



REFERENCE SAMPLE PROGRAM

**METHOD OF TEST FOR
DETERMINING THEORETICAL
MAXIMUM SPECIFIC GRAVITY AND
DENSITY OF HOT MIX ASPHALT**

2014 PROFICIENCY TEST RESULTS

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1.0 OVERVIEW

In mid-2014, the proficiency test for determining theoretical maximum specific gravity and density of hot mix asphalt was initiated. This proficiency test was based on a California Test (CT) method, CT 309 “Method of Test for Determining Theoretical Maximum (RICE) Specific Gravity and Density of Hot Mix Asphalt.” Each set of proficiency samples have a known asphalt content and aggregate gradation in order to minimize sample variability.

The Rice specific gravity test determines values for percent air voids in compacted HMA, establishes target values for compacting HMA, and determines the amount of binder absorbed by the individual aggregate particles in HMA.

The proficiency samples were prepared in accordance with CT 304 “Preparation of Hot Mix Asphalt for test Specimens.” The target sample mass was 2500 grams using ¾-inch nominal aggregate size with five percent asphalt binder content. The sample size was selected based on expected sample mass variance and the CT 309 minimum HMA sample size of 2000 grams for ¾-inch aggregate. The materials used in these proficiency test samples originated from a single source to maintain uniformity and minimize variability.

The premise of the Rice specific gravity test was to determine the participating laboratories’ proficiency in conducting the test, suitability of their test equipment, and their ability to achieve statistically satisfactory results.

The participants for this round of proficiency testing were 178 laboratories including private, local agency, and Caltrans laboratories.

In determining rating scores, statistical analysis was conducted on the combined data set excluding one outlier, and four results that were submitted late. The statistical analysis result was used as the basis for the proficiency scores.

2.0 ANALYSIS OF TEST RESULTS

2.1 EVALUATION CRITERIA

Test results were analyzed using a statistical evaluation system in which the mean (X) and standard deviation (s) were calculated. A rating score was then given to the test results based on the criteria shown in Table 1. A test result with a score of 3 or greater was considered acceptable. A test result with a score of 2 or less was considered unacceptable and a retest was required.

Table 1: Evaluation Criteria

Test Result	Rating	Interpretation of Results	Acceptance
$X \pm 1.0s$	5	Very Good	Acceptable
$X \pm 1.5s$	4	Good	
$X \pm 2.0s$	3	Fair	
$X \pm 2.5s$	2	Poor	Unacceptable
$X \pm 3.0s$	1	Very Poor	

2.2 INITIAL TEST

A total of 178 laboratories participated in the initial test. Four laboratories were excluded from the statistical analysis because their results were received one year past the prescribed deadline. Analysis for outliers in accordance with ASTM E 178 was conducted for the remaining 174 laboratories, and one outlier was found. This outlier is summarized in Table 2. The initial statistical analysis is summarized in Table 3.

Table 2: Labs and Test Results Considered as Outliers

Item	# of Laboratories	# of Outliers	Lab ID
CT 309	174	1	125

Table 3: Summary of Initial Test Results

CT 309 – RICE Specific Gravity

Item	# of Laboratories	Average	Standard Deviation	Number of Labs Achieved Score of				
				5	4	3	2	1
CT 309	174	2.531	.6090	173	0	0	0	1
% of Total				99.4%	0%	0%	0%	0.6%

After excluding the outlier, the mean and standard deviation were re-calculated to determine the score for each of the remaining 173 laboratories. The analysis results are presented in Table 4. Detailed test results are provided in Appendix A.

Table 4: Summary of Initial Test Results*

CT 309 – RICE Specific Gravity

Item	# of Laboratories	Average	Standard Deviation	Number of Labs Achieved Score of				
				5	4	3	2	1
CT 309	173	2.485	.0276	162	5	2	1	4
% of Total				93.1%	2.9%	1.1%	0.6%	2.3%

*Outlier excluded

2.3 RETEST

Laboratories whose test results were considered as outliers and laboratories that achieved a score lower than 3 were considered as unsatisfactory. In the initial test, 5 laboratories did not receive an acceptable score. In August 2014, these laboratories were sent additional samples to conduct a retest. These Laboratories were: 83, 125, 201, 266, and 480. The retest score for each laboratory was determined by comparing the results with the rating range from the initial test. The retest summary is presented in Table 5. Detailed test results and scores are provided in Appendix B. Laboratory 83 failed the retest and was given a third sample to test; however, Caltrans IA staff witnessed the tester conducting the third retest. A summary of the IA witness tests is presented in Table 6.

Table 5: Summary of Retest Results (CT 309)

Item	# of Laboratories	Average	Standard Deviation	Number of Labs Achieved Score of				
				5	4	3	2	1
CT 309	5	2.481	.0445	2	2	-	-	1
% of Total				40%	40%	-	-	10%

Table 6: Summary of Witness Test Results (CT 309)

Item	# of Laboratories	Average	Standard Deviation	Number of Labs Achieved Score of				
				5	4	3	2	1
CT 309	1	2.412	-	-	-	-	-	1*
% of Total				-	-	-	-	100%

*This laboratory should not have been sent a sample as they do not do CT 309

2.4 COMBINED RESULTS

A total of 178 laboratories participated in the reference sample program. Five laboratories participated in both the initial test and the retest with a single laboratory failing to produce an acceptable result. This laboratory also failed to produce an acceptable result during Caltrans IA witnessed testing. It was determined that the single failing laboratory should not have been sent a sample as they do not perform CT 309. Table 7 shows combined scores from the initial test, retest and Caltrans IA witnessed testing. The final combined scores are provided in Appendix C.

Table 7: Summary of Combined Test Results (CT-309)

Test Method	# of Laboratories	Number of Labs Achieved Score of				
		5	4	3	2	1
CT 309	178	168	7	2	-	1*
	% of Total	94.4%	3.9%	1.1%	-	0.6%

*This laboratory should not have been sent a sample as they do not perform CT 309

2.5 OBSERVATIONS

During the initial test there were 5 laboratories that failed the Rice specific gravity test. A retest was performed by these laboratories. During the second round of testing all but one of the laboratories were able to produce acceptable results. Laboratory 83 was again provided with samples to run the third re-test with Caltrans IA staff witnessing the test. The laboratory was unable to achieve acceptable results during the third retest and was disqualified from performing CT 309. While witnessing the retest, Caltrans IA observed that the laboratory does not perform CT 309. As such, they should not have received a reference sample for testing.

3.0 SUMMARY

CT 309 – In the initial round of testing 178 laboratories participated. Five laboratories failed in the initial test. The failure constitutes laboratories whose results were considered outliers and those with results below a score of 3. Laboratories that after being sent a sample didn't send in results from their test were not considered in the statistical analysis. Samples were provided to the 5 failed laboratories for a retest, and 4 laboratories passed. One laboratory failed the retest and performed another test with Caltrans IA staff witnessing. The laboratory did not achieve acceptable results, and it was observed that they should not have received a sample as they do not perform CT 309.

4.0 REFERENCES

ASTM, "Standard Practice for Dealing with Outlying Observations," Designation E 178 – 80.

Caltrans, "Independent Assurance Manual," Sacramento, July 2005.

APPENDIX – A

Test Results from Initial Test

Laboratory ID#	Results, G _{mm}	Score
1	2.495	5
2	2.491	5
3	2.482	5
4	2.470	5
5	2.496	5
6	2.505	5
7	2.494	5
8	2.483	5
9	2.474	5
10	2.480	5
12	2.484	5
20	2.503	5
24	2.475	5
28	2.500	5
29	2.472	5
32	2.501	5
38	2.469	5
40	2.481	5
47	2.484	5
49	2.483	5
52	2.487	5
53	2.485	5
56	2.493	5
57	2.488	5
59	2.488	5
62	2.463	5
63	2.484	5
64	2.481	5
65	2.490	5
66	2.486	5
67	2.488	5
68	2.478	5
69	2.473	5
71	2.499	5
73	2.489	5
75	2.473	5
76	2.501	5
79	2.497	5
80	2.480	5
83	2.378	1

Laboratory ID#	Results, G _{mm}	Score
84	2.489	5
87	2.491	5
88	2.473	5
91	2.481	5
94	2.475	5
96	2.472	5
99	2.486	5
102	2.486	5
103	2.492	5
114	2.510	5
120	2.505	5
122	2.514	4
123	2.504	5
125	10.510	0
131	2.486	5
135	2.492	5
139	2.487	5
140	2.489	5
141	2.504	5
143	2.488	5
144	2.495	5
146	2.485	5
147	2.485	5
154	2.500	5
155	2.493	5
156	2.487	5
158	2.487	5
160	2.497	5
161	2.490	5
164	2.477	5
170	2.505	5
173	2.486	5
177	2.476	5
183	2.495	5
184	2.497	5
191	2.506	5
192	2.490	5
193	2.496	5
195	2.490	5
196	2.486	5

Laboratory ID#	Results, G _{mm}	Score
201	2.215	1
206	2.479	5
209	2.474	5
210	2.490	5
213	2.433	3
216	2.464	5
219	2.505	5
223	2.484	5
233	2.485	5
234	2.498	5
246	2.495	5
248	2.474	5
249	2.486	5
250	2.483	5
252	2.499	5
254	2.494	5
256	2.507	5
257	2.510	5
263	2.491	5
264	2.508	5
265	2.479	5
266	2.372	1
273	2.479	5
281	2.523	4
283	2.500	5
284	2.511	5
290	2.472	5
292	2.491	5
293	2.470	5
294	2.486	5
295	2.496	5
300	2.491	5
302	2.500	5
303	2.496	5
309	2.496	5
316	2.483	5
317	2.484	5
318	2.483	5
326	2.485	5
332	2.493	5

Laboratory ID#	Results, G _{mm}	Score
334	2.491	5
348	2.478	5
349	2.493	5
352	2.507	5
353	2.472	5
359	2.506	5
360	2.478	5
361	2.492	5
362	2.491	5
368	2.530	3
370	2.465	5
377	2.486	5
381	2.479	5
382	2.503	5
390	2.490	5
393	2.500	5
394	2.482	5
395	2.471	5
396	2.492	5
405	2.483	5
412	2.478	5
413	2.479	5
416	2.470	5
417	2.471	5
419	2.496	5
422	2.490	5
423	2.477	5
428	2.498	5
430	2.491	5
437	2.488	5
441	2.486	5
443	2.522	4
447	2.472	5
454	2.489	5
457	2.490	5
464	2.488	5
480	2.421	2
482	2.500	5
483	2.502	5
493	2.473	5

Laboratory ID#	Results, G _{mm}	Score
508	2.487	5
511	2.485	5
513	2.489	5
521	2.484	5
526	2.501	5
534	2.509	5
543	2.473	5
551	2.519	4
564	2.492	5
565	2.477	5
569	2.492	5
574	2.486	5
576	2.479	5
580	2.475	5
581	2.497	5
587	2.457	4
600	2.499	5
603	2.488	5

Legend:

1, 2	Unacceptable Score
O	Outlier

APPENDIX - B

Test Results from Retest

Laboratory ID#	Results, G _{mm}	Score
83	2.412	1
266	2.473	5
125	2.516	4
480	2.524	4
201	2.481	5

Legend:

1, 2 Unacceptable Score

APPENDIX - C

Final Scores from Witness Test

Laboratory ID#	Results, G _{mm}	Score
83	2.412	1

Legend:

1, 2 Unacceptable Score