AGGREGATES

Section 7 – Quality Assurance and Quality Acceptance

Quality Assurance

- **Definition: a systematic method for sampling, testing and evaluating material to assure specification compliance. Includes incentives and disincentives**

- **Composed of:**
  - **Quality Control (QC)**
  - **Quality Acceptance (QA)**

Quality Assurance (continued)

- Quality Control – A systematic procedure to sample, test and monitor production. Generally a contractor responsibility.

- Quality Acceptance – A statistical method for evaluating compliance.
  - Gradation – "Percent within limits" approach
    - Quality Index > Quality Level > Pay Factor
  - Compaction – "Percent above limit" approach
    - Quality Index > Pay Factor

Acceptance Methods

- **Representative Sample - Traditional**
  - **Pass-Fail**
  - **Limited Information**
  - **Ex.30 pound Sample for 1000 tons, How much material is really out-of-specification?**
    - **2,000,000 lbs/30lbs = 66,667 samples**
  - **No Information on Variability**

Acceptance Methods (continued)

- Sample Average
  - 5 (3 to 7) Gradation Samples
  - Pass-Fail based on multiple Samples & percent within limits
  - Shows Distribution
  - Rewards Consistency in Practice
  - Use Tighter Specs for Job Mix Design

Acceptance Methods (continued)

Example - Grading A Plant Mix Paving

Normal Range for #4 is 45-65%

Have Reduced Acceptance Limits on Specific Jobs based on JMF Target ± 5%,

For example 52 ± 5% (47 – 52 – 57)

So, the Narrow Band is:

Upper Specification Limit = 57

Lower Specification Limit = 47

Acceptance Methods (continued)

- **Statistical Method**
  - **Determine $\bar{x}$ and s from data**
  - **Define Material Assuming It Has a "Normal Probability" Distribution**
  - **Contractor Gets Paid for % of Materials within the Upper and Lower Specification Limits**

Acceptance Methods (continued)

- Historically, basis from W. Edwards Deming (A Wyoming native from Cody and Powell, UW Graduate in Engineering in 1921)

- WYDOT has used procedure since
  - 1984 in field
  - 1974 in lab

- How does the System work?

Quality Acceptance for Gradations

- For Gradations, Quality is based on the "Percentage of aggregate within specification limits".
- Example:
  - Grading W
    - #4 - 45-65%
    - #8 – 33-53%
    - #200 – 3-12%
  - Based on - #4
    - If all of the stockpile was between 45% and 65%, Full Pay

Table 803.4.4-1 Section 4-9

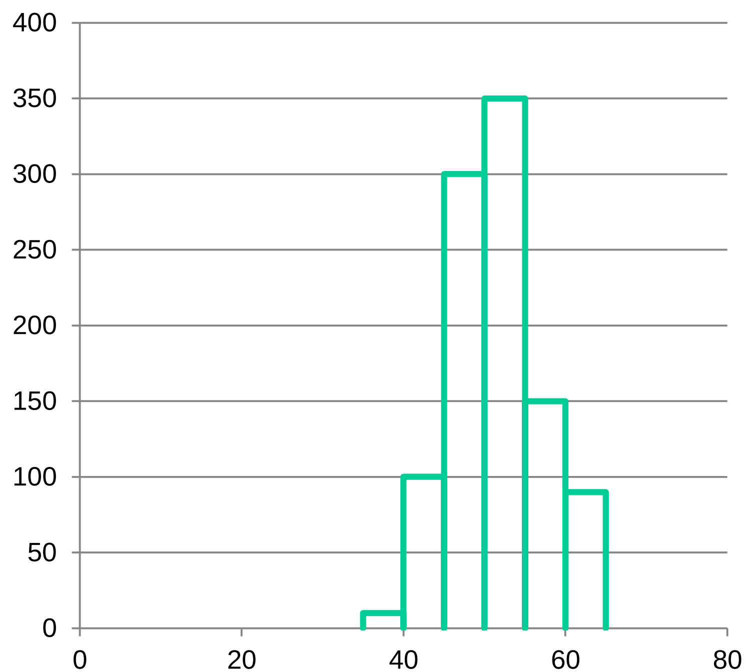
Gradation Requirements: Subbase and Base

Sieve	Grading J	Grading GR	Grading L	Grading K	Grading W
	% Passing				
2 in	100	-	-	-	-
1 1/2 in	90-100	-	100	100	100
1 in	-	100	90-100	90-100	90-100
3/4 in	-	90-100	-	-	
1/2 in	-	65-85	60-85	-	60-85
3/8 in	-	-	-	-	
No. 4	35-75	50-78	35-55	40-65	45-65
No. 8	-	37-67	25-50	30-55	33-53
No. 30	-	13-35	10-30	-	-
No. 200	0-15	4-15	3-15	3-15	3-12

Quality Acceptance for Gradations

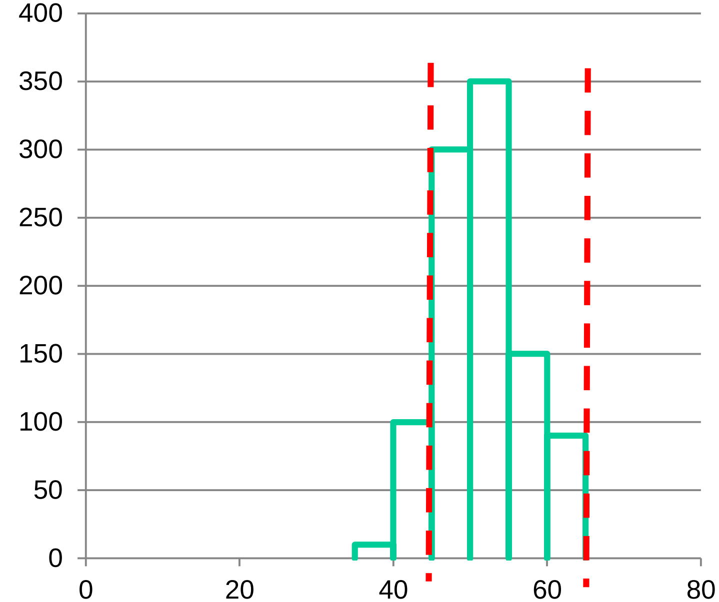
- **How do we determine if a stockpile has between 45% and 65% passing the #4?**
- **We could go out and obtain 1000 samples and test them. This would give a very accurate picture of the -#4 fraction of the pile.**
- **We could draw a picture of this distribution of -#4 values, shown as the green boxes.**

%Passing Range	No. of Tests
35 – 40	10
40 – 45	100
45 – 50	300
50 – 55	350
55 – 60	150
60 – 65	90
65 – 70	0



Quality Acceptance for Gradations

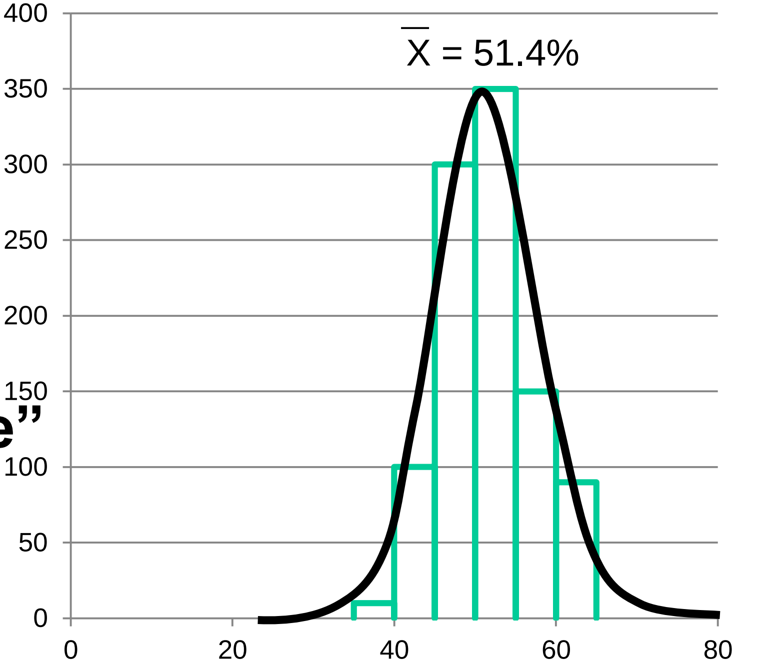
- The red lines are the upper and lower specification limits of 45% and 65%
- There are 110 samples out of 1000 (11%) that fall outside of the limits.



- Since Quality is defined as the percentage of material within the specification limits, The Contractor would be paid for 89% of the material.

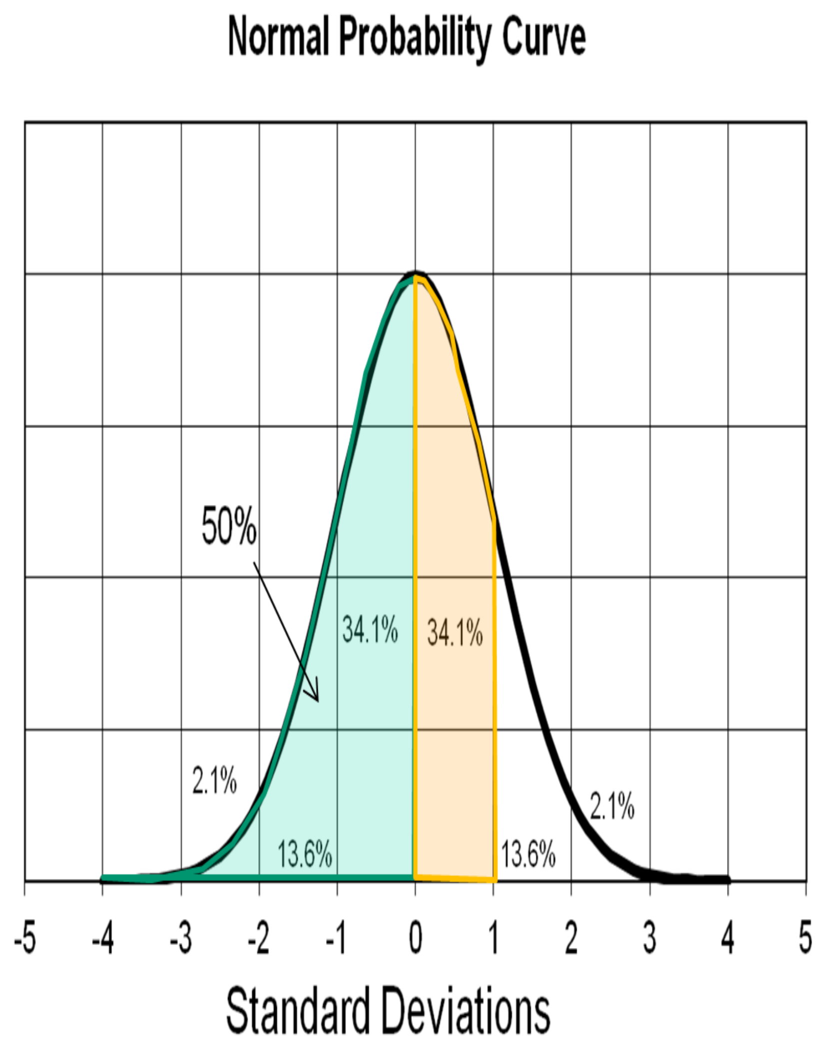
Quality Acceptance for Gradations

- However, it is not feasible to obtain 1000 samples of a pile, so another technique is needed.
- If the width of the bins was smaller, say 2% instead of 5%, we would see a much smoother curve develop.
- It has a “bell” like shape and is known as the “Normal Probability Distribution Curve”
- It can be defined by two values, the “average” or “mean” and the “standard deviation”.



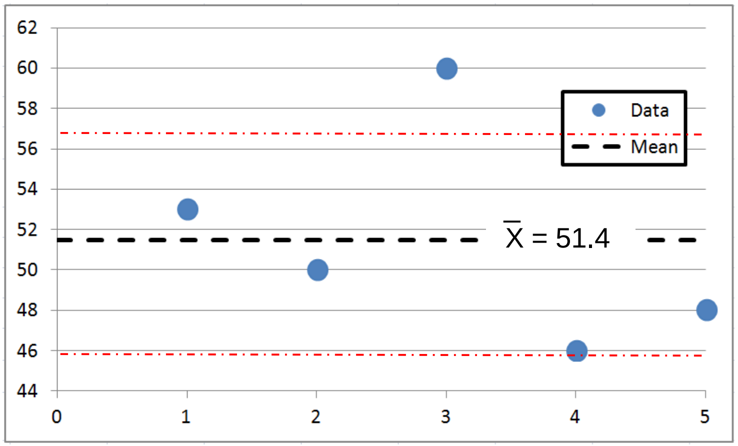
Properties of the Normal Probability Curve

- The total area under the curve is 100%, which means that all the tests will be included under the curve mathematically.
- The $\bar{x}$ value at the peak is the mean or average value. Half the area is above the mean and half is below.
- 34.1% of the area is under the curve from zero to one Standard Deviation.
- About 2/3 of the data is between +1 and -1 SD
- 84.1% (50% + 34.1%) of the area is below the curve and less than 1.0 Standard Deviation.
- We will assume this curve represents the pile.



Quality Assurance

- Let's select 5 values out of the 1000 tests.



	x		$(x - \bar{x})$			$(x - \bar{x})^2$	
1	53		= 53.0 - 51.4 =	1.6		= 1.6 * 1.6 =	2.56
2	50		= 50.0 - 51.4 =	-1.4		= -1.4 * -1.4 =	1.96
3	60		= 60.0 - 51.4=	8.6		= 8.6 * 8.6 =	73.96
4	46		= 46.0 - 51.4 =	-5.4		= -5.4 * -5.4 =	29.16
5	48		= 48.0 - 51.4 =	-3.4		= -3.4 * -3.4=	11.56

Sum = 257.0

Mean = 257.0/5 = 51.4 $= \bar{x}$

$\Sigma(x - \bar{x}) =$ 0.0

Doesn't Help

$\Sigma(x - \bar{x})^2 =$ 119.2

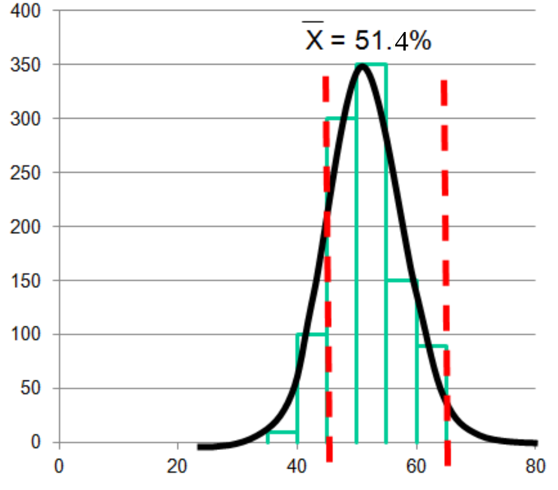
Standard Deviation =

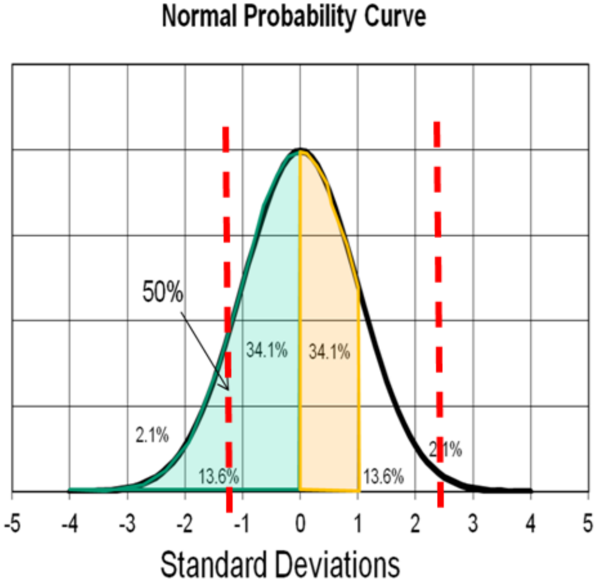
$$s = \sqrt{\frac{\sum\left(x - \bar{x}\right)^2}{n-1}}$$

$$s = \sqrt{\frac{119.2}{5-1}} = 5.46$$

Quality Assurance

- We now have the Mean ($\bar{x}$ = 51.4) and Standard Deviation (s = 5.46) to describe the "Normal Probability Distribution Curve"
- We need to relate the area under the curves in both diagrams.
- The upper and lower Specification Limits are SL_u = 65 and SL_l = 45.

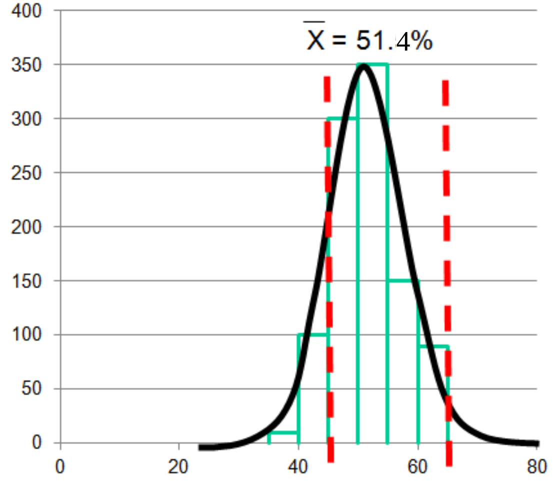


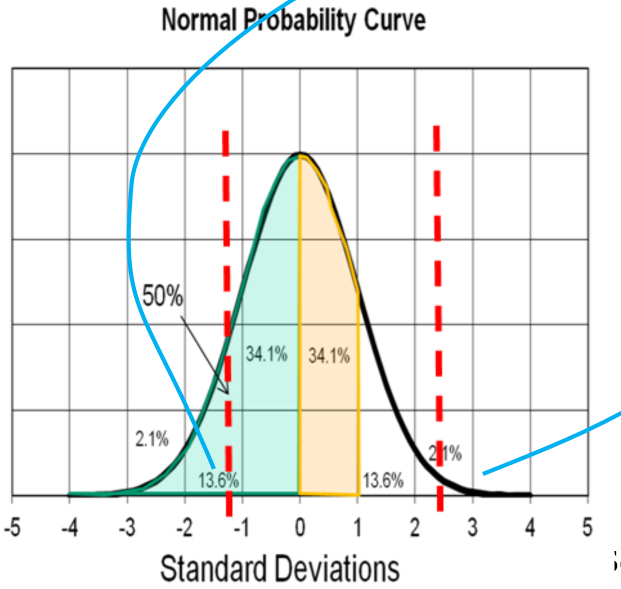


- **We can relate the specification limits to the standard deviations by the Quality Index.**

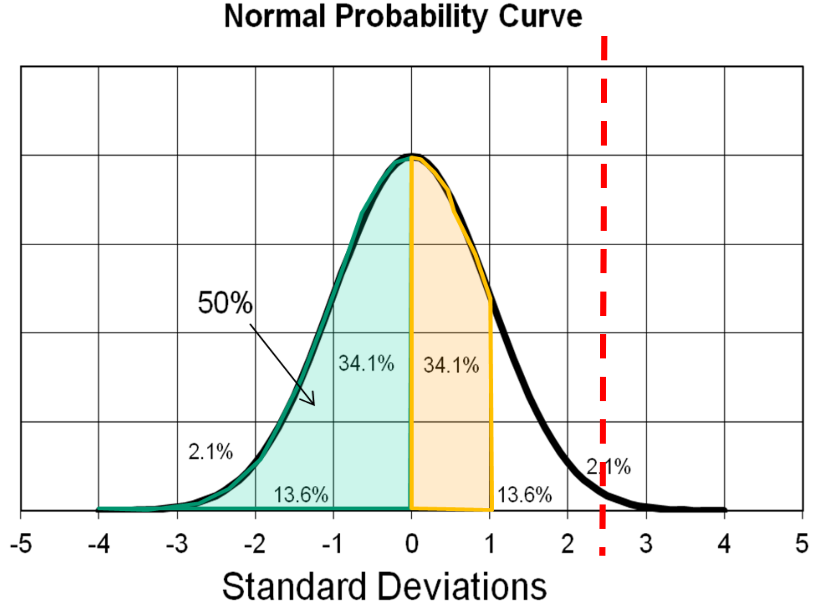
$$\text{Upper Quality Index} = Q_u = \frac{SL_u - \bar{x}}{s} = \frac{65 - 51.4}{5.46} = 2.49$$

$$\text{Lower Quality Index} = Q_l = \frac{\bar{x} - SL_l}{s} = \frac{51.4 - 45}{5.46} = 1.17$$





- **Remember, we are trying to determine the percentage of material between the upper and lower specification limits.**
- **The area less than the upper specification limit is a function of the Upper Quality Index, $Q_u = 2.49$.**



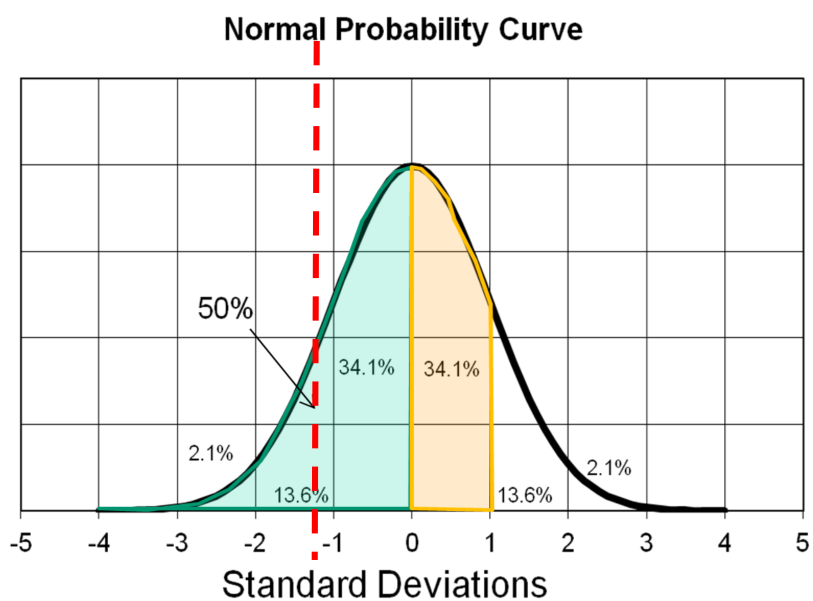
- **Table 113.1-1 relates Quality Indices to the remaining area, P_u.**

Table 113.1-1

Quality Level Analysis by the Standard Deviation Method

P_U or P_L percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L				
	n = 3	n = 4	n = 5	n = 6	n = 7
100	1.16	1.50	1.79	2.03	2.23
99		1.47	1.67	1.80	1.89
98	1.15	1.44	1.60	1.70	1.76
97		1.41	1.54	1.62	1.67
96	1.14	1.38	1.49	1.55	1.59
95		1.35	1.44	1.49	1.52
94	1.13	1.32	1.39	1.43	1.46
93		1.29	1.35	1.38	1.40
92	1.12	1.26	1.31	1.33	1.35
91	1.11	1.23	1.27	1.29	1.30
90	1.10	1.20	1.23	1.24	1.25
89	1.09	1.17	1.19	1.20	1.20
88	1.07	1.14	1.15	1.16	1.16
87	1.06	1.11	1.12	1.12	1.12
86	1.04	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00
83	1.00	0.99	0.98	0.97	0.97
82	0.97	0.96	0.95	0.94	0.93
81	0.96	0.93	0.91	0.90	0.90
80	0.93	0.90	0.88	0.87	0.86
79	0.91	0.87	0.85	0.84	0.83
78	0.89	0.84	0.82	0.80	0.80
77	0.87	0.81	0.78	0.77	0.76
76	0.84	0.78	0.75	0.74	0.73
75	0.82	0.75	0.72	0.71	0.70
74	0.79	0.72	0.69	0.68	0.67
73	0.76	0.69	0.66	0.65	0.64
72	0.74	0.66	0.63	0.62	0.61
71	0.71	0.63	0.60	0.59	0.58
70	0.68	0.60	0.57	0.56	0.55
69	0.65	0.57	0.54	0.53	0.52
68	0.62	0.54	0.51	0.50	0.49
67	0.59	0.51	0.47	0.47	0.46
66	0.56	0.48	0.45	0.44	0.44
65	0.52	0.45	0.43	0.41	0.41
64	0.49	0.42	0.40	0.39	0.38
63	0.46	0.39	0.37	0.36	0.35
62	0.43	0.36	0.34	0.33	0.32
61	0.39	0.33	0.31	0.30	0.30
60	0.36	0.30	0.28	0.27	0.27
59	0.32	0.27	0.25	0.25	0.24
58	0.29	0.24	0.23	0.22	0.21
57	0.25	0.21	0.20	0.19	0.19
56	0.22	0.18	0.17	0.16	0.16
55	0.18	0.15	0.14	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11
53	0.11	0.09	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00

- The area greater than the lower specification limit is a function of the Lower Quality Index, Q_l = 1.17.
- Table 113.1-1 shows P_l =89%.



- Note that was the same area as we found with the 1000 samples!

Table 113.1-1
Quality Level Analysis by the Standard Deviation Method

P_U or P_L percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L				
	n = 3	n = 4	n = 5	n = 6	n = 7
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97		1.41	1.54	1.62	1.67
96	1.14	1.38	1.49	1.55	1.59
95		1.35	1.44	1.49	1.52
94	1.13	1.32	1.39	1.43	1.46
93		1.29	1.35	1.38	1.40
92	1.12	1.26	1.31	1.33	1.35
91	1.11	1.23	1.27	1.29	1.30
90	1.10	1.20	1.23	1.24	1.25
89	1.09	1.17	1.19	1.20	1.20
88	1.07	1.14	1.15	1.16	1.16
87	1.06	1.11	1.12	1.12	1.12
86	1.04	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00
83	1.00	0.99	0.98	0.97	0.97
82	0.97	0.96	0.95	0.94	0.93
81	0.96	0.93	0.91	0.90	0.90
80	0.93	0.90	0.88	0.87	0.86
79	0.91	0.87	0.85	0.84	0.83
78	0.89	0.84	0.82	0.80	0.80
77	0.87	0.81	0.78	0.77	0.76
76	0.84	0.78	0.75	0.74	0.73
75	0.82	0.75	0.72	0.71	0.70
74	0.79	0.72	0.69	0.68	0.67
73	0.76	0.69	0.66	0.65	0.64
72	0.74	0.66	0.63	0.62	0.61
71	0.71	0.63	0.60	0.59	0.58
70	0.68	0.60	0.57	0.56	0.55
69	0.65	0.57	0.54	0.53	0.52
68	0.62	0.54	0.51	0.50	0.49
67	0.59	0.51	0.47	0.47	0.46
66	0.56	0.48	0.45	0.44	0.44

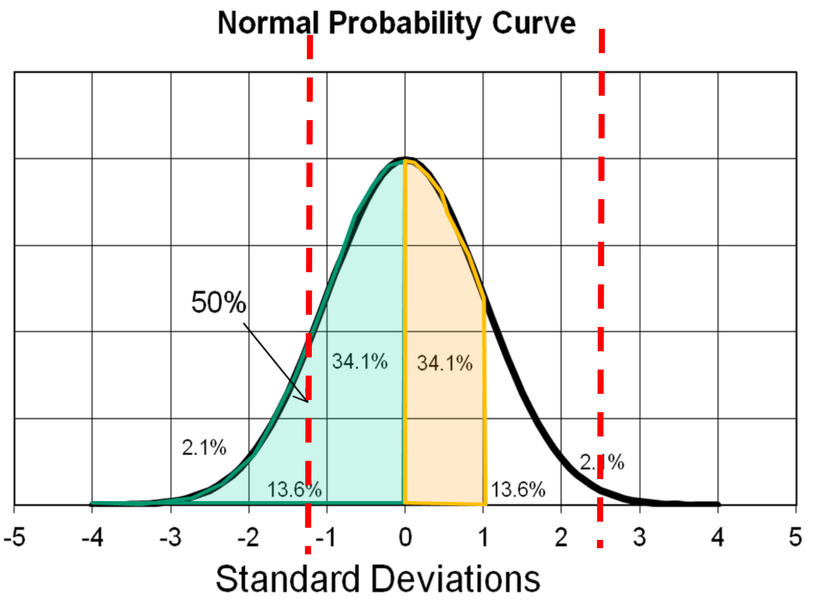
P_U or P_L percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L				
	n = 3	n = 4	n = 5	n = 6	n = 7
65	0.52	0.45	0.43	0.41	0.41
64	0.49	0.42	0.40	0.39	0.38
63	0.46	0.39	0.37	0.36	0.35
62	0.43	0.36	0.34	0.33	0.32
61	0.39	0.33	0.31	0.30	0.30
60	0.36	0.30	0.28	0.27	0.27
59	0.32	0.27	0.25	0.25	0.24
58	0.29	0.24	0.23	0.22	0.21
57	0.25	0.21	0.20	0.19	0.19
56	0.22	0.18	0.17	0.16	0.16
55	0.18	0.15	0.14	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11
53	0.11	0.09	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00

- **Upper Percent Area = 100%**
- **Lower Percent Area = 89%**
- **The Total Area, the Quality Level, is equal to:**

$QL = P_u + P_l - 100\%$

$= 100\% + 89\% - 100\%$

$QL = 89\%$



- **Note that was the same area as we found with the 1000 samples!**

Pay Factor Calculations

- **Finally, we use the Quality Level to determine <u>Pay Factors</u> for the contractor.**

- **Table 113.1-2 in the Standard Specifications Book shows a Pay Factor of 1.03 for a QL = 89%.**

Table 113.1-2 Pay Factors

Pay Factor	Required Quality Level for a Given Sample Size n and Pay Factor				
	n = 3	n = 4	n = 5	n = 6	n = 7
1.05	100	100	100	100	100
1.04	90	91	92	93	93
1.03	80	85	87	88	89
1.02	75	80	83	85	86
1.01	71	77	80	82	84
1.00	68	74	78	80	81
0.99	66	72	75	77	79
0.98	64	70	73	75	77
0.97	62	68	71	74	75
0.96	60	66	69	72	73
0.95	59	64	68	70	72
0.94	57	63	66	68	70
0.93	56	61	65	67	69
0.92	55	60	63	65	67
0.91	53	58	62	64	66
0.90	52	57	60	63	64
0.89	51	55	59	61	63
0.88	50	54	57	60	62
0.87	48	53	56	58	60
0.86	47	51	55	57	59
0.85	46	50	53	56	58
0.84	45	49	52	55	56
0.83	44	48	51	53	55
0.82	42	46	50	52	54
0.81	41	45	48	51	53
0.80	40	44	47	50	52
0.79	38	43	46	48	50
0.78	37	41	45	47	49
0.77	36	40	43	46	48
0.76	34	39	42	45	47
0.75	33	38	41	44	46

- Maximum Pay Factor
  - Base and Subbase – 1.00
  - Treated Base – 1.00
  - Plant Mix Pavement – 1.05
  - Plant Mix Wearing Course – 1.05
  - Seal Coat Aggregate – 1.05
  - PCCP – 1.00

Pay Factor Calculation (continued)

TERMS

- **x – an individual test value**
- **Σx – the summation of test values**
- **$\bar{x}$ – the average of a series of test values**
- **N – the number of test values**
- **s – the standard deviation**
- **SL_U – the upper specification limit**
- **SL_L – the lower specification limit**
- **Q_U – the Upper Quality Index**
- **Q_L – the Lower Quality Index**
- **P_U – the percent of material within SL_U**
- **P_L – the percent of material within SL_L**
- **QL - Quality Level – the total percent of material within specifications**

Pay Factor Worksheet - #1

Aggregate Specification: Crushed Base Grading W **Test Value:** #4

Test Results: $n =$ 5

Test Values: 53 50 60 46 48

Average Value: $\bar{x} =$ 51.4 **Standard Deviation:** $s =$ 5.46 (σ_{n-1})

Upper Specification Limit, SL_U = 65

Lower Specification Limit, SL_L = 45

Upper Quality Index, $Q_U = \frac{SL_U - \bar{x}}{s} = \frac{65 - 51.4}{5.46} =$ 2.49

Percent Material Within SL_U $P_U =$ 100 (From Table 113.1-1)

(If SL_U is not specified, $P_U = 100$)

Lower Quality Index, $Q_L = \frac{\bar{x} - SL_L}{s} = \frac{51.4 - 45}{5.46} =$ 1.17

Percent Material Within SL_L $P_L =$ 89 (From Table 113.1-1)

(If SL_L is not specified, $P_L = 100$)

Quality Level = Percent Within Specification Limits

$QL = (P_U + P_L) - 100 =$ 100 **+** 89 **-100 =** 89

Pay Factor = PF = 1.03 (From Table 113.1-2)

Minimum Pay Factor = 1.00

Max Pay Factor= 1.00

Pay Adjustment Factor = PAF

= Min Pay Factor - 1.00 = 1.00 **-1.00 =** 0.00

Table 113.1-1

Quality Level Analysis by the Standard Deviation Method

P_U or P_L percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L				
	n = 3	n = 4	n = 5	n = 6	n = 7
100	1.16	1.50	1.79	2.03	2.23
99		1.47	1.67	1.80	1.89
98	1.15	1.44	1.60	1.70	1.76
97		1.41	1.54	1.62	1.67
96	1.14	1.38	1.49	1.55	1.59
95		1.35	1.44	1.49	1.52
94	1.13	1.32	1.39	1.43	1.46
93		1.29	1.35	1.38	1.40
92	1.12	1.26	1.31	1.33	1.35
91	1.11	1.23	1.27	1.29	1.30
90	1.10	1.20	1.23	1.24	1.25
89	1.09	1.17	1.19	1.20	1.20
88	1.07	1.14	1.15	1.16	1.16
87	1.06	1.11	1.12	1.12	1.12
86	1.04	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00
83	1.00	0.99	0.98	0.97	0.97
82	0.97	0.96	0.95	0.94	0.93
81	0.96	0.93	0.91	0.90	0.90
80	0.93	0.90	0.88	0.87	0.86
79	0.91	0.87	0.85	0.84	0.83
78	0.89	0.84	0.82	0.80	0.80
77	0.87	0.81	0.78	0.77	0.76
76	0.84	0.78	0.75	0.74	0.73
75	0.82	0.75	0.72	0.71	0.70
74	0.79	0.72	0.69	0.68	0.67
73	0.76	0.69	0.66	0.65	0.64
72	0.74	0.66	0.63	0.62	0.61
71	0.71	0.63	0.60	0.59	0.58
70	0.68	0.60	0.57	0.56	0.55
69	0.65	0.57	0.54	0.53	0.52
68	0.62	0.54	0.51	0.50	0.49
67	0.59	0.51	0.47	0.47	0.46
66	0.56	0.48	0.45	0.44	0.44

P_U or P_L percent Within Limits for Positive Values of Q_U or Q_L	Upper Quality Index Q_U or Lower Quality Index Q_L				
	n = 3	n = 4	n = 5	n = 6	n = 7
65	0.52	0.45	0.43	0.41	0.41
64	0.49	0.42	0.40	0.39	0.38
63	0.46	0.39	0.37	0.36	0.35
62	0.43	0.36	0.34	0.33	0.32
61	0.39	0.33	0.31	0.30	0.30
60	0.36	0.30	0.28	0.27	0.27
59	0.32	0.27	0.25	0.25	0.24
58	0.29	0.24	0.23	0.22	0.21
57	0.25	0.21	0.20	0.19	0.19
56	0.22	0.18	0.17	0.16	0.16
55	0.18	0.15	0.14	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11
53	0.11	0.09	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00

Table 113.1-2 Pay Factors

Pay Factor	Required Quality Level for a Given Sample Size n and Pay Factor				
	n = 3	n = 4	n = 5	n = 6	n = 7
1.05	100	100	100	100	100
1.04	90	91	92	93	93
1.03	80	85	87	88	89
1.02	75	80	83	85	86
1.01	71	77	80	82	84
1.00	68	74	78	80	81
0.99	66	72	75	77	79
0.98	64	70	73	75	77
0.97	62	68	71	74	75
0.96	60	66	69	72	73
0.95	59	64	68	70	72
0.94	57	63	66	68	70
0.93	56	61	65	67	69
0.92	55	60	63	65	67
0.91	53	58	62	64	66
0.90	52	57	60	63	64
0.89	51	55	59	61	63
0.88	50	54	57	60	62
0.87	48	53	56	58	60
0.86	47	51	55	57	59
0.85	46	50	53	56	58
0.84	45	49	52	55	56
0.83	44	48	51	53	55
0.82	42	46	50	52	54
0.81	41	45	48	51	53
0.80	40	44	47	50	52
0.79	38	43	46	48	50
0.78	37	41	45	47	49
0.77	36	40	43	46	48
0.76	34	39	42	45	47
0.75	33	38	41	44	46

- **Maximum Pay Factor**
  - **Base and Subbase – 1.00**
  - **Treated Base – 1.00**
  - **Plant Mix Pavement – 1.05**
  - **Plant Mix Wearing Course – 1.05**
  - **Seal Coat Aggregate – 1.05**
  - **PCCP – 1.00**

Pay Factor Worksheet - #2

Aggregate Specification: Crushed Base Grading W ____ **Test Value:** #4 ____

Test Results: $n =$ 5

Test Values: 40 45 53 57 62

Average Value: $\bar{x} =$ ____ **Standard Deviation:** $s =$ ____ (σ_{n-1})

Upper Specification Limit, $SL_U =$ ____

Lower Specification Limit, $SL_L =$ ____

Upper Quality Index, $Q_U = \dfrac{SL_U - \bar{x}}{s}$ = ____ = ____

Percent Material Within SL_U $P_U =$ ____ (From Table 113.1-1)

(If SL_U is not specified, $P_U = 100$)

Lower Quality Index, $Q_L = \dfrac{\bar{x} - SL_L}{s}$ = ____ = ____

Percent Material Within SL_L $P_L =$ ____ (From Table 113.1-1)

(If SL_L is not specified, $P_L = 100$)

Quality Level = Percent Within Specification Limits

$QL = (P_U + P_L) - 100 =$ ____ + ____ **-100 =** ____

Pay Factor = PF = ____ (From Table 113.1-2)

Minimum Pay Factor = ____

Max Pay Factor= ____

Pay Adjustment Factor = PAF

= Min Pay Factor - 1.00 = ____ **-1.00 =** ____

Pay Factor Worksheet - #3

Aggregate Specification: Plant Mix Wearing Course **Test Value:** #200

Test Results: $n =$ 5

Test Values: 3.1 4.9 6.7 7.1 5.9

Average Value: $\bar{x} =$ ______ **Standard Deviation:** $s =$ ______ (σ_{n-1})

Upper Specification Limit, $SL_U =$ ______

Lower Specification Limit, $SL_L =$ ______

Upper Quality Index, $Q_U = \dfrac{SL_U - \bar{x}}{s}$ = ______ = ______

Percent Material Within SL_U $P_U =$ ______ (From Table 113.1-1)

(If SL_U is not specified, $P_U = 100$)

Lower Quality Index, $Q_L = \dfrac{\bar{x} - SL_L}{s}$ = ______ = ______

Percent Material Within SL_L $P_L =$ ______ (From Table 113.1-1)

(If SL_L is not specified, $P_L = 100$)

Quality Level = Percent Within Specification Limits

$QL = (P_U + P_L) - 100 =$ ______ + ______ $-100 =$ ______

Pay Factor = PF = ______ (From Table 113.1-2)

Minimum Pay Factor = ______

Max Pay Factor= ______

Pay Adjustment Factor = PAF

= Min Pay Factor - 1.00 = ______ **-1.00 =** ______

Pay Factor

Additional Stipulations

- Lots consist of 3 to 7 samples but usually 5
- Contractor samples – Engineer directs
- Sample size $\geq$ 30 lbs
- PF for lot = lowest PF for any sieve
- Does not apply to 97 – 100 or 95 – 100
- Minimum acceptable PF – 0.75

Pay Factor (continued)

- Reject material removed
- Obviously defective material – rejected and removed
- 2 Consecutive Lots < 1.00 PF – Adjustments
- Contractor may remove and replace to avoid penalty

Pay Factor Calculations

- 100 Tons of Plant Mix Aggregate
- $15.00 per Ton
- Minimum Payment Adjustment Factor
  PAF = +0.02
- Regular Payment =
  (100 Tons)($15.00/Ton) = $1500
- Bonus for Quality Aggregate =
  (+0.02)($1500) = $30.00
- Total Payment = $1530.00

Maximum Pay Factors

- **Base and Subbase – 1.00**
- **Treated Base – 1.00**
- **Plant Mix Pavement – 1.05**
- **Plant Mix Wearing Course – 1.05**
- **Seal Coat Aggregate – 1.05**
- **PCCP – 1.00**