Section 39 QC/QA STG Meeting

Group Memory

March 17, 2015

39-4 QUALITY CONTROL/QUALITY ASSURANCE CONSTRUCTION PROCESS

39-4.01 GENERAL

Section 39-4 includes specifications for HMA produced and constructed under the Quality Control / Quality Assurance construction process.

The QC/QA construction process consists of:

1. Establishing, maintaining, and changing if needed a quality control system providing assurance the HMA complies with the specifications
2. Sampling and testing at specified intervals, or sublots, to demonstrate compliance and to control the process
3. Department sampling and testing at specified intervals to verify the testing process and HMA quality
4. Engineer using test results, statistical evaluation of verified quality control tests, and inspection to accept HMA for payment

A lot is a quantity of HMA. The Engineer designates a new lot when:

1. 20 sublots are complete
2. JMF changes
3. Production stops for more than 30 days

(Feb 25, 2015) Industry comment: Should we revise this requirement?

(Feb 28, 2015) CT comment: If you stop production for longer than 30 days, a production start-up evaluation is required.

(March 17, 2015) CT/Industry comment: change “30” to “45”

Each lot consists of no more than 20 sublots. A sublot is 750 tons, except a quantity of HMA paved at day's end greater than 250 tons is a sublot. If a quantity of HMA paved at day's end is less than 250 tons, you may either make this quantity a sublot or include it in the previous sublot's test results for statistical evaluation.

39-4.02 CONTRACTOR QUALITY CONTROL

39-4.02A General

Use a composite quality factor, QF_C, and individual quality factors, QF_{QCi}, to control your process and evaluate the quality control program. For quality characteristics without quality factors, use your QC plan's action limits to control your process.

Control HMA quality including:

1. Materials
2. Proportioning
3. Spreading and compacting
4. Finished roadway surface (what does this entail can we regulate?)

Develop, implement, and maintain a quality control program that includes:

1. Inspection (should this say plant and field inspection?)
2. Sampling
3. Testing

39-4.02B Quality Control Plan

With the JMF submittal, submit a QC plan. The QC plan must comply with the Department's *Quality Control Manual for Hot Mix Asphalt Production and Placement*. Discuss the QC plan with the Engineer during the prepaving conference.

The Engineer reviews each QC plan within 5 business days from the submittal. Do not produce HMA until the Engineer authorizes the QC plan.

The QC plan must include the name and qualifications of a QC manager. The QC manager administers the QC plan and during paving must be at the job site within 3 hours of receiving notice. The QC manager must not be any of the following on the project:

(Feb 25, 2015) Industry comment: Can we have a QC Manager have a designated assistant? Let's look at having two sets of requirements for "standard" and QC/QA.

(Feb 28, 2015) CT comment: Is designated qualified and authorized to perform QC Manager's functions as described in the QC/QA manual?

(March 17, 2015) CT/Industry comment: List alternate in the QC Plan. Alternate must "qualified and authorized to perform QC Manager's functions as described in the QC/QA manual".

(March 17, 2015) Industry comment: One guy on the field one guy in the plant for projects greater than 2000 tons. Must follows new (to be created) "standard" QC manual.

1. Foreman
2. Production or paving crewmember
3. Inspector
4. Tester

The QC plan must include action limits and details of corrective action you will take if a test result for any quality characteristic falls outside an action limit.

As work progresses, you must submit a QC plan supplement to change quality control procedures, personnel, tester qualification status, or laboratory accreditation status.

39-4.02C Quality Control Inspection, Sampling, and Testing

Sample, test, inspect, and manage HMA quality control.

Provide a roadway inspector while HMA paving activities are in progress. Provide a plant inspector during HMA production.

Inspectors must comply with the Department's *Quality Control Manual for Hot Mix Asphalt Production and Placement*.

Provide a testing laboratory and personnel for quality control testing. Provide the Engineer unrestricted access to the quality control activities. Before providing services for the project, the Engineer reviews, accredits, and qualifies the testing laboratory and personnel under the Department's Independent Assurance Program.

For HMA at production start-up and every 5,000 tons (10,000?), sample and test under California Test 371 (AASHTO T 283) Submit the test results to the Engineer and to:

Moisture_Tests@dot.ca.gov

(Feb 25, 2015) Industry comment: Should this be removed?

(Feb 28, 2015) CT comment: Yes. Modify to AASHTO T 283 for spec compliance.

(Feb 28, 2015) CT comment: Test frequency for Hamburg and moisture should be every 10,000 tons

(Feb 25, 2015) Industry comment: We need to review 371 data to determine the need for continued use of CT 371.

(Feb 28, 2015) CT comment: Test frequency for hamburg and moisture should be every 10,000 tons

(Feb 28, 2015) CT comment: Audrie is tracking all Superpave projects. We can look at those available test results.

(March 17, 2015): Industry/CT comment: Continue to monitor Hamburg and T 283. Continue to collect enough data/info to make a decision.

For HMA at production start-up and once during production, submit samples split from your HMA production sample for California Test 371 (AASHTO T 283) to the Engineer and the Transportation Laboratory, Attention: Moisture Test.

The Department does not use results from California Test 371 to determine specification compliance.

(Feb 25, 2015) Industry comment: Should this be removed?

(Feb 28, 2015) CT comment: Yes. No 371 anymore. Now we run T 283 for spec compliance.

Comply with the values for the HMA quality characteristics and minimum random sampling and testing for quality control shown in the following table:

(Feb 25, 2015) Industry comment: Replace table with superpave Section 39 and modify as necessary.

Minimum Quality Control—QC/QA Construction Process

Quality characteristic	Test method	Minimum sampling and testing frequency	HMA Type			Location of sampling	Maxi-mum report-ing time allow-ance
			A	B	RHMA-G		
Aggregate gradation[a]	California Test 202	1 per 750 tons	JMF ± tolerance [b]	JMF ± tolerance [b]	JMF ± tolerance [b]	California Test 125	24 hours
Asphalt binder content (%)	California Test 379 or 382		JMF ±0.45	JMF ±0.45	JMF ±0.50	Loose mix behind paver See California Test 125	
Percent of maximum theoretical density (%)[c,d]	QC plan		92–96	92–96	91–96	QC plan	
Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants[e]	California Test 226 or 370	2 per day during production	--	--	--	Stock-piles or cold feed belts	--
Sand equivalent (min) [f]	California Test 217	1 per 750 tons	47	42	47	California Test 125	24 hours
HMA moisture content (%,max)	California Test 226 or 370	1 per 2,500 tons but not less than 1 per paving day	1.0	1.0	1.0	Loose Mix Behind Paver See California Test 125	24 hours
Stabilometer value (min)[f,g] No. 4 and 3/8" gradings 1/2" and 3/4" gradings	California Test 366	1 per 4,000 tons or 2 per 5 business days, whichever is greater	30 37	30 35	-- 23		48 hours
Air void content (%)[f,h]	California Test 367		4 ± 2	4 ± 2	TV ± 2		

Percent of crushed particles coarse aggregate (% min.): One fractured face Two fractured faces Fine aggregate (% min) (Passing no. 4 sieve and retained on no. 8 sieve.): One fractured face	California Test 205	As design-ated in QC plan. At least once per project.	90 75 70	25 -- 20	-- 90 70	California Test 125	48 hours
Los Angeles Rattler (% max): Loss at 100 rev. Loss at 500 rev.	California Test 211		12 45	-- 50	12 40	California Test 125	
Fine aggregate angularity (% min)	California Test 234		45	45	45	California Test 125	
Flat and elongated particle (% max by weight @ 5:1)	California Test 235		Report only	Report only	Report only	California Test 125	
Voids filled with asphalt (%) [i]: No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	Report only	California Test 367	
Voids in mineral aggregate (% min.) [i]: No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		17.0 15.0 14.0 13.0	17.0 15.0 14.0 13.0	-- -- 18.0–23.0[j] 18.0–23.0[j]	California Test 367	

Dust proportion [i]: No. 4 and 3/8" gradings 1/2" and 3/4" gradings	California Test 367		0.9–2.0 0.6–1.3	0.9–2.0 0.6–1.3	Report only	California Test 367	
Smoothness	Section 39-1.12	--	12-foot straight-edge, must-grind, and PI_0	12-foot straight-edge, must-grind, and PI_0	12-foot straight-edge, must-grind, and PI_0	--	
Asphalt rubber binder viscosity @ 350 °F, centipoises	Section 39-1.02D	--	--	--	1,500–4,000	Section 39-1.02D	24 hours
CRM	Section 39-1.02D	--	--	--	Section 39-1.02D	Section 39-1.02D	48 hours

[a] Determine combined aggregate gradation containing RAP under California Test 367.
[b] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[c] Required for HMA Type A, Type B, and RHMA-G if the specified paved thickness is at least 0.15 foot.
[d] Determine maximum theoretical density (California Test 309) at the frequency specified for test maximum density under California Test 375, Part 5 D.
[e] For adjusting the plant controller at the HMA plant.
[f] Report the average of 3 tests from a single split sample.
[g] California Test 304, Part 2.13.
[h] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

Within the specified reporting time, submit test results including:

1. Sampling location, quantity, and time
2. Testing results
3. Supporting data and calculations

If test results for any quality characteristic are beyond the action limits in the QC plan, take corrective actions. Document the corrective actions taken in the inspection records under section 39-4.02E.

Stop production, notify the Engineer, take corrective action, and demonstrate compliance with the specifications before resuming production and placement if:

(Feb 25, 2015 Industry comment: May require hot drop or production start-up. Is this problematic?

(Feb 28, 2015) CT comment: What is the purpose of continuing production when materials are clearly failing?.

(March 17, 2015) Action Item: Al and Tim to propose alternative language.

1. A lot's composite quality factor, QF_C, or an individual quality factor, QF_{QCi} for i = 3, 4, or 5, is below 0.90 determined under section 39-4.02F using quality control data
2. An individual quality factor, QF_{QCi} for i = 1 or 2, is below 0.75 using quality control data
3. Quality characteristics for which a quality factor, QF_{QCi}, is not determined has 2 consecutive quality control tests not in compliance with the specifications

39-4.02D Charts and Records

Record sampling and testing results for quality control on forms provided in the *Quality Control Manual for Hot Mix Asphalt Production and Placement*, or on forms you submit with the QC plan. The QC plan must also include posting locations and submittal times for forms.

Submit quality control test results using the Department's statistical evaluation program, HMAPay. For HMAPay, go to the Department's Construction Web site.

(Feb 25, 2015) Industry comment: For ease of use and consistency consider specifying specific software to be provided by the contractor for use by Caltrans and Contractor. This requirement would be similar to the requirement to provide Primavera P6 software for all CT projects. Primavera is paid for as a lump sum bid item.

(March 17, 2015) Action Item: Tony to provide Primavera software language. (Done!!) Legal problem for CT? key language change from the first and second memo seems to be "or its equivalent"

39-4.02E Records of Inspection and Testing

During HMA production, submit a daily:

1. *HMA Construction Daily Record of Inspection*. Also make this record available at the HMA plant and job site each day.
2. *HMA Inspection and Testing Summary*. Include in the summary:
   - 2.1. QC worksheet with updated test results from the HMAPay program
   - 2.2. Test forms with the testers' signatures and QC manager's initials
   - 2.3. Inspection forms with the inspectors' signatures and QC manager's initials
   - 2.4. List and explanation of deviations from the specifications or regular practices
   - 2.5. Signed statement by the QC manager that says:

     "It is hereby certified that the information contained in this record is accurate, and that information, tests, or calculations documented herein comply with the specifications of the Contract and the standards set forth in the testing procedures. Exceptions to this certification are documented as part of this record."

Retain for inspection the records generated as part of quality control, including inspection, sampling, and testing for at least 3 years after final acceptance.

39-4.02F Statistical Evaluation

39-4.02F(1) General

Determine a lot's composite quality factor, QF_C, and the individual quality factors, QF_{QCi}. Perform statistical evaluation calculations to determine these quality factors based on quality control test results for:

1. Aggregate gradation (action/suspension?)
2. Asphalt binder content
3. Percent of maximum theoretical density

(Feb 25, 2015) Industry comment: Do we want to add any other Quality Characteristics here? IRI Smoothness?

(Feb 25, 2015) Industry comment: Should gradation become an action/suspension limit item and replaced with an air voids pay item?

(Feb 28, 2015) CT comment: CT is looking at keeping #200 (if not then DP)

The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, QF_{QC5}, for HMA paved in:

1. Areas where the total paved thickness is less than 0.15 foot

2. Areas where the total paved thickness is less than 0.20 foot and 3/4-inch grading is specified and used
3. Dig outs
4. Leveling courses
5. Areas where compaction or compaction measurement by conventional methods is impeded

(Feb 25, 2015) Industry comment: possible language to “areas where method specification for density is required”

(Feb 28, 2015) CT comment: OE will not opposed “ambiguous” term ie: what are these area?

39-4.02F(2) Statistical Evaluation Calculations

Use the Variability-Unknown / Standard Deviation Method to determine the percentage of a lot not in compliance with the specifications.

Determine the percentage of work not in compliance with the specification limits for each quality characteristic as follows:

1. Calculate the arithmetic mean ($\overline{X}$) of the test values

$$\overline{X} = \frac{\Sigma x}{n}$$

where:

x = individual test values
n = number of test values

2. Calculate the standard deviation

$$s = \sqrt{\frac{n\,(\Sigma x^2)-(\Sigma x)^2}{n(n-1)}}$$

where:

$\sum(x^2)$ = sum of the squares of individual test values
$(\sum x)^2$ = sum of the individual test values squared
n = number of test values

3. Calculate the upper quality index (Qu)

$$Q_u = \frac{USL - \overline{X}}{s}$$

where:

USL = TV plus the production tolerance or upper specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

4. Calculate the lower quality index (QL);

$$Q_L = \frac{\overline{X} - LSL}{s}$$

where:

LSL = TV minus production tolerance or lower specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

5. From the table, Upper Quality Index Q_U or Lower Quality Index Q_L, determine P_U ;

where:

P_U = estimated percentage of work outside the USL
P_U = 0, if USL is not specified

6. From the table, Upper Quality Index Q_U or Lower Quality Index Q_L, determine P_L;

where:

P_L = estimated percentage of work outside the LSL
P_L = 0, if LSL is not specified

7. Calculate the total estimated percentage of work outside the USL and LSL, percent defective

Percent defective = PU + PL

The P_U and P_L are determined from the following:

P_U or P_L	**Upper Quality Index Q_U or Lower Quality Index Q_L**												
	Sample Size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
0	1.72	1.88	1.99	2.07	2.13	2.20	2.28	2.34	2.39	2.44	2.48	2.51	2.56
1	1.64	1.75	1.82	1.88	1.91	1.96	2.01	2.04	2.07	2.09	2.12	2.14	2.16
2	1.58	1.66	1.72	1.75	1.78	1.81	1.84	1.87	1.89	1.91	1.93	1.94	1.95
3	1.52	1.59	1.63	1.66	1.68	1.71	1.73	1.75	1.76	1.78	1.79	1.80	1.81
4	1.47	1.52	1.56	1.58	1.60	1.62	1.64	1.65	1.66	1.67	1.68	1.69	1.70
5	1.42	1.47	1.49	1.51	1.52	1.54	1.55	1.56	1.57	1.58	1.59	1.59	1.60
6	1.38	1.41	1.43	1.45	1.46	1.47	1.48	1.49	1.50	1.50	1.51	1.51	1.52
7	1.33	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43	1.43	1.44	1.44	1.44
8	1.29	1.31	1.33	1.33	1.34	1.35	1.35	1.36	1.36	1.37	1.37	1.37	1.38
9	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.31	1.31	1.31	1.31
10	1.21	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.26	1.26
11	1.18	1.18	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20
12	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
13	1.10	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11
14	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
15	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
17	0.97	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
18	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90
19	0.90	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
20	0.87	0.86	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83
21	0.84	0.82	0.82	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.79
22	0.81	0.79	0.79	0.78	0.78	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76
23	0.77	0.76	0.75	0.75	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
24	0.74	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.70	0.70
25	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.66
26	0.68	0.67	0.67	0.65	0.65	0.65	0.64	0.64	0.64	0.64	0.64	0.64	0.63
27	0.65	0.64	0.63	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.60
28	0.62	0.61	0.60	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.58	0.58	0.57
29	0.59	0.58	0.57	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.54
30	0.56	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52
31	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49
32	0.50	0.49	0.48	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46
33	0.47	0.48	0.45	0.45	0.45	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.43
34	0.45	0.43	0.43	0.42	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.40
35	0.42	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38	0.38
36	0.39	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
37	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.32
38	0.33	0.32	0.32	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
39	0.30	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
40	0.28	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
41	0.25	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
42	0.23	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
43	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
44	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
45	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
46	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
47	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
48	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
49	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NOTES:

1. If the value of Q_U or Q_L does not correspond to a value in the table, use the next lower value.
2. If Q_U or Q_L are negative values, P_U or P_L is equal to 100 minus the table value for P_U or P_L.

(revisit rounding question or increasing maximum pay factor)

39-4.02F(3) Quality Factor Determination

Determine individual quality factors, QF_{QCi}, using percent defective = $P_U + P_L$ and the following:

Quality Factors

Quality factor	Maximum allowable percent defective ($P_U + P_L$)												
	Sample size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
1.05				0	0	0	0	0	0	0	0	0	0
1.04			0	1	3	5	4	4	4	3	3	3	3
1.03		0	2	4	6	8	7	7	6	5	5	4	4
1.02		1	3	6	9	11	10	9	8	7	7	6	6
1.01	0	2	5	8	11	13	12	11	10	9	8	8	7
1.00	22	20	18	17	16	15	14	13	12	11	10	9	8
0.99	24	22	20	19	18	17	16	15	14	13	11	10	9
0.98	26	24	22	21	20	19	18	16	15	14	13	12	10
0.97	28	26	24	23	22	21	19	18	17	16	14	13	12
0.96	30	28	26	25	24	22	21	19	18	17	16	14	13
0.95	32	29	28	26	25	24	22	21	20	18	17	16	14
0.94	33	31	29	28	27	25	24	22	21	20	18	17	15
0.93	35	33	31	29	28	27	25	24	22	21	20	18	16
0.92	37	34	32	31	30	28	27	25	24	22	21	19	18
0.91	38	36	34	32	31	30	28	26	25	24	22	21	19
0.90	39	37	35	34	33	31	29	28	26	25	23	22	20
0.89	41	38	37	35	34	32	31	29	28	26	25	23	21
0.88	42	40	38	36	35	34	32	30	29	27	26	24	22
0.87	43	41	39	38	37	35	33	32	30	29	27	25	23
0.86	45	42	41	39	38	36	34	33	31	30	28	26	24
0.85	46	44	42	40	39	38	36	34	33	31	29	28	25
0.84	47	45	43	42	40	39	37	35	34	32	30	29	27
0.83	49	46	44	43	42	40	38	36	35	33	31	30	28
0.82	50	47	46	44	43	41	39	38	36	34	33	31	29
0.81	51	49	47	45	44	42	41	39	37	36	34	32	30
0.80	52	50	48	46	45	44	42	40	38	37	35	33	31
0.79	54	51	49	48	46	45	43	41	39	38	36	34	32
0.78	55	52	50	49	48	46	44	42	41	39	37	35	33
0.77	56	54	52	50	49	47	45	43	42	40	38	36	34
0.76	57	55	53	51	50	48	46	44	43	41	39	37	35
0.75	58	56	54	52	51	49	47	46	44	42	40	38	36
Reject	60	57	55	53	52	51	48	47	45	43	41	40	37
	61	58	56	55	53	52	50	48	46	44	43	41	38
	62	59	57	56	54	53	51	49	47	45	44	42	39
	63	61	58	57	55	54	52	50	48	47	45	43	40
	64	62	60	58	57	55	53	51	49	48	46	44	41
Reject values greater than those shown above													

NOTE: To obtain a quality factor if the estimated percent outside specification limits from table titled, "Upper Quality Index Q_U or Lower Quality Index Q_L," does not correspond to a value in the table, use the next larger value.

Compute the composite of single quality factors, QF_C, for a lot using:

$$QF_C = \sum_{i=1}^{5} w_i \, QF_{QC_i}$$

where:

QF_C = the composite quality factor for the lot rounded to 2 decimal places

QF_{QCi} = the quality factor for the individual quality characteristic
w = the weighting factor listed in the table titled "HMA Acceptance – QC/QA Construction Process"
i = the quality characteristic index number in the table titled "HMA Acceptance – QC/QA Construction Process"

39-4.03 QUALITY ASSURANCE

39-4.03A General

The Department assures quality by:

1. Reviewing mix designs and proposed JMF
2. Inspecting procedures
3. Conducting oversight of quality control inspection and records
4. Verification sampling and testing during production and paving

39-4.03B Verification Sampling and Testing

39-4.03B(1) General

The Department samples:

1. Aggregate to verify gradation
2. HMA to verify asphalt binder content

(Feb 25, 2015) Industry comment: May need to add language to address smoothness or other Quality Characteristics

39-4.03B(2) Verification

For aggregate gradation and asphalt binder content, the ratio of verification testing frequency to the minimum quality control testing frequency is 1:5. The Department performs at least 3 verification tests per lot.

Using the t-test, the Engineer compares quality control tests results for aggregate gradation and asphalt binder content with corresponding verification test results. The Engineer uses the average and standard deviation of up to 20 sequential sublots for the comparison. The Engineer uses production start-up evaluation tests to represent the 1st sublot. If there are less than 20 sequential sublots, the Engineer uses the maximum number of sequential sublots available. The 21st sublot becomes the 1st sublot (n = 1) in the next lot.

The t-value for a group of test data is computed as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \qquad \text{and} \qquad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

n_c = Number of quality control tests (2 min, 20 max).
n_v = Number of verification tests (min of 1 required).
$\overline{X}_c$ = Mean of quality control tests.
$\overline{X}_v$ = Mean of verification tests.
S_p = Pooled standard deviation (when $n_v = 1$, $S_p = S_c$).
S_c = Standard deviation of quality control tests.
S_v = Standard deviation of verification tests (when $n_v > 1$).

The comparison of quality control test results and the verification test results is at a level of significance of α = 0.025. The Engineer computes t and compares it to the following critical t-values, t_{crit}:

Critical T-Value

Degrees of freedom (n_c+n_v-2)	t_{crit} (for α = 0.025)	Degrees of freedom (n_c+n_v-2)	t_{crit} (for α = 0.025)
1	24.452	18	2.445
2	6.205	19	2.433
3	4.177	20	2.423
4	3.495	21	2.414
5	3.163	22	2.405
6	2.969	23	2.398
7	2.841	24	2.391
8	2.752	25	2.385
9	2.685	26	2.379
10	2.634	27	2.373
11	2.593	28	2.368
12	2.560	29	2.364
13	2.533	30	2.360
14	2.510	40	2.329
15	2.490	60	2.299
16	2.473	120	2.270
17	2.458	∞	2.241

If the t-value computed is less than or equal to t_{crit}, quality control test results are verified.

If the t-value computed is greater than t_{crit} and both $\overline{X}_v$ and $\overline{X}_c$ comply with acceptance specifications, the quality control tests are verified. You may continue to produce and place HMA with the following allowable differences:

1. $\left|\overline{X}_v - \overline{X}_c\right|$ ≤ 1.0 percent for any grading
2. $\left|\overline{X}_v - \overline{X}_c\right|$ ≤ 0.1 percent for asphalt binder content

If the t-value computed is greater than t_{crit} and the $\left|\overline{X}_v - \overline{X}_c\right|$ for grading and asphalt binder content are greater than the allowable differences, quality control test results are not verified and:

1. Engineer notifies you.
2. You and the Engineer must investigate why the difference exists.
3. If the reason for the difference cannot be found and corrected, the Department's test results are used for acceptance and pay.

(Feb 25, 2015) Industry comment: Should we include an option for the contractor to use the Engineers test results and pay factor rather than go into dispute resolution testing?

(Feb 28, 2015) CT comment: If contractor tests are not verified per FHWA contractor test results cannot be used for acceptance/payment. The only data acceptable to FHWA are Engineer tests. .

39-4.04 ACCEPTANCE CRITERIA

39-4.04A Testing

The Engineer samples for acceptance testing and tests for the following quality characteristics:

(Feb 25, 2015) Industry comment: Replace table with superpave Section 39 and modify as necessary

HMA Acceptance—QC/QA Construction Process

Index (i)	Quality characteristic				Weight-ing factor (w)	Test method	HMA type		
							A	B	RHMA-G
		Aggregate gradation [a]							
	Sieve	3/4"	1/2"	3/8"					
1	1/2"	X [b]	--	--	0.05	California Test 202	JMF ± Tolerance [c]		
1	3/8"	--	X	--	0.05				
1	No. 4	--	--	X	0.05				
2	No. 8	X	X	X	0.10				
3	No. 200	X	X	X	0.15				
4	Asphalt binder content (%)				0.30	California Test 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.5
5	Percent of maximum theoretical density (%) [d, e]				0.40	California Test 375	92–96	92–96	91–96
	Sand equivalent (min) [f]					California Test 217	47	42	47
	Stabilometer value (min) [f,g] No. 4 and 3/8" gradings 1/2" and 3/4" gradings					California Test 366	 30 37	 30 35	 -- 23
	Air void content (%)[f, h]					California Test 367	4 ± 2	4 ± 2	TV ± 2
	Percent of crushed particles coarse aggregate (% min) One fractured face Two fractured faces Fine aggregate (% min) (Passing No. 4 sieve and retained on No. 8 sieve.) One fractured face					California Test 205	 90 75 70	 25 -- 20	 -- 90 70
	HMA moisture content (%, max)					California Test 226 or 370	1.0	1.0	1.0
	Los Angeles Rattler (% max) Loss at 100 rev. Loss at 500 rev.					California Test 211	 12 45	 -- 50	 12 40
	Fine aggregate angularity (% min)					California Test 234	45	45	45
	Flat and elongated particle (% max by weight @ 5:1)					California Test 235	Report only	Report only	Report only
	Voids in mineral aggregate (% min) [i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading					California Test 367	 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	(Note j) -- -- 18.0–23.0 18.0–23.0

	Voids filled with asphalt (%) [i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading		California Test 367	76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	Report only
	Dust proportion [i] No. 4 and 3/8" gradings 1/2" and 3/4" gradings		California Test 367	0.9–2.0 0.6–1.3	0.9–2.0 0.6–1.3	Report only
	Smoothness		Section 39-1.12	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0
	Asphalt binder		Various	Section 92	Section 92	Section 92
	Asphalt rubber binder		Various	--	--	Section 92-1.01D(2) and section 39-1.02D
	Asphalt modifier		Various	--	--	Section 39-1.02D
	CRM		Various	--	--	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under California Test 367.
[b] "X" denotes the sieves the Engineer tests for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[d] The Engineer determines percent of maximum theoretical density if the specified total paved thickness is at least 0.15 foot under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each density core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[e] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] The Engineer reports the average of 3 tests from a single split sample.
[g] California Test 304, Part 2.13.
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

The Department determines the percent of maximum theoretical density from the average density of 3 density cores you take from every 750 tons of production or part thereof divided by the maximum theoretical density.

(Feb 25, 2015) Caltrans comment: Should we combine QC and QA test results?

(Feb 28, 2015) CT comment: FHWA is OK with using both QC and QA test results. FHWA require Engineer to verify QC test results first.

If the specified total paved thickness is at least 0.15 foot and any layer is less than 0.15 foot, the Department determines the percent of maximum theoretical density from density cores taken from the final layer measured the full depth of the total paved HMA thickness.

The Engineer calculates QF_{QCi} for i = 1, 2, 3, and 4 using quality control data and QF_{QCi} for i = 5 using quality assurance data,

The Engineer stops production and terminates a lot if:

1. A lot's composite quality factor, QF_C, or an individual quality factor, QF_{QCi} for i = 3, 4, or 5, is below 0.90 determined under section 39-4.02F
2. An individual quality factor, QF_{QCi} for i = 1 or 2, is below 0.75
3. Quality characteristics for which a quality factor, QF_{QCi}, is not determined has 2 consecutive acceptance or quality control test results not in compliance with the specifications.

(Feb 25, 2015) Industry comment: should we remove the requirement to terminate the lot?

(Feb 28, 2015) CT comment: Need to add “3 tests in one day" condition.

For any single quality characteristic for which a quality factor, QF_{QCi}, is not determined, except smoothness, if 2 consecutive acceptance test results do not comply with specifications:

1. Stop production.
2. Take corrective action.
3. Take samples and split each sample into 4 parts in the Engineer's presence. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Department tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement.

(Feb 25, 2015) Industry comment: Is the material subject to rejection or is the penalty the contractor having to stop work. If this occurred on a pay factor quality characteristic would the material be allowed to remain in place? What if this happened on HWT, it is a critical item but does not have a pay factor.

(Feb 28, 2015) Caltrans comment: Caltrans would treat these quality characteristics (where quality factor is not determined) exactly the same way they are treated in the “standard” Superpave Section 39.

39-4.04B Statistical Evaluation, Determination of Quality Factors, and Acceptance

39-4.04B(1) Statistical Evaluation and Determination of Quality Factors

To determine the individual quality factor, $QF_{QCi,}$ for any quality factor i = 1 through 5 or a lot's composite quality factor, QF_C, for acceptance and payment adjustment, the Engineer uses the evaluation specifications under section 39-4.02F and the following:

1. Verified quality control test results for aggregate gradation
2. Verified quality control test results for asphalt binder content
3. Department's test results for percent of maximum theoretical density

39-4.04B(2) Lot Acceptance Based on Quality Factors

The Engineer accepts a lot based on the quality factors determined for aggregate gradation and asphalt binder content, QF_{QCi} for i = 1 through 4, using the total number of verified quality control test result values and the total percent defective ($P_U + P_L$).

The Engineer accepts a lot based on the quality factor determined for maximum theoretical density, QF_{QC5}, using the total number of test result values from cores and the total percent defective ($P_U + P_L$).

The Engineer calculates the quality factor for the lot, QF_C, which is a composite of weighted individual quality factors, QF_{QCi}, determined for each quality characteristic in the HMA Acceptance – QC/QA table in section 39-4.04A.

The Engineer accepts a lot based on quality factors if:

1. Current composite quality factor, QF_C, is 0.90 or greater
2. Each individual quality factor, QF_{QCi} for i = 3, 4, and 5, is 0.90 or greater
3. Each individual quality factor, QF_{QCi} for i = 1 and 2, is 0.75 or greater

No single quality characteristic test may represent more than 750 tons or 1 day's production, whichever is less.

39-4.04B(3) Payment Adjustment

If a lot is accepted, the Engineer adjusts payment with the following formula:

$$PA = \sum_{i=1}^{n} HMACP * wi * \left[QF_{QCi} * (HMATT - WHMATTi) + WHMATTi\right] - \left(HMACP * HMATT\right)$$

where:

PA =	payment adjustment rounded to 2 decimal places
HMACP =	HMA Contract price
HMATT =	HMA total tons represented in the lot
$WHMATT_i$ =	total tons of waived quality characteristic HMA
QF_{QCi} =	running quality factor for the individual quality characteristic
	QF_{QCi} for i = 1 through 4 must be from verified Contractor's QC results. QF_{QC5} must be determined from the Engineer's results on density cores taken for percent of maximum theoretical density determination.
w =	weighting factor listed in the HMA acceptance table
i =	quality characteristic index number in the HMA acceptance table

If the payment adjustment is a negative value, the Engineer deducts this amount from payment. If the payment adjustment is a positive value, the Engineer adds this amount to payment.

The 21st sublot becomes the 1st sublot (n = 1) in the next lot. If the 21st sequential sublot becomes the 1st sublot, the previous 20 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 8 sublots, these sublots must be added to the previous lot for quality factor determination using 21 to 27 sublots.

(Feb 25, 2015) Caltrans comment: Should we be using rolling 20?

(Feb 28, 2015) Caltrans comment: No rolling if QFQC is used to determine pay for the lot. Rolling if QFQC is used to "stop production and terminate the lot."

(Feb 25, 2015) Caltrans comment: After QC data verification should we combining QC and QA data for to determine pay factor? Need to check with FHWA to see if this would be acceptable. Industry needs to weigh in on this as well.

(Feb 28, 2015) Caltrans comment: According to FHWA, verification of QC data is an essential component. Payment is dictated by the agency. Agency can elect to base 100% payment on QA test. Caltrans proposed combining QC and QA test data only if the data verified. If data does not verified, Caltrans would use only QA data.

39-4.04C Dispute Resolution

For a lot, if you or the Engineer dispute any quality factor, QF_{QCi}, or verification test result, every sublot in that lot must be retested.

Referee tests must be performed under the specifications for acceptance testing.

Any quality factor, QF_{QCi}, must be determined using the referee tests.

For any quality factor, QF_{QCi}, for i = 1 through 5, dispute resolution:

1. If the difference between the quality factors for QF_{QCi} using the referee test result and the disputed test result is less than or equal to 0.01, the original test result is correct

2. If the difference between the quality factor for QF_{QCi} using the referee test result and the disputed test result is more than 0.01, the quality factor determined from the referee tests supersedes the previously determined quality factor

(Feb 25, 2015) Industry comment: Look at adding requirements allowing the contractor to review the Engineers testing laboratory operations in an effort to resolve differences in test results at the lowest possible level.

(Feb 28, 2015) CT comment: CT recommends that CT IA personnel review Contractor/Engineer testing in the presence of Engineer/Contractor.

(March 17, 2015) Action Item: Industry question: “Industry would like access to Engineer’s lab to resolve difference in test results (prior to formal dispute).