Practical Applications of Precision Statements: Part II - Effects of *Conditioning on Test Results for Acceptance*

ASTM Committee D 04 Workshop on Precision and Bias

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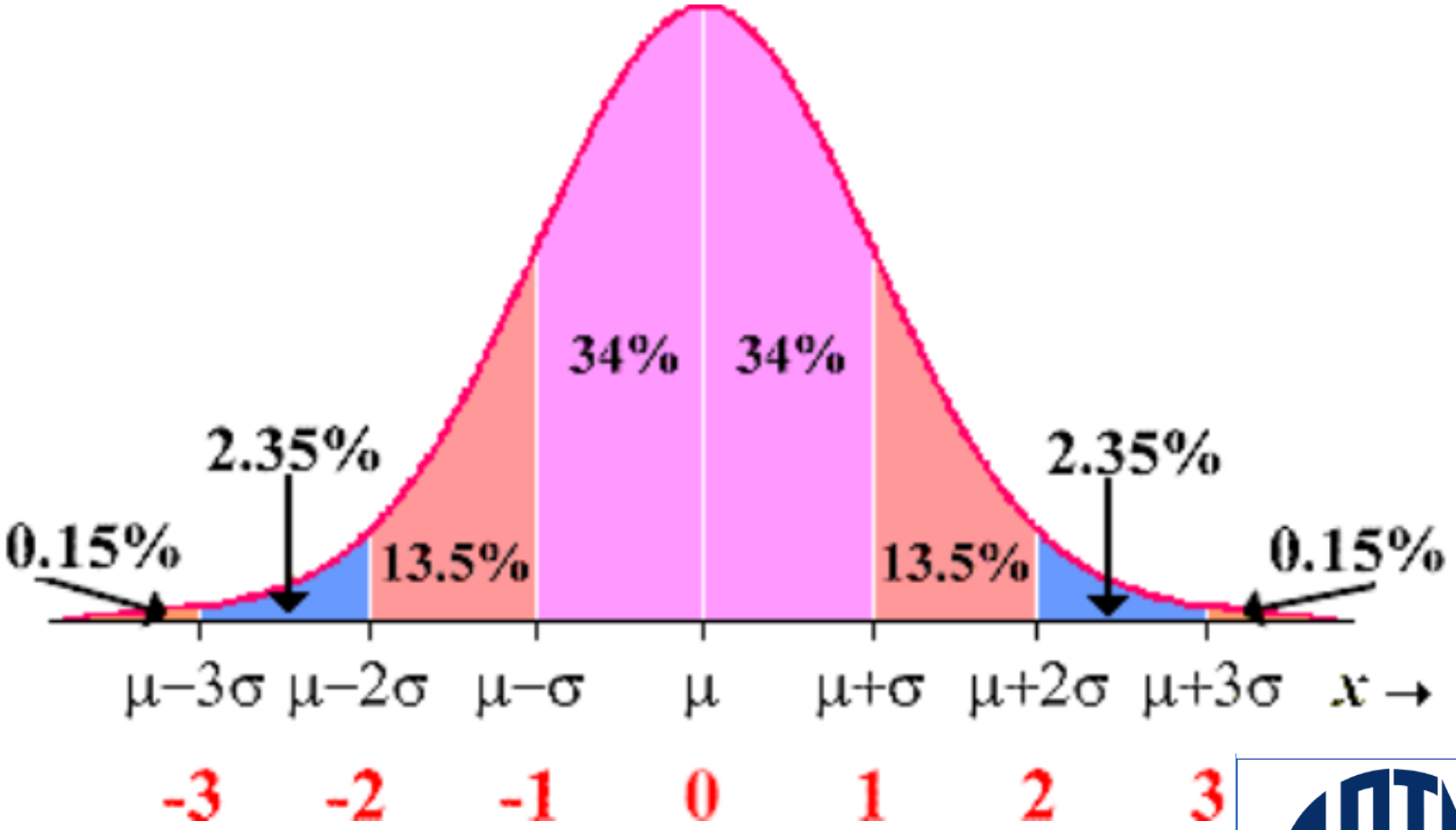
68-95-99.7 Rule



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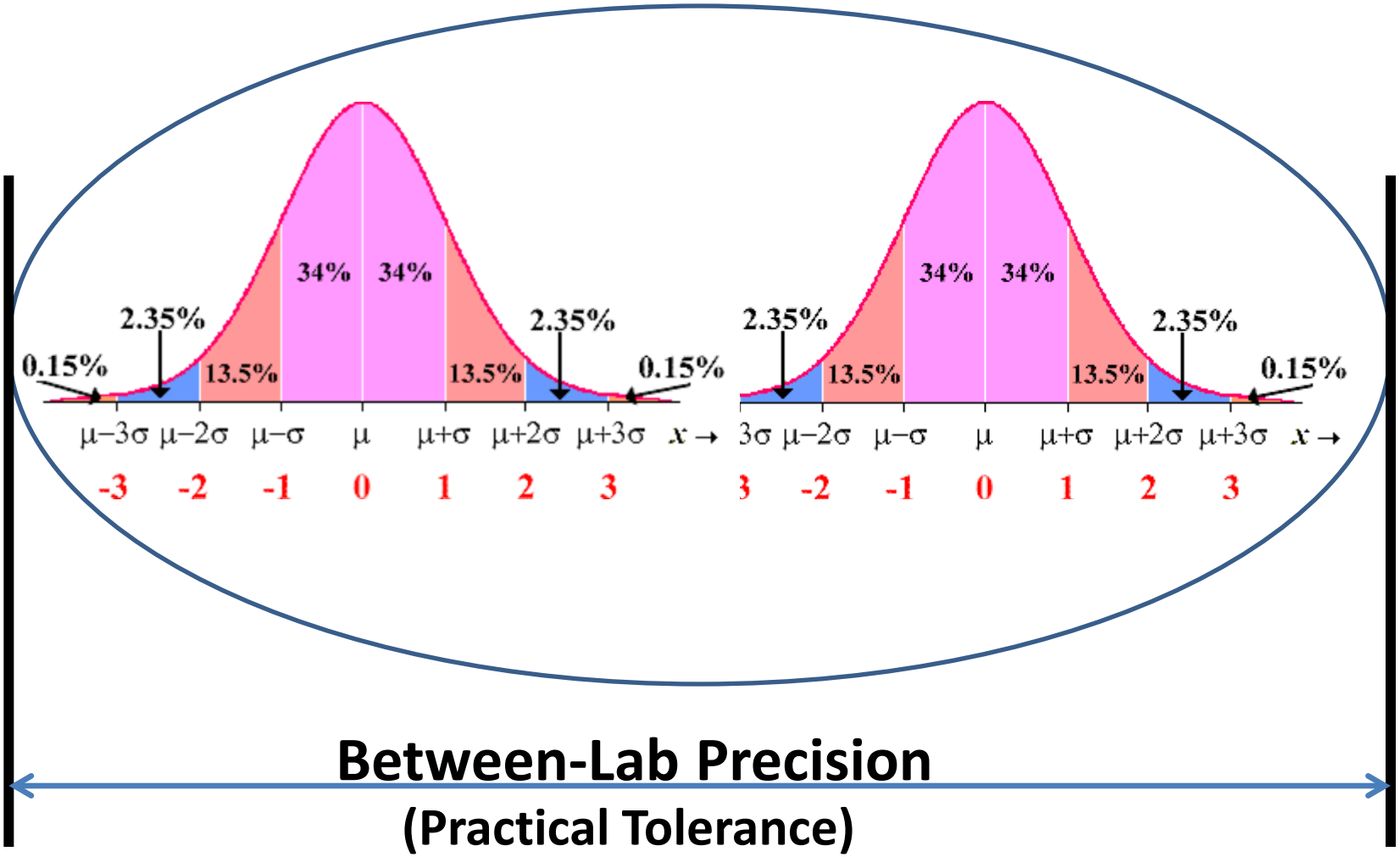
One population or two?



Between-Lab Precision

(Practical Tolerance)

Maryland's Specifications

50th Annual Asphalt Paving Conference

Data Collection & Analysis

Marshall Klinefelter
David A. Bramble, Inc.

Background – Mix

- QA samples taken from behind the paver
  - 1/1000 tons or 1/day whichever is greater
  - Tested at State Lab
- QC samples taken at plant
  - 1/1000 tons or 1/day whichever is greater
  - Tested at Contractor Lab
- G_{mm} determined each day for density calculation
  - Contractor from plant sample
  - State from road sample behind the paver

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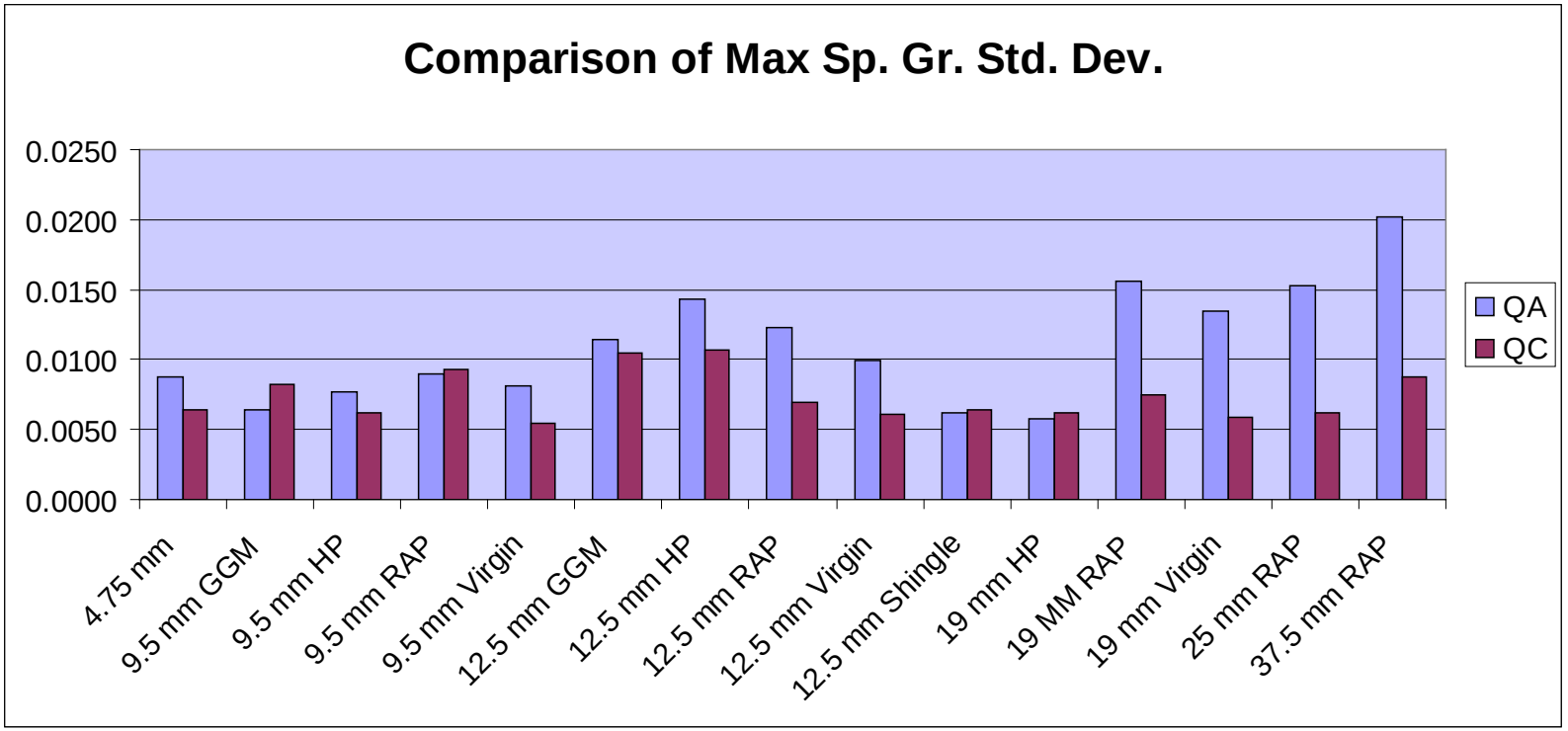
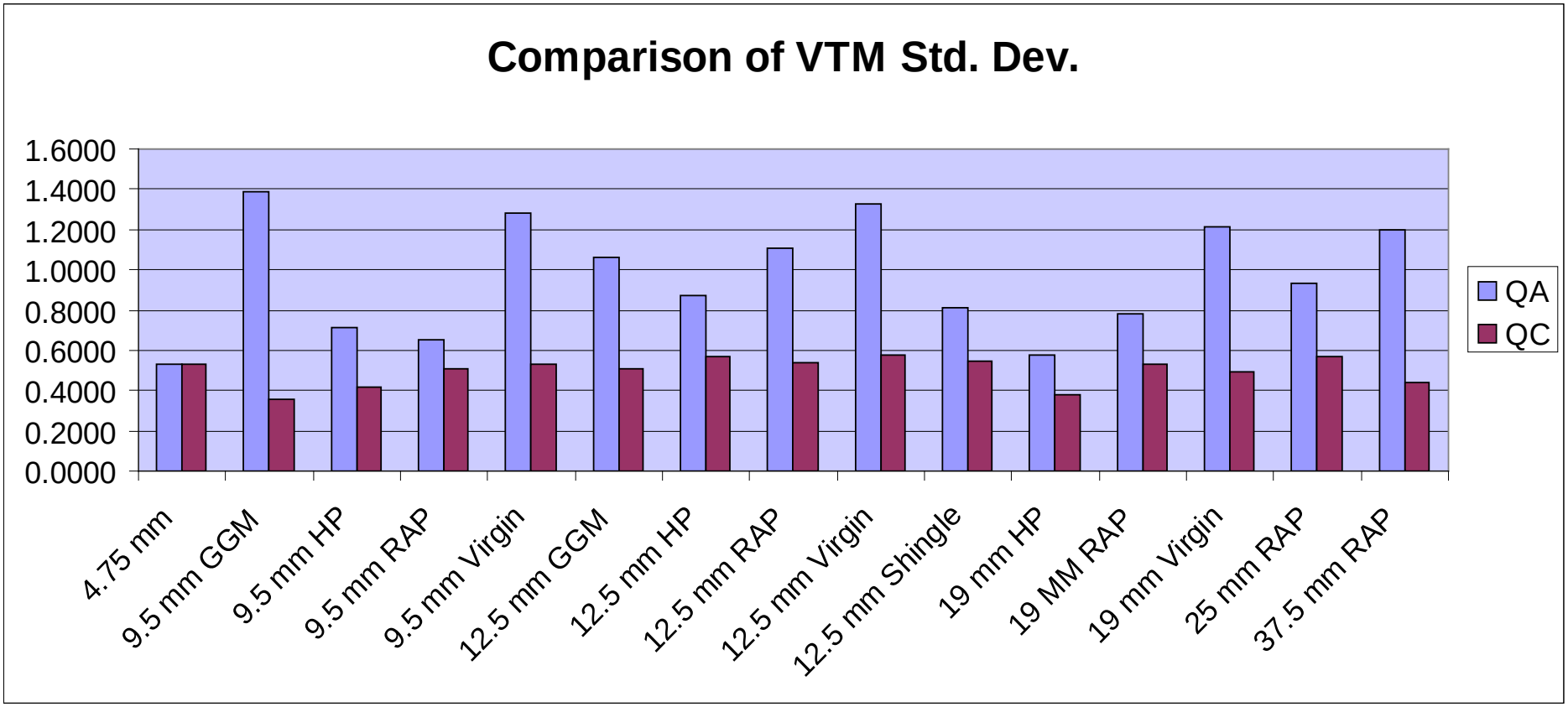
Maximum Specific Gravity



Correl 0.355902

5,598 data points

VTM



Correl 0.126713

Table of Pooled Standard Deviations and Tolerances

Quality Characteristic

SHA DATA	**Gmm**	**P 075mm**	**P 236mm**	**P 475mm**	**VTM**	**AC**
Pooled SD	0.0104	0.621	1.970	2.696	0.902	0.180
Tolerance	0.0170	1.022	3.241	4.435	1.483	0.296
Full	0.0095	0.6994	2.4523	3.5798	0.959	0.1978
QC Data						
Pooled SD	0.0067	0.462	1.394	1.824	0.482	0.122
Tolerance	0.0110	0.760	2.293	3.001	0.792	0.201
Full	0.0070	0.4897	1.6026	2.2198	0.5100	0.1324
Combined Data						
Pooled SD	0.0123	0.774	2.414	3.255	1.022	0.217
Tolerance	0.0203	1.274	3.970	5.355	1.682	0.358
Current Spec	0.030	2.0	4.0	7.0	1.2	0.4
Requested Tolerance	0.040	2.0	5.0	7.0	2.0	0.5

Issues

- If G_{mm} results from State and Contractor were not within testing tolerance, only state results used for density calculation.
- Were the density results from the same population?
- What was causing the differences?

ProjectID	JMFID	Activity	TestDate	Lot	Sublot	TestValue	15718
MO6955177	S12012G3F05F	QC	4/21/2003	1	1	96.4	1
MO6955177	S12012G3F05F	QC	4/21/2003	1	2	96.6	1
MO6955177	S12012G3F05F	QC	4/21/2003	1	3	97	1
MO6955177	S12012G3F05F	QC	4/21/2003	1	4	95.8	1
MO6955177	S12012G3F05F	QC	4/21/2003	1	5	94.4	1
MO6955177	S12012G3F05T	QC	4/21/2003	1	1	96.4	1
MO6955177	S12012G3F05T	QC	4/21/2003	1	2	96.6	1
MO6955177	S12012G3F05T	QC	4/21/2003	1	3	97	1
MO6955177	S12012G3F05T	QC	4/21/2003	1	4	95.8	1
MO6955177	S12012G3F05T	QC	4/21/2003	1	5	94.4	1
MO69551			4/22/2003	2	1	96.5	1
PG50251			12/26/2006	34	5	95.1	0
PG50251			12/27/2006	12	1	95.6	0
PG5025173	S10919H4E03F	QC	12/27/2006	12	2	95.5	0
PG5025173	S10919H4E03F	QC	12/27/2006	12	3	94.1	0
PG5025173	S10919H4E				4	93.9	0
PG5025173	S10919H4E				5	94.9	0
HA301B51	N13912R2C				1	96.6	0
HA301B51	N13912R2C				2	94.7	0
HA301B51	N13912R2C01F	QC	1/4/2007	1	3	93.6	0
HA301B51	N13912R2C01F	QC	1/4/2007	1	4	94.8	0

15,718 QC cores
16,553 QA cores

8,088 contractor G_{mm}
5,2988 state G_{mm}

New Standard Practice/Guide for Determinating Effect of Sample Conditioning on Test Results – WK 33655

Table 1 - Data Summary			
Test name			
Split Sample Number	**Condition x1**	**Condition x2**	**Absolute Difference (x_d)**
1	5.51	5.03	0.48
2	5.52	5.02	0.50
3	5.54	5.03	0.51
n	n1	n2	I n1-n2 I

Check Data:

1. population using T-test
2. Within expected testing variation:
   a. Betwn-lab precision
   b. Agency set tolerance.

Analysis of Core Densities

Test: is $X_{d\ Mean}$ <> Betwn-lab precision or (practical) test tolerance ?

Core Density - %G_{mm}

Split Sample Number	Contractor	Agency	Difference (Xd)
1	96.40	93.80	2.600
2	96.60	92.60	4.000
3	97.00	93.70	3.300
4	95.80	91.70	4.100
5	94.40	91.20	3.200
6	96.40	94.90	1.500
7	96.60	97.20	0.600
8	97.00	94.00	3.000
9	95.80	92.40	3.400
10	94.40	93.70	0.700

$X_{d\ Mean}$	**2.64**	Degree of Freedom	9
S_d	1.28	Prob. α	1%
t_{pair}	**6.54**	$t_{critical}$	3.25
Split Sample Results:		**Do not Correlate**	

Note: 2-sublots randomly chosen out of Md data set.

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Analysis of G_{mm}

G_{mm}							
Split Sample Number	**Plant**	**Reheated week later**	**Difference (Xd)**	**$X_{d\ Mean}$**	**0.08**	Degree of Freedom	9
1	2.625	2.474	0.151	S_d	0.07	Prob. α	1%
2	2.611	2.461	0.150	t_{pair}	**3.70**	$t_{critical}$	3.25
3	2.611	2.580	0.031	**Split Sample Results:**		**Do not Correlate**	
4	2.586	2.448	0.138				
5	2.588	2.451	0.137				
6	2.580	2.432	0.148				
7	2.588	2.615	0.027				
8	2.588	2.603	0.015				
9	2.591	2.594	0.003				
10	2.591	2.594	0.003				

Adjusted G_{mm} Data

G_{mm}							
Split Sample Number	**Plant**	**Reheated week later**	**Difference (Xd)**	**$X_{d\ Mean}$**	***0.02***	Degree of Freedom	4
1				S_d	0.01	Prob. α	1%
2				t_{pair}	**3.82**	$t_{critical}$	4.60
3	2.611	2.580	0.031	**Split Sample Results:**		**Correlates**	
4							
5							
6							
7	2.588	2.615	0.027				
8	2.588	2.603	0.015				
9	2.591	2.594	0.003				
10	2.591	2.594	0.003				

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Further G_{mm} Analysis

G_{mm}							
Split Sample Number	**Plant**	**Reheated same day**	**Difference (Xd)**	**$X_{d\ Mean}$**	**0.08**	Degree of Freedom	9
1	2.756	2.798	0.042	S_d	0.06	Prob. α	1%
2	2.756	2.635	0.121	t_{pair}	**4.18**	$t_{critical}$	3.25
3	2.567	2.649	0.082	**Split Sample Results:**		**Do not Correlate**	
4	2.646	2.652	0.006				
5	2.646	2.651	0.005				
6	2.662	2.532	0.130				
7	2.661	2.514	0.147				
8	2.513	2.581	0.068				
9	2.505	2.650	0.145				
10	2.698	2.712	0.014				

Analysis of Core G_{mb}

Core G_{mb}							
Split Sample Number	**Contractor**	**Agency**	**Difference (Xd)**	**$X_{d\ Mean}$**	***0.03***	Degree of Freedom	9
1	2.437	2.492	0.055	S_d	0.04	Prob. α	1%
2	2.406	2.384	0.022	t_{pair}	**2.90**	$t_{critical}$	3.25
3	2.369	2.429	0.060	**Split Sample Results:**		**Correlates**	
4	2.366	2.484	0.118				
5	2.455	2.465	0.010				
6	2.430	2.403	0.027				
7	2.451	2.435	0.016				
8	2.451	2.453	0.002				
9	2.440	2.422	0.018				
10	2.414	2.415	0.001				

Summary

- G_{mb} results from same population
- From PAPA presentation: chance of all data being used for Pay Factor Calculation increased by 36.7% by using G_{mb} instead of $\%G_{mm}$.
- Sample Conditioning makes a difference in measured and calculated results.

Conclusion

Check for effects of sample conditioning on measured test results.