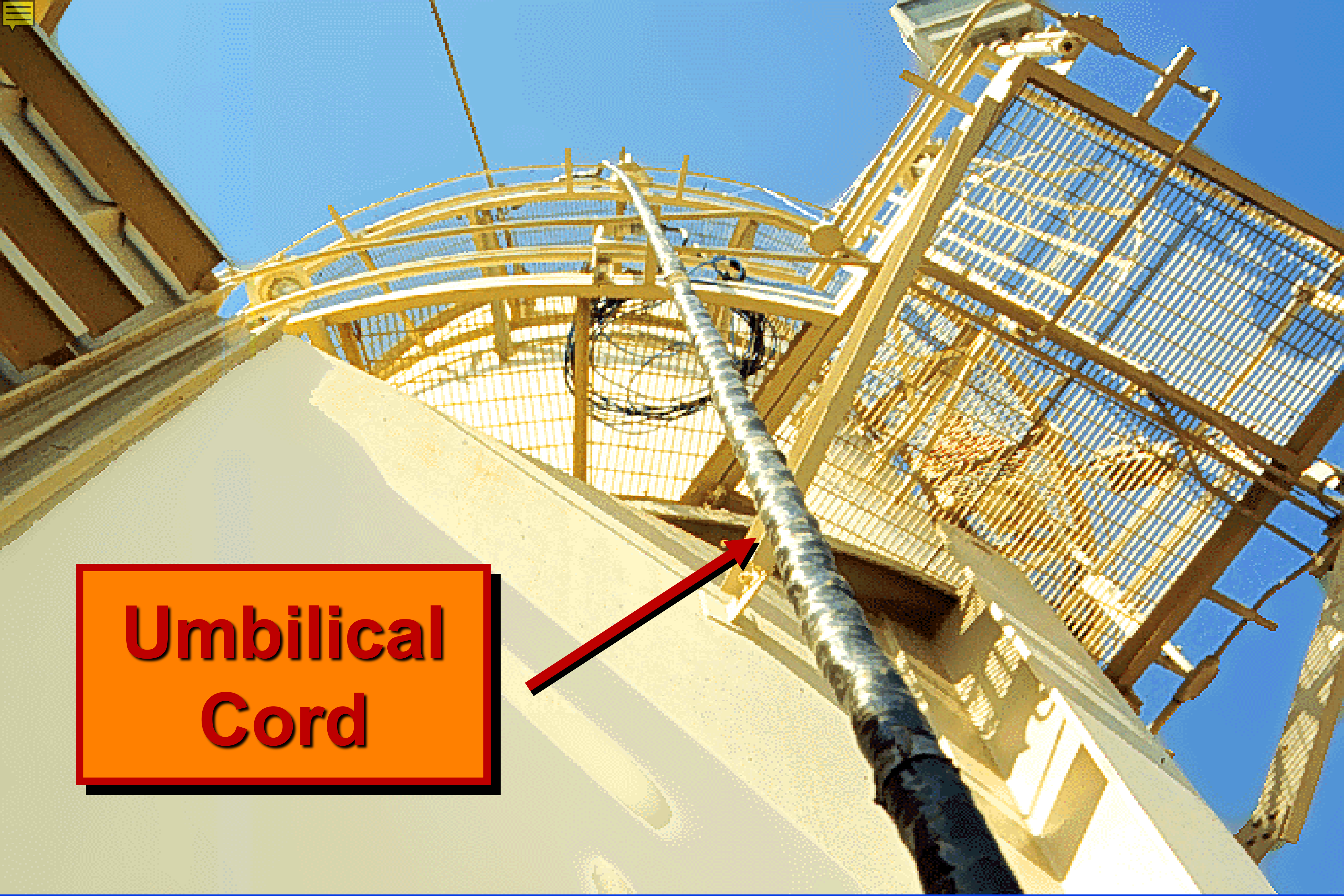
Physical Inspections

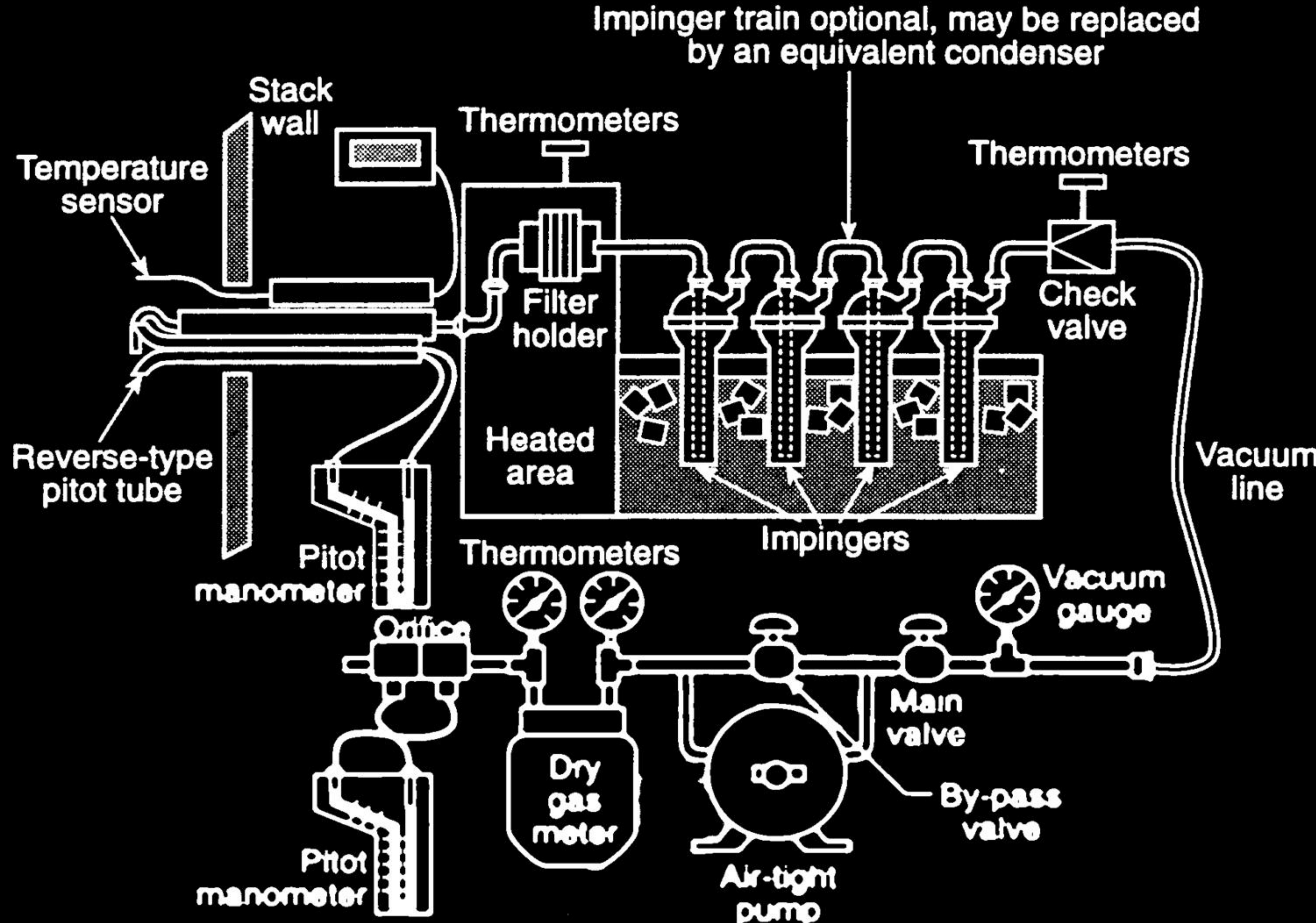
- Sampling Case - Cold Side
  - Glassware Properly Set-Up
  - Proper Solutions in Impingers
  - Ice & Water Bath -
    Exit Temperature

Water Knock-Out


Umbilical
Cord


Umbilical
Cord

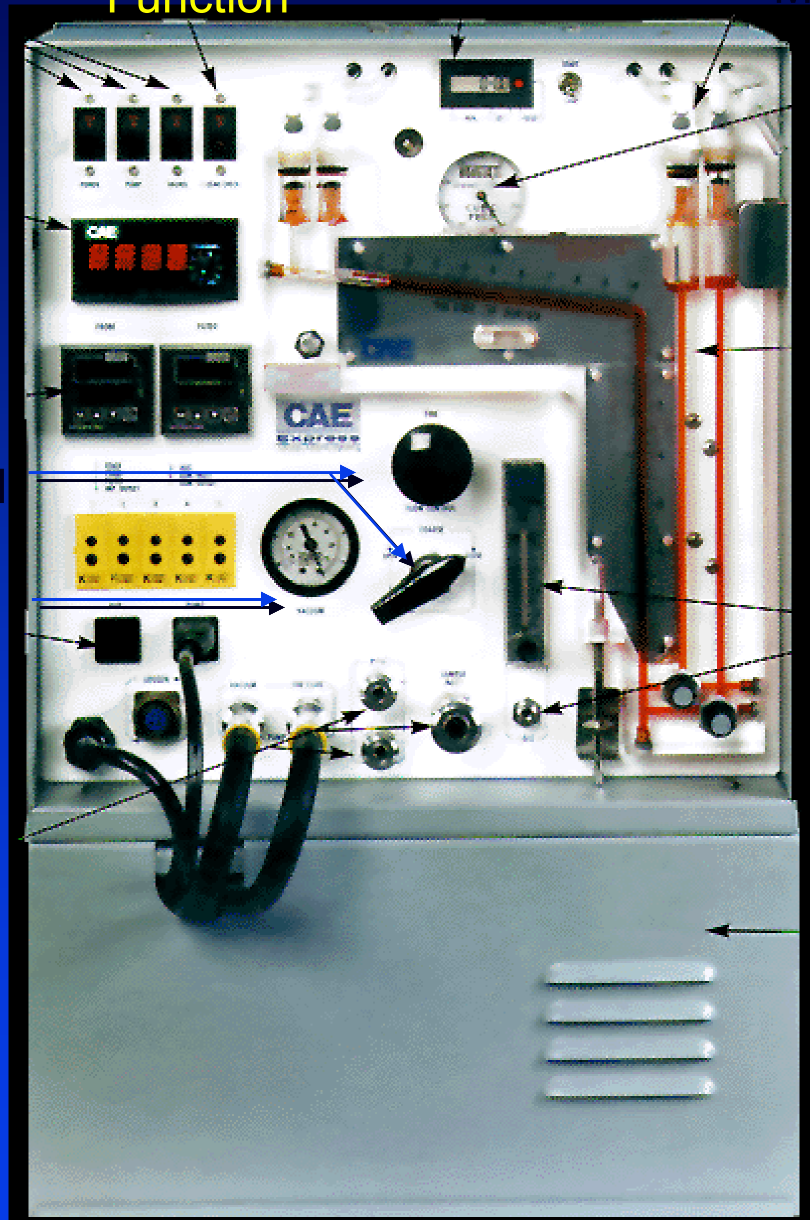

Umbilical
Cord



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

Isokinetic Control Console

Control Console



Physical Inspections

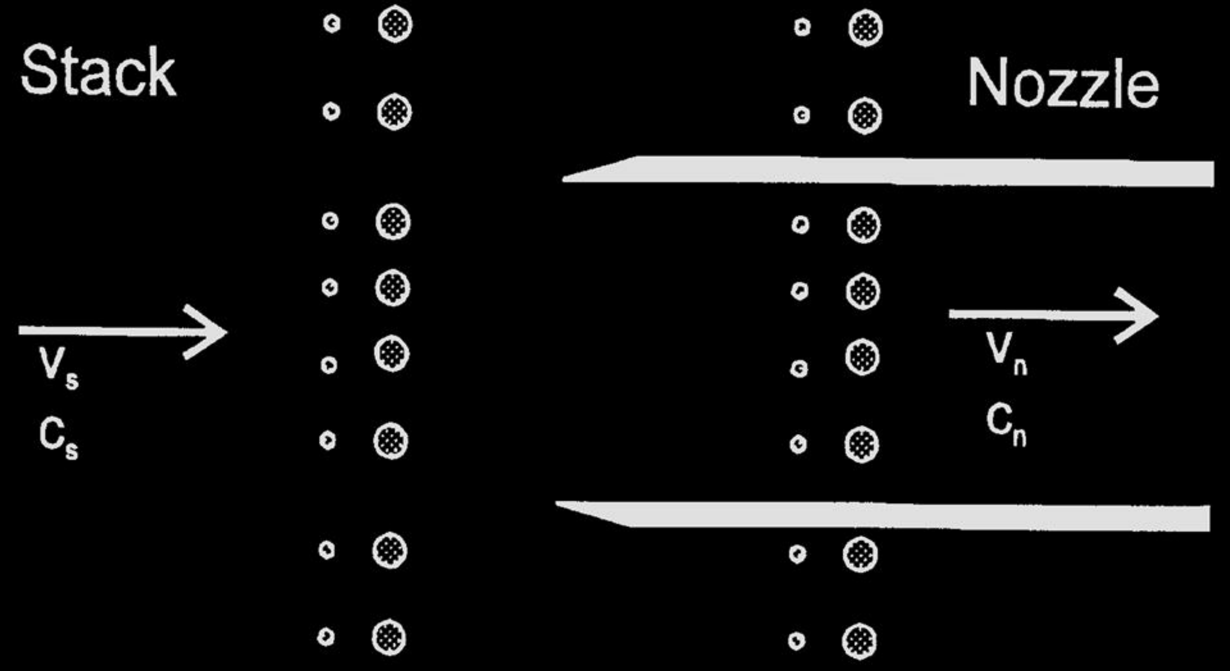
- Pump
  - Non-reactive and leak free
- Dry gas meter
  - Leak free
  - Calibrated
- Orifice meter
  - Calibrated

Sampling Rate

- Constant Rate
- Proportional
- Isokinetic


Let's Discuss
Isokinetic
Sampling

Isokinetic Sampling



100% Isokinetic

$v_n = v_s$

$m_n = 0.44$ grams/min

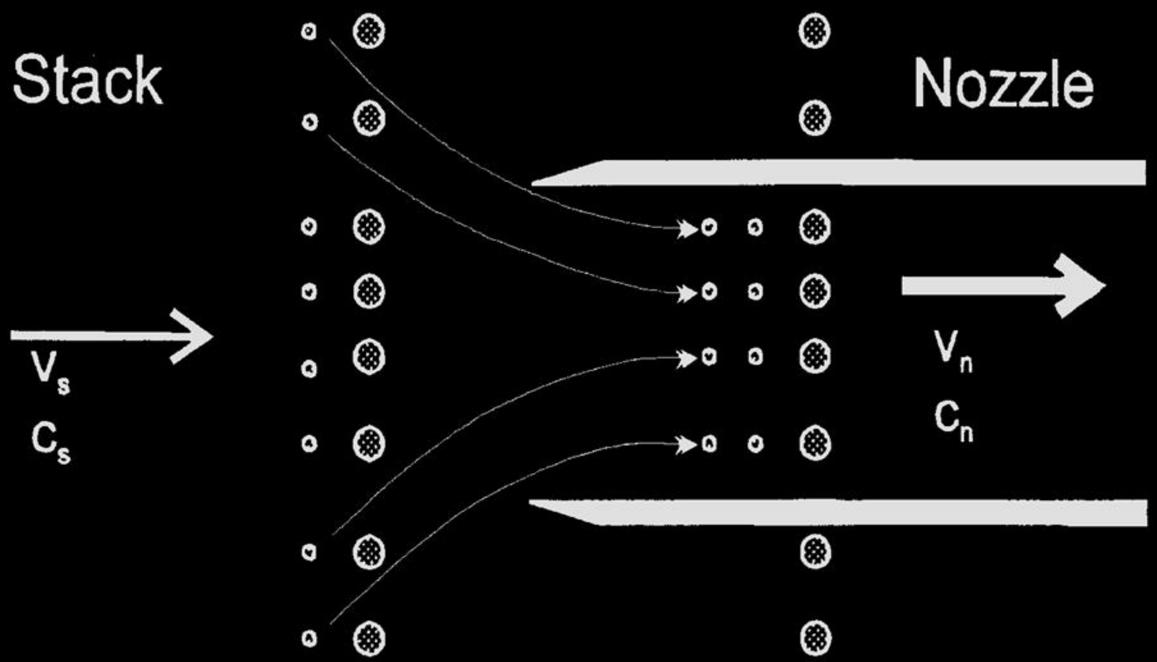
$Q_n = 0.025\ m^3/min$

$c_n = 0.44/0.025 = 17.6\ g/m^3$

$c_s = 17.6\ g/m^3$

Over Isokinetic Sampling

150% Isokinetic



$v_n = 1.5\ v_s$

$m_n = 0.48$ grams/min

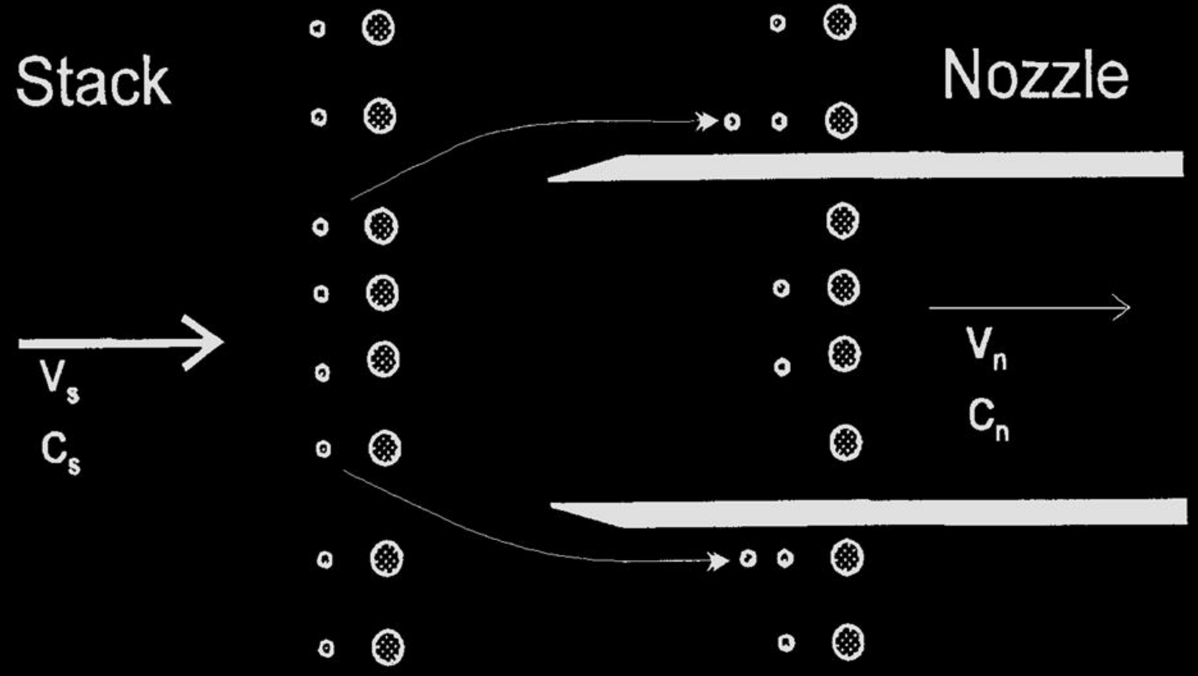
$Q_n = 0.0375\ m^3/min$

$c_n = 0.48/0.0375 = 12.8\ g/m^3$

$c_s = ?\ (c_s > c_n)$

Under Isokinetic Sampling

75% Isokinetic



$v_n = 0.75\ v_s$

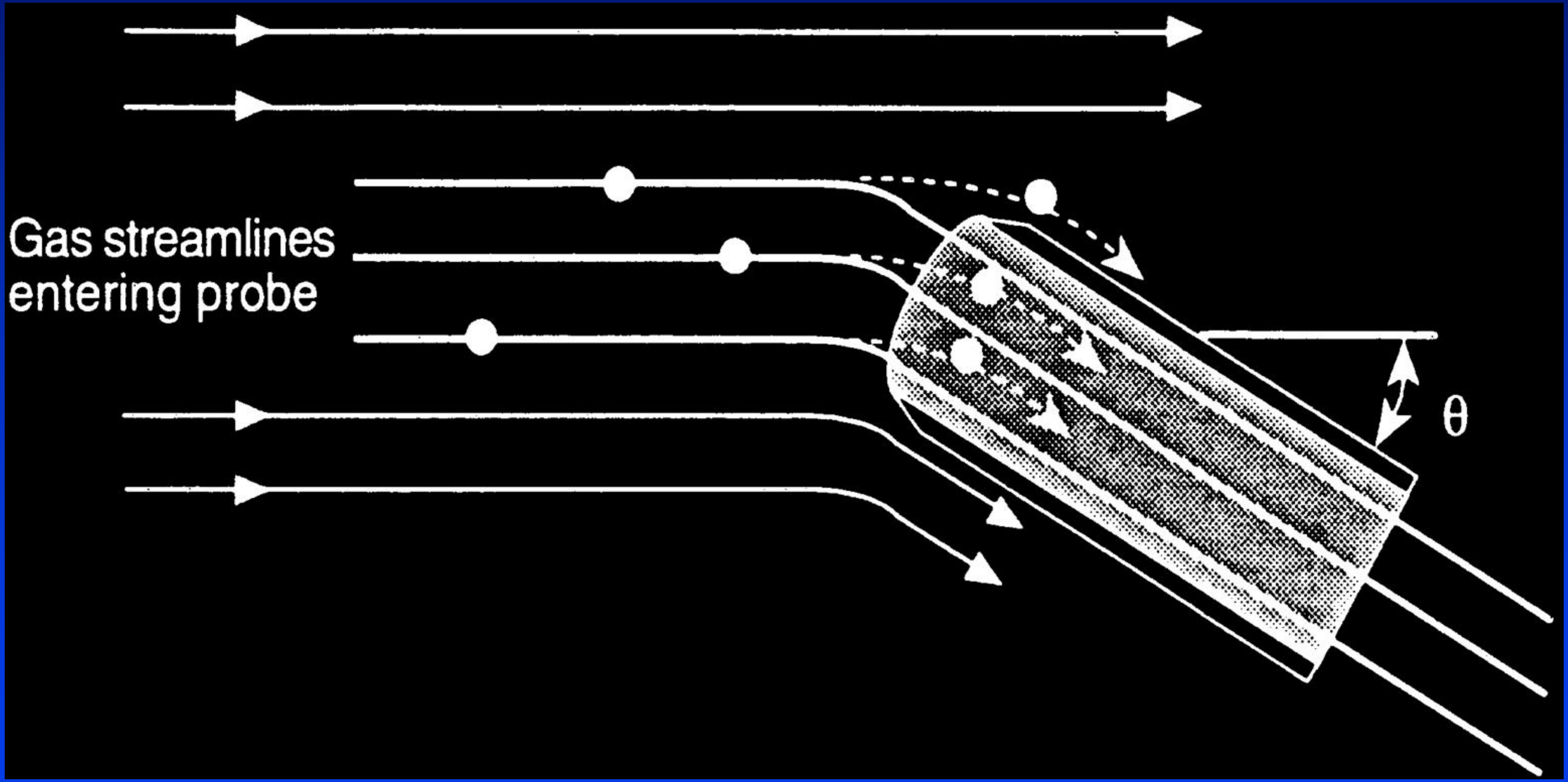
$m_n = 0.42$ grams/min

$Q_n = 0.01875\ m^3/min$

$c_n = 0.42/0.01875 = 22.4\ g/m^3$

$c_s = ?\ (c_s < c_n)$

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

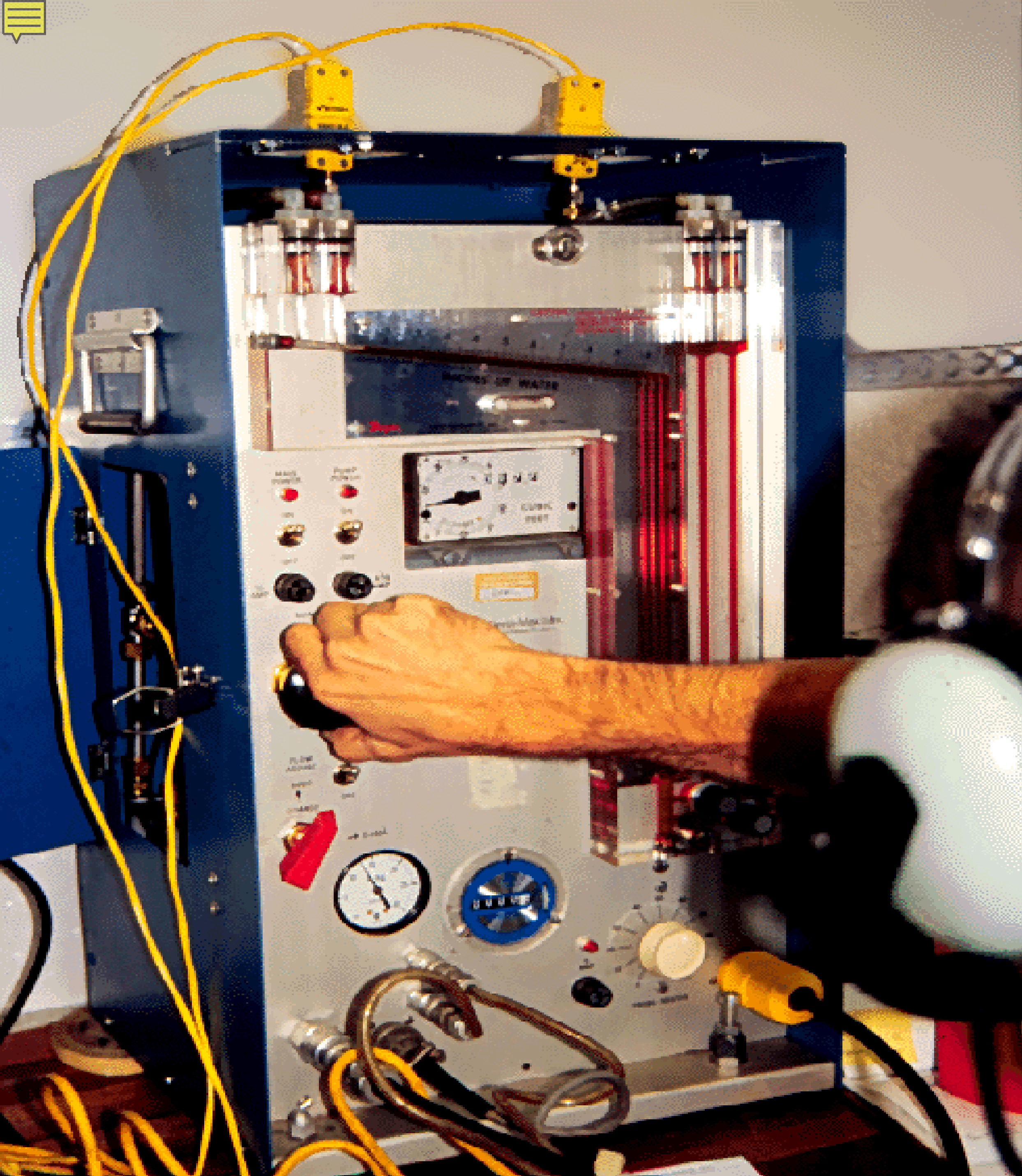
- $K_H = 0.803$
- $D_n = 0.576$ cm
- $\Delta H_@ = 49.3$ mm H_2O
- $C_p = 0.84$
- $B_{ws} = 15\%$
- $\Delta p = 38.1$ mm H_2O
- $M_d = 30.0$ g/mole
- $M_s = 28.2$ g/mole
- $T_m = 28°C$
- $T_s = 345°C$
- $p_s = 35$ mm H_2O
- $P_m = 683.3$ mm Hg

$$\Delta H = 0.803 x (0.576)^4 x 49.3 x 0.84^2 (1-0.15)^2 \frac{30.0 x (28+273) x (680+{}^{35}/_{13.6})}{28.2 x (345+273) x 683.3} \; x\ 38.1$$

K Factor = 1.15

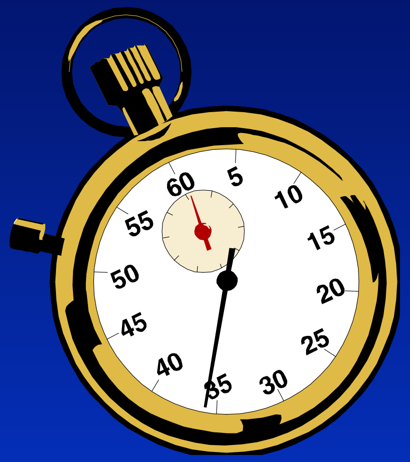
$\Delta p = 38.1$

$$\Delta H = K \times \Delta p = 43.81$$



Console Adjustment

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 m^3/ml K
(0.002669 in Hg ft^3/ml °R)

Percent Isokinetic

- $T_s = 345^oC$
- $\Theta = 48$ min
- $V_{lc} = 113$ ml
- $V_m = 1.008\ m^3$
- $T_m = 28^oC$
- $P_b = 680$ mm Hg
- $\Delta H = 43$ mm H_2O
- $A_n = 2.6x10^{-5}\ m^2$
- $V_s = 32.5$ m/s
- $p_s = 35$ mm H_2O

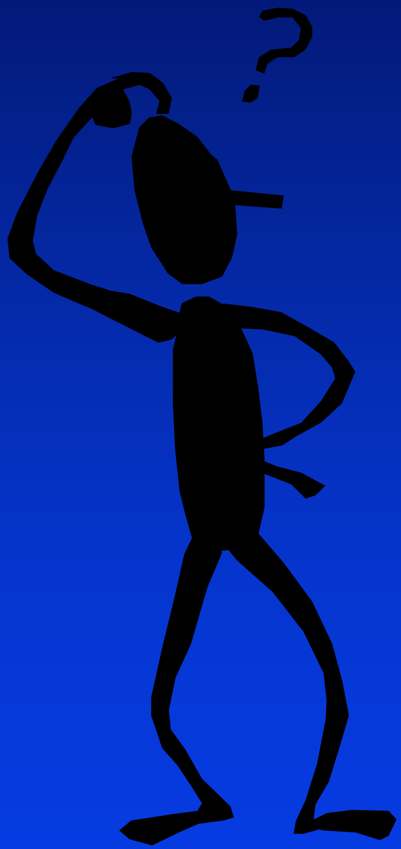
$$\%I = 100\ \frac{(345+273)[113x0.003454+1.008/(28+273)(680+43/13.6)]}{60x48x2.6x10^{-5}x32.5x(680+35/13.6)}$$

$$\%I = 99.7\%$$

Procedural Inspections

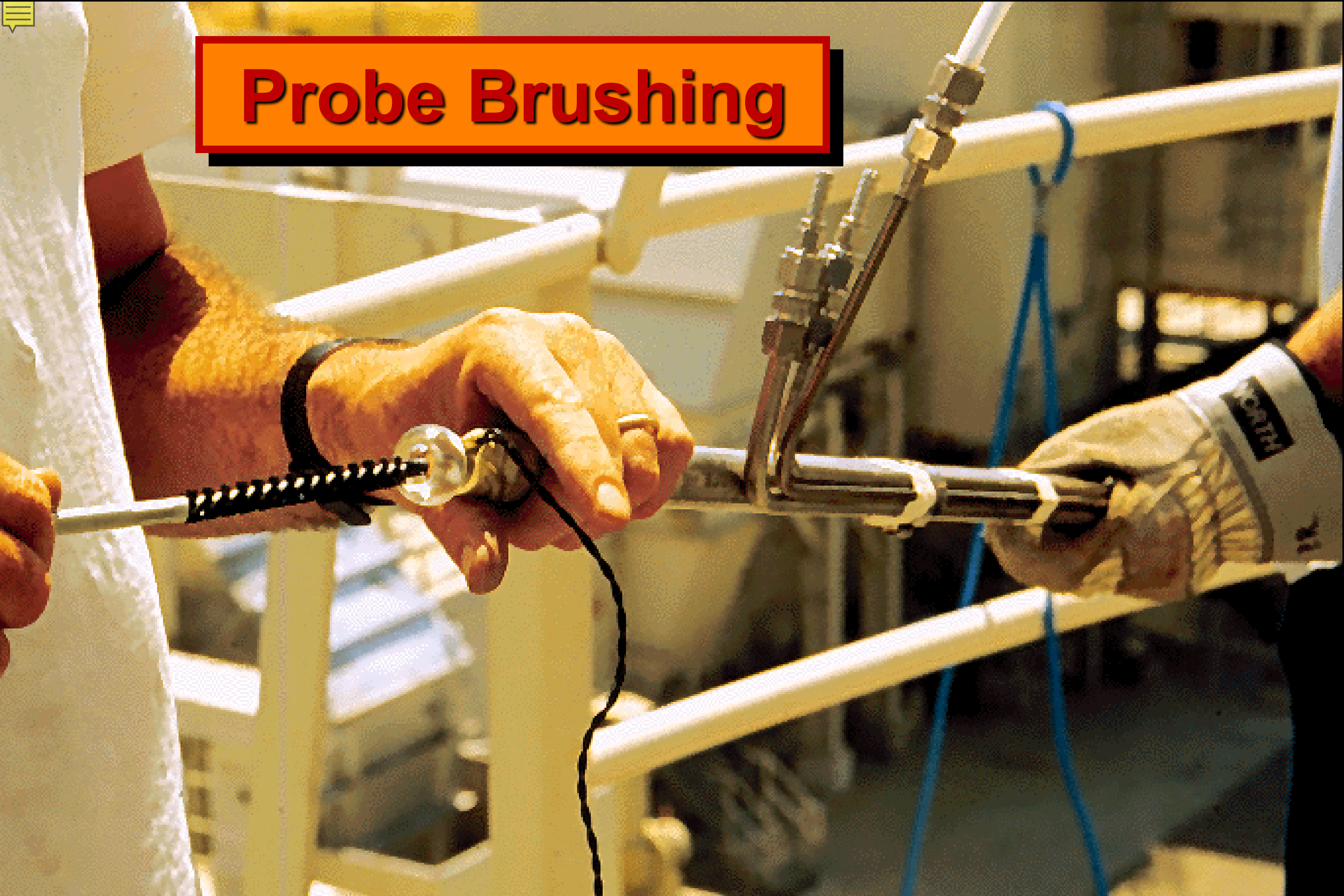
Procedural Inspections

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



Sampling Train Leak Test

Probe Brushing

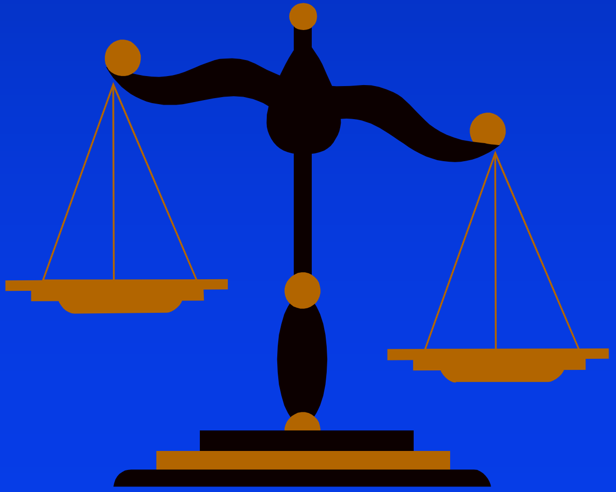


Probe Rinse

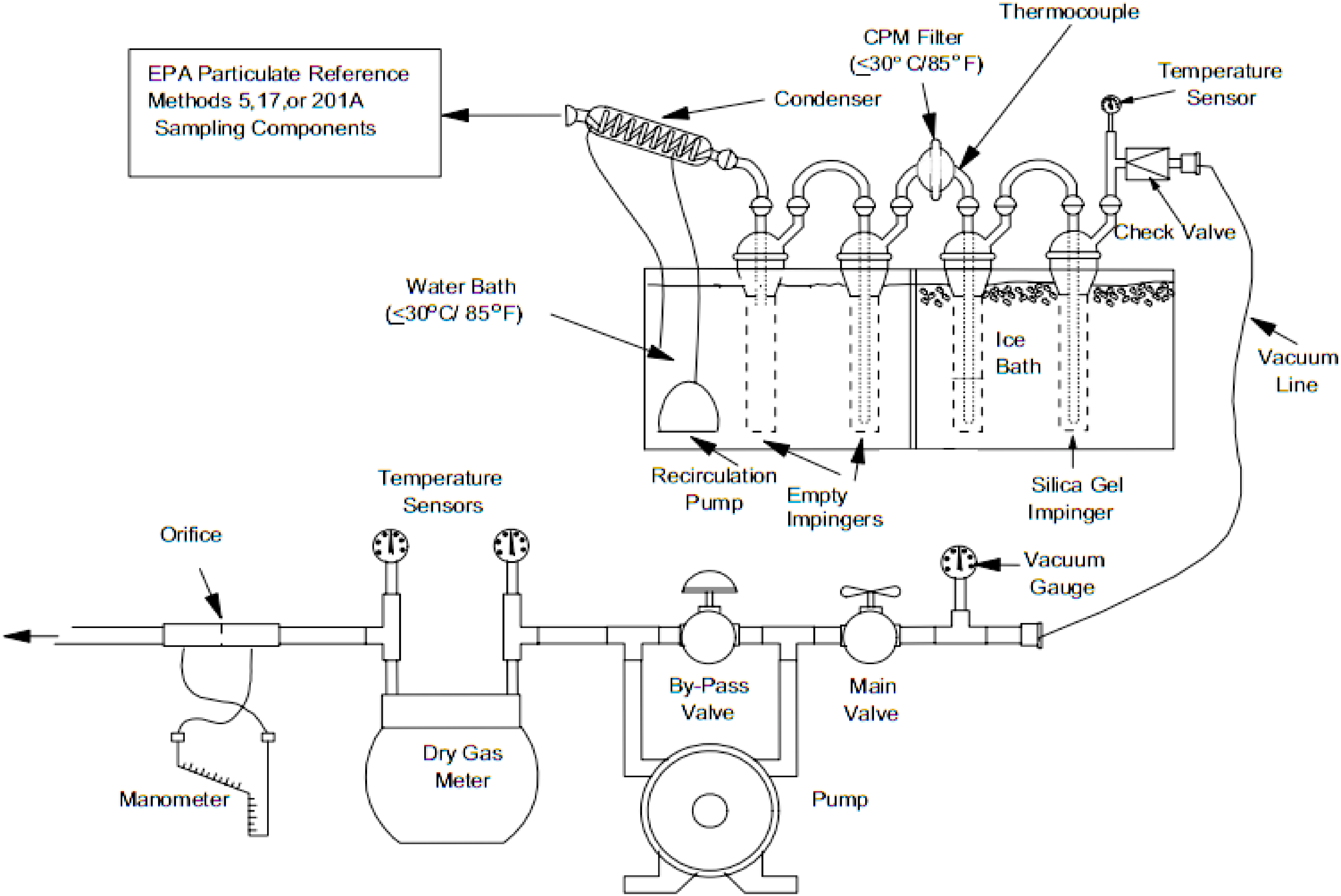

Filter Recovery

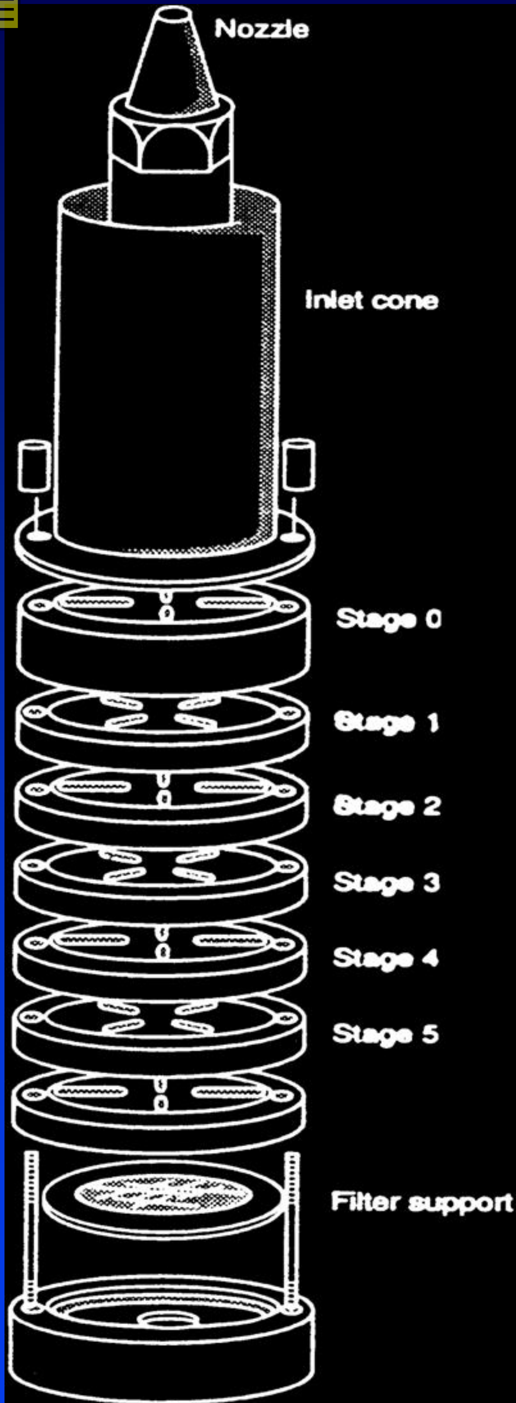
Physical Inspections

- Sample Properly Recovered
  - Good Particulate Deposit - No Evidence of Leaks
  - Impinger Solution Weighed &/or Recovered After Sampling
  - Rinse Front Half of Filter Holder Back Half Also
  - Probe Properly Cleaned
  - Filter Properly Weighed

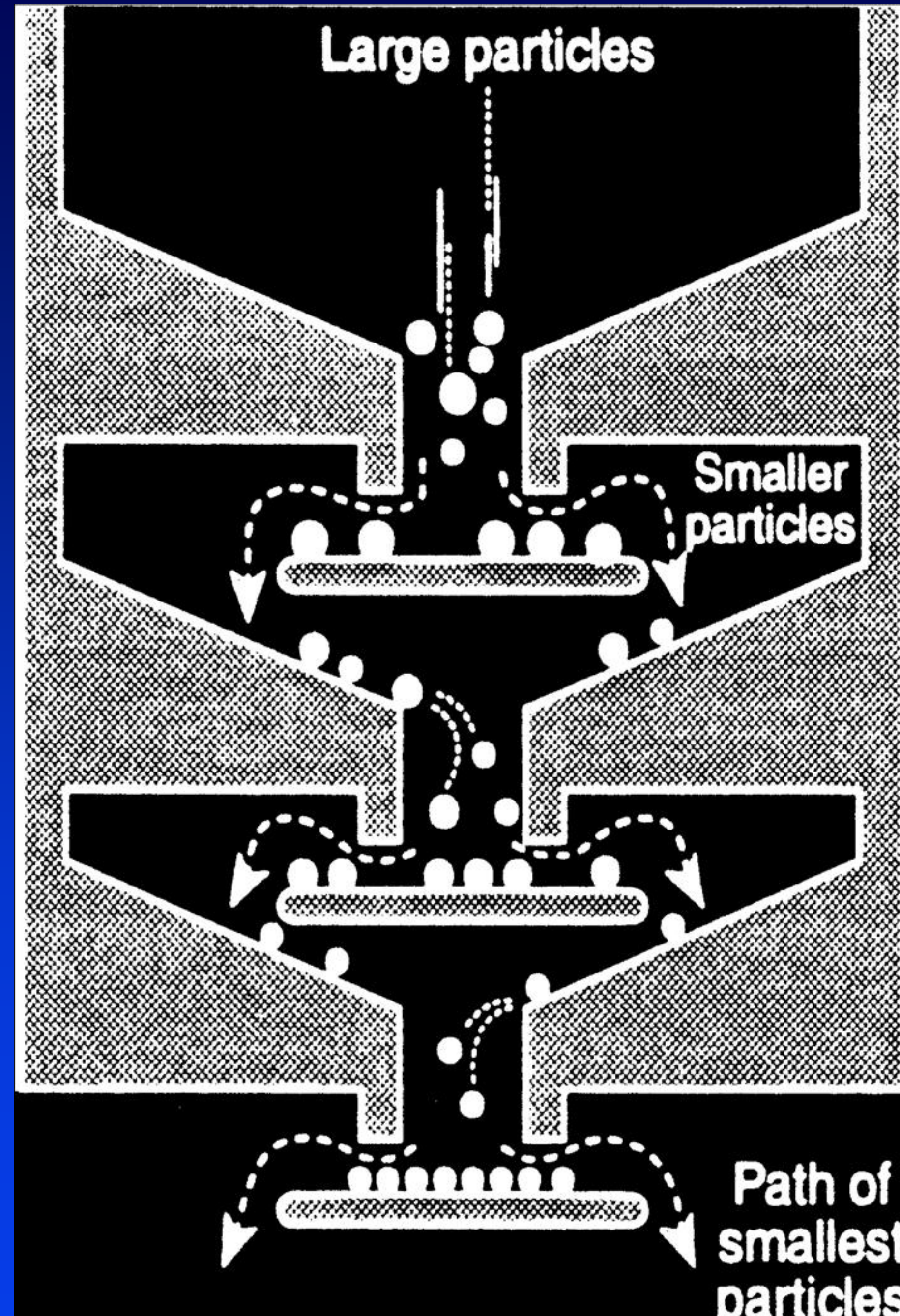


PM_{10} - Sampling Train


EPA Particulate Reference
Methods 5,17,or 201A
Sampling Components
Thermocouple
CPM Filter
(≤30° C/85° F)
Condenser
Temperature
Sensor
Check Valve
Water Bath
(≤30°C/ 85°F)
Ice
Bath
Vacuum
Line
Recirculation
Pump
Empty
Impingers
Silica Gel
Impinger
Temperature
Sensors
Orifice
Vacuum
Gauge
By-Pass
Valve
Main
Valve
Dry Gas
Meter
Manometer
Pump

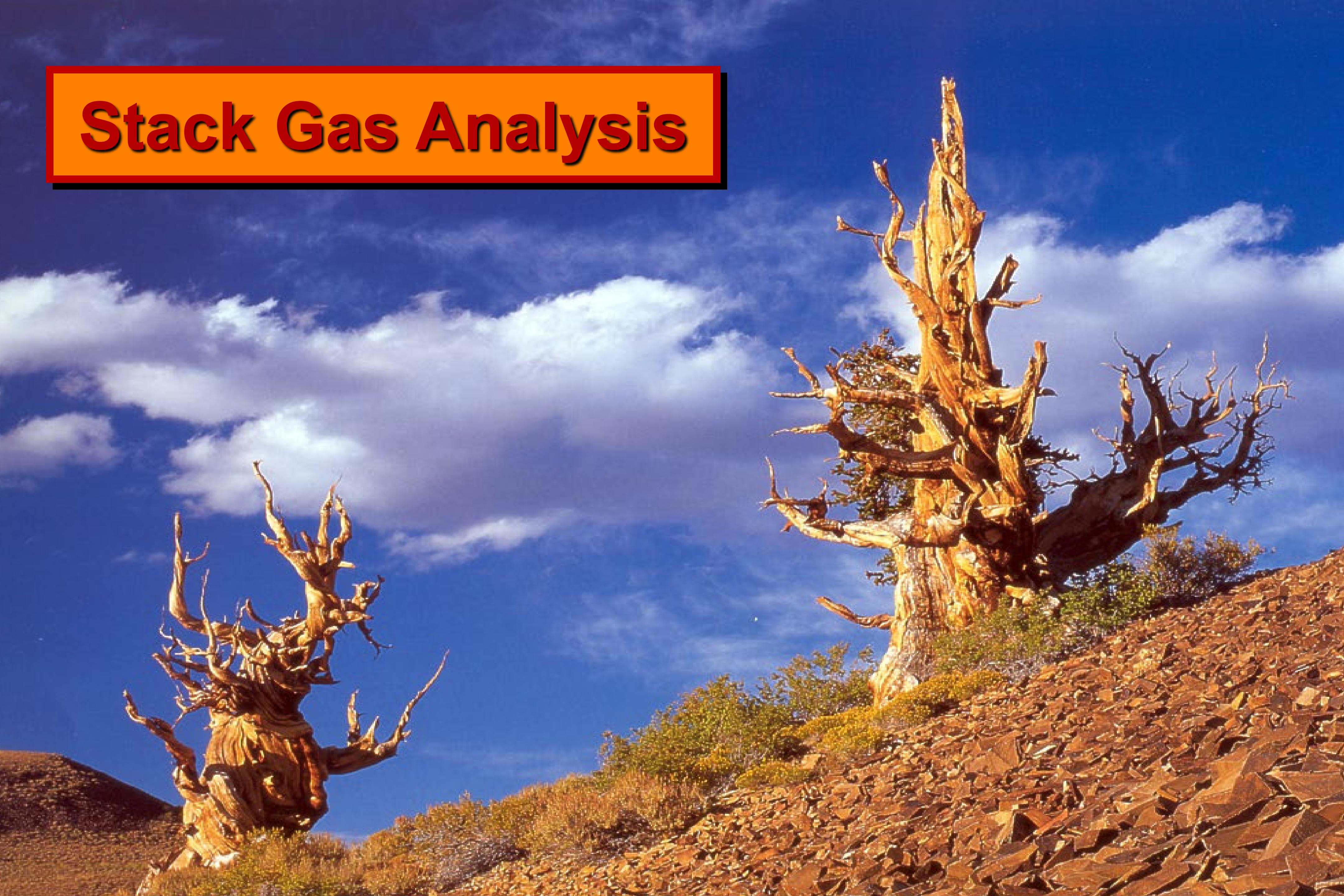


Cascade or Inertial Impactor

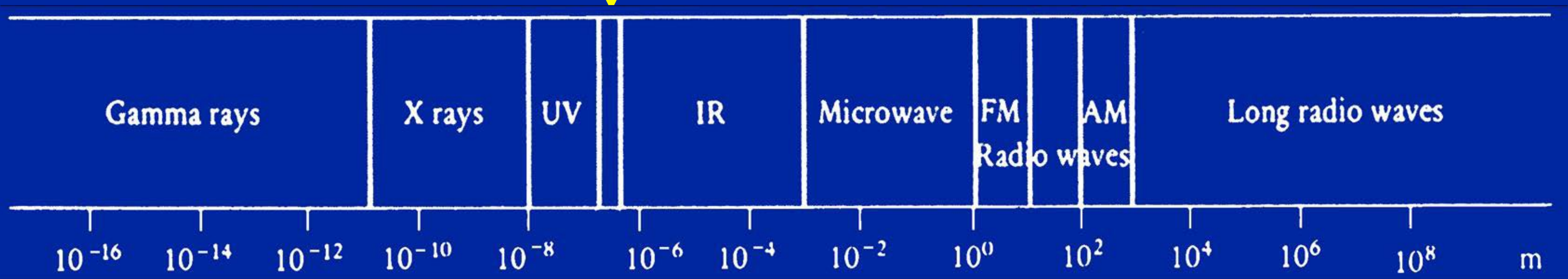


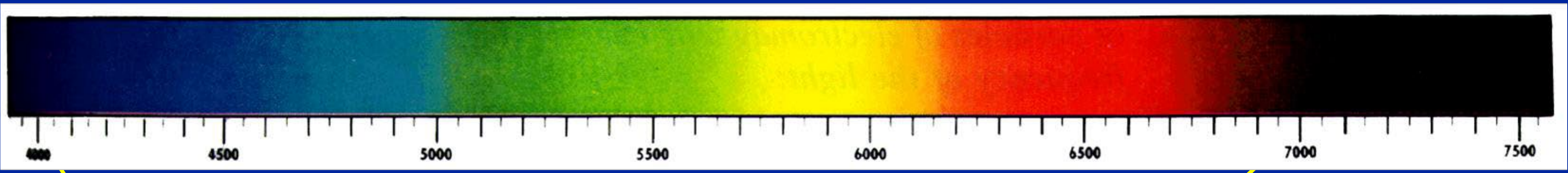

Inertial
Impactor
SWISS MADE
GENERAL

Stack Gas Analysis



Electromagnetic Spectrum



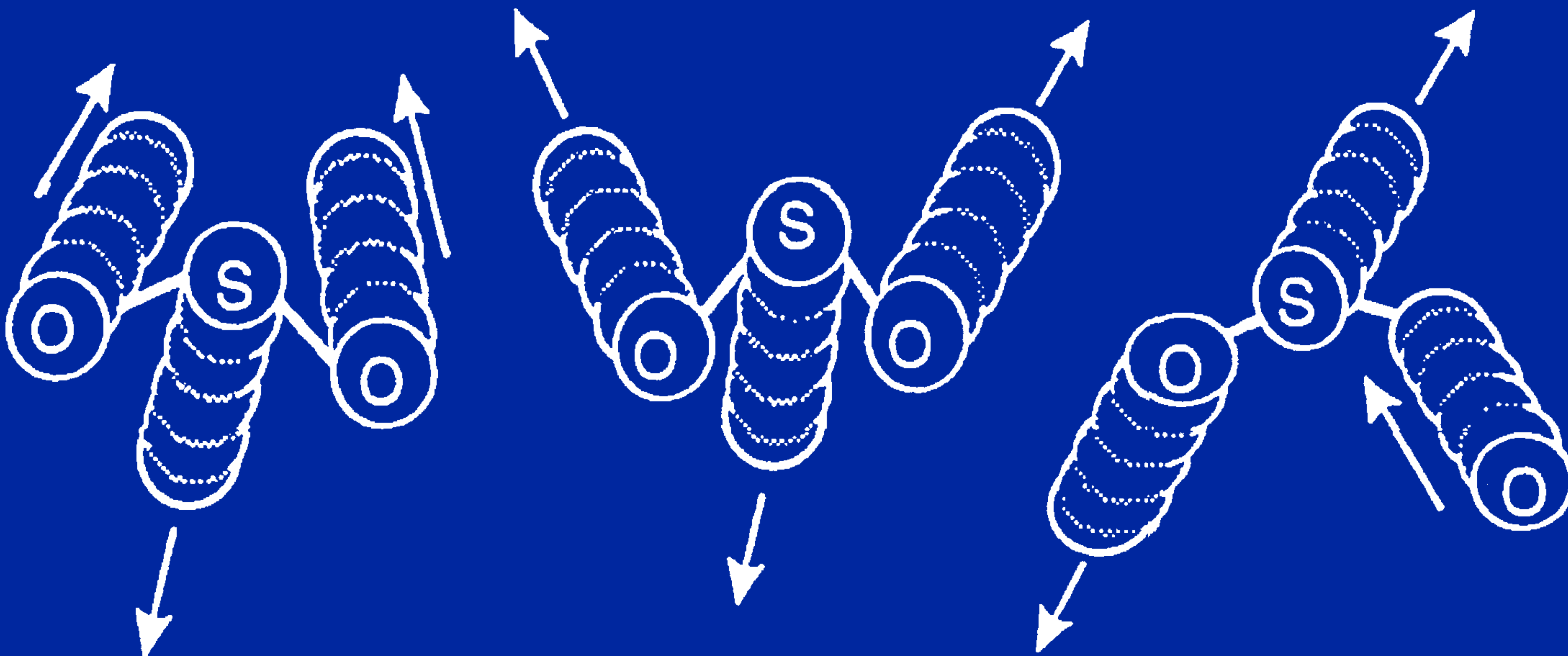


400 nm

Visible Range

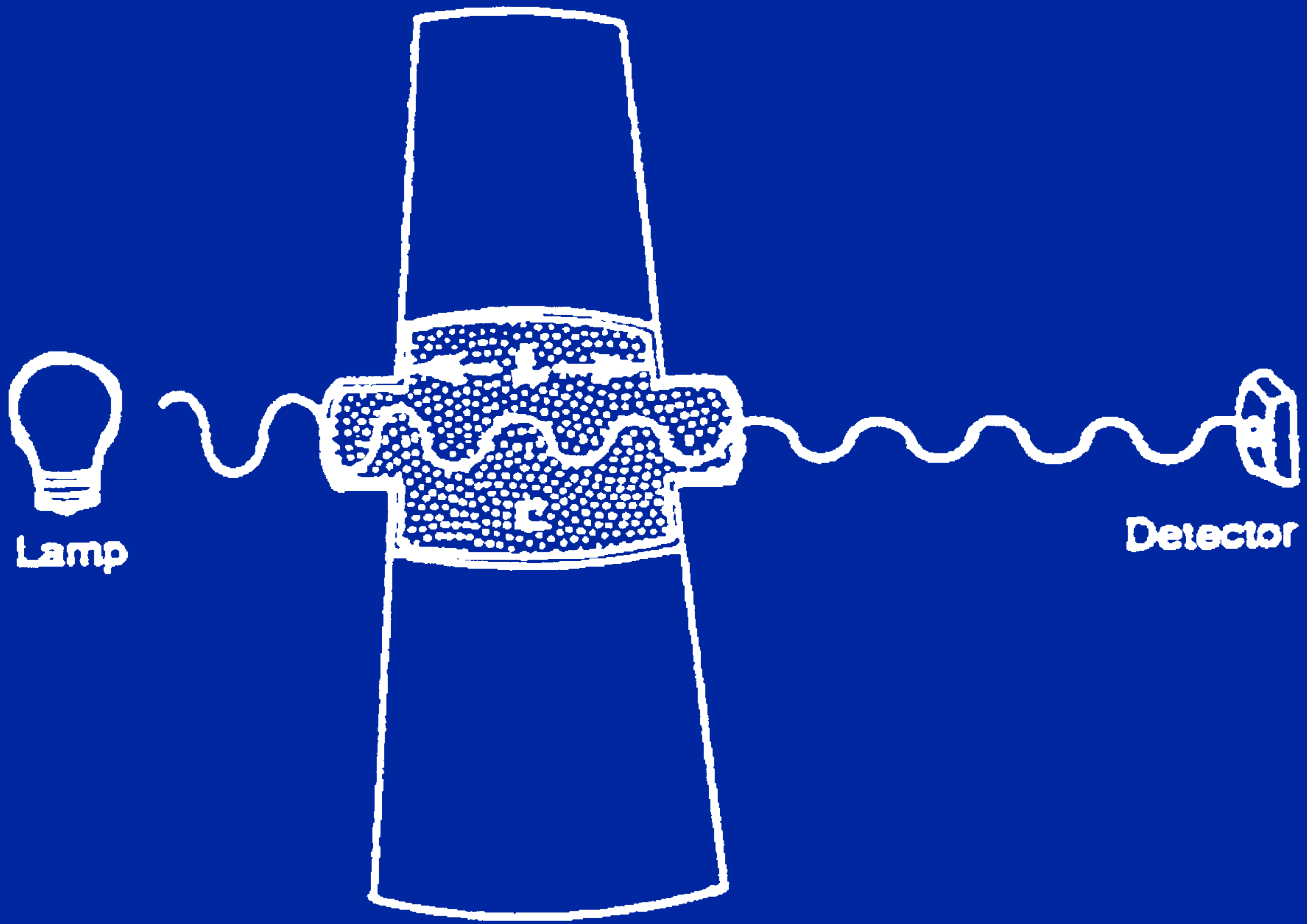
700 nm

Normal Vibration of SO_2 Molecules

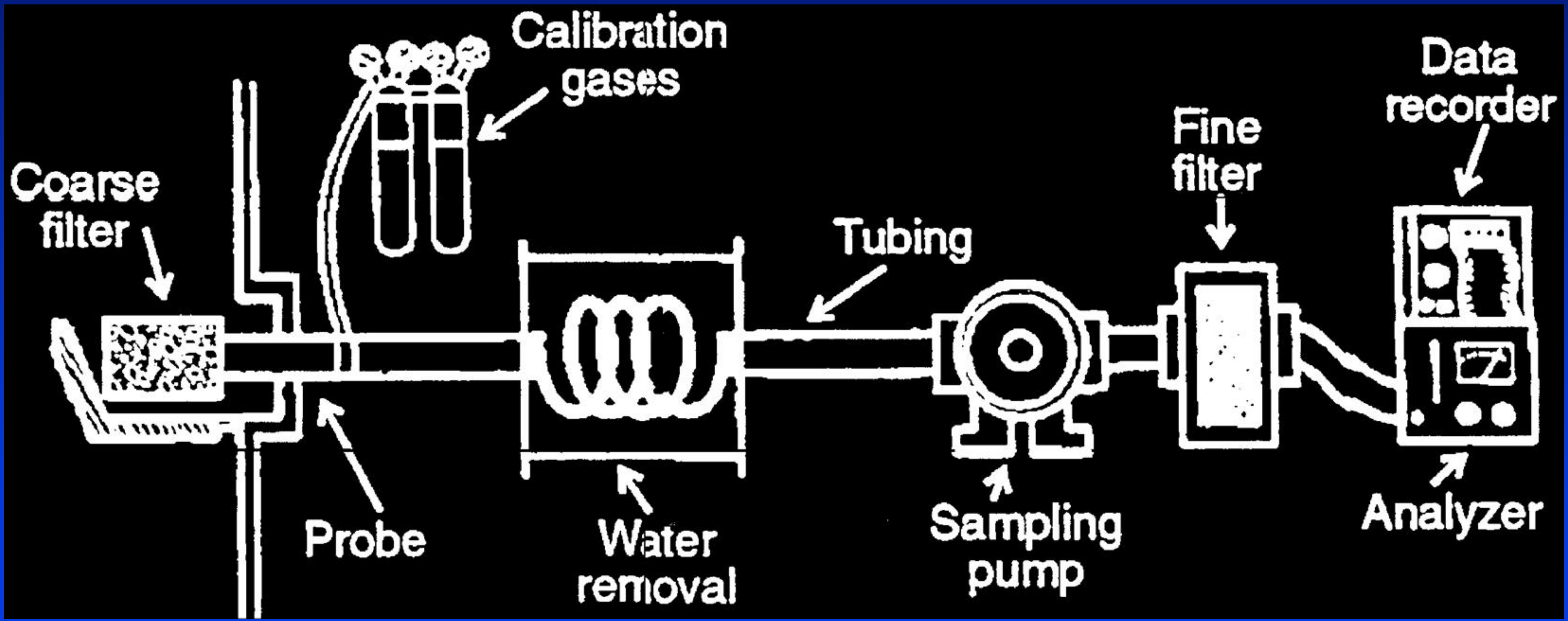


$\lambda = 8.69\ \mu m$ $\lambda = 7.48\ \mu m$ $\lambda = 19.1\ \mu m$

Simplified Stack Sample System

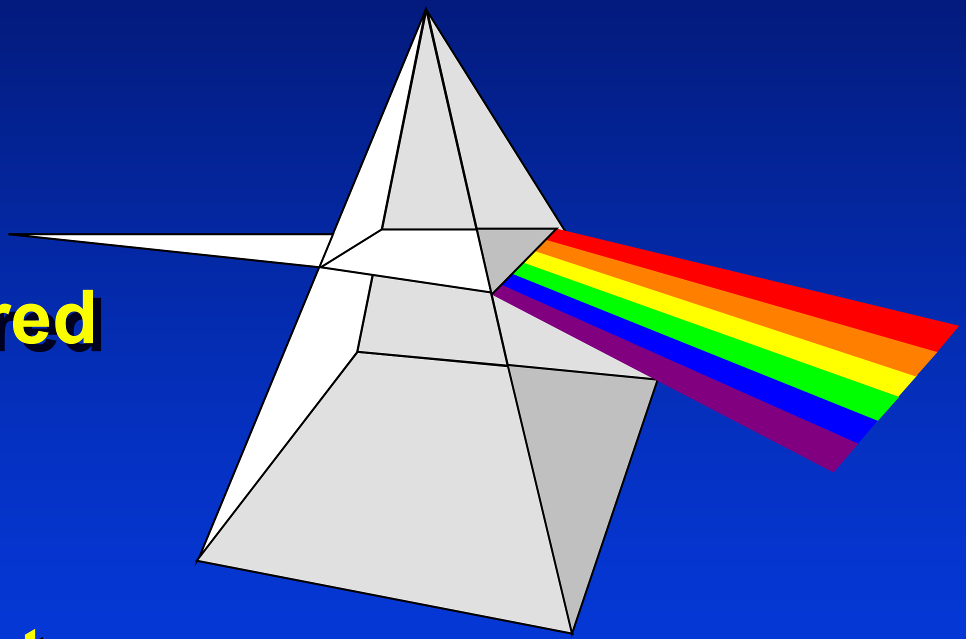


Basic Extractive System



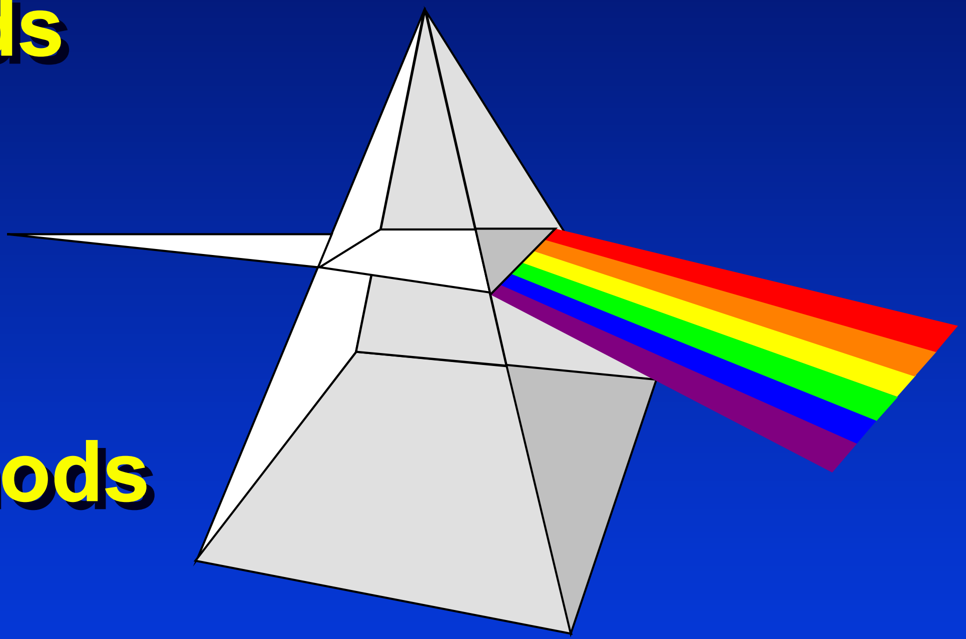
Source Test Analytical Techniques

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



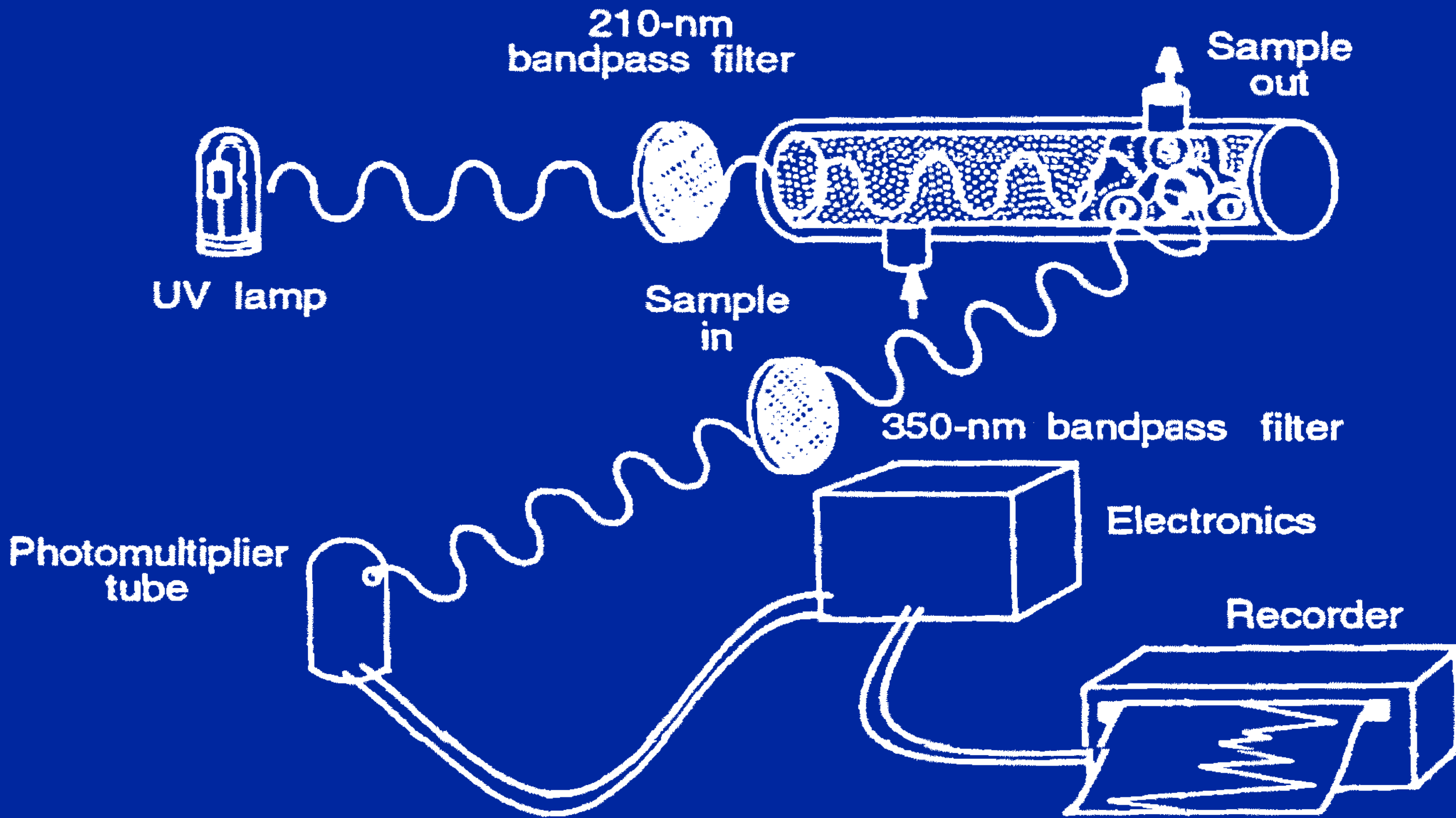
Source Test Analytical Techniques

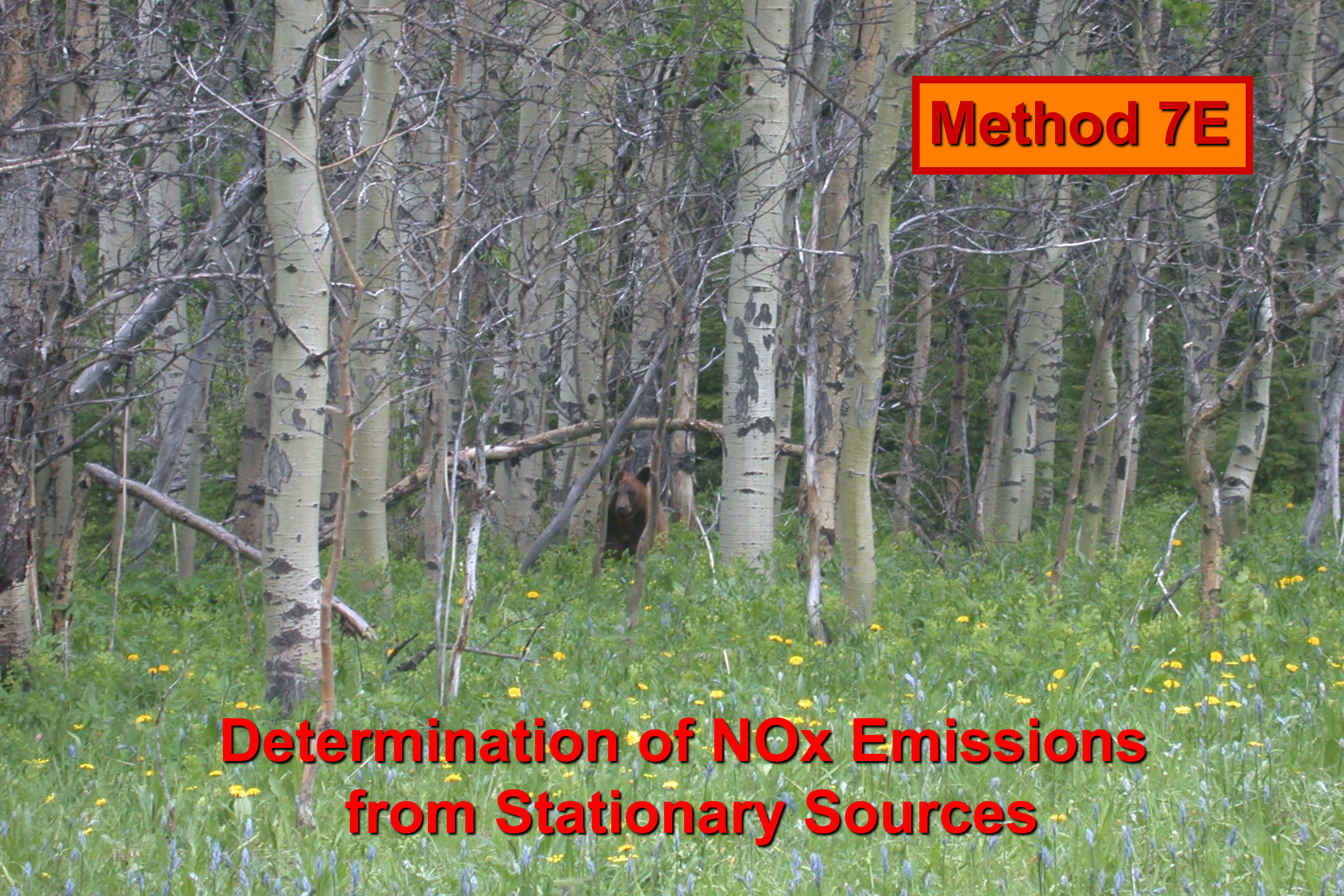
- Luminescence Methods
  - Fluorescence
  - Chemiluminescence
  - Flame Photometry
- Electroanalytical Methods
  - Polarography
  - Electrocatalytic
  - Paramagnetism
  - Conductivity



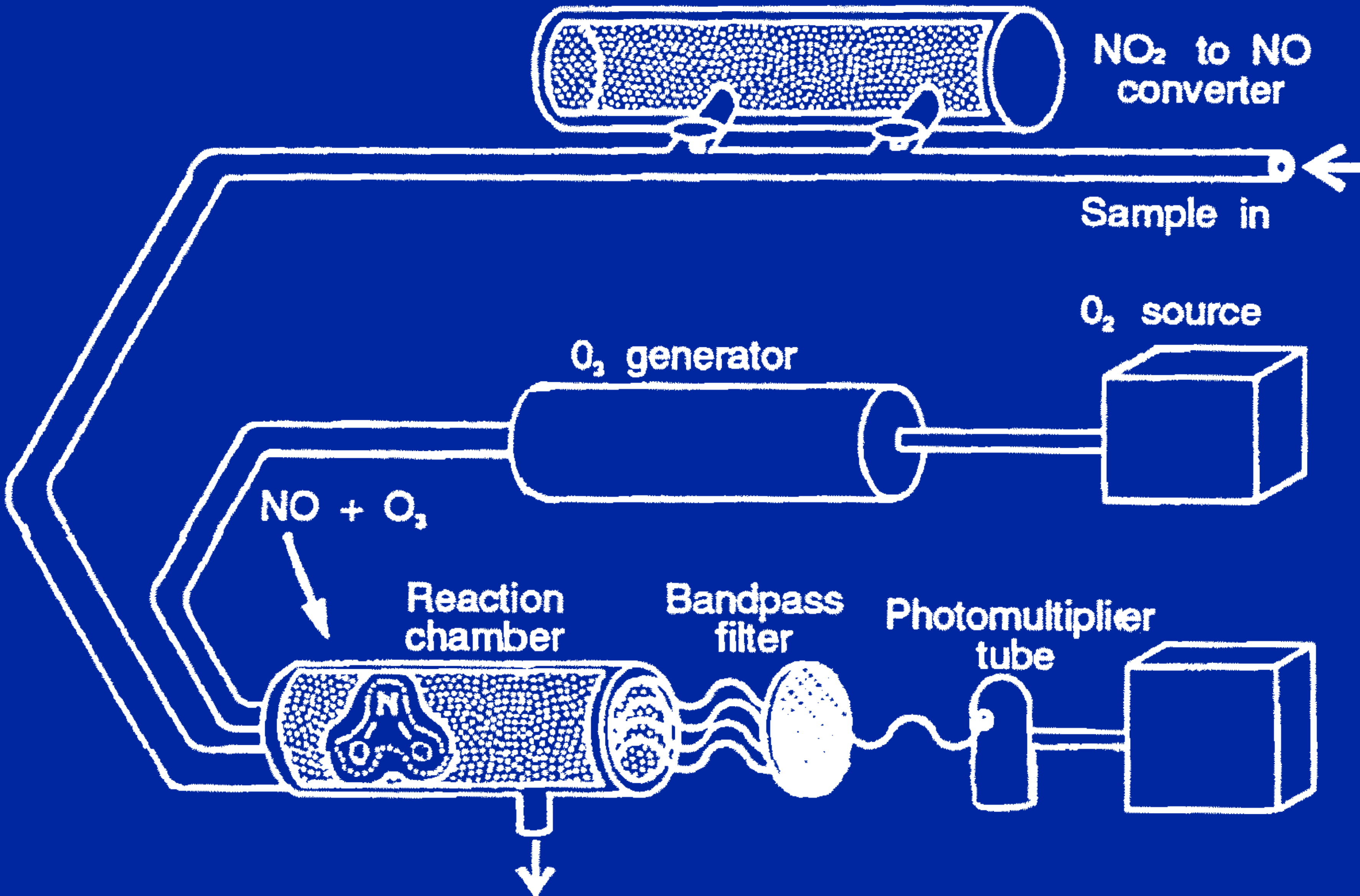

Method 6C
Determination of SOx Emissions
from Stationary Sources

Fluorescence SO_2 Analyzer

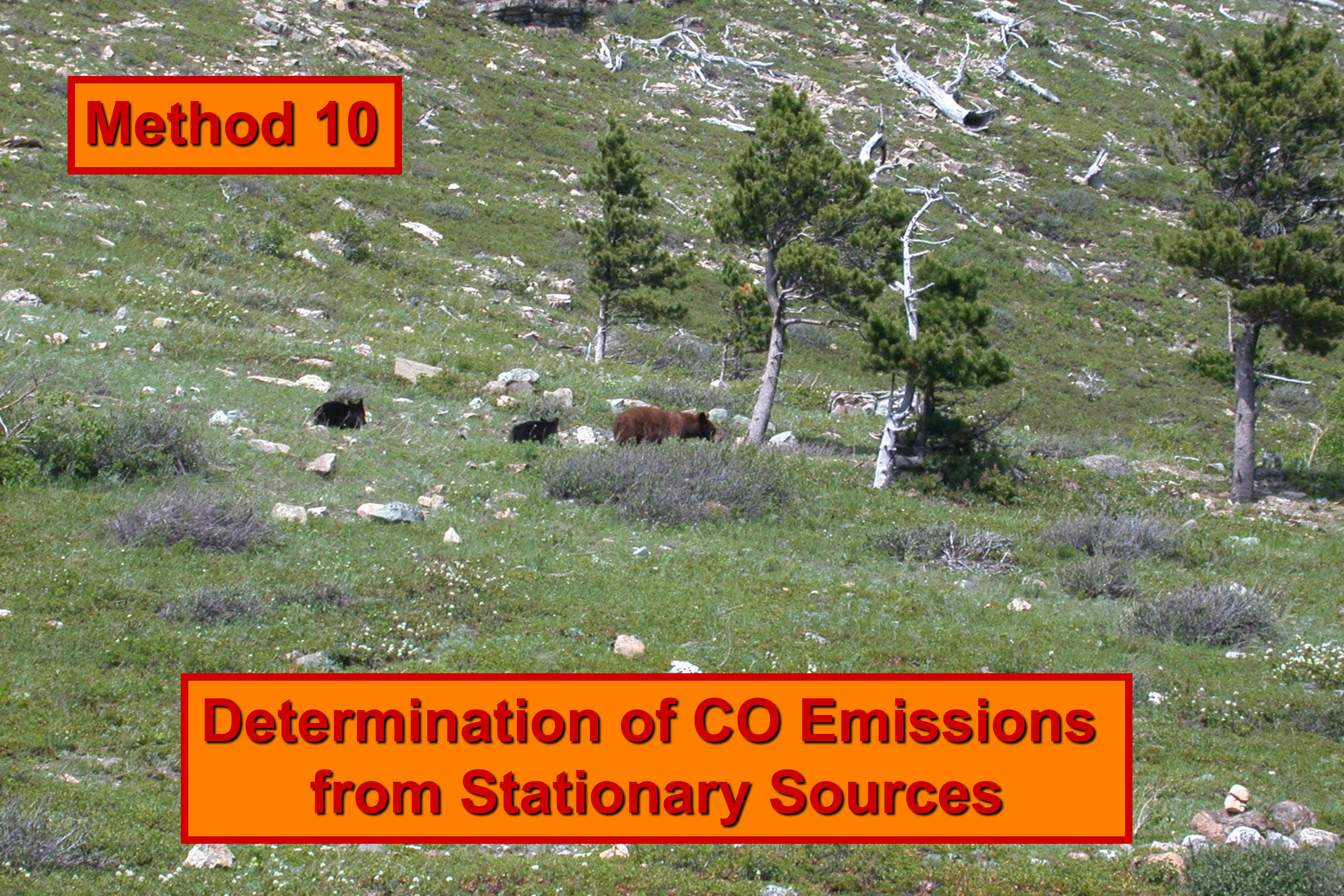



Method 7E
Determination of NOx Emissions
from Stationary Sources

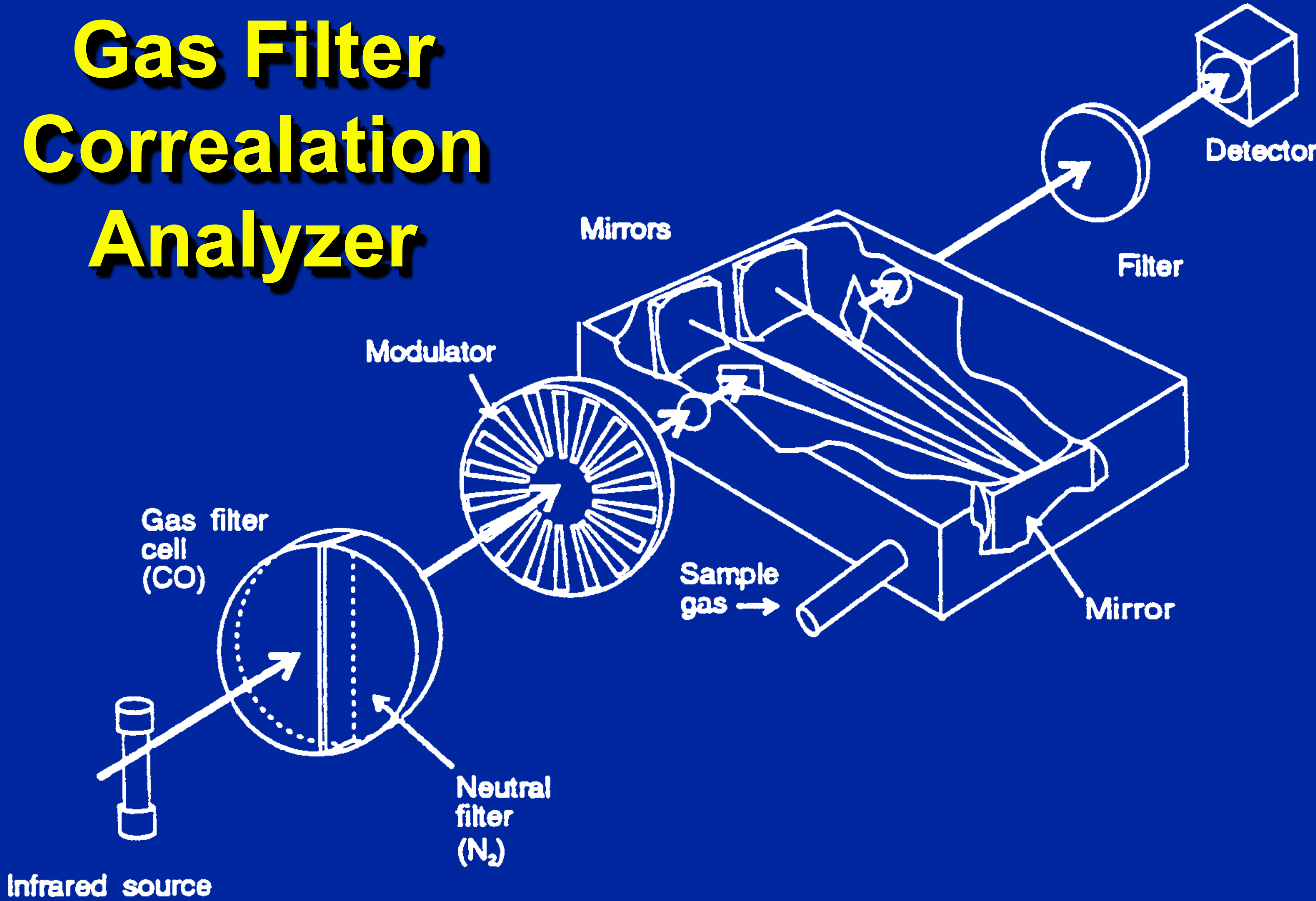
Chemiluminescence NO_x Analyzer




NOx
& CO
Analyzer
CHEMILUMINESCENCE NOx ANALYZER
POWER
Thermo Environmental
Instruments Inc.
Made in U.S.A.
Model 42D
REM ENT Z/FS DISP CAL STAT MAN AUTO
GAS FILTER CORRELATION CO ANALYZER
SAMPLE
FLOW
POWER
Thermo Environmental
Instruments Inc.
Made in U.S.A.
Model 48
TEST
REMOTE Z/FS DAC INT. P/T STAT. H.A. RUN
ZERO LO SPAN HI SPAN T


Method 10
Determination of CO Emissions
from Stationary Sources

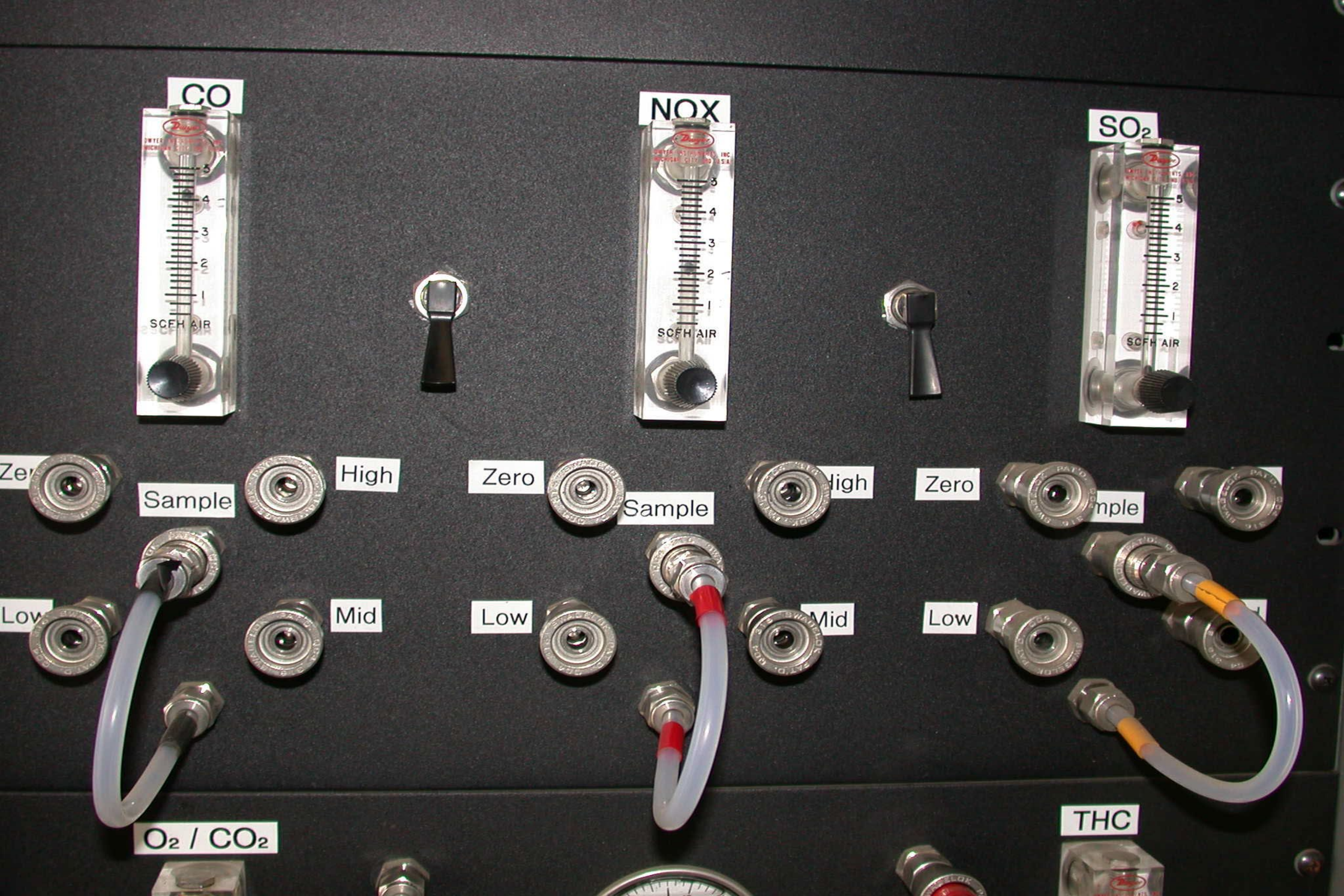
Gas Filter Correalation Analyzer




Source
Test Van
Instruments
CONVERTER
L 2200

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


CO
NOX
SO2
SCFH AIR
SCFH AIR
SCFH AIR
High
Sample
Zero
Sample
Zero
Low
Mid
Low
Mid
Low
O2 / CO2
THC

Cal Gas Certificate Points

- Cylinder ID Number
- Balance Gas
- Cylinder Pressure
- Certification Date
- Expiration Date
- Lab & Analyst ID
- (PGVP – Part 75)
- Reference Standard Data
- Statement of Procedures
- Certified Concentration
- Gas Analyzer ID & Cal Date
- Analyzer Readings & Calc Used
- Chronological Cert Record

Air & Radiation Home
Clean Air Markets Home
Basic Information
Where You Live
About Acid Rain
Doing Business With Us
Programs and Regulations
Progress and Results
Cap and Trade
Allowance Trading
Emissions Monitoring
Data and Maps
Environmental Issues
Resource Center
Meetings and Workshops
Related Links

2013 Emission PGVP Participants and Vendor IDs

The table below lists the current participants in EPA's Protocol Gas Verification Program (PGVP) for stationary source monitoring. This list is updated: (1) at the beginning of each calendar year; (2) whenever an EPA Protocol gas production site joins the program; (3) whenever the information for a listed production site changes; and (4) whenever a production site is taken off the list. Historical versions of the table are retained. The vendor IDs in the Table are production site-specific. The vendor IDs are the same ones that are used in the PGVP for ambient air monitoring, which is run by EPA's Office of Air Quality Planning and Standards in Research Triangle Park, NC.

On and after May 27, 2011, the owner or operator of a unit subject to Part 75 emissions monitoring that uses EPA Protocol gases must procure the gases from a production site that is listed in the Table on the date that it procures the gases, or from a merchant who sells unaltered EPA Protocol gases produced by an EPA Protocol gas production site that was listed in the Table on the date the merchant procured the gases. (See 40 CFR 75.21(g)(6) and (7).)

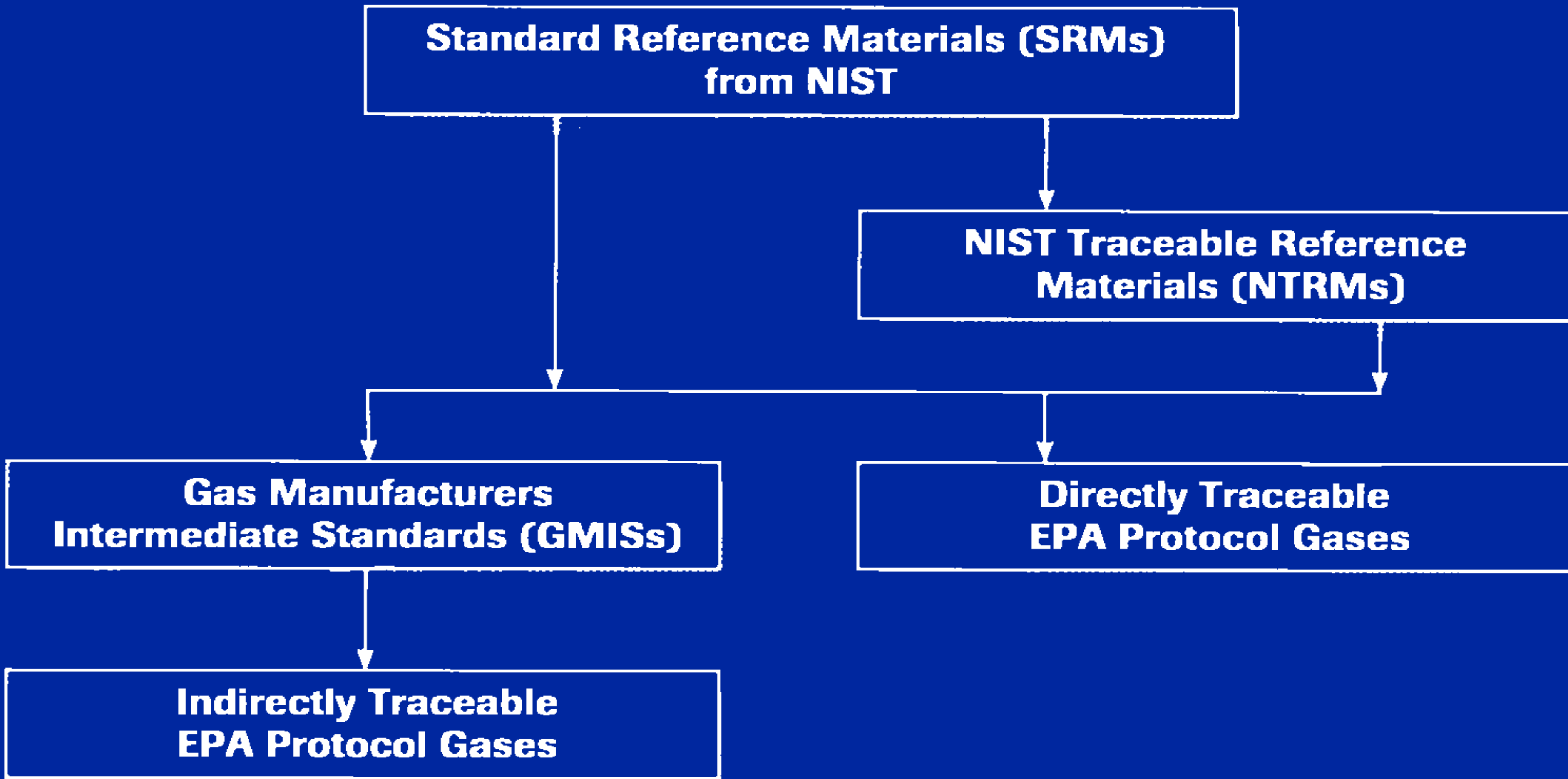
Participating EPA Protocol gas production sites and vendor IDs will be posted as soon as EPA receives the necessary information from the participating production sites. Sources subject to Part 75 do not need to start purchasing EPA Protocol gases from participating production sites until May 27, 2011. EPA Protocol gases purchased prior to this date may be used until the earlier of the cylinder expiration date or the date the cylinder pressure reaches 150 psig.

Emissions Monitoring
- Part 75 Petition Responses
- Rules, Policy, and Instructions
- Emission Protocol Gas Verification Program
- Air Emission Testing Bodies
- 2010 EPA Protocol Gas Audit
- Audits
- FLOW CALC Software
- Other Monitoring Resources
- Hourly Emissions Data

2013 EPA Emission Protocol Gas Verification Program Participants

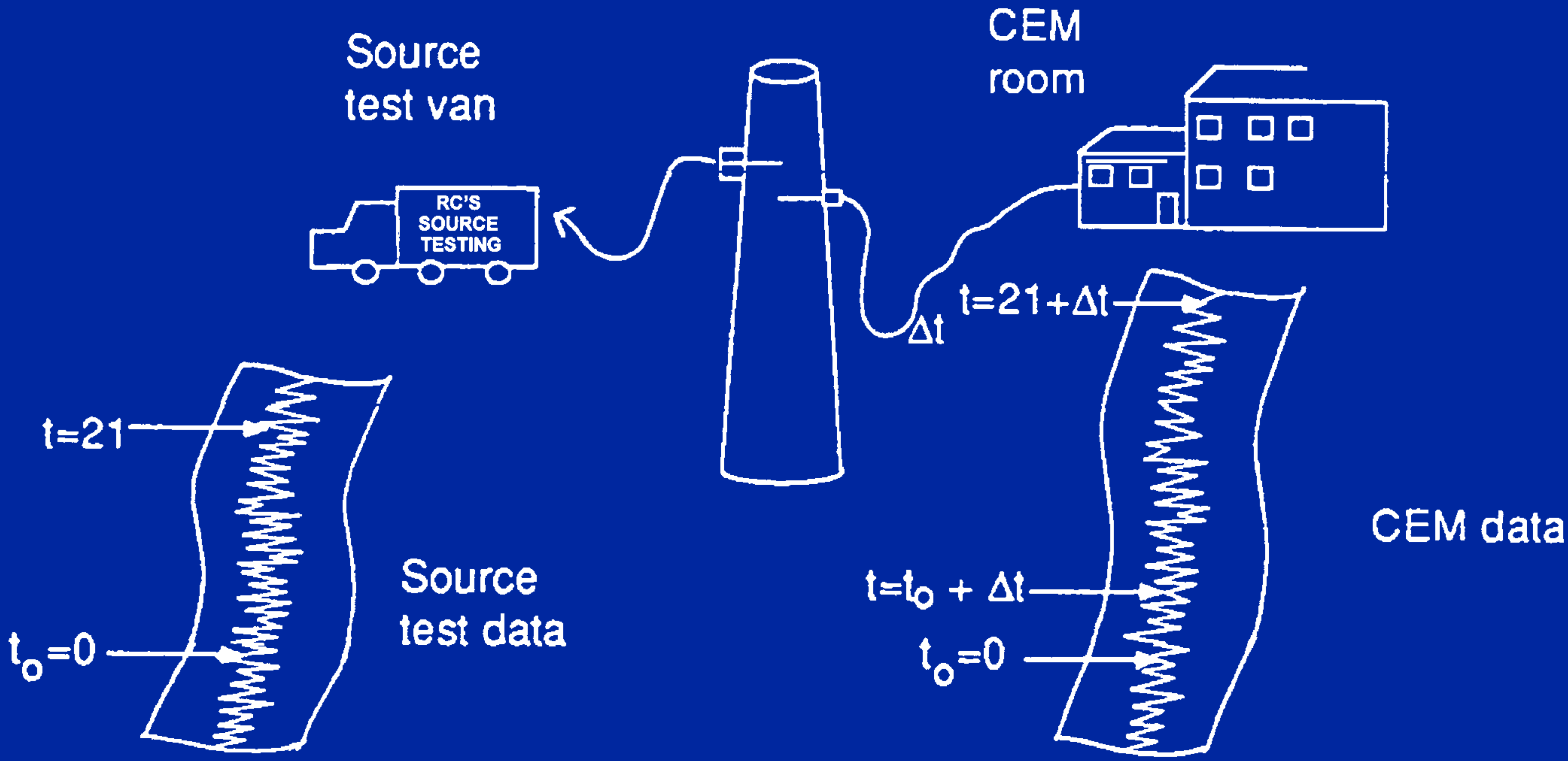
Vendor ID	Specialty Gas Company	Production Site	Production Site Participation Start Date (mm/dd/yy)	Date Delisted (mm/dd/yy)
A12013	Air Liquide America Specialty Gases LLC	Air Liquide America Specialty Gases (PA) 6141 Easton Road PO BOX 310 Plumsteadville, PA 18949-0310	01/01/13	
A22013	Air Liquide America Specialty Gases LLC	Air Liquide America Specialty Gases (MI) 1290 Combermere Street Troy, MI 48083	01/01/13	
A32013	Air Liquide America Specialty Gases LLC	Air Liquide America Specialty Gases (TX) 11426 Fairmont Parkway Laporte, TX 77571	01/01/13	
A42013	Air Liquide America Specialty Gases LLC	Air Liquide America Specialty Gases (CO) 500 Weaver Park Road Longmont, CO 80501	01/01/13	

Calibration Gas Hierarchy

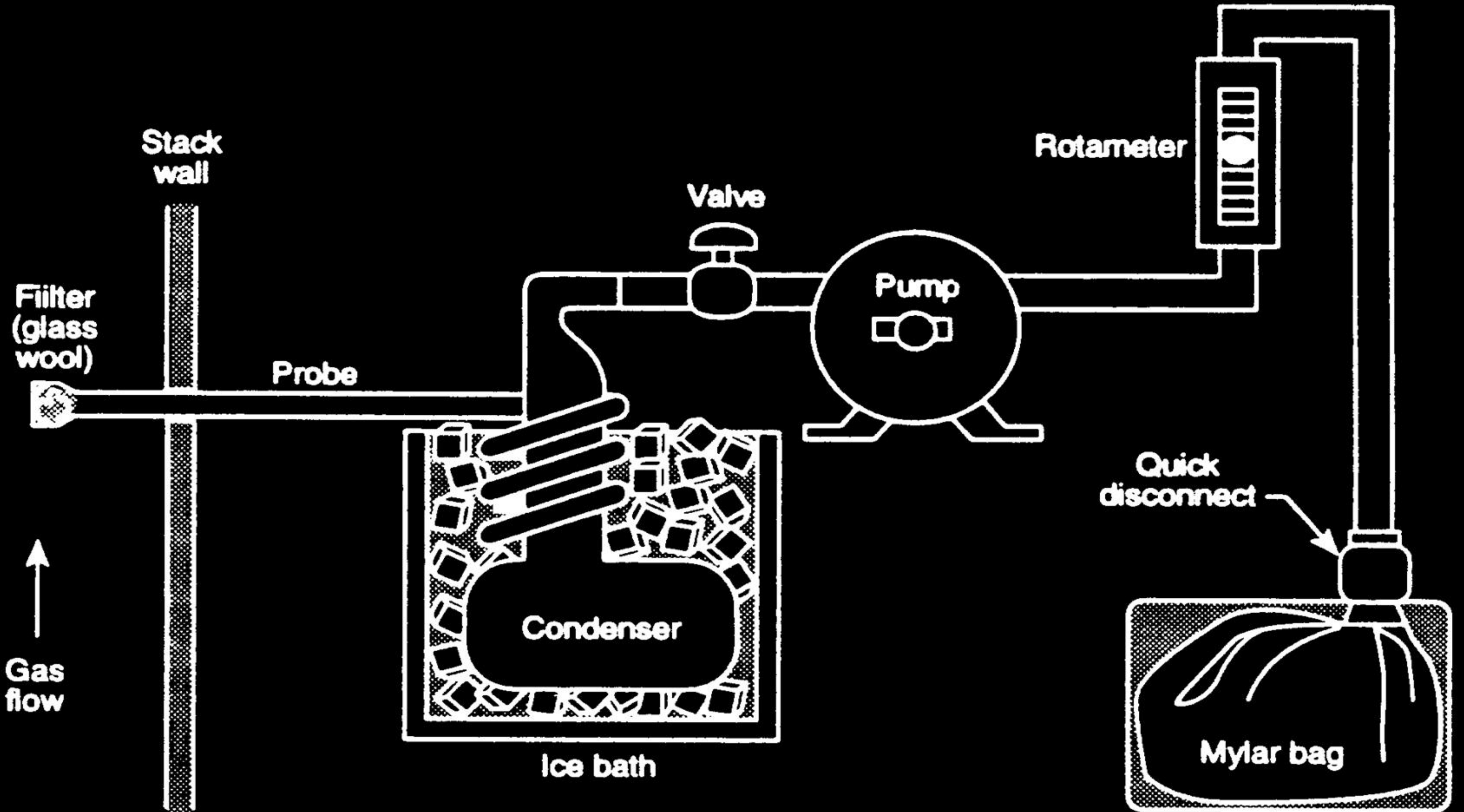



???
Source
Test Van
Cal Gas

Relative Accuracy Test Audit (RATA) vs. CEMS



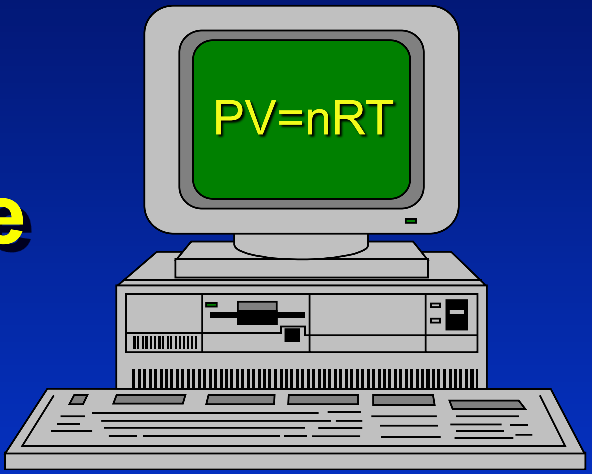
Integrated Sampling



Grab Sample Case

Procedural Inspections

Data Recording

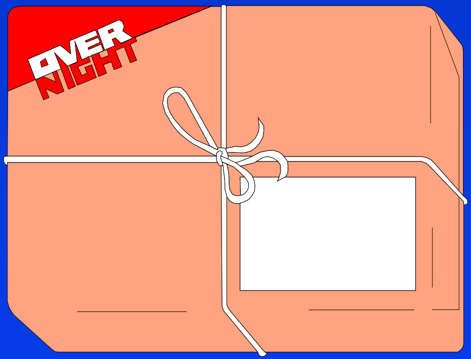


- Timely, Accurate, & Complete
- Standardized Form Used
- Computer Data Entry:
  - Automatic - Computer Controlled Equipment
  - On Site After Sampling or During Sample (Computer Data Entry Form)
  - After Sampling Completed

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



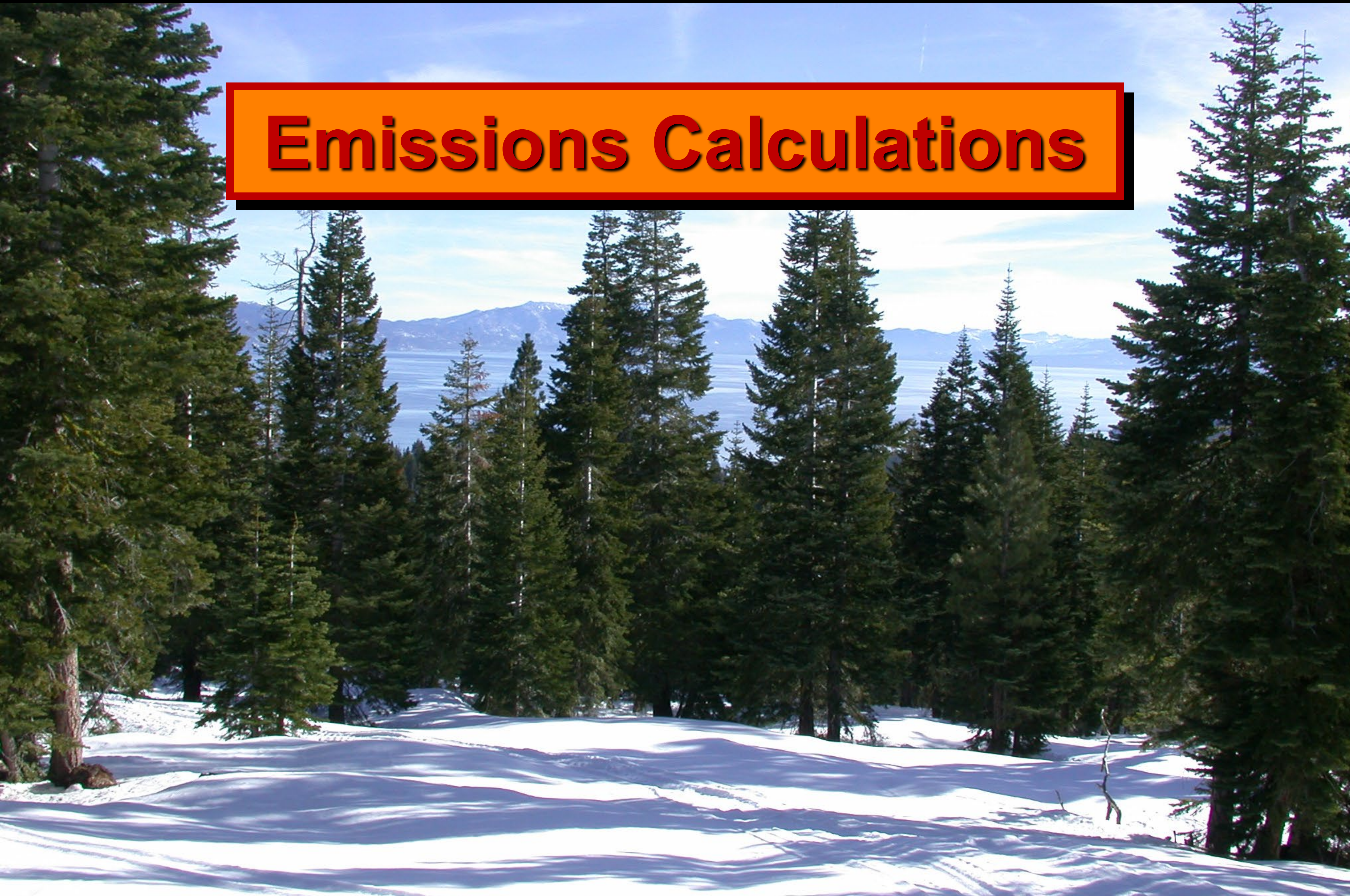
Procedural Inspections

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


Lab Analysis
Americium
SATURN 3 LOGBOOK
SATURN #3 PARTS
SATURN #3 PARTS
SATURN #3 PARTS

Emissions Calculations



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

$$E = \frac{pmr_s}{Q_H} = \frac{c_s Q_s}{Q_H}$$

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

Calculation Inspections

- Normalized to Diluent Gas
  - O_2
  - CO_2

Conditions

12% CO_2

6 % O_2

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

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

Effects of Errors

Impact of Errors on Validity of Test

- What ~~is~~ will the Data ~~to~~ be Used for?
- What is the Direction & Magnitude of any Biases?
- What is the Acceptable Bias Before Rejecting the Testing?

Effects of Errors

Accuracy

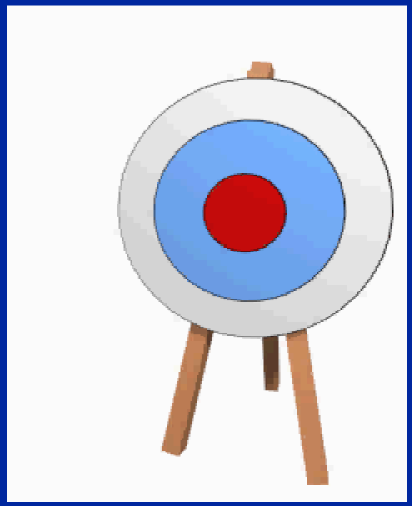
→ Compares Well with the Correct Value

Precision

→ Repeated Tests Give the Same Results

Accuracy & Precision

Accurate and Precise



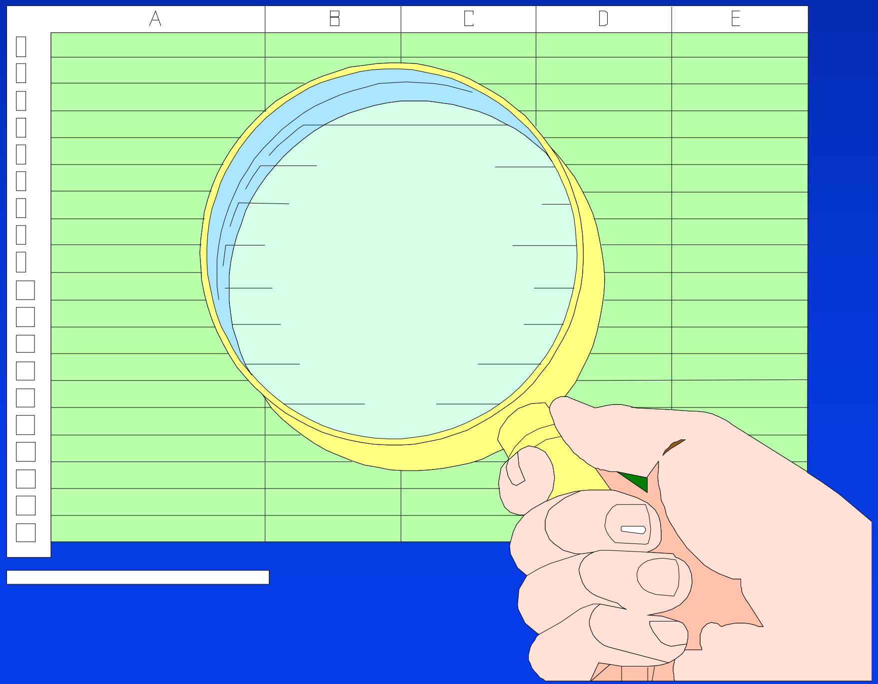
Neither Accurate nor Precise

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

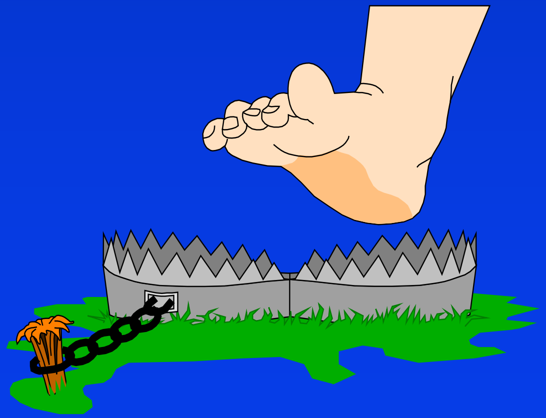


Post Test Activities

- Evaluation of Compliance in Light of the Test Result
  - Current Enforcement Action
  - Future Inspections
  - Enforcement

Inspector Safety

- Proper equipment
- Plant warnings
- Heat
- High pressure steam
- Electrical hazards



- Noise
- Moving parts
- Inhalation hazards
- Hazardous materials
- Machine disintegration
- Other hazards & traps

In Summary: Source Test Successful

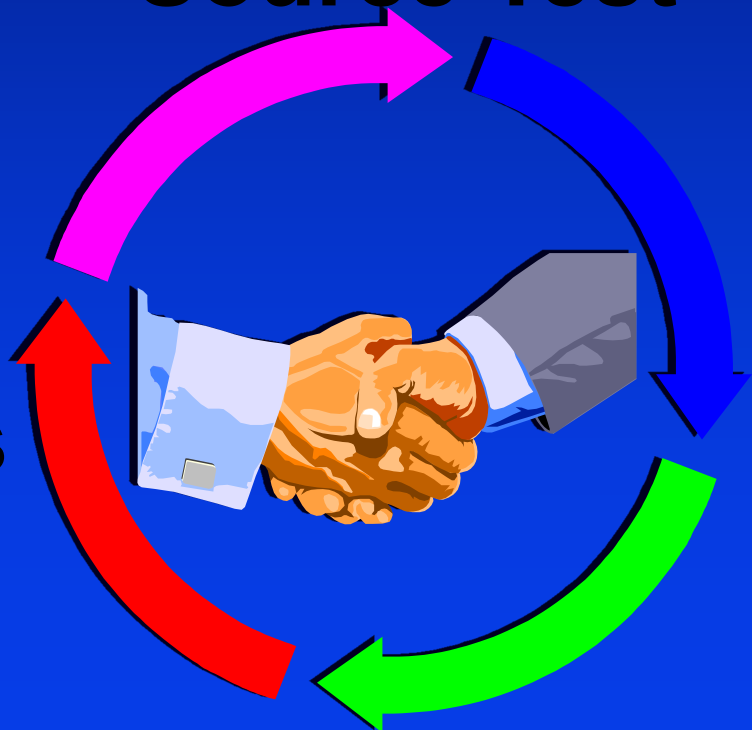
If an Evaluator Can Evaluate Representativeness of :

- Process & Control Equipment Operation
- Sampling Port Location
- Sample(s) Collected
- Sample Recovery & Analysis
- Final Report

Source Test Enforcement Cycle

Permitting

Source Test



Facility Inspections

Continued Compliance


Thank You