

## Section 106 QUALITY ASSURANCE ACCEPTANCE PROGRAM

**106.01 Quality Assurance Acceptance Program.** The Department's Quality Assurance Acceptance Program uses a statistical evaluation of test results to estimate the percent of a lot which falls within specification limits or tolerances established for each quality index parameter and uses this percent within limits (PWL) to calculate the pay adjustment for each lot. Each material or pay item covered by this acceptance program has its own quality index parameter(s) on which acceptance and payment is based. Refer to specific sections of these standard specifications and to the project documents for details.

**106.02 Lot Size and Make Up.** This procedure requires the acceptance and payment of discrete lots of material or pay items based on the evaluation of test results representing the lot. Prior to beginning any work that is covered by this acceptance procedure, individual lot size and make up shall be agreed upon by the Engineer. As work progresses the Contractor shall assign a unique identification number to each lot to which all quality control and quality assurance test results for the lot must be referenced.

Lot size will normally be as agreed upon. In the event that operational conditions cause work to be interrupted before the lot size has been achieved, the reduced lot shall be added to the previous complete lot, or in the case of the first lot of material placed, added to the next complete lot. This combined lot shall be evaluated using all tests completed on the material in the lot.

**106.03 Quality Index Analysis.** The percentage of each lot within the specification limits established for each quality index parameter will be determined by the following general procedure.

- A. The "n" sampling locations within the lot will be determined by the Engineer using the random sampling procedure outlined in the Materials Quality Assurance Manual.
- B. A measurement will be taken at each location, or a sample collected and the measurement made on the sample portion.
- C. Use Equation 1 to determine the arithmetic mean ( $\bar{x}$ ) of the number ( $n$ ) of test results ( $x_i$ ).

$$\bar{x} = \frac{\sum x_i}{n} \quad \text{Equation 1}$$

- D. Use Equation 2 to compute the standard deviation ( $S$ ) of the test results:

$$S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}} \quad \text{Equation 2}$$

- E. Use Equation 3 and the upper specification limit (USL) to compute the upper quality index ( $Q_U$ ). If an upper specification limit is not specified, the upper percent within limits will be 100.

$$Q_U = \frac{USL - \bar{x}}{S}$$

Equation 3

- F. Use Equation 4 and the lower specification limit (LSL) to compute the lower quality index ( $Q_L$ ). If a lower specification limit is not specified, the lower percent within limits will be 100.

$$Q_L = \frac{\bar{x} - LSL}{S}$$

Equation 4

- G. Estimate the percentage of materials ( $P_U$ ) that will fall within the upper specification limit (USL) by entering Table 106-1 with  $Q_U$ , using the column appropriate to the total number of tests (n). If only an upper specification limit applies,  $P_U$  is the percent within limits (PWL).
- H. Estimate the percentage of materials ( $P_L$ ) that will fall within the lower specification limit (LSL) by entering Table 106-1 with  $Q_L$ , using the column appropriate to the total number of tests (n). If only a lower specification limit applies,  $P_L$  is the percent within limits (PWL).
- I. Determine the quality level stated as Percent Within Limits (PWL) using Equation 5.

$$PWL = (P_U + P_L) - 100 \quad \text{Equation 5}$$

- J. If the percent defective (PD) is required to calculate pay adjustments, Equation 6 is used to calculate this value.

$$PD = 100 - PWL \quad \text{Equation 6}$$

- K. When determining the percentage within specification limits when the calculated Quality Index (Q) value is between two tabular values in Table 106-1 the following procedure is used:
1. The difference between the tabular value on either side of the calculated value (Q) will be determined.
  2. The difference will be divided by 2 and the quotient added to the lower tabular value, resulting in the interpolated Q value.
  3. If the calculated value (Q) is equal to or greater than the interpolated value, the higher listed percent within limits will be used.

4. If the calculated value (Q) is less than the interpolated value, the lower listed percent within limits will be used.
- L. Refer to specific sections of these standard specifications and to the contract documents for any retest provisions and rejection criteria which may apply.

**106.04 Payment.** The related adjustment to the contract price will be determined using the estimated Percent Within Limits (PWL) by the method designated in the appropriate specification section or in the contract documents. On a lot-by-lot basis, the pay adjustment for each material or pay item covered by this procedure shall be computed by the Contractor. All calculations shall be provided by the Contractor to the Engineer for review and approval prior to payment.

Table 106-1 Estimated Percent Within Limits

Q <sub>U</sub> or Q <sub>L</sub>	Percent Within Limits for Given Sample Sizes ( AASHTO R 9 Appendix C) (a)									
	n=1 (b)	n=2 (b)	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
0.05	55.10	51.68	51.38	51.67	51.78	51.84	51.87	51.89	51.91	51.92
0.10	60.20	53.36	52.76	53.33	53.56	53.67	53.74	53.78	53.82	53.84
0.15	65.31	55.03	54.15	55.00	55.33	55.50	55.60	55.67	55.71	55.75
0.20	70.41	56.71	56.54	56.67	57.10	57.32	57.46	57.54	57.60	57.65
0.25	75.51	58.39	56.95	58.33	58.87	59.14	59.30	59.41	59.48	59.53
0.30	80.61	60.07	58.37	60.00	60.63	60.94	61.13	61.25	61.34	61.40
0.35	85.71	61.74	59.80	61.67	62.38	62.73	62.94	63.08	63.18	63.25
0.40	90.82	63.42	61.26	63.33	64.12	64.51	64.74	64.89	65.00	65.07
0.45	95.92	65.10	62.74	65.00	65.84	66.27	66.51	66.67	66.79	66.87
0.50	100.00	66.78	64.25	66.67	67.56	68.00	68.26	68.43	68.55	68.63
0.55	100.00	68.46	65.80	68.33	69.26	69.72	69.99	70.16	70.28	70.36
0.60	100.00	70.13	67.39	70.00	70.95	71.41	71.68	71.85	71.97	72.06
0.65	100.00	71.81	69.03	71.67	72.61	73.08	73.34	73.51	73.63	73.72
0.70	100.00	72.49	70.73	73.33	74.26	74.71	74.97	75.14	75.25	75.33
0.75	100.00	75.17	72.50	75.00	75.89	76.32	76.56	76.72	76.83	76.90
0.80	100.00	76.85	74.36	76.67	77.49	77.89	78.12	78.26	78.36	78.43
0.85	100.00	78.52	76.33	78.33	79.07	79.43	79.63	79.76	79.84	79.90
0.90	100.00	80.20	78.45	80.00	80.62	80.93	81.10	81.21	81.28	81.33
0.95	100.00	81.88	80.75	81.67	82.14	82.39	82.52	82.61	82.67	82.71
1.00	100.00	83.56	83.33	83.33	83.64	83.80	83.90	83.96	84.00	84.03
1.05	100.00	85.23	86.37	85.00	85.09	85.18	85.23	85.26	85.28	85.29
1.10	100.00	86.91	90.16	86.67	86.52	86.50	86.51	86.51	86.51	86.50
1.15	100.00	88.59	97.13	88.33	87.90	87.78	87.73	87.70	87.68	87.66
1.20	100.00	90.27	100.00	90.00	89.24	89.01	88.90	88.83	88.79	88.76
1.25	100.00	91.95	100.00	91.67	90.54	90.19	90.02	89.91	89.85	89.79
1.30	100.00	93.62	100.00	93.33	91.79	91.31	91.07	90.94	90.84	90.78
1.35	100.00	95.30	100.00	95.00	92.98	92.37	92.08	91.90	91.78	91.70
1.40	100.00	96.98	100.00	96.67	94.12	93.37	93.02	92.81	92.67	92.56
1.45	100.00	98.66	100.00	98.33	95.19	94.32	93.90	93.65	93.49	93.37

**Table 106-1 Estimated Percent Within Limits (continued)**

Q <sub>U</sub> or Q <sub>L</sub>	Percent Within Limits for Given Sample Sizes ( AASHTO R 9 Appendix C) (a)									
	n=1 (b)	n=2 (b)	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
1.50	100.00	100.00	100.00	100.00	96.20	95.19	94.72	94.44	94.26	94.13
1.55	100.00	100.00	100.00	100.00	97.13	96.00	95.48	95.17	94.97	94.82
1.60	100.00	100.00	100.00	100.00	97.97	96.75	96.17	95.84	95.62	95.46
1.65	100.00	100.00	100.00	100.00	98.72	97.42	96.81	96.45	96.22	96.05
1.70	100.00	100.00	100.00	100.00	99.34	98.02	97.38	97.01	96.76	96.59
1.75	100.00	100.00	100.00	100.00	99.81	98.55	97.89	97.51	97.25	97.07
1.80	100.00	100.00	100.00	100.00	100.00	98.99	98.35	97.96	97.70	97.51
1.85	100.00	100.00	100.00	100.00	100.00	99.36	98.74	98.35	98.09	97.91
1.90	100.00	100.00	100.00	100.00	100.00	99.65	99.07	98.69	98.44	98.25
1.95	100.00	100.00	100.00	100.00	100.00	99.85	99.35	98.99	98.74	98.56
2.00	100.00	100.00	100.00	100.00	100.00	99.97	99.57	99.24	99.00	98.83
2.05	100.00	100.00	100.00	100.00	100.00	100.00	99.74	99.45	99.23	99.06
2.10	100.00	100.00	100.00	100.00	100.00	100.00	99.86	99.61	99.41	99.26
2.15	100.00	100.00	100.00	100.00	100.00	100.00	99.94	99.74	99.57	99.42
2.20	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.84	99.69	99.56
2.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.91	99.79	99.68
2.30	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.96	99.86	99.77
2.35	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.92	99.84
2.40	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.95	99.89
2.45	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.93
2.50	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.96
2.55	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.60	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.65	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

a. Numbers in the body of this table are estimates of percent within limits (PWL) corresponding to specific values of Q, the quality index. For Q values less than zero, subtract the table value from 100.

b. Table values for n values of 1 and 2 are empirically derived. All other values are from AASHTO R9.