

*NCAUPG's North Central
Hot Mix Asphalt Conference*

*Using Contractor's
Test Results for
Acceptance*

*Rick Kreider, KsDOT
Asst Bureau Chief of Materials and Research*



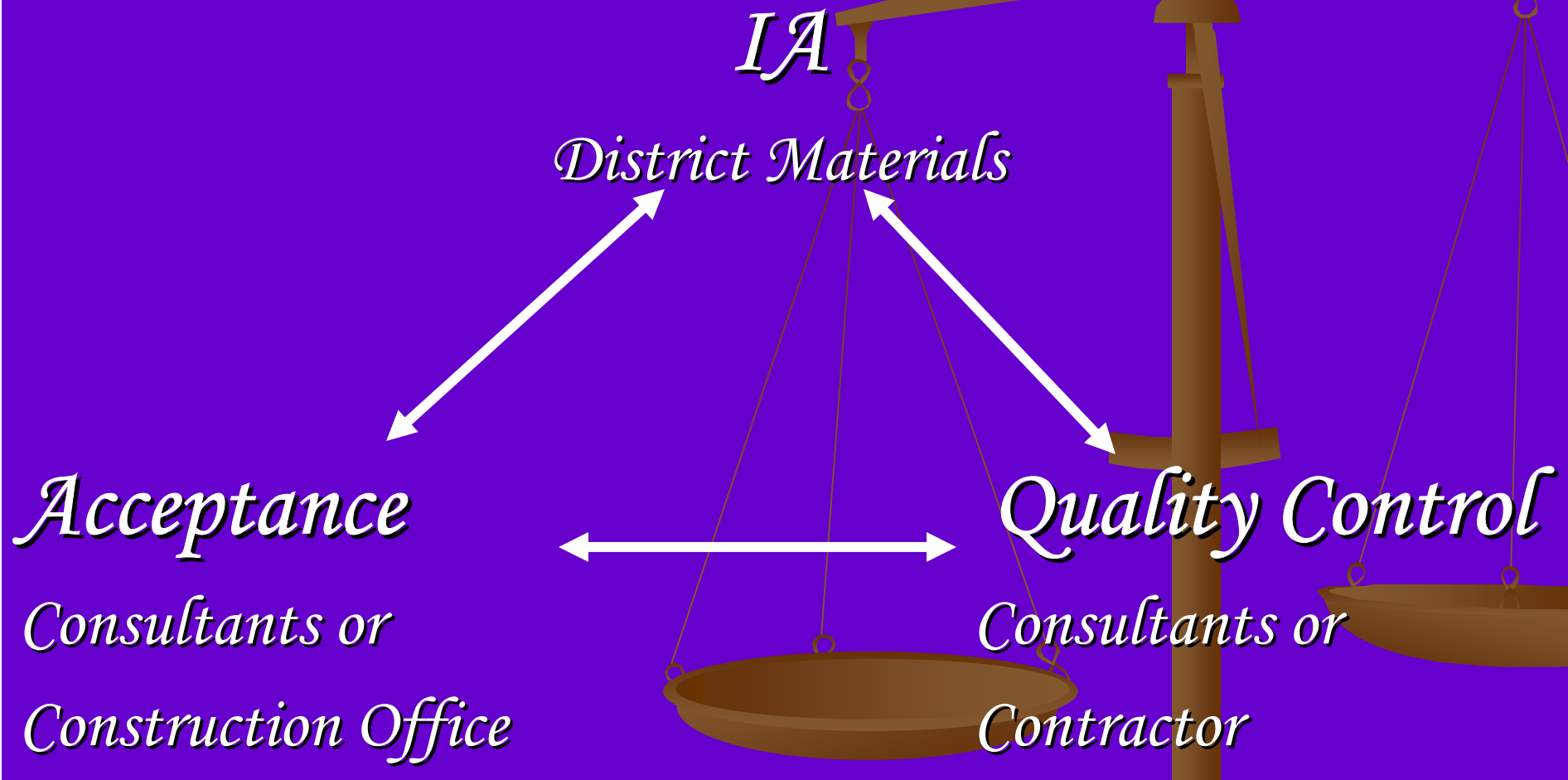
Today's Topics

- *Quality 101*
- *Using Statistics to Compare Test Results*
- *Analysis*

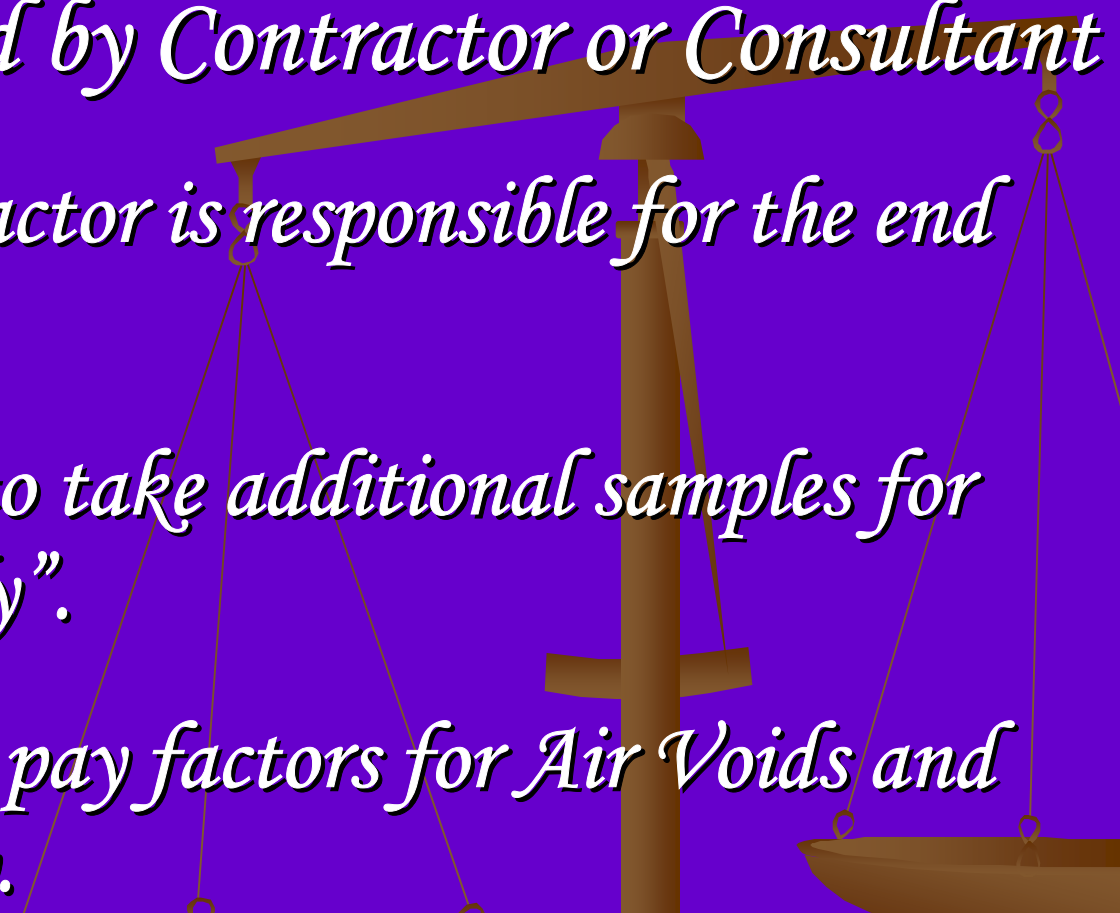


Quality 101 - Testing

The 3-leg stool or triangle philosophy.




Quality Control

- *Testing Performed by Contractor or Consultant*
 - *The Prime Contractor is responsible for the end product.*
 - *QC is permitted to take additional samples for “information only”.*
 - *QC/QA Spec has pay factors for Air Voids and In-Place Density.*
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Quality Assurance

- *Testing Performed by KsDOT or Consultant*
 - *KsDOT is responsible for Verification and Acceptance.*
 - *KsDOT has the option to visit the Contractor's lab at anytime. KsDOT field testers use some of the Contractor's test equipment.*
 - *All testers (both QC and QA) are "Certified".*
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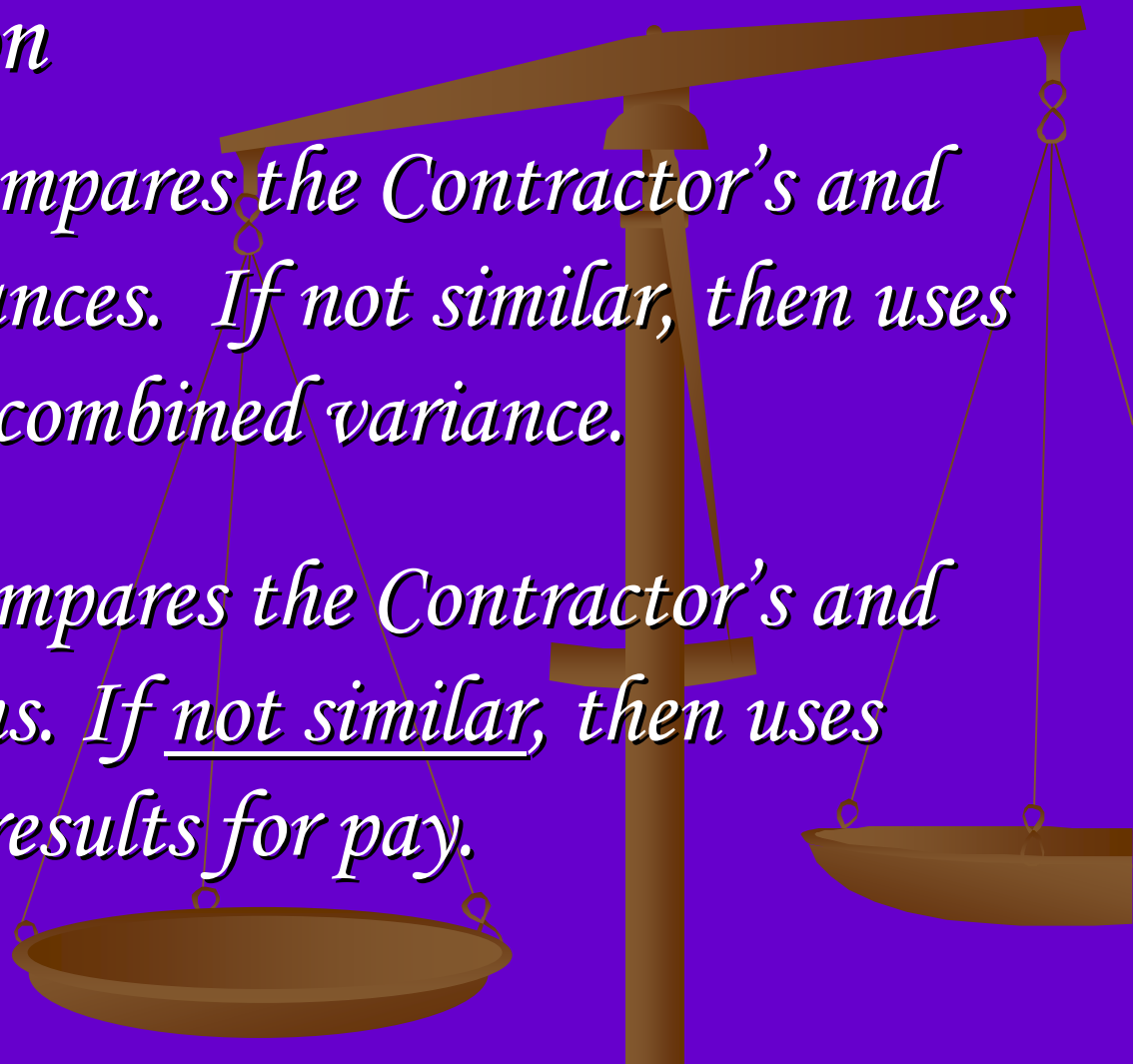
Independent Assurance

- *Performed by KsDOT's District Materials Personnel*
 - *The District checks KsDOT field, contractor and consultant test procedures and test equipment.*
 - *They perform replicate/witness testing.*
- It's all about the "check and balance".*
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Using Statistics to Compare Test Results

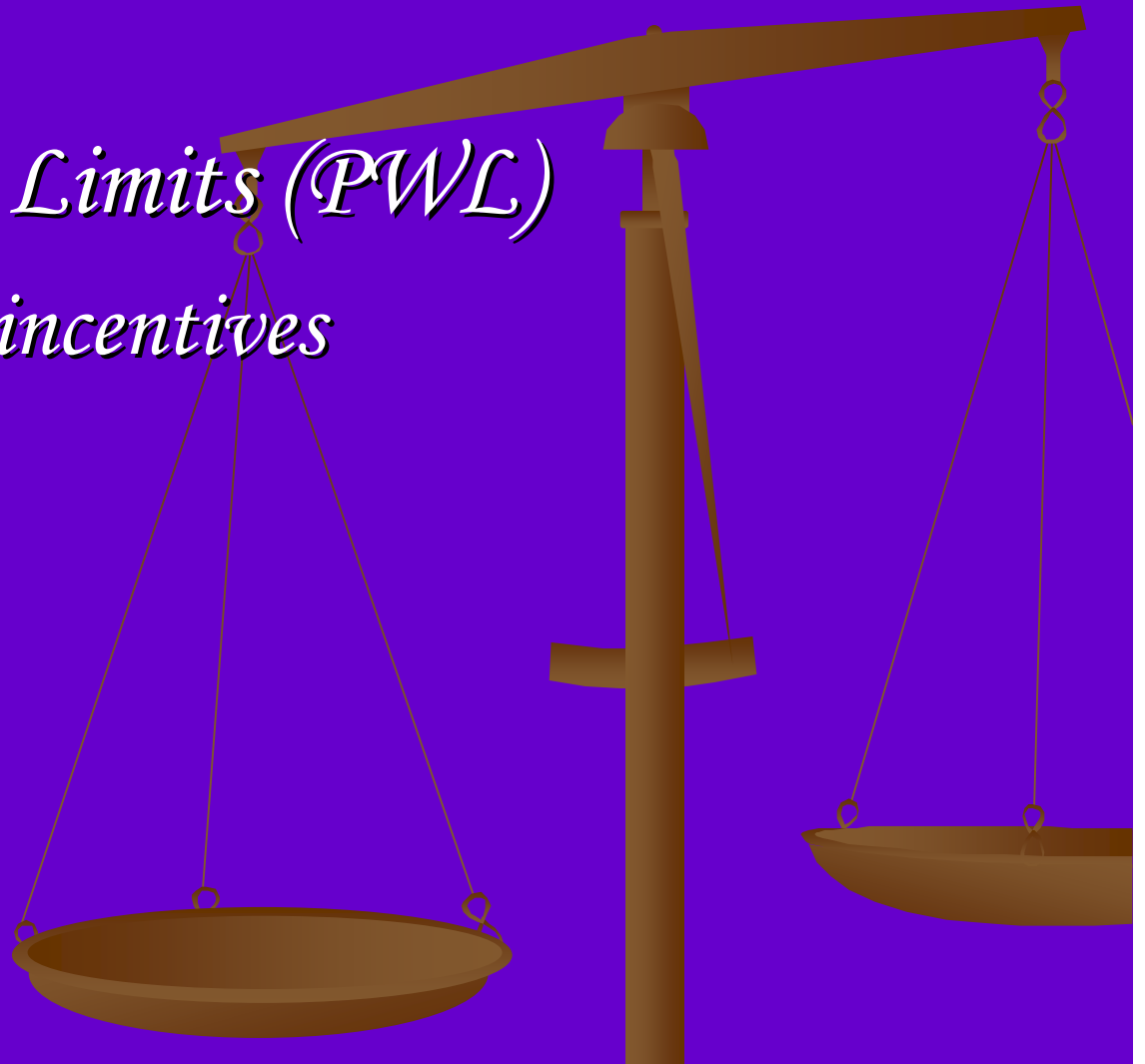
■ *F&t Comparison*

- *F-Analysis: Compares the Contractor's and K_sDOT's variances. If not similar, then uses a conservative combined variance.*
- *t-Analysis: Compares the Contractor's and K_sDOT's means. If not similar, then uses K_sDOT's test results for pay.*



Using Statistics to Compare Test Results

- *Percent Within Limits (PWL)*
 - *Incentives/Disincentives*
 - *Air Voids*
 - *Density*



Air Voids									
Lot	Date	Contractor Quality Control Tests (%)	KDOT Verification Test (%)	Number of Contractor Tests	Number of KDOT Tests	T Test	T(crit)	Are Means The Same?	Use Contractor Test Results?
1A	9/28/2004	4.72	4.30	4	1				YES
1B	9/30/2004	2.41							
1C	9/30/2004	4.47							
1D	10/04/2004	3.98							
1E									
1F						Pass			
2A	10/04/2004	3.38	4.60	4	1				YES
2B	10/05/2004	4.61							
2C	10/05/2004	4.61							
2D	10/11/2004	4.49							
2E									
2F						Pass			
3A	10/11/2004	4.22	2.70	12	3				YES
3B	10/11/2004	4.07							
3C	10/12/2004	4.97							
3D	10/13/2004	4.80							
3E									
3F						0.72	3.01	Pass	
4A	10/13/2004	4.95							

90MP-230-R10								
Lots:	1A	11D	Project #			Name of QC Tester		
Dates:	9/28/2004	12/09/2004	Contract #			Certification # of QC Tester		
Air Voids								
Lot	Date	Contractor or KDOT Test Result (%)	PWL _{UV}	PWL _{LV}	P _V	Lot Size (TON)	Air Voids Pay Adjustment	
1A	9/28/2004	4.72						
1B	9/30/2004	2.41						
1C	9/30/2004	4.47						
1D	10/04/2004	3.98						
1E								
1F			93.57	86.82	-0.029	3000.00	(\$2,697.00)	
2A	10/04/2004	3.38						
2B	10/05/2004	4.61						
2C	10/05/2004	4.61						
2D	10/11/2004	4.49						
2E								
2F			100.00	100.00	0.030	3000.00	\$2,790.00	
3A	10/11/2004	4.22						
3B	10/11/2004	4.07						
3C	10/12/2004	4.97						
3D	10/13/2004	4.80						
3E								
3F			100.00	100.00	0.030	3000.00	\$2,790.00	
4A	10/13/2004	4.95						

90M/P-230-R10										
Lots:		1A	11D	Project #			Name of QC Tester			
Dates:		9/28/2004	12/09/2004	Contract #			Certification # of QC Tester			
		Gmm								
Lot	Date	Contractor Quality Control Tests (Gmm)	KDOT Verification Test (Gmm)	Number of Contractor Tests	Number of KDOT Tests	T Test	T(crit)	Are Means The Same?	Use Contractor Test Results?	
1A	9/28/2004	2.454							YES	
1B	9/30/2004	2.455							YES	
1C	9/30/2004	2.456	2.443						YES	
1D	10/04/2004	2.440							YES	
1E									YES	
1F				4	1			Pass	YES	
2A	10/04/2004	2.437							YES	
2B	10/05/2004	2.427							YES	
2C	10/05/2004	2.424	2.434						YES	
2D	10/11/2004	2.422							YES	
2E									YES	
2F				4	1			Pass	YES	
3A	10/11/2004	2.429							YES	
3B	10/11/2004	2.427							YES	
3C	10/12/2004	2.428	2.422						YES	
3D	10/13/2004	2.422							YES	
3E									YES	
3F				12	3	0.25	3.01	Pass	YES	

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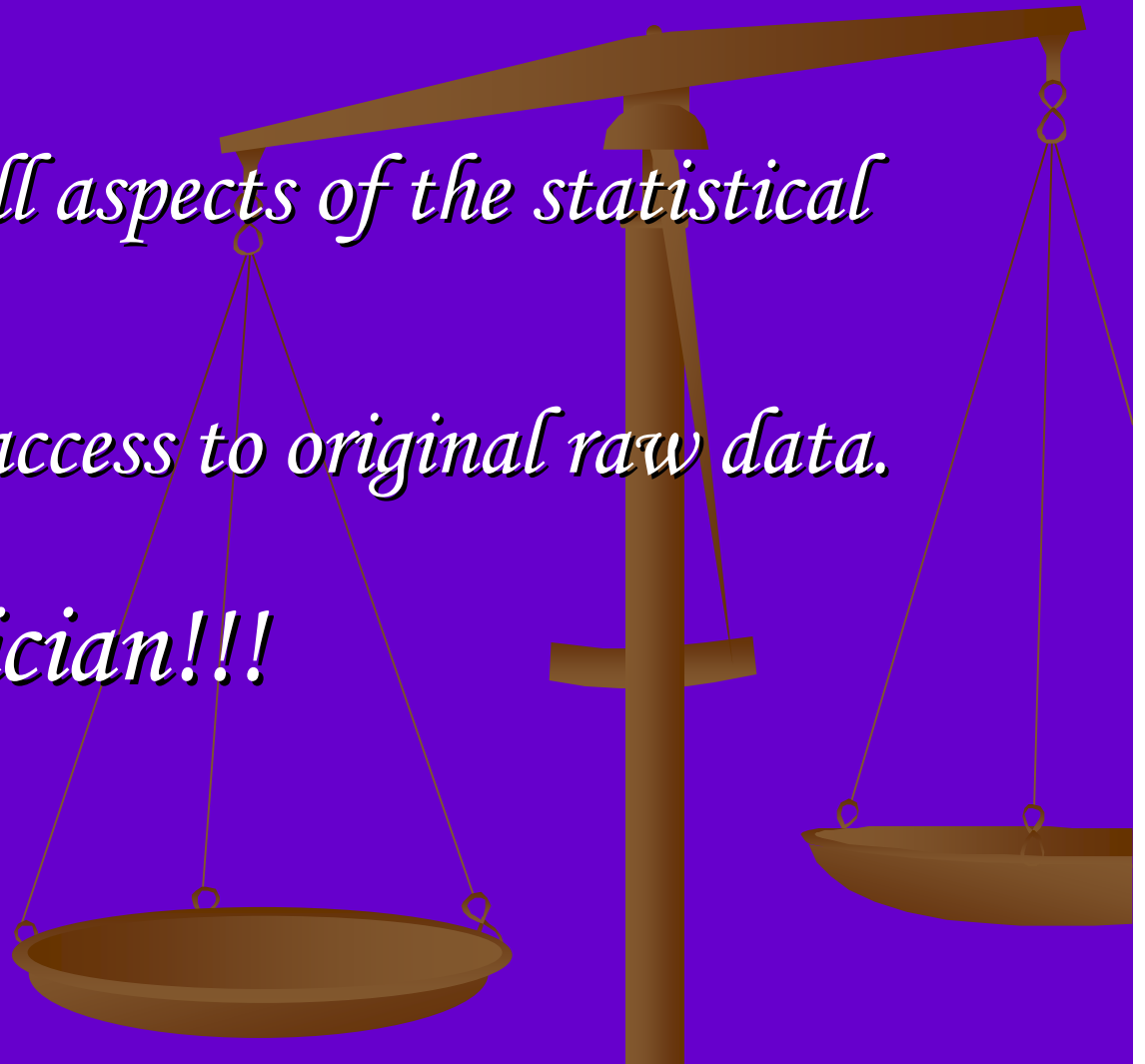
1	90MP-230-R10															
2	Lots:	1	37	Project #											Name of QC Tester	
3	Dates:	9/28/2004	12/09/2004	Contract #											Certification # of QC Tester	
4	Mix Type	SR19APG6422														

	Lot	Date	Contractor Test Results (pcf)	Gmm	Contractor Quality Control Tests	KDOT Test Results (pcf)	KDOT Verification Tests (%Gmm)	Number of Contractor Tests	Number of KDOT Tests	T Test	T(crit)	Are Means The Same?	Use Contractor Test Results?
8	1A1	9/28/2004	2317.886	2.444	1523.70	2308.542	1517.56	6	3	0.58	3.50	Pass	YES
9	1A2	9/28/2004	2299.137		1511.38								
10	1B1	9/28/2004	2321.377		1526.00								
11	1B2	9/28/2004	2340.833		1538.79								
12	1C1	9/28/2004	2320.911		1525.69								
13	1C2	9/28/2004	2318.098		1523.84								
14	1D1	9/28/2004											
15	1D2	9/28/2004											
16	1E1	9/28/2004											
17	1E2	9/28/2004											
18	2A1	9/29/2004	2289.118	2.454	1498.66	2290.605	1499.63	6	3	0.48	3.50	Pass	YES
19	2A2	9/29/2004	2271.165		1486.91								
20	2B1	9/29/2004	2268.028		1484.85								
21	2B2	9/29/2004	2276.593		1490.46								
22	2C1	9/29/2004	2302.685		1507.54								
23	2C2	9/29/2004	2284.007		1495.31								
24	2D1	9/29/2004											
25	2D2	9/29/2004											
26	2E1	9/29/2004											
27	2E2	9/29/2004											
28	3A1	9/30/2004	2328.988	2.455	1524.14	2309.344	1511.29	10	5	0.57	3.01	Pass	YES
29	3A2	9/30/2004	2293.340		1500.81								
30	3B1	9/30/2004	2254.856		1475.63								
31	3B2	9/30/2004	2257.978		1477.67								
32	3C1	9/30/2004	2313.699		1514.14								
33	3C2	9/30/2004	2334.838		1527.97								
34	3D1	9/30/2004	2294.390		1501.50								
35	3D2	9/30/2004	2343.892	1533.89									
36	3E1	9/30/2004	2312.517	1513.36									
37	3E2	9/30/2004	2270.287	1485.73									

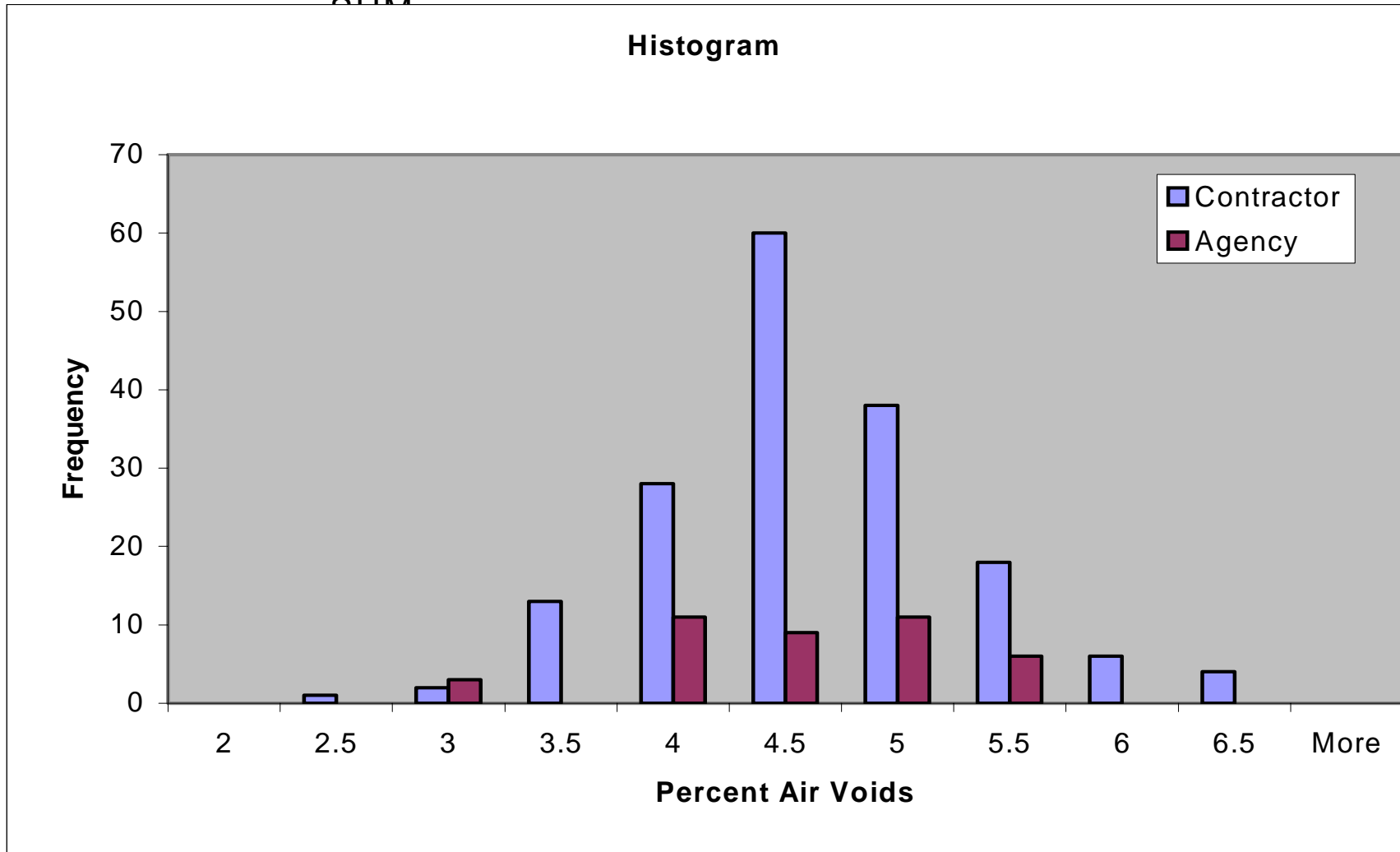
	A	C	E	L	N	O	P	Q	R
1	90M/P-230-R10								
2	Lots:	1	37	Project #		Name of QC Tester			
3	Dates:	9/28/2004	12/09/2004	Contract #		Certification # of QC Tester			
4							Plan Thickness		300 m
6	Density								
7	Lot	Date	Contractor or KDOT Test Results (%Gmm)	PWL_{LD}	Pay Adjustment Factor (P_D)	Mainline/ Shoulder	Lot Size (Mg)	Density Pay Adjustment	
8	1A1	9/28/2004	1523.70						
9	1A2	9/28/2004	1511.38						
10	1B1	9/28/2004	1526.00						
11	1B2	9/28/2004	1538.79			Other			
12	1C1	9/28/2004	1525.69						
13	1C2	9/28/2004	1523.84						
14	1D1	9/28/2004		100.00	0	Shoulder			
15	1D2	9/28/2004							
16	1E1	9/28/2004							
17	1E2	9/28/2004		100.00	0.040	Mainline		223.47	\$277.10
18	2A1	9/29/2004	1498.66						
19	2A2	9/29/2004	1486.91						
20	2B1	9/29/2004	1484.85						
21	2B2	9/29/2004	1490.46			Other			
22	2C1	9/29/2004	1507.54						
23	2C2	9/29/2004	1495.31						
24	2D1	9/29/2004		100.00	0	Shoulder			
25	2D2	9/29/2004							

Analysis

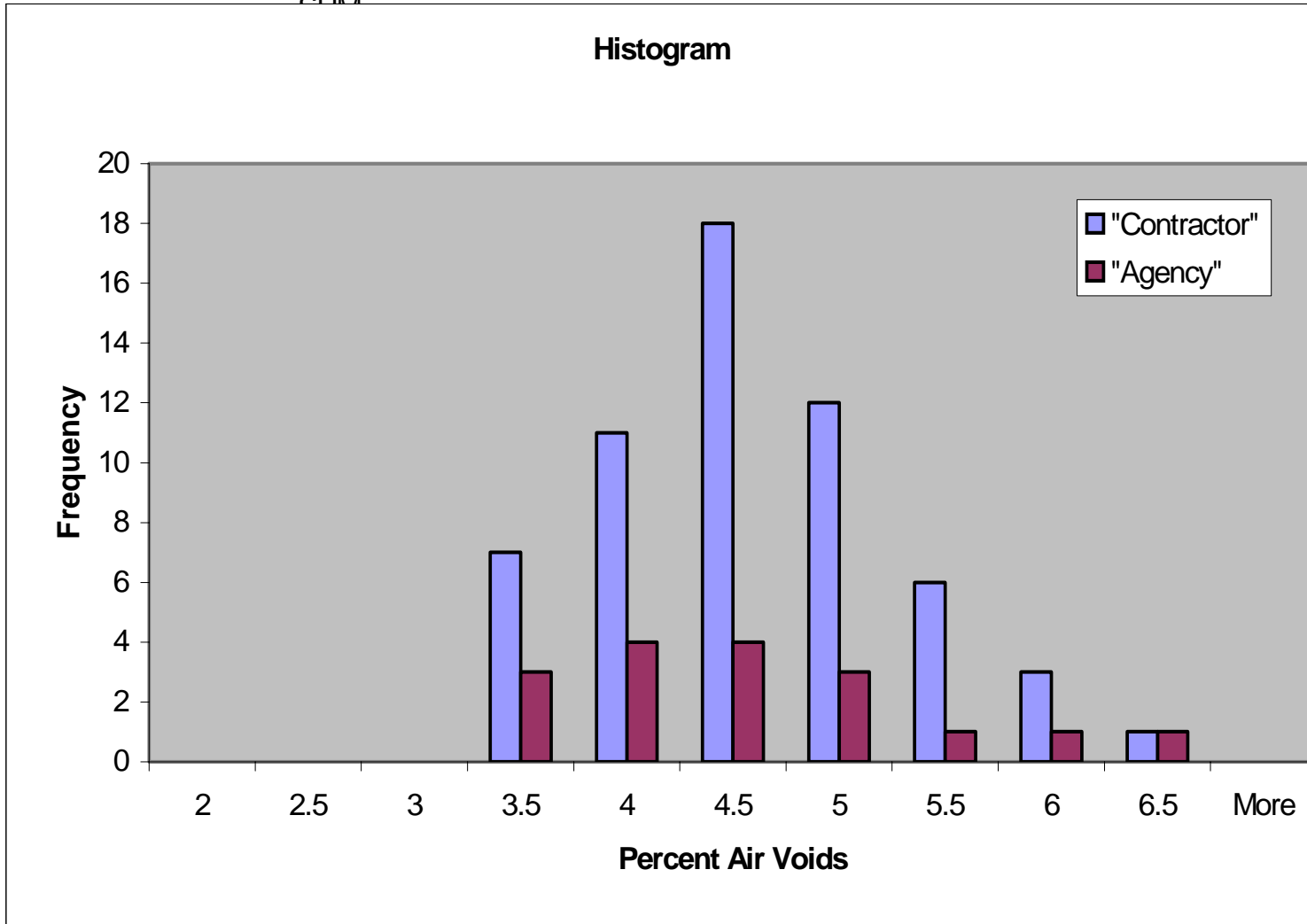
- *Need to look at all aspects of the statistical analysis.*
- *Best if you have access to original raw data.*
- *Hire a Statistician!!!*



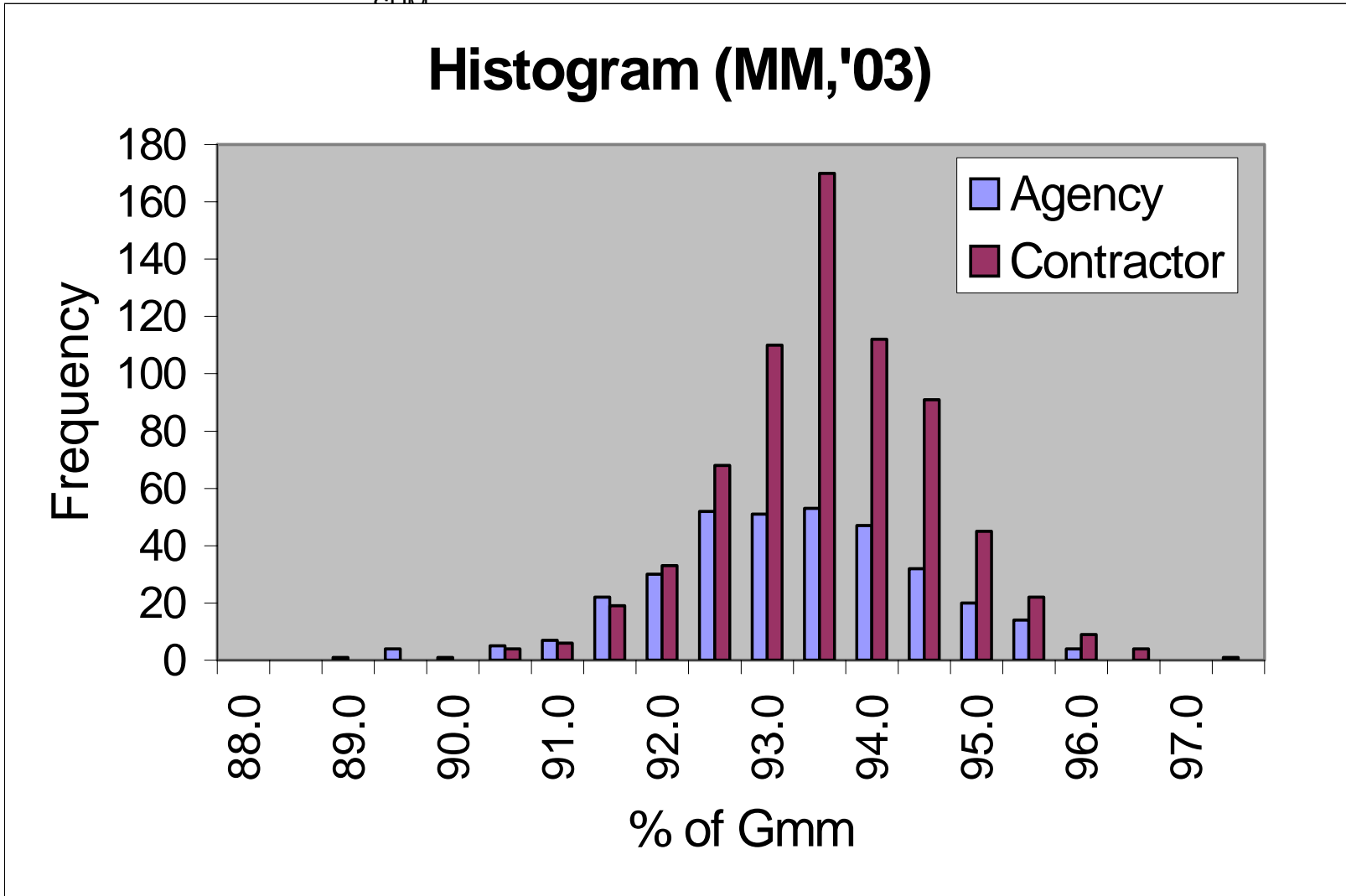
	Cont	KDOT	Pay Factr
Count	170	40	42
Mean	4.400118	4.29525	0.001238
ssd	0.673909	0.655188	0.0443
skew	0.213582	-0.586894	-1.476857
kurtosis	0.437518	0.188864	1.18375
SUM			



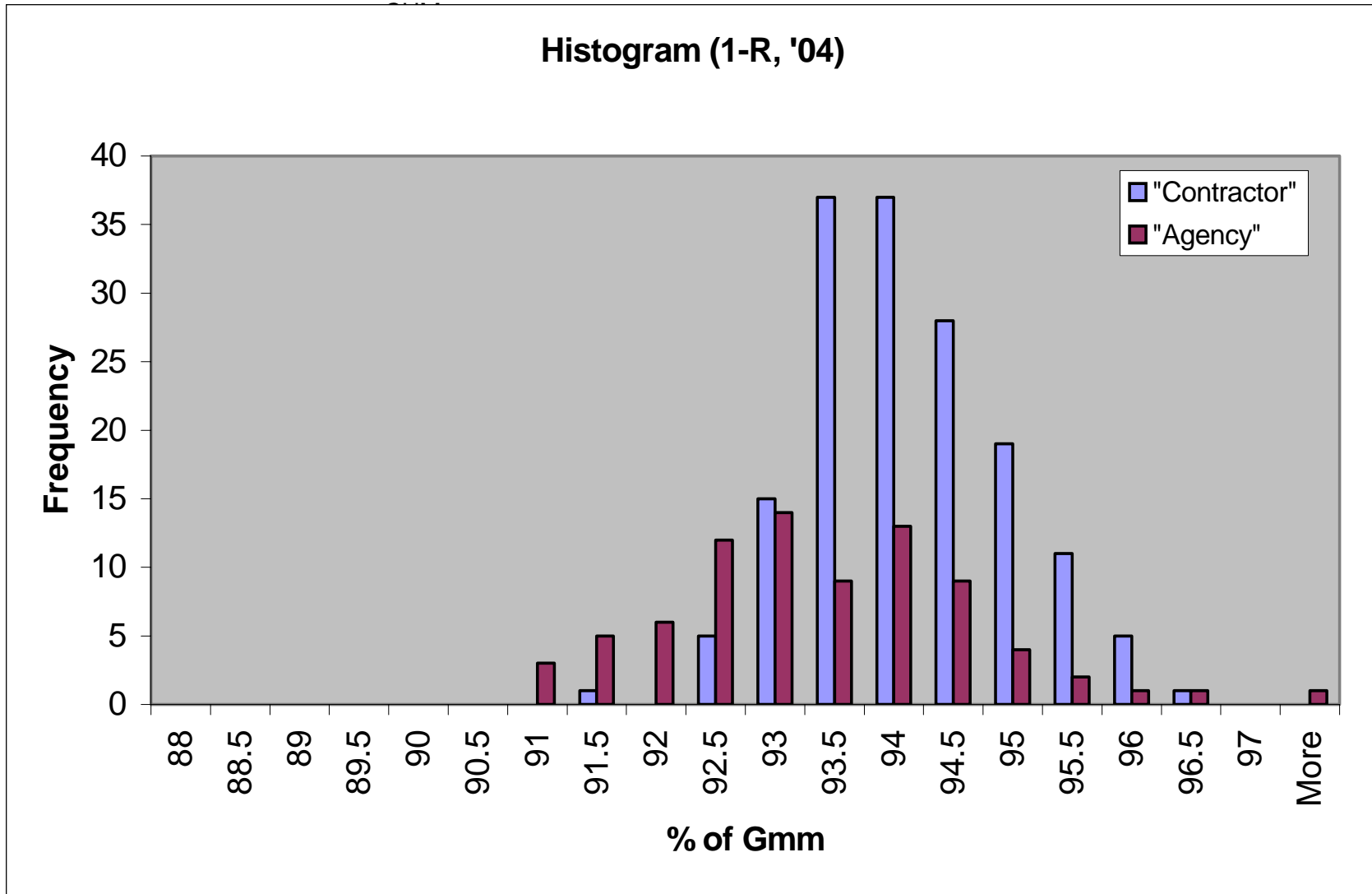
	Cont	KDOT	Pay Factr
Count	58	17	13
Mean	4.347931034	4.287058824	0.0045385
ssd	0.720771416	0.871677726	0.0167959
skew	0.368358453	0.978107345	-0.494807
kurtosis	-0.119565575	0.921363836	1.9354643
CUM			



	Cont	KDOT	Pay Factr
Count	693	344	75
Mean	93.3313276	92.969593	0.0064
ssd	1.00329067	1.27398361	0.01771776
skew	-0.0249041	-0.2633961	-2.1609427
kurtosis	0.24794603	0.53596752	5.7705695



	Cont	KDOT	Pay Factr
Count	159	80	16
Mean	93.8879245	93.12825	0.032375
ssd	0.82445001	1.28516834	0.01504161
skew	0.29955379	0.60504537	-1.7248444
kurtosis	0.22257582	1.20307861	1.33389995





Thank You!