

Presentation for:

Asbestos Point Counting Analysis

- the Truth, Myth, and Controversy

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Built Environment Testing

Objectives

- What is asbestos point counting analysis?
- How do we do point counting analysis?
- What types of point counting should you use?
- What are the pros and cons of point counting analysis?
- Why do we do point counting analysis?
- Point counting analysis case studies
- Common questions related to point count
- The truth, myth, and controversy of point counting



What is Point Counting?

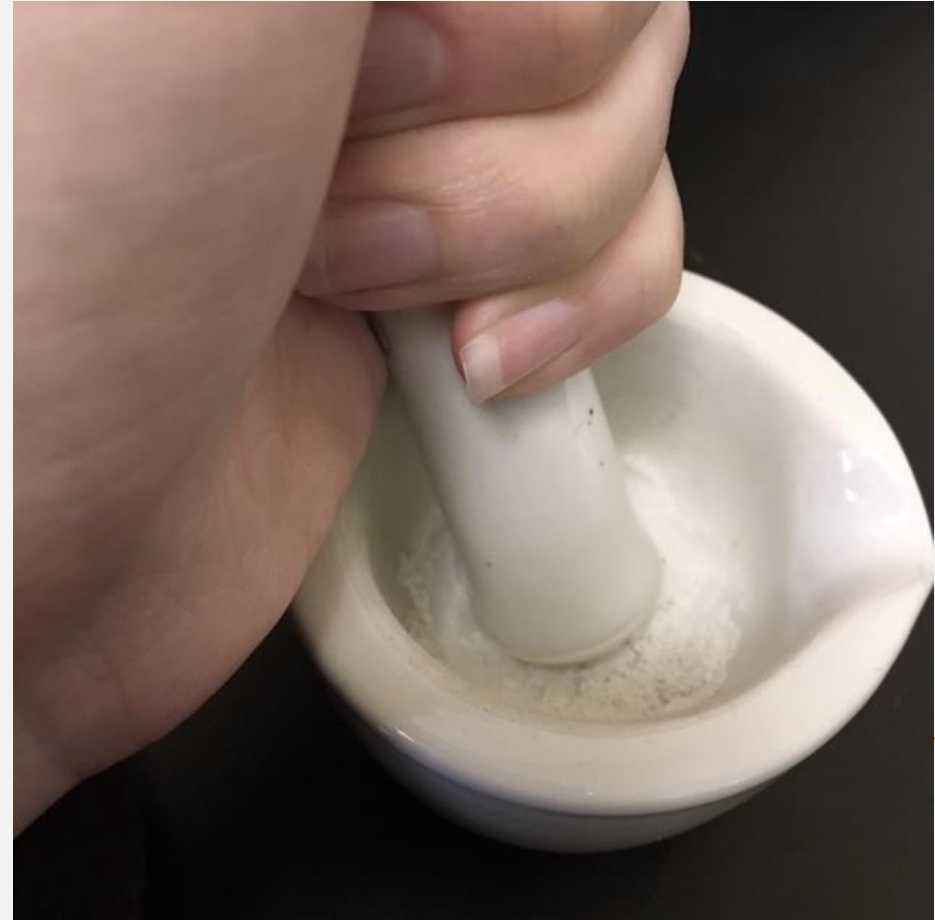
Point Counting is a method to determine the proportion of an area that is covered by some objects of interest. In most cases the area is a thin section or a polished slab

$$P_i \approx H_i / N$$

Where, P_i is the true proportion of the object i
 H_i is the number of points hitting object i
 N is the total number of points counted
(simplified assuming **uniform thickness and density**)

Asbestos Point Counting Analysis

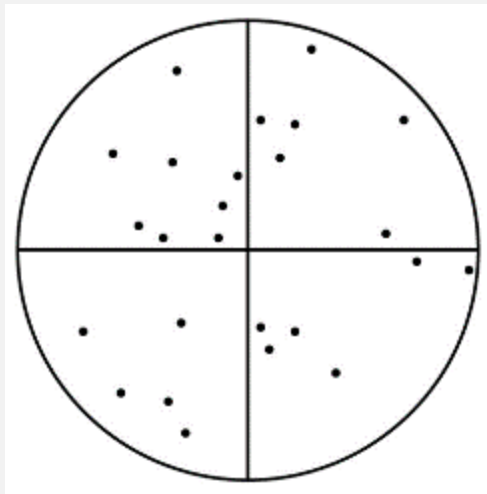
- Sample Prep:
 - Sample is homogenized using mortar and pestle
 - Subsamples are prepped on 8-10 slides
 - Each layer should be prepped separately



Point Count Sample Analysis

Slides are examined using a polarized light microscope at 100x magnification with a point count ocular.

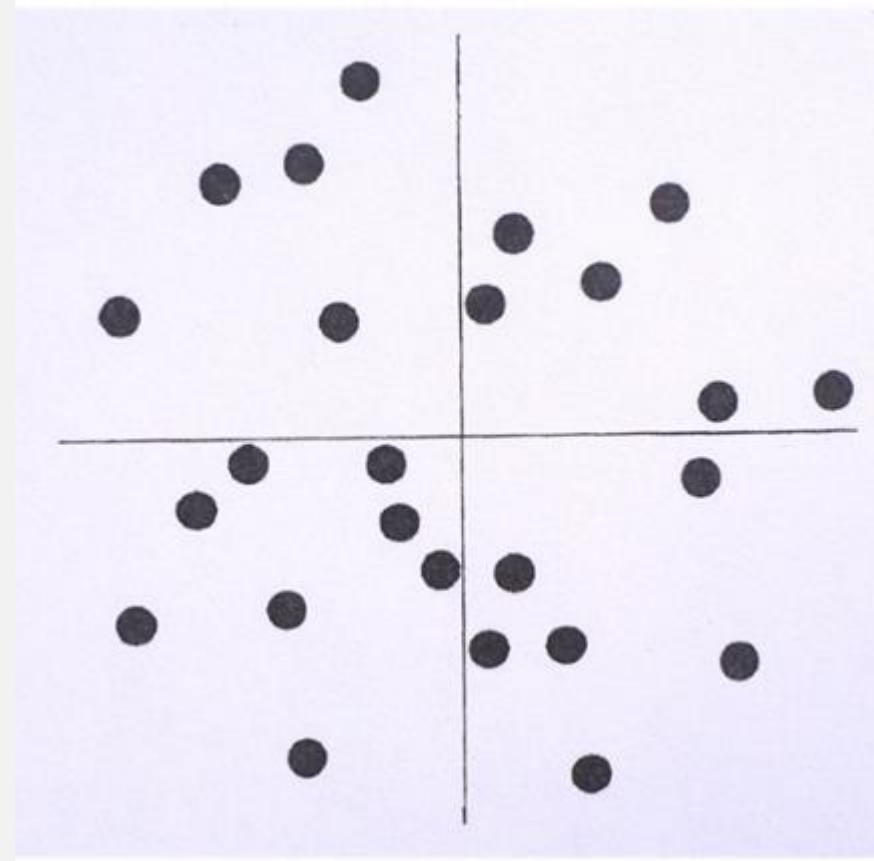
Asbestos Percentage is quantified by selecting random fields under the microscope and counting 400 or 1000 random points under which any sample material may fall.



$$\text{Asbestos \%} = \frac{\text{Asbestos points counted}}{\text{Total points counted}}$$

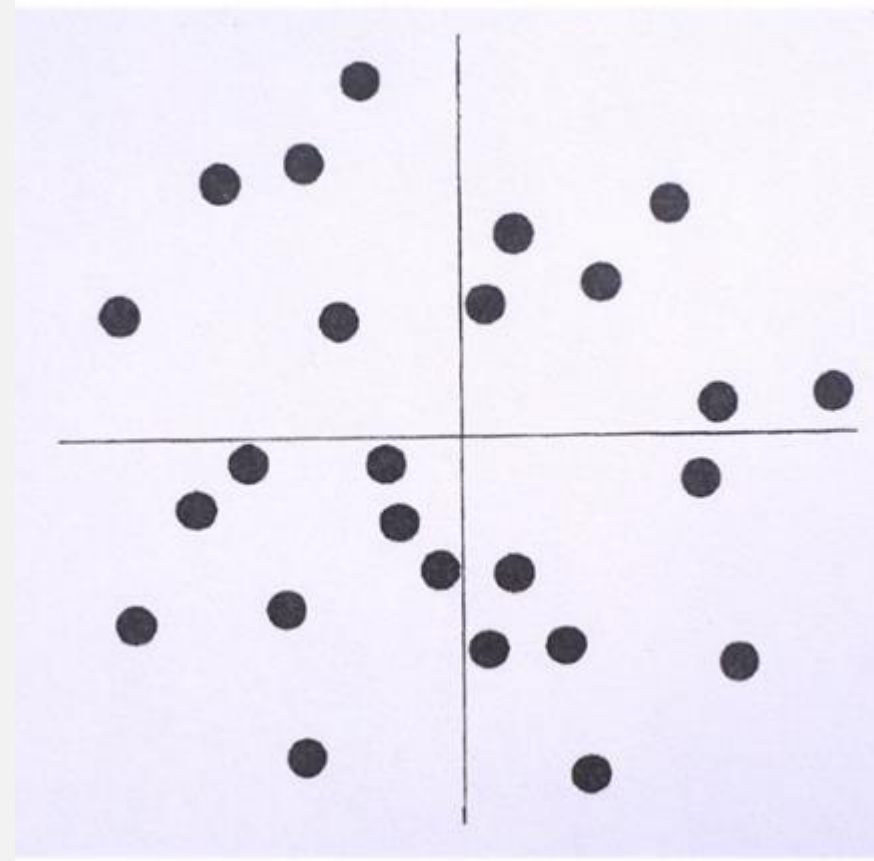
Asbestos Point Counting Analysis

- Methods:
 - EPA 600 (400 or 1000 PC)
 - NY 198.1 – stratified PC

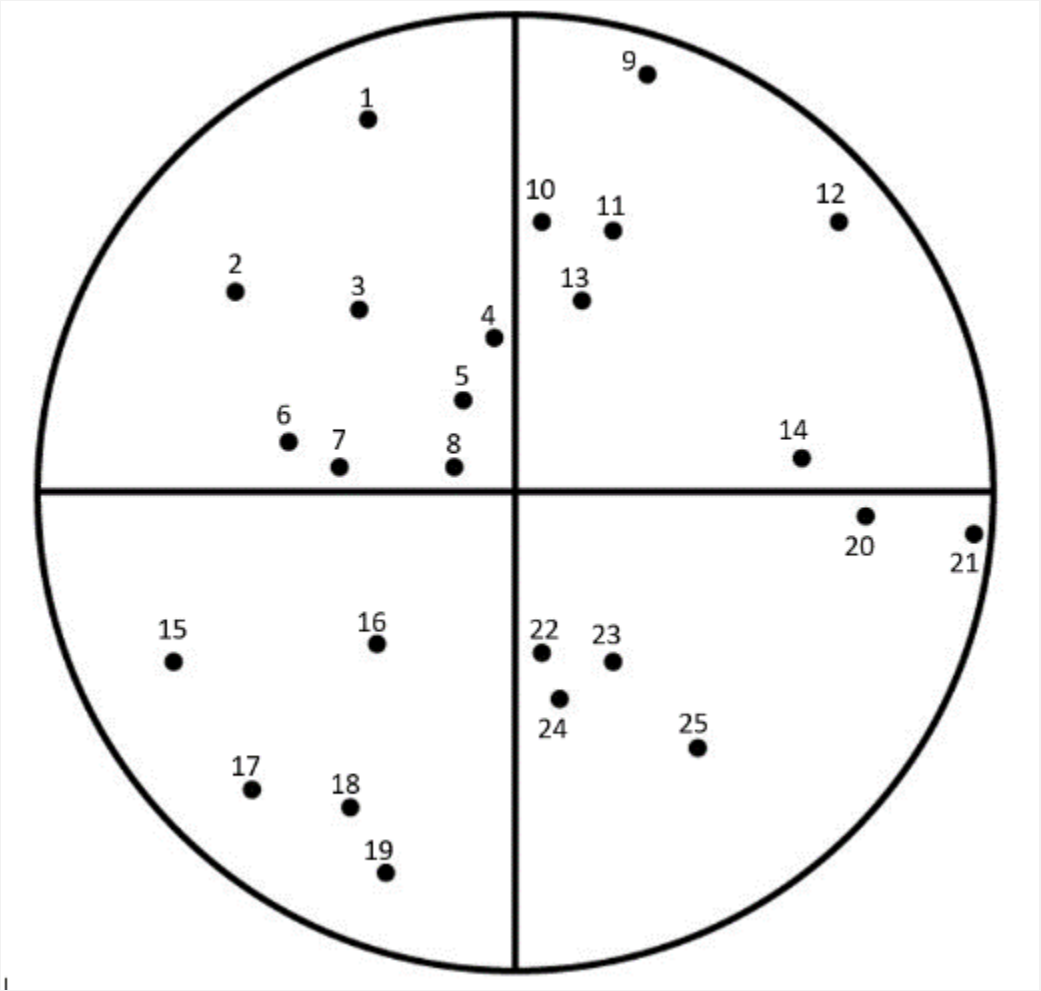


Asbestos Point Counting Analysis

- Counting Tools:
 - Chalkley Point-Count reticle
 - Cross hair
 - Cross point



Asbestos Point Counting Analysis



PLM Point Count

Advantages

- Most accurate method (?) for quantifying low level friable materials
- EPA approved method for verification of low percentage (<10%) asbestos sample.
- Cost-effective when only a few samples need verification.
- Accepted by the EPA over a PLM calibrated visual estimate.
- Quick turn-around-time.
- Excellent for friable bulk building materials such as plaster and insulation.

Disadvantages

- Non-friable organically bound (NOB) materials cannot be quantified by this method alone.
- Analysts cannot resolve fibers <0.25 micrometers in width.
- Primarily used to supplement original PLM calibrated visual estimate.
- More expensive than PLM analysis alone.
- Not a percentage by weight.
- Time consuming.

Gravimetric Point Count Sample Prep

- Sample is combusted in muffle furnace for 6-8 hours to remove organic material.
- Sample undergoes acid dissolution to remove acid soluble material.
- Sample is filtered and dried.



Gravimetric Point Count Sample Analysis

- Concentrated residue, is analyzed under polarized light microscopy using PLM Point Count method.
- Asbestos results are a derivative of the percentage of asbestos in the residue.

$$\text{Asbestos \% in Sample} = \frac{\% \text{ of Sample in Residue} \times \% \text{ Asbestos in Residue}}{100}$$

PLM Gravimetric Point Count

Advantages

- The only way a non-friable organically bound material (NOB) can be point counted.
- Approved by the EPA for confirmation of low concentrations of asbestos in bulk building materials.
- Better accuracy than direct PLM analysis in some NOB materials.
- Lower reporting limit can be achieved.

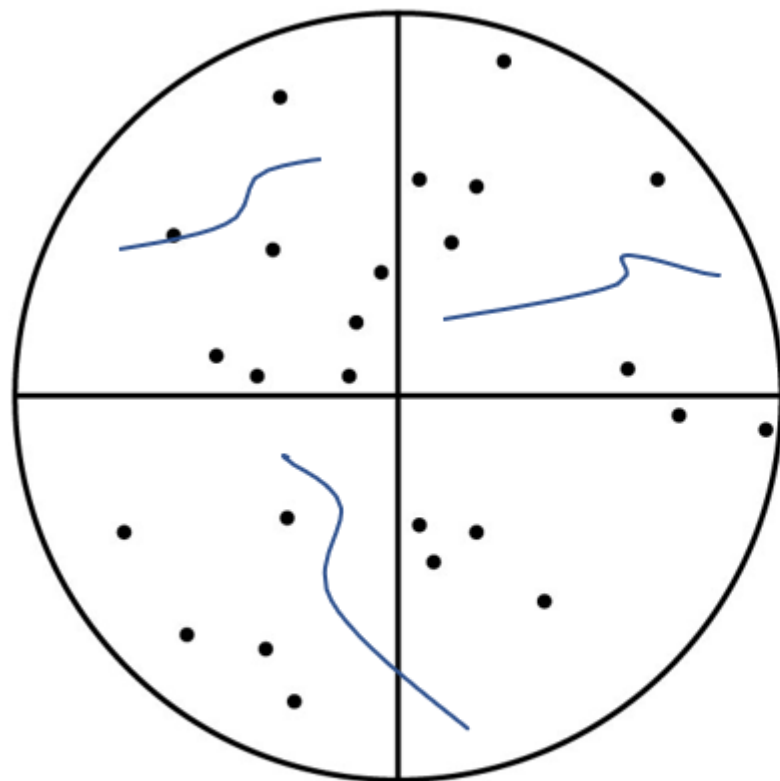
Disadvantages

- Analysts cannot resolve fibers <0.25 micrometers in width.
- Not intended for granular friable materials such as plaster and concrete.
- Longer turn-around times for results.
- Must collect large amounts (between 0.200 and 0.500 grams) of material for samples like floor tile mastic.
- Higher cost than PLM or TEM.
- Less accurate than TEM result

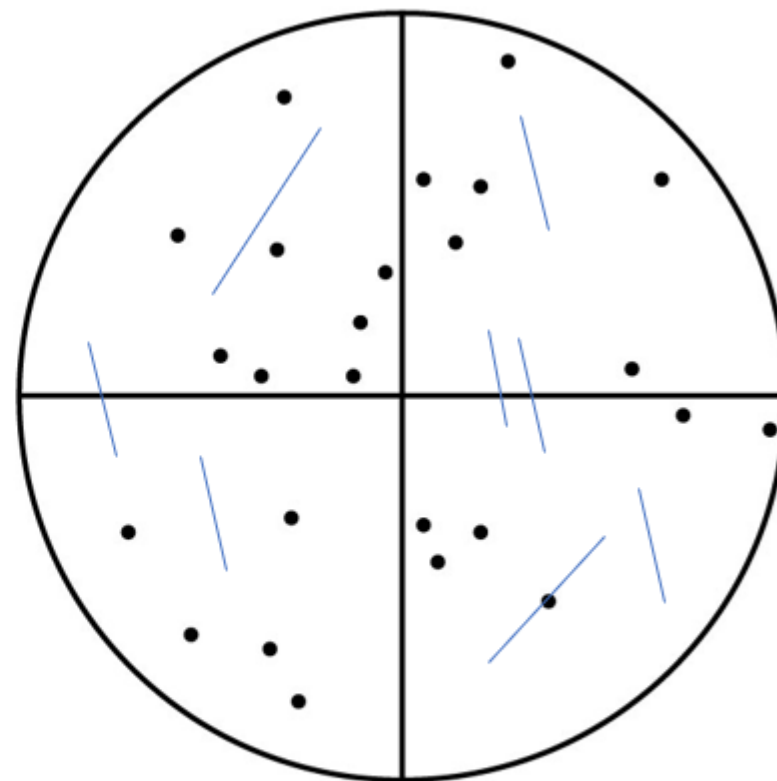
Stratified Point Count Sample Analysis

- 4 asbestos pts on a minimum of 4 slides
- For each of the first four slides, count until one asbestos point or 50 nonempty points
- If less than four asbestos pts have been counted after the first four slides, additional preps shall be analyzed (at the rate of 50 nonempty pts per preparation) until either:
 - At least four asbestos points have been counted; or
 - At least 400 nonempty points from at least 8 slide preps
- Example;
 - 1st slide – 1st asbestos point when counted 20 nonempty points
 - 2nd slide – 1st asbestos point when counted 10 nonempty points
 - 3rd slide – 1st asbestos point when counted 15 nonempty points
 - 4th slide – 1st asbestos point when counted 15 nonempty points
- Asbestos (%) = $(4 \text{ asbestos pts}) / (20 + 10 + 15 + 15 \text{ total points}) \times 100\% = 6.7\%$

Asbestos Point Counting Analysis



1 asbestos point
2 points analyzed



1 asbestos point
25 points analyzed

Stratified Point Count

Advantages

- Meets NYELAP accreditation for methods 198.1 and 198.6.
- Faster than standard EPA 400 point count.
- Less cost associated.
- Lower reporting limit can be achieved.

Disadvantages

- Analysts cannot resolve fibers <0.25 micrometers in width.
- Longer turn-around times for results.
- Less accurate than standard EPA 400 point count.

Why do we do Point Counting Analysis?

- Asbestos NESHAP requirement (Federal Register, Volume 55, Number 224, November 20, 1990)
- Perform point counting to quantify asbestos below 10%
- Friable materials only
- For non-friable materials, using alternative methods such as TEM and gravimetric point count
- Also applicable to AHERA projects
- Detailed explanation in EPA Memo dated 05/08/1991





Why do we do Point Counting Analysis?

How does it work?

- No point count required if no asbestos in a sample is detected by PLM
 - A minimum of three slide mounts to be prepared and examined
- If analyst detects asbestos in the sample and estimates by calibrated visual estimation to be less than 10%, the building owner can choose to
 - Assume the amount to be greater than one percent and treat as ACM
 - Verify the amount by perform a minimum of 400 point count

Why do we do Point Counting Analysis?

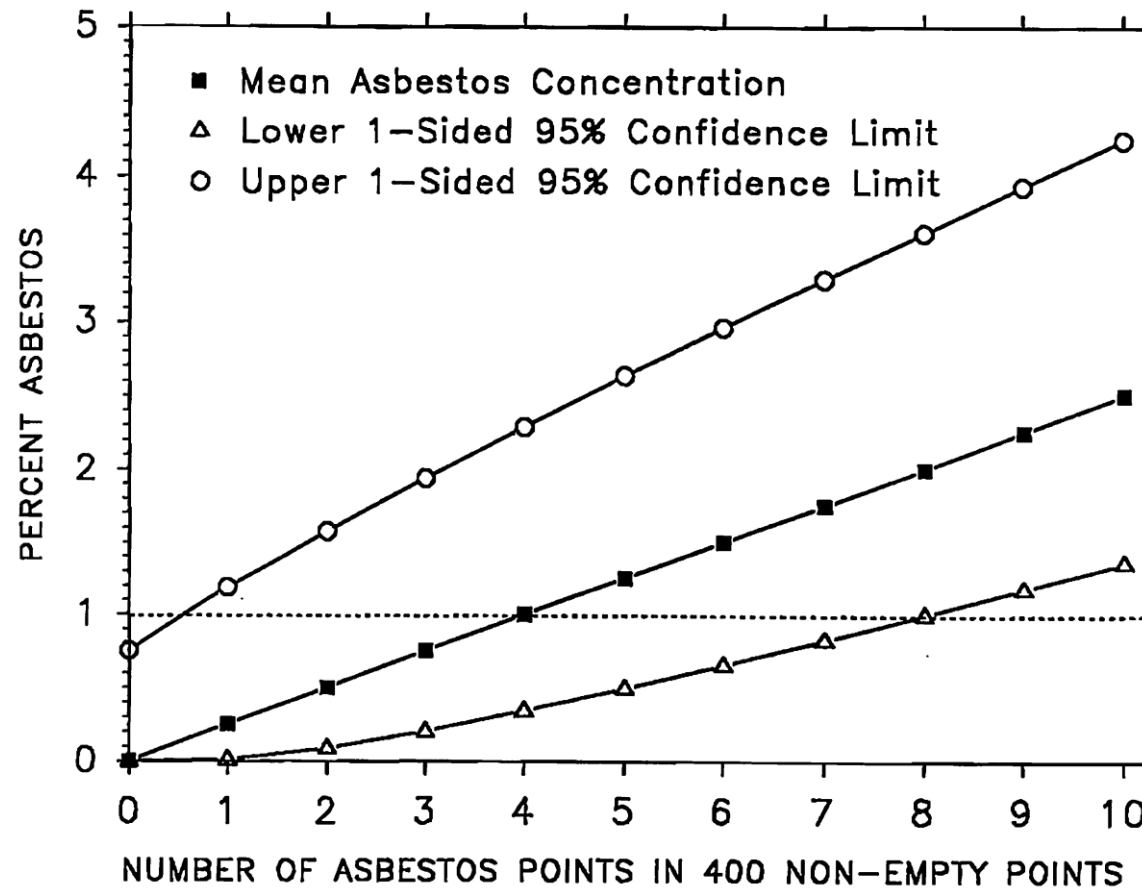
How does it work?

- If a result obtained by point count is different from a result obtained by visual estimate, the point count result will be used.
- This is a two-way street.
- All samples in the same homogeneous area need to be point counted to prove negative, but only one sample is required to prove positive by point count
- Gravimetric PC and TEM can be used to rebut the PLM results

Point Counting – the Truth

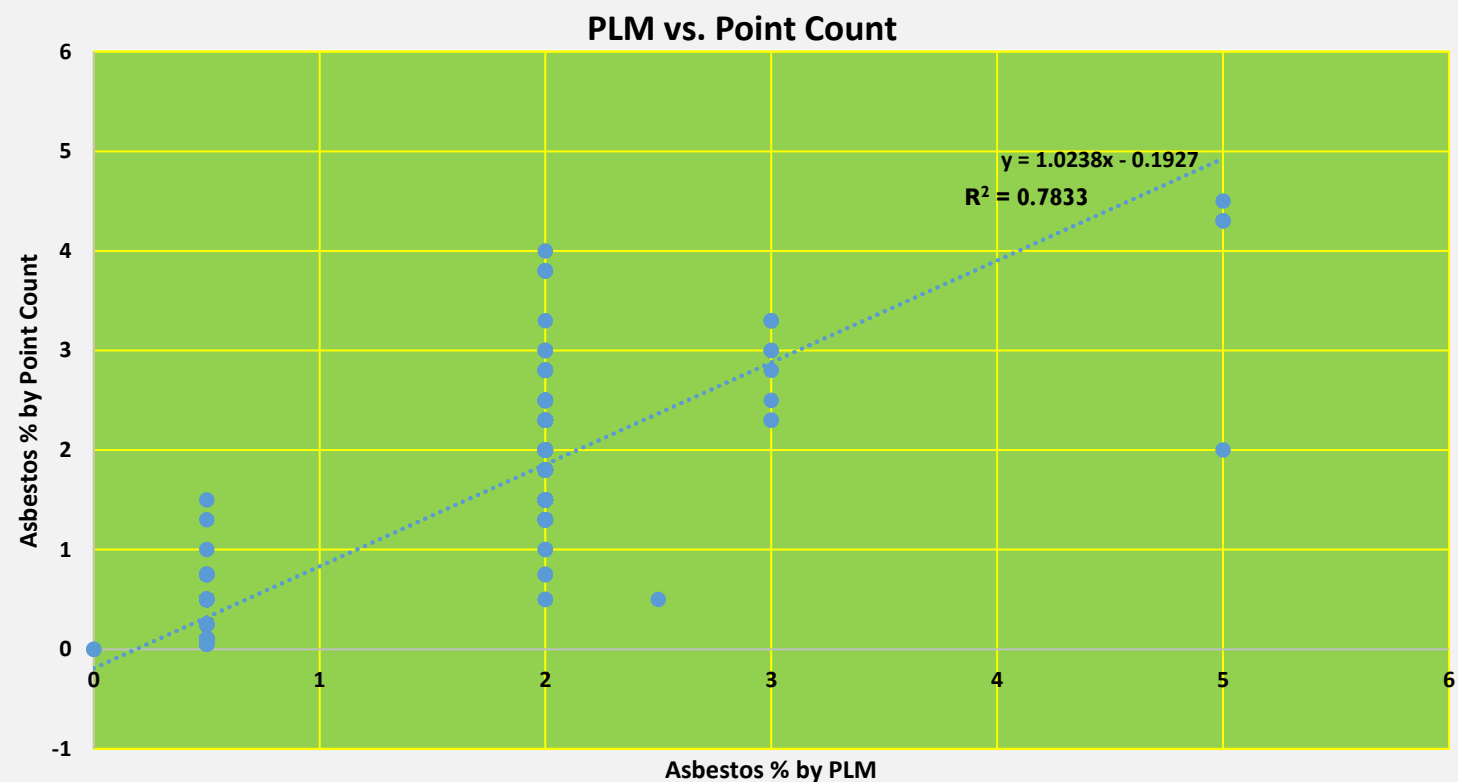
Is Point Counting more accurate?

ONE-SIDED 95% CONFIDENCE LIMITS FOR 400-POINT COUNT



From Dr. Chatfield, 2003

Is Point Counting more accurate?



ECEI 2022 Q3 Point Count Comparison, total 524 samples

Is Point Counting accurate?

Point Counts of Spiked Samples

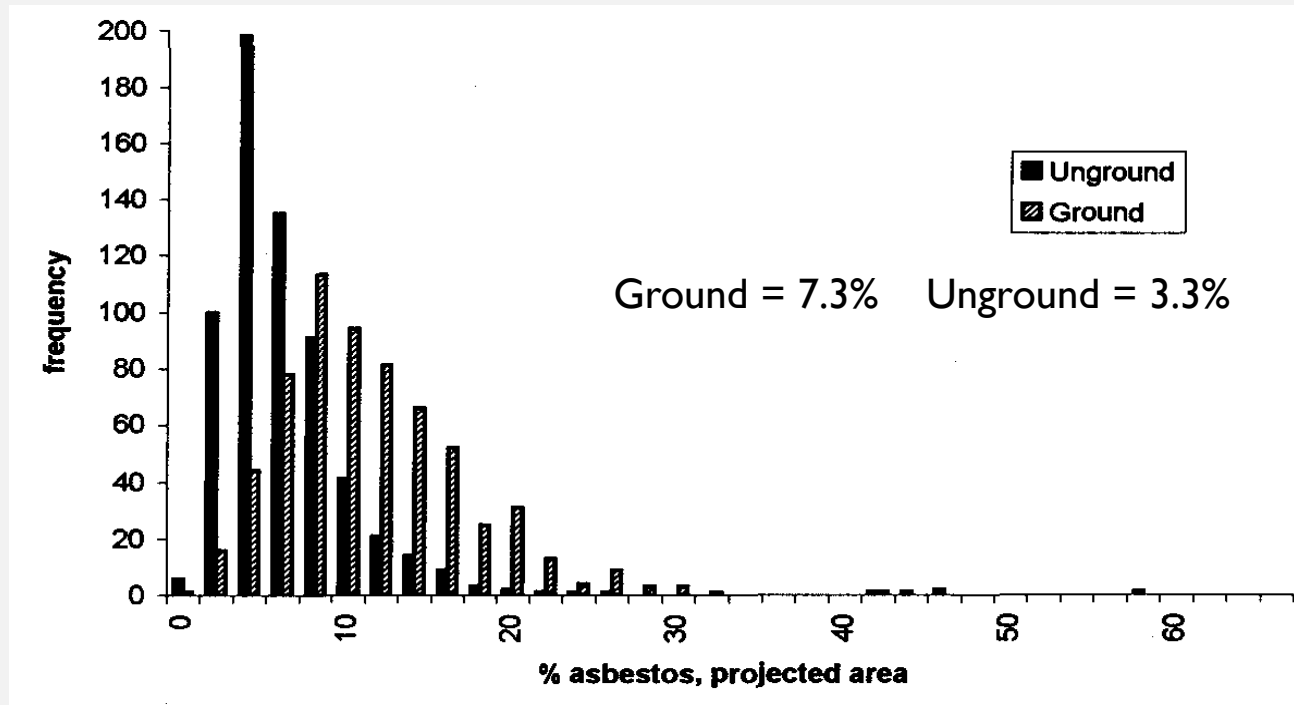
Sample #	Actual %	Total % By Point Count Analyst		
		1	2	3
1	0	0	0	0
2	.5	0*	1.0	0*
3	1.0	1.0	0*	0*
4	2.5	1.0	2.0	1.0
5	2.7	1.3	1.0	0.3
6	7.2	19.5	8.8	1.0
7	14.9	22.8	20.5	17.0
8	20.3	22.8	21.1	37.8
9	28.9	43.8	46.9	36.8
10	48.4	43.8	60.8	51.5
11	62.8	72.8	52.6	62.0

*At least one asbestos fiber observed but not falling under a counting point.

Jankovic et al., 1988

Is Point Counting more accurate?

It depends on sample prep



Verkouteren J., et al., 2000

Point Counting – the Truth

Is Point Counting more accurate? It depends on the types of asbestos

	NYELAP PT Sample Number								
	8261	9421	3741	5472	5657	9819	2158	7885	8661
Mean	17.1	21.5	1.9	21.6	9.4	72.8	11.4	10.6	14.0
SD	5.9	5.1	1.8	6.3	4.1	12.3	6.8	7.7	4.5
RSD	0.34	0.24	0.94	0.29	0.44	0.17	0.60	0.72	0.32
Assigned Value	21.6	65.8	5.3	13.7	2.8	84.3	5.7	4.7	13.7
Mean/Assigned	0.79	0.33	0.37	1.58	3.35	0.86	2.00	2.26	1.02
Asbestos Type	CROC	CHRY	CHRY	TREM	AMOS	CHRY	AMOS	TREM	CHRY
	Average Mean/Assigned- CHRY = 0.65					Average RSD - CHRY = 0.42			
	Average Mean/Assigned- AMPH = 2.0					Average RSD - AMPH = 0.48			

Weber et al., 1990

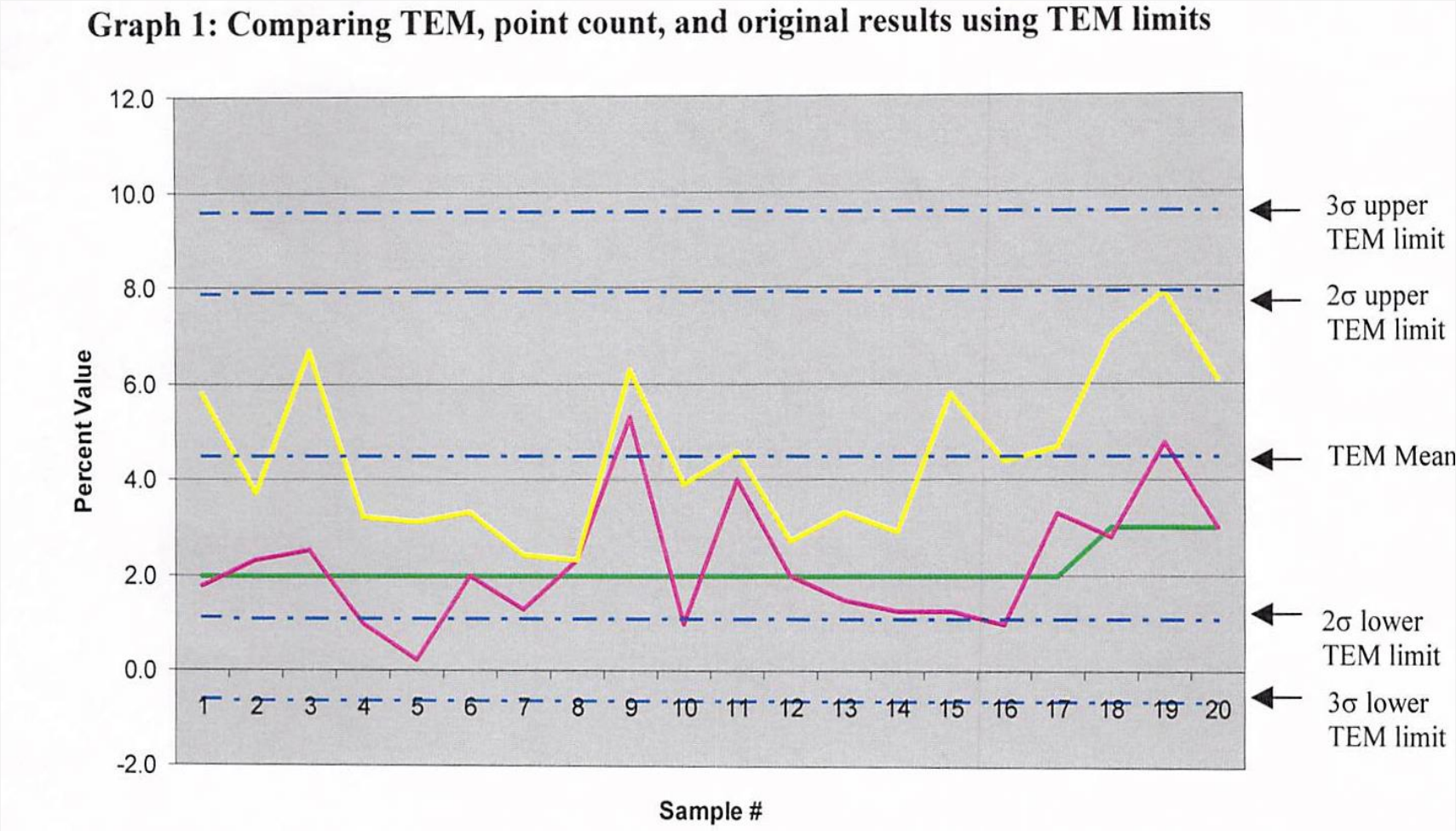
Joint Compound Study

- Compare PLM visual estimate with other methods (point count and TEM)
- 20 random joint compound samples with original results at 2% or 3% by PLM visual estimation
- Each sample was split and submitted for 400 point count analysis and TEM semiquantitative analysis w/gravimetric reduction
- Each sample was re-labeled with a different ID and submitted as a blind sample
- Point counting and TEM analysis performed following EPA 600 method

Joint Compound Study

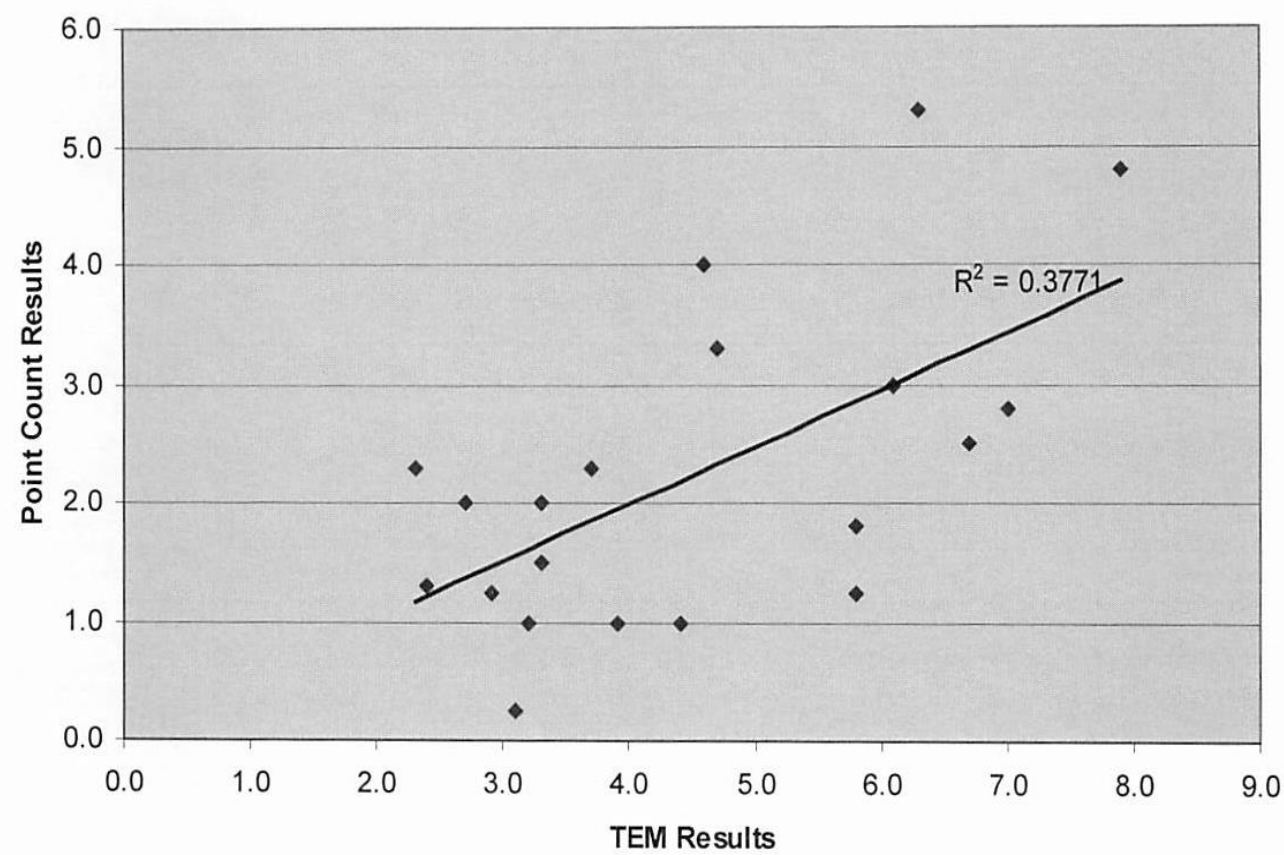
Original Analyst	Original ID	New ID	PC Analyst	Original Result	PC Result	TEM Result
GR	A1837244	2014-01	TM	2	1.8	5.8
GR	A1849145	2014-02	TM	2	2.3	3.7
GR	A1837418	2014-03	TM	2	2.5	6.7
TM	A1830667	2014-04	TM	2	1	3.2
TM	A1844615	2014-05	SS	2	0.25	3.1
TM	A1859585	2014-06	SS	2	2	3.3
TM	A1859338	2014-07	SS	2	1.3	2.4
EN	A1869483	2014-08	SS	2	2.3	2.3
LB	A1850025	2014-09	GR	2	5.3	6.3
LB	A1851671	2014-10	GR	2	1	3.9
LB	A1839603	2014-11	GR	2	4	4.6
SS	A1828366	2014-12	GR	2	2	2.7
SS	A1828367	2014-13	EG	2	1.5	3.3
SS	A1828369	2014-14	EG	2	1.25	2.9
SS	A1860286	2014-15	EG	2	1.25	5.8
SS	A1828370	2014-16	EG	2	1	4.4
EG	A1829768	2014-17	CB	2	3.3	4.7
RS	A1849459	2014-18	CB	3	2.8	7
RS	A1849454	2014-19	CB	3	4.8	7.9
DL	A1844062	2014-20	CB	3	3	6.1

Joint Compound Study



Joint Compound Study

Graph 2: TEM versus Point Count Results



Joint Compound Study

- Summary

- The average concentration by TEM is the highest at 4.5%, and the average concentrations by point count and PLM visual estimate are both at 2.2%
- There is a slight correlation between TEM and original PLM results ($R^2 = 0.40$) and between TEM and point count data ($R^2 = 0.38$)
- Point count data do not correlate well with the original PLM results ($R^2 = 0.18$)
- The TEM result matches very well with historical chrysotile concentrations put in joint compound (4.5% - 5.5%) (Brorby G., et al., 2008)

Floor Tile Study

- Samples prepped nine times each (one set for each analyst) with a blank prepared in between each sample tile.
 - Sample 1: 2.4% chrysotile by TEM
 - Sample 2: 7.6% chrysotile by TEM
 - Sample 3: 12% chrysotile by TEM
 - Sample 4: 20% chrysotile by TEM
- Samples analyzed by each analyst using three methods
 - 198.6 method (stratified gravimetric point count: oil)
 - Modified 198.6 method (stratified gravimetric point count: acid)
 - EPA 600 method (Bulk PLM calibrated visual estimate).

Floor Tile Study

	Sample 1			Sample 2			Sample 3			Sample 4		
	198.6 Oil	198.6 Acid	EPA 600	198.6 Oil	198.6 Acid	EPA 600	198.6 Oil	198.6 Acid	EPA 600	198.6 Oil	198.6 Acid	EPA 600
CB	0.16	0.53	3	0.34	0.52	3	0.65	1.4	5	1.4	3.7	7
DC	1.1	0.88	5	0.80	1.1	3	2.6	1.9	7	4.8	4.9	7
GR	0.97	3.0	2	0.18	0.12	2	0.69	0.44	2	2.3	2.9	3
GS	1.6	2.8	5	0.47	0.26	2	0.59	0.66	3	1.0	0.94	5
MM	0.39	1.2	2	0.45	0.69	2	1.3	1.1	5	7.8	10.6	7
SC	1.4	1.7	3	0.33	0.27	2	0.76	0.86	3	2.4	2.9	5
SL	1.9	2.3	3	0.32	0.35	2	0.33	0.35	5	0.51	0.54	3
SM	3.4	3.1	3	0.36	0.35	2	0.56	0.67	2	1.4	1.5	4
SP	1.0	0.68	3	0.68	0.46	2	0.78	5.87	2	1.6	4.6	3
AVE	1.3	1.8	3.2	0.44	0.46	2.2	0.92	1.5	3.8	2.6	3.6	4.9
TEM	2.4			7.6			12			20		

Floor Tile Study

- Percent False <1% Result

Method	Sample 1	Sample 2	Sample 3	Sample 4	Total
I98.6	33%	100%	78%	11%	50%
Modified I98.6	33%	89%	56%	22%	50%
EPA 600	0%	0%	0%	0%	0%

- The findings of this study indicate that I98.6 gravimetric point count is not a reliable method for obtaining asbestos percentages in floor tile samples.
- The gravimetric analysis consistently underestimated the asbestos percentages when compared to calibrated visual estimates and TEM analysis.

Point Counting – the Truth

Is Point Counting more accurate? - Summary

- Potential Factors influencing point counting accuracy
 - Material type
 - Grinding
 - Sample prep
 - Number of points counted
 - Type of asbestos
 - Asbestos concentration



Will point counting my sample change the result from ACM to Non-ACM or vice-versa?

Maybe, based on our historical data from our laboratory, approximately 1.7% of samples reported as less than 1% by PLM return a point count result greater than 1% and approximately 1.6% of samples reported as greater than 1% by PLM return a point count result less than 1%.

Historical Point Count Record

Change in Result	Total Samples	Percentage
<1% to 1%	254	1.7%
2% to 1%	177	1.2%
3% to 1%	4	0.03%
Change to 1%	435	2.9%
<1% to >1%	258	1.7%
Change to >1%	258	1.7%
2% to <1%	228	1.5%
3% to <1%	10	0.07%
>3% to <1%	4	0.03%
Change to <1%	242	1.6%

15,152 point count results compared to original PLM Bulk results. 2014-2021

Common Questions

I requested a point count on my sample but the laboratory says it's an NOB, should I choose TEM Bulk Chatfield or PLM Gravimetric Point Count?

TEM Bulk Chatfield is both more accurate and more cost efficient than PLM Gravimetric Point Count. PLM Gravimetric Point Counts can lead to false trace results in some materials, especially floor tiles, and intentionally selecting the method to achieve a false non-ACM result is unethical.

What materials are considered NOB?

Non-friable organically bound materials (NOBs) are ones that require a heat or chemical matrix reduction to release asbestos fibers. Friable materials are ones in which asbestos fibers can be released using crushing, grinding or hand pressure.

Friable vs. NOB Materials

Friable Materials		Non-Friable Organically Bound Materials (NOBs)	
Insulation Aircell Vermiculite Sheetrock Mud Texture Plaster Skim Coat Plaster Base Coat Paper	Wall Covering Fiberboard CMU Brick Transite Acoustic Tile Ceramic Tile Terrazzo	Felt Paper Mastic Covebase Caulking Glazing Sheet Vinyl Floor Tile Stair Tread	Tar Shingle Flashing Sealant Aluminum Paint Rubber Membrane Built-Up Roofing Asphalt

How do you analyze drywall/joint compound wall systems?

EPA allows for composite analysis of drywall/joint compound wall systems for demolition and renovation purposes.

However, OSHA does not allow composite analysis. Neither are some of the states in the US, such as NY, NJ, SC, and OH.

Common Questions

My drywall/joint compound composite result is $<1\%$, so I have to request point count. How do you point count drywall/jc in the lab?

Due to the presence of tape in the drywall/joint compound system, homogenization using mortar/pestle is ineffective.

Freezer mill or pulverizer should be used (increase cost significantly)

Alternatively, point count JC only and use math calculations to determine the composite concentration based on the proportion of JC in the whole sample.

Or use gravimetric point count

Stratified point count is allowed only in NY



Point Counting – the Myth

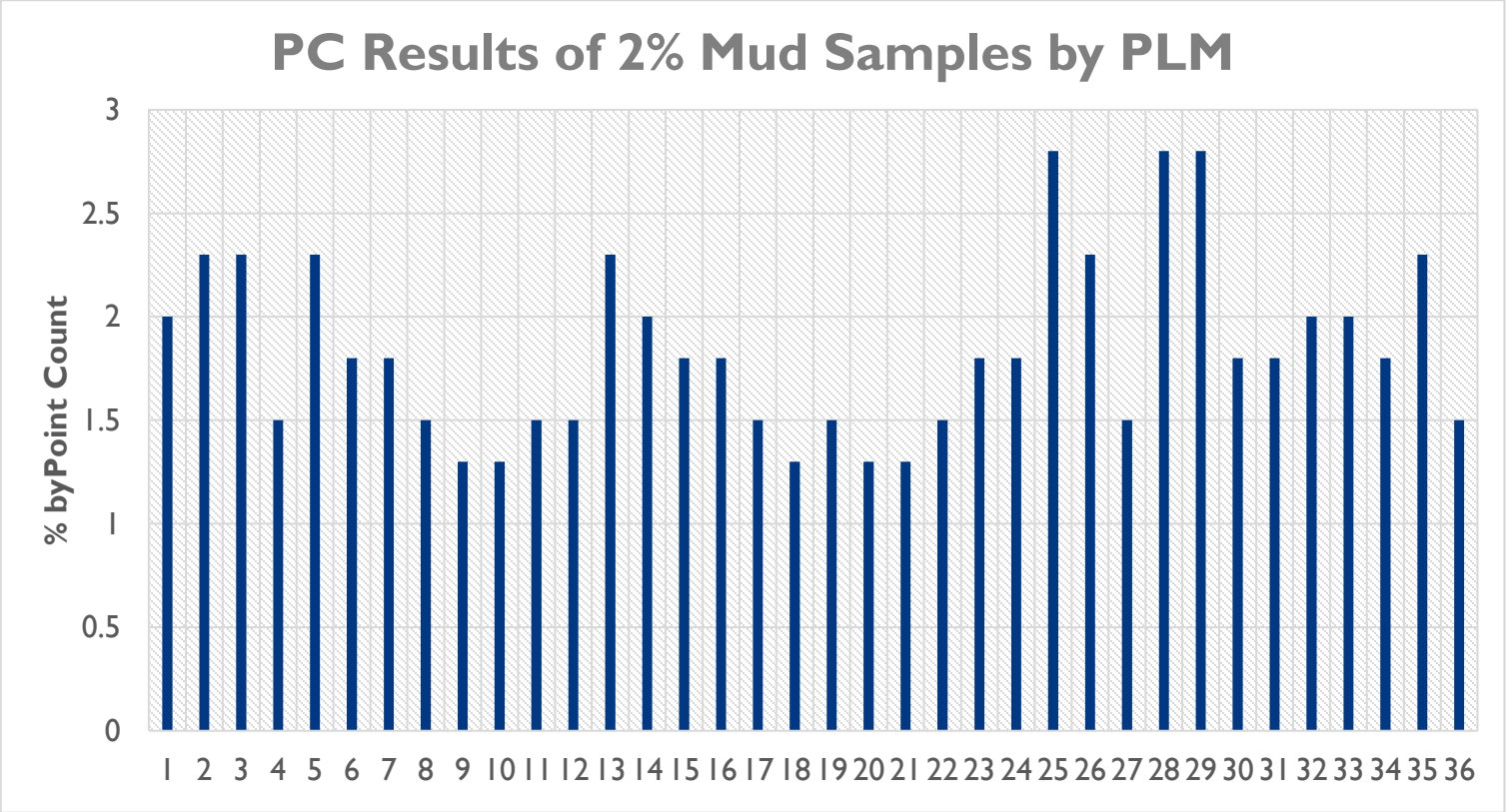
How can labs offer free or low price point count?

Does the lab actually point count your samples or use correct method?

Use simplified point count technique (stratified PC, 200 PC, etc.) may not be acceptable to EPA or state regulators

Point Counting – the Myth

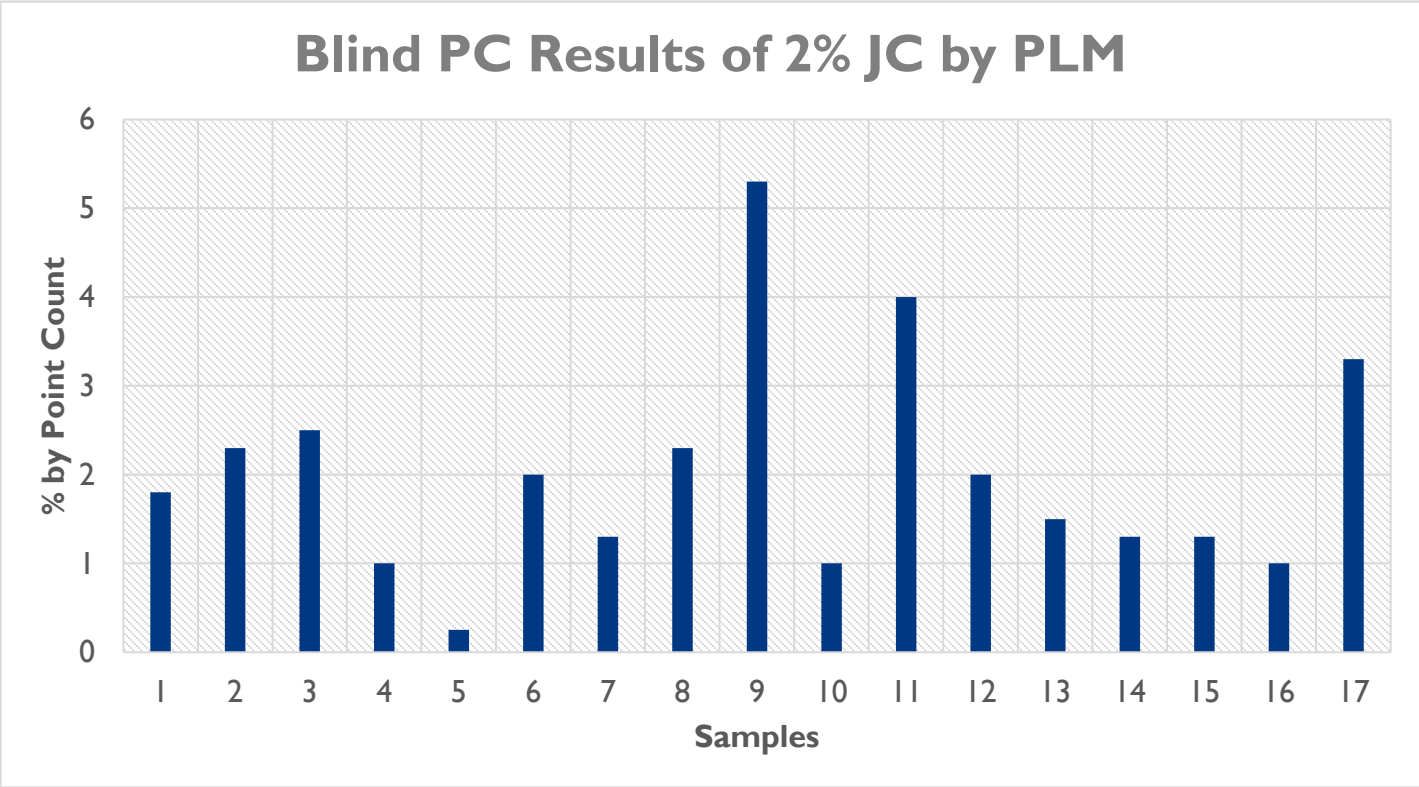
Why the difference?



Mean = 1.84%; RSD = 0.24

Point Counting – the Myth

Why the difference?



Mean = 2.01%; RSD = 0.62

Point Counting – the Controversy

- 5 asbestos points on a 400 point count, is it RACM or non-RACM?
- **EPA: Control Number: A070006 on 01/31/2007**
 - If the sample result yields $a=5$, the result is 1.25 percent asbestos, which may be rounded down to 1 percent, which is not greater than 1 percent and therefore not regulated. If the sample result yields $a=6$, the result is 1.5 percent asbestos, which would be rounded to 2 percent and therefore regulated.
- **OSHA: Letter on June 8, 2010 by Thomas Galassi, Acting Director**
 - OSHA does not agree that this referenced EPA letter of interpretation apply to all situations.

Point Counting – the Controversy

Do labs report <1% results to get more point count analysis?

Time consuming

Analysts don't like to do PC

THANK YOU



Built Environment Testing