OHD L-47
Guidelines for Resolving Differences in Test Results

1 SCOPE

1.1 The guidelines provided are as follows:

1.1.1 Standard Practice for the Evaluation of Different Superpave Gyratory Compactors (SGC's) Used in the Design and the Field Management of Superpave Mixtures

1.1.2 Standard Practice for the Evaluation of Different Rainhart Gyratory Compactors (RGC's) Used in the Design and the Field Management of Hveem Mixtures

1.1.3 Standard Practice for the Evaluation of Different Rice Apparatus for the Determination of Maximum Theoretical Specific Gravity

1.2 References to tables, figures and such shall be within the section categories as shown above.

1.3 Any references to the specifying agency shall be deemed as being ODOT, Oklahoma Department of Transportation.

Standard Practice for the Evaluation of Different Superpave Gyratory Compactors (SGC's) Used in the Design and the Field Management of Superpave Mixtures

1 SCOPE

1.1 This method should be used in conjunction with the latest AASHTO standard of the same or similar title. ODOT, Oklahoma Department of Transportation, standards and test methods and exceptions as noted below shall override similar AASHTO standards and references.

1.2 This method covers the procedure for the evaluation of different SGC's used in the design and the field management of Superpave mixtures. SGC's shall satisfy AASHTO PP 35 and shall be operated according to AASHTO T 312. Evaluation of SGC's should include the SGC used for the mix design evaluated with the SGC used for production quality control (QC) and the SGC used for production quality acceptance (QA). The evaluation will assist in the identification of within procedure differences that may impact the field management of asphalt mixes. If differences are attributed to mechanical differences in SGC's, a supplemental offset procedure is provided.

1.3 This practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 REFERENCED DOCUMENTS

2.1 AASHTO Standards: (Note: Use the most current Standard)

- MP1, Specification for Performance Graded Asphalt Binder
- MP2, Specification for Superpave Volumetric Mix Design
- PP28, Practice for Designing SUPERPAVE™ of Hot-Mix Asphalt (HMA)
- PP35, Practice for Evaluation of Superpave Gyratory Compactors (SGC's)
- T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures (Method A)
- T 168, Practice for Sampling Bituminous Paving Mixtures
- T 209, Maximum Specific Gravity of Bituminous Paving Mixtures
- T 248, Method for Reducing Samples of Aggregate to Testing Size
- T 275, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
- T 312, Method for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor

2.2 *OHD: (Note: Use the most current version or those stipulated in Contract documents.)*

- L-14, Method for Determining the Specific Gravity and Unit Weight of Compacted Bituminous Mixtures
- L-26, Method for Determination of Bitumen Content in Bituminous Paving Mixtures
- L-45, Method for Determining the Specific Gravity and Unit Weight of Compacted Bituminous Mixtures Using the CoreLok™ Apparatus

2.3 *Special Provision: (Note: Use the most current version or those stipulated in Contract documents.)*

- 708-3, Superpave Mixture Specifications
- 708-20, Superpave Performance Binder Specifications

3 SUMMARY OF METHOD

3.1 This method is intended to provide a uniform process to assist in the identification of within procedure differences that may impact the field management of asphalt mixes. If the differences are attributed to mechanical differences in SGC's, a supplemental offset procedure is provided.

3.2 The design, QC, and/or QA SGC's shall be evaluated. All SGC's shall satisfy AASHTO PP35 and shall be operated according to AASHTO T 312.

3.3 Laboratory prepared or production mix shall be utilized in the evaluation. OMRL, Oklahoma Material Reference Laboratory, material may be obtained from the Materials Division. If insufficient material is available, the material may be obtained by either means as shown above.

3.4 Documentation of within procedure differences and assessment of compacted specimens shall be utilized in the evaluation.

3.5 The evaluation shall be conducted in two phases. The initial evaluation shall use multiple operators and existing within procedure handling practices. The second phase, if required, shall utilize a single operator and consistent, within procedure handling practices. One laboratory shall be used in the determination of the compacted bulk specific gravities (Gmb's) of the Gyratory specimens.

4 SIGNIFICANCE OF USE

SGC's fabricated according to AASHTO T 312 and satisfying AASHTO PP35, create cylindrical specimens from loose HMA through a gyratory (kneading) effort. Within procedure differences may impact the comparability of SGC's. In addition, variability within the manufacturing process may result in mechanical differences in SGC performance.

5 RESPONSIBILITIES SPECIFIC TO THE STANDARD

The laboratories used in the evaluation are identified in the following sections.

5.1 Mix Design Laboratory - Based upon the contract document, the Hveem mix design can be conducted by either the specifying agency, contractor, or private consultant.

5.2 Field Quality Control Laboratory - QC testing is performed by the contractor to ensure the quality of the production process. QC results are not used in the acceptance of production mixes.

5.3 Field Quality Acceptance or Assurance Laboratory - QA testing is required by the specifying agency for the acceptance of production mixes. Based upon the contract document, QA testing can be conducted by either the specifying agency, contractor, or private consultant.

5.4 Independent Quality Assurance Laboratory (IQAL) - Based upon the contract document, an IQAL may be employed to arbitrate differences in contractor and specifying agency results. Typically the IQAL is a private consultant or a different specifying agency laboratory. The Materials Division's Independent Assurance Sampling (IAS) may be called upon to assist in the arbitration of differences. The IAS may seek additional help from the Materials Division's Asphalt Design Laboratory.

5.5 The actual operator responsible for each laboratory shall be used in the initial phase of the evaluation.

6 PROCEDURE: PHASE I - INITIAL EVALUATION

6.1 The specifying agency shall identify the laboratories to be included in the evaluation.

6.2 Prior to compaction of any specimens, each operator shall verify the SGC calibration according to AASHTO T 312.

6.3 The Evaluation mix shall conform to one of the following sections.

6.3.1 *Laboratory Prepared Mix*–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One laboratory shall prepare sufficient mix for four (4) SGC specimens per each evaluation. The SGC specimens shall be compacted according to the Superpave Special Provision parameters.

6.3.2 *Plant Produced Mix*–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One sample shall be taken from a production haul vehicle (truck), according to AASHTO T 168, of sufficient size to fabricate four (4) SGC specimens per each evaluation. The SGC specimens shall be compacted according to the Superpave Special Provision parameters.

6.3.3 Logistics of the SGC's may result in the cooling of mix samples prior to compaction. The cooling and reheating of asphalt mixes can affect the measured volumetrics. Reheating of the mix is not part of the mix design, as specified in AASHTO PP28. The laboratory prepared or production mix shall be split according to AASHTO T 248 and provided to each laboratory. Any differences in handling shall be recorded. If possible, an observer from either the specifying agency or contractor should assist in recording any within procedure differences.

6.3.4 OMRL *Mix*–A mix distributed by the Materials Division of ODOT. Sufficient material shall be obtained to fabricate four (4) SGC specimens per each evaluation. The SGC specimens shall be compacted according to the Superpave Special Provision parameters.

6.4 The mix shall be heated to the compaction temperature for the duration as specified in the Superpave Special Provision. The details of the method used shall be recorded.

6.5 Four (4) SGC specimens shall be compacted in each SGC according to AASHTO T 312, to the design number of gyrations (Ndes) anticipated for the production mix or as shown on the mix design. Each individual operator shall perform the compaction and bulk specific gravity (Gmb) of the specimens.

7 REPORTING

7.1 *Phase 1: Initial Evaluation*–The results of each laboratory shall be compiled in a similar manner as shown in Table 1.

Table 1–SGC Evaluation Form

Laboratory					
Operator's Name					
SGC	Make:	Model:		Meets PP35 Y_ N _	
Oven	Make:	Model:			
Mix Designation					
Mix Type	Lab _	Production _		OMRL _	
Mixing Temp., °C	Specified Range:	Actual:			
Compaction Temp., °C	Specified:	Actual:			
Heating Method /Time	In Mold _	In Pan _			
Comments					
SGC Compaction	Bulk Specific Gravity (Gmb)				
	A	B	C	D	Ave. ($\bar{x}$)	Std. Dv. (s)
Nini=_____						
Ndes=____						
Recorded Observations:						

7.2 The sample average ($\bar{x}$) and the sample standard deviation (s) shall be calculated based on the four (4) compacted specimens' Gmb as-well-as the SGC height data as shown in equations 7.3 and 7.4.

7.3 Sample average,

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \text{(Equation 7.3)}$$

Where,

i = Specimen number, and
n = Total number of specimens.

Report the sample average ($\bar{x}$) to four (4) significant digits.

7.4 Sample standard deviation,

$$s = \left(\frac{\sum_{i=1}^{n} (\bar{x} - x_i)^2}{n-1} \right)^{0.5} \quad \text{(Equation 7.4)}$$

Report the sample standard deviation (s) to four (4) significant digits.

7.5 The sample standard deviations for the various compaction levels for each laboratory should be within the typical values indicated in Tables 2a and 2b.

Table 2a shall be used when specimens are tested for Gmb according to OHD L-14. Table 2b shall be used when specimens are tested for Gmb according to OHD L-45 or AASHTO T 275.

Table 2a–Typical standard deviations for Gmb of specimens compacted in the SGC and tested according to OHD L-14.

SGC Compaction Level	Typical Standard Deviation
Nini	0.008
Ndes	0.006

Table 2b–Typical standard deviations for Gmb of specimens compacted in the SGC and tested according to OHD L-45 or AASHTO T 275.

SGC Compaction Level	Typical Standard Deviation
Nini	NA
Ndes	0.014

Note 1–Values for tables 2a, 2b, 3a and 3b are based on four (4) specimens.

Note 2--Values for tables 2a and 3a are based on an analysis of 20 production mixes from HMA plants located throughout the United States. Data was collected as part of the FHWA demonstration Project No. 90, "Superpave Asphalt Mix Design & Field Management." Ninety-eight percent (98%) of the production data analyzed is within the above typical standard deviations times two (2) plus the sample average Gmb.

Note 3–Values for tables 2b and 3b are based on preliminary reports from the Round Robin tests performed in the FHWA sponsored "Bulk Specific Gravity Round-Robin Using the CoreLok Vacuum Sealing Device" project. Tests performed according to AASHTO T 275 may exceed these limits.

7.6 The absolute difference of the averages ($\bar{x}_1$) between any two laboratories should be within the typical values indicated in Tables 3a and 3b.

Table 3a–Typical absolute difference of the averages in Gmb values for two laboratories when compacted in the SGC and tested according to OHD L-14.

SGC Compaction Level	Typical Standard Deviation
Nini	0.022
Ndes	0.015

Table 3b–Typical absolute difference of the averages in Gmb values for two laboratories when compacted in the SGC and tested according to OHD L-45.

SGC Compaction Level	Typical Standard Deviation
Nini	NA
Ndes	0.038

8 PROCEDURE: PHASE II - SINGLE OPERATOR EVALUATION

8.1 If one or more of the SGC's evaluated is not providing results within the typical ranges as indicated in the appropriate tables above, the second phase of the evaluation should be employed.

8.2 A meeting between the laboratory operators will be held to identify and discuss within procedure differences; see section 9 for discussion topics. The specifying agency should establish a uniform procedure to address the identified differences. This should be based on the consensus of the group.

8.3 Repeat section 6 with the following exceptions:

8.3.1 A single operator shall be used throughout the evaluation.

8.3.2 An evaluation mix as in section 6.3 shall be used. It shall be split according to AASHTO T 248 by Method B–Quartering. It shall be allowed to be cooled to ambient temperature for a minimum of 12 hours. The split samples shall be uniformly handled and reheated to the specified compaction temperature.

8.3.3 Table 1 or similar forms shall be used to summarize the evaluation data.

8.3.4 A statistical evaluation shall be conducted using the typical values provided in tables shown in section 7.5 and 7.6.

8.4 If one or more of the SGC's evaluated still does not provide results within the typical ranges, the single operator should re-verify the calibration of the SGC's or contact the manufacturer for service.

9 SUPPLEMENTAL OFFSET PROCEDURE

9.1 After completion of Phase II, the consensus of all involved partied may agree to this supplement offset procedure. This procedure shall only be specific to that particular HMA, Hot-Mix Asphalt, mixture for the specific SGC's involved in the resolution of differences.

9.2 The average or target Gmb shall be determined. This average or target may require additional testing. The Materials Division's Asphalt Design Laboratory may provide such assistance and guidance if the field mixture is used in-lieu of the OMRL mixture.

9.3 Offset formula,

(Equation 9.3) $G_{mb} = G_{mb1}(G_{mb}\,avg / G_{mb0})$

Where,

G_{mb} = Corrected Bulk Specific Gravity of mixture (includes offset),

G_{mb1} = Uncorrected Bulk Specific Gravity of mixture,

$G_{mb}avg$ = Average Bulk Specific Gravity of mixture,

G_{mbo} = Initial Bulk Specific Gravity of mixture, and

$\left(\frac{G_{mb}avg}{G_{mbo}}\right)$ = Offset correction factor.

10 DISCUSSION TOPICS

Within procedure differences that may impact the field management of asphalt mixes. The following provides topics for discussion in identifying potential differences. This is by no means a complete list.

10.1 SGC Calibration–Most versions of the SGC manufactured today allow the use of both 100mm and 150 mm molds. During the calibration process it is not always apparent which setting is in use. Verify that each compactor is set to 150 mm per AASHTO T 312. A setting of 100 mm will result in a lower than specified consolidation pressure, which will in turn result in lower densities.

10.2 Sample Segregation–If a compactor is not providing results within the typical standard deviations, a comparison of each specimen's gradation should be performed. Extraction of the aggregate can be accomplished though either a solvent or ignition oven method according to OHD L-26.

10.3 Method of Heating–The method of heating specimens may affect the densities. Heating in the pan may age the mix more than heating in the mold. This can result in lower densities. Also, the method of transfer from the pan to the mold may result in cooling of the mix, which in turn can result in lower densities.

10.4 .*Use of One Mold*–The use of one mold may affect the compaction effort. If the mold is not reheated according to AASHTO T 312, the mold may cool which can result in lower densities.

10.5 *Rodding of the Sample*–Operators familiar with the Hveem method of compaction may rod the specimen prior to compaction. This is not part of AASHTO T 312, and should not be performed.

10.6 *Forced-Draft Oven*–The oven set temperature should not be significantly above the compaction temperature. Over heated molds and mix may result in excessive aging of the mix which results in lower density. Also, the level or lack thereof of the forced-draft-ness may be discussed.

10.7 *Reheating*–Logistics may require some of the compacted specimens to be reheated. Reheating may result in higher absorption of the asphalt binder. The lower effective asphalt content can result in lower densities.

Note: This can be a significant factor for the more absorptive mixtures. If the difference between the mix design's Gse and Gsb is greater than 0.025 then one can expect the mixture's aggregate to absorb more asphalt.

10.8 *Different Mix*–The evaluators may wish to include a different mix in the evaluation, ex. a coarse vs. a fine mix.

10.9 *SGC Calibration*–Since the SGC is a relatively new piece of equipment, there may be unforeseen issues with calibration. If after the second phase of evaluation a given SGC is still not comparing to the other unit, the manufacturer should be consulted to verify the calibration.

10.10 *Angle of Gyration*–The FHWA's internal angle device should be used when possible. Not all SGC's measure the angle of gyration in the same manner. Angle of gyration is the most sensitive parameter that affects compaction.

10.11 *Mold Dimensions*–Thin mold wall thickness has resulted in lower densities for some SGC's.

Standard Practice for the Evaluation of Different Rainhart Gyratory Compactors (RGC's) Used in the Design and the Field Management of Hveem Mixtures

1 SCOPE

1.1 This method should be used in conjunction with the latest AASHTO standards, ODOT, Oklahoma Department of Transportation, standards and test methods with applicable exceptions as noted below. These exceptions shall override similar AASHTO standards and references.

1.2 This method covers the procedure for the evaluation of different RGC's used in the design and the field management of Hveem mixtures. RGC's shall satisfy OHD L-8 and shall be operated according to those procedures. Evaluation of RGC's should include the RGC used for the mix design evaluated with the RGC used for production quality control (QC) and the RGC used for production quality acceptance (QA). The evaluation will assist in the identification of within procedure differences that may impact the field management of asphalt mixes. If differences are attributed to mechanical differences in RGC's, a supplemental offset procedure is provided.

1.3 This practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 REFERENCED DOCUMENTS

2.1 AASHTO Standards: (Note: Use the most current Standard)

- MP1, Specification for Performance Graded Asphalt Binder
- T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures (Method A)
- T 168, Practice for Sampling Bituminous Paving Mixtures
- T 209, Maximum Specific Gravity of Bituminous Paving Mixtures
- T 248, Method for Reducing Samples of Aggregate to Testing Size
- T 275, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
- T 312, Method for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor

2.2 OHD: (Note: Use the most current version or those stipulated in Contract documents.)

- L-8, Method for Compacting Bituminous Mixtures for Stabilometer Value
- L-14, Method for Determining the Specific Gravity and Unit Weight of Compacted Bituminous Mixtures
- L-26, Method for Determination of Bitumen Content in Bituminous Paving Mixtures
- L-45, Method for Determining the Specific Gravity and Unit Weight of Compacted Bituminous Mixtures Using the CoreLok™ Apparatus

2.3 Special Provision: (Note: Use the most current version or those stipulated in Contract documents.)

- 708-20, Superpave Performance Binder Specifications

3 SUMMARY OF METHOD

3.1 This method is intended to provide a uniform process to assist in the identification of within procedure differences that may impact the field management of asphalt mixes. If the differences are attributed to mechanical differences in RGC's, a supplemental offset procedure is provided.

3.2 The design, QC, and/or QA RGC's shall be evaluated. All RGC's shall satisfy the requirements in OHD L-8 and shall be operated accordingly.

3.3 Laboratory prepared or production mix shall be utilized in the evaluation. OMRL, Oklahoma Material Reference Laboratory, material may be obtained from the Materials Division. If insufficient material is available, the material may be obtained by either means as shown above.

3.4 Documentation of within procedure differences and assessment of compacted specimens shall be utilized in the evaluation.

3.5 The evaluation shall be conducted in two phases. The initial evaluation shall use multiple operators and existing within procedure handling practices. The second phase, if required, shall utilize a single operator and consistent, within procedure handling practices. One laboratory shall be used in the determination of the compacted bulk specific gravities (Gmb's) of the Gyratory specimens.

4 SIGNIFICANCE OF USE

RGC's fabricated according to OHD L-8 specifications, create cylindrical specimens from loose HMA through a gyratory (kneading) effort.

5 RESPONSIBILITIES SPECIFIC TO THE STANDARD

The laboratories used in the evaluation are identified in the following sections.

5.1 Mix Design Laboratory - Based upon the contract document, the Superpave mix design can be conducted by either the specifying agency, contractor, or private consultant.

5.2 Field Quality Control Laboratory - QC testing is performed by the contractor to ensure the quality of the production process. QC results are not used in the acceptance of production mixes.

5.3 Field Quality Acceptance or Assurance Laboratory - QA testing is required by the specifying agency for the acceptance of production mixes. Based upon the contract document, QA testing can be conducted by either the specifying agency, contractor, or private consultant.

5.4 Independent Quality Assurance Laboratory (IQAL) - Based upon the contract document, an IQAL may be employed to arbitrate differences in contractor and specifying agency results. Typically the IQAL is a private consultant or a different specifying agency laboratory. The Materials Division's Independent Assurance Sampling (IAS) may be called upon to assist in the arbitration of differences. The IAS may seek additional help from the Materials Division's Asphalt Design Laboratory.

5.5 The actual operator responsible for each laboratory shall be used in the initial phase of the evaluation.

6 PROCEDURE: PHASE I - INITIAL EVALUATION

6.1 The specifying agency shall identify the laboratories to be included in the evaluation.

6.2 Prior to compaction of any specimens, each operator shall verify the RGC calibration according to OHD L-8.

6.2.1 The angle shall be verified. The tilt mechanism shall a 4 degree angle or as adjusted to match OMRL comparison specimens due to wear.

6.2.2 The ram movement shall be verified to be 0.025 inches by one stroke of the hydraulic hand pump handle.

6.3 The Evaluation mix shall conform to one of the following sections.

6.3.1 *Laboratory Prepared Mix*–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One laboratory shall prepare sufficient mix for four (4) RGC specimens per each evaluation. The RGC specimens shall be compacted according to the OHD L-8 parameters.

6.3.2 *Plant Produced Mix*–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One sample shall be taken from a production haul vehicle, according to AASHTO T 168, of sufficient size to fabricate four (4) RGC specimens per each evaluation. The RGC specimens shall be compacted according to the OHD L-8 parameters.

6.3.3 Logistics of the RGC's may result in the cooling of mix samples prior to compaction. The cooling and reheating of asphalt mixes can affect the measured volumetrics. Reheating of the mix is not part of the mix design process. The laboratory prepared or production mix shall be split according to AASHTO T 248 and provided to each laboratory. Any differences in handling shall be recorded. If possible, an observer from either the specifying agency or contractor should assist in recording any within procedure differences.

6.3.4 *OMRL Mix*–A mix distributed by the Materials Division of ODOT. Sufficient material shall be obtained to fabricate four (4) RGC specimens per each evaluation. The RGC specimens shall be compacted according to the OHD L-8 parameters.

6.4 The mix shall be heated to the compaction temperature for the duration as specified in the OHD L-8. The details of the method used shall be recorded.

6.5 Four (4) RGC specimens shall be compacted in each RGC according to OHD L-8. Each individual operator shall perform the compaction and bulk specific gravity (Gmb) of the specimens.

7 REPORTING

7.1 *Phase 1: Initial Evaluation*–The results of each laboratory shall be compiled in a similar manner as shown in Table 1.

Table 1–RGC Evaluation Form

Laboratory						
Operator's Name						
RGC	Make:		Model:		Meets OHD L-8 Y_ N _	
Oven	Make:		Model:			
Mix Designation						
Mix Type	Lab _		Production _		OMRL _	
Mixing Temp., °C	Specified Range:		Actual:			
Compaction Temp., °C	Specified:		Actual:			
Heating Method /Time	In Mold _		In Pan _			
Comments						
RGC Compaction	Bulk Specific Gravity (Gmb)					
	A	B	C	D	Ave. ($\bar{x}$)	Std. Dv. (s)
Recorded Observations:						

7.2 The sample average ($\bar{x}$) and the sample standard deviation (s) shall be calculated based on the four (4) compacted specimens' Gmb as shown in equations 7.3 and 7.4.

7.3 Sample average,

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \text{(Equation 7.3)}$$

Where,

i = Specimen number, and
n = Total number of specimens.

Report the sample average ($\bar{x}$) to four (4) significant digits.

7.4 Sample standard deviation,

$$s = \left(\frac{\sum_{i=1}^{n} (\bar{x} - x_i)^2}{n - 1} \right)^{0.5} \quad \text{(Equation 7.4)}$$

Report the sample standard deviation (s) to four (4) significant digits.

7.5 The sample standard deviations for the various compaction levels for each laboratory should be within the typical values indicated in Tables 2a and 2b.

Table 2a shall be used when specimens are tested for Gmb according to OHD L-14. Table 2b shall be used when specimens are tested for Gmb according to OHD L-45 or AASHTO T 275.

Table 2a–Typical standard deviations for Gmb of specimens compacted in the RGC and tested according to OHD L-14.

RGC Compaction Level	Typical Standard Deviation
Gmb	0.008

Table 2b–Typical standard deviations for Gmb of specimens compacted in the SGC and tested according to OHD L-45 or AASHTO T 275.

RGC Compaction Level	Typical Standard Deviation
Gmb	0.014

Note 1–Values for tables 2a, 2b, 3a and 3b are based on four (4) specimens.

Note 2--Values for tables 2a and 3a are based on an analysis of 20 production mixes from HMA plants located throughout the United States. Data was collected as part of the FHWA demonstration Project No. 90, "Superpave Asphalt Mix Design & Field Management." Ninety-eight percent (98%) of the production data analyzed is within the above typical standard deviations times two (2) plus the sample average Gmb.
Note 3–Values for tables 2b and 3b are based on preliminary reports from the Round Robin tests performed in the FHWA sponsored "Bulk Specific Gravity Round-Robin Using the CoreLok Vacuum Sealing Device" project. Tests performed according to AASHTO T 275 may exceed these limits.

7.6 The absolute difference of the averages ($|\bar{x}_1 - \bar{x}_2|$) between any two laboratories should be within the typical values indicated in Tables 3a and 3b.

Table 3a–Typical absolute difference of the averages in Gmb values for two laboratories when compacted in the RGC and tested according to OHD L-14.

SGC Compaction Level	Typical Standard Deviation
Gmb	0.015

Table 3b–Typical absolute difference of the averages in Gmb values for two laboratories when compacted in the RGC and tested according to OHD L-45.

SGC Compaction Level	Typical Standard Deviation
Ndes	0.038

8 PROCEDURE: PHASE II - SINGLE OPERATOR EVALUATION

8.1 If one or more of the RGC's evaluated is not providing results within the typical ranges as indicated in the appropriate tables above, the second phase of the evaluation should be employed.

8.2 A meeting between the laboratory operators will be held to identify and discuss within procedure differences; see section 9 for discussion topics. The specifying agency should establish a uniform procedure to address the identified differences. This should be based on the consensus of the group.

8.3 Repeat section 6 with the following exceptions:

8.3.1 A single operator shall be used throughout the evaluation.

8.3.2 An evaluation mix as in section 6.3 shall be used. It shall be split according to AASHTO T 248 by Method B–Quartering. It shall be allowed to be cooled to ambient temperature for a minimum of 12 hours. The split samples shall be uniformly handled and reheated to the specified compaction temperature.

8.3.3 Table 1 or similar forms shall be used to summarize the evaluation data.

8.3.4 A statistical evaluation shall be conducted using the typical values provided in tables shown in section 7.5 and 7.6.

8.4 If one or more of the RGC's evaluated still does not provide results within the typical ranges, the single operator should re-verify the calibration of the RGC's or contact the manufacturer for service.

9 SUPPLEMENTAL OFFSET PROCEDURE

9.1 After completion of Phase II, the consensus of all involved partied may agree to this supplement offset procedure.

9.1.1 This procedure shall only be specific to that particular HMA, Hot-Mix Asphalt, mixture for the specific SGC's involved in the resolution of differences.

9.2 The average or target Gmb shall be determined. This average or target may require additional testing. The Materials Division's Asphalt Design Laboratory may provide such assistance and guidance if the field mixture is used in-lieu of the OMRL mixture.

9.3 Offset formula, $$G_{mb} = G_{mb1}\left(\frac{G_{mb}avg}{G_{mb0}}\right)$$ (Equation 9.3)

Where,

G_{mb} = Corrected Bulk Specific Gravity of mixture (includes offset),

G_{mb1} = Uncorrected Bulk Specific Gravity of mixture,

$G_{mb}avg$ = Average Bulk Specific Gravity of mixture,

G_{mbo} = Initial Bulk Specific Gravity of mixture, and

$\left(\frac{G_{mb}avg}{G_{mbo}}\right)$ = Offset correction factor.

10 DISCUSSION TOPICS

Within procedure differences that may impact the field management of asphalt mixes. The following provides topics for discussion in identifying potential differences. This is by no means a complete list.

10.1 RGC Calibration–Due to wear, an RGC meeting the specifications of OHD L-8 may not actually be "in calibration". OMRL samples shall be used to verify the calibration yearly and adjusted accordingly.

10.2 *Sample Segregation*–If a compactor is not providing results within the typical standard deviations, a comparison of each specimen's gradation should be performed. Extraction of the aggregate can be accomplished though either a solvent or ignition oven method according to OHD L-26.

10.3 Method of Heating–The method of heating specimens may affect the densities. Heating in the pan may age the mix more than heating in the mold. This can result in lower densities. Also, the method of transfer from the pan to the mold may result in cooling of the mix, which in turn can result in lower densities.

10.4 *Use of One Mold*–The use of one mold may affect the compaction effort. If the mold is not reheated, the mold may cool which can result in lower densities.

10.5 *Rodding of the Sample*–Operators familiar with the Superpave method of compaction may not rod the specimen prior to compaction.

10.6 *Forced-Draft Oven*–The oven set temperature should not be significantly above the compaction temperature. Over heated molds and mix may result in excessive aging of the mix which results in lower density. Also, the level or lack thereof of the forced-draftness may be discussed.

10.7 *Reheating*–Logistics may require some of the compacted specimens to be reheated. Reheating may result in higher absorption of the asphalt binder. The lower effective asphalt content can result in lower densities.

Note: Absorptive aggregates are identified as those with 2 percent or more water absorption. The ODOT Aggregate Information is published bi-annually. Contact the Materials Division for this information if needed.

10.8 Different Mix–The evaluators may wish to include a different mix in the evaluation, ex. a coarse vs. a fine mix.

10.9 *Mold Dimensions*–This is an especially important property for the Hveem stability test. Check OHD L-8 for mold dimensions.

Standard Practice for the Evaluation of Different Rice Apparatus for the Determination of Maximum Theoretical Specific Gravity

1 SCOPE

1.1 This method should be used in conjunction with the latest AASHTO standards. ODOT, Oklahoma Department of Transportation, standards and test methods and exceptions as noted below shall override similar AASHTO standards and references.

1.2 This method covers the procedure for the evaluation of differences between laboratories in the determination of Gmm, maximum theoretical specific gravity, according to AASHTO T 209.

1.3 This practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 REFERENCED DOCUMENTS

2.1 *AASHTO Standards: (Note: Use the most current Standard)*

- T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures (Method A)
- T 168, Practice for Sampling Bituminous Paving Mixtures
- T 209, Maximum Specific Gravity of Bituminous Paving Mixtures
- T 248, Method for Reducing Samples of Aggregate to Testing Size

2.2 *OHD: (Note: Use the most current version or those stipulated in Contract documents.)*

- L-26, Method for Determination of Bitumen Content in Bituminous Paving Mixtures

3 SUMMARY OF METHOD

3.1 This method is intended to provide a uniform process to assist in the identification of within procedure differences that may impact the field management of asphalt mixes.

3.2 The design, QC, and/or QA Rice apparatus shall be evaluated. All Rice apparatus shall satisfy AASHTO T 209 and shall be operated accordingly.

3.3 Laboratory prepared or production mix shall be utilized in the evaluation. OMRL, Oklahoma Material Reference Laboratory, material may be obtained from the Materials Division. If insufficient material is available, the material may be obtained by either means as shown above.

3.4 Documentation of within procedure differences and assessment of the Rice apparatus shall be utilized in the evaluation.

3.5 The evaluation shall be conducted in two phases. The initial evaluation shall use multiple operators and existing within procedure handling practices. The second phase, if required, shall utilize a single operator and consistent, within procedure handling practices. One laboratory shall be used in the determination of the maximum theoretical specific gravities (Gmm's).

4 SIGNIFICANCE OF USE

Due to significant variances in the bowl method, ODOT will only accept Gmm values using the flask method as specified in AASHTO T 209. The terms Gmm, maximum theoretical specific gravity and Rice are all synonymous.

5 RESPONSIBILITIES SPECIFIC TO THE STANDARD

The laboratories used in the evaluation are identified in the following sections.

5.1 Mix Design Laboratory - Based upon the contract document, the Hveem mix design or Superpave mix design can be conducted by either the specifying agency, contractor, or private consultant.

5.2 Field Quality Control Laboratory - QC testing is performed by the contractor to ensure the quality of the production process. QC results are not used in the acceptance of production mixes.

5.3 Field Quality Acceptance or Assurance Laboratory - QA testing is required by the specifying agency for the acceptance of production mixes. Based upon the contract document, QA testing can be conducted by either the specifying agency, contractor, or private consultant.

5.4 Independent Quality Assurance Laboratory (IQAL) - Based upon the contract document, an IQAL may be employed to arbitrate differences in contractor and specifying agency results. Typically the IQAL is a private consultant or a different specifying agency laboratory. The Materials Division's Independent Assurance Sampling (IAS) may be called upon to assist in the arbitration of differences. The IAS may seek additional help from the Materials Division's Asphalt Design Laboratory.

5.5 The actual operator responsible for each laboratory shall be used in the initial phase of the evaluation.

6 PROCEDURE: PHASE I - INITIAL EVALUATION

6.1 The specifying agency shall identify the laboratories to be included in the evaluation.

6.2 Prior to initial testing of any specimens, each operator shall verify the Rice apparatus is set up properly and that the flasks are re-calibrated according to AASHTO T 209.

6.3 The Evaluation mix shall conform to one of the following sections.

6.3.1 *Laboratory Prepared Mix*–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One laboratory shall prepare sufficient mix for four (4) Rice specimens per each evaluation.

6.3.2 Plant Produced Mix–A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One sample shall be taken from a production haul vehicle, according to AASHTO T 168, of sufficient size to obtain four (4) Rice specimens per each evaluation.

6.3.3 Logistics of the Rice material collection may result in the cooling of mixtures prior to testing. The cooling and reheating of asphalt mixes can affect the measured volumetrics. Reheating of the mix is not part of the mix design. The laboratory prepared or production mix shall be split according to AASHTO T 248 and provided to each laboratory. Any differences in handling shall be recorded. If possible, an observer from either the specifying agency or contractor should assist in recording any within procedure differences.

6.3.4 *OMRL Mix*–A mix distributed by the Materials Division of ODOT. Sufficient material shall be obtained to obtain four (4) Rice specimens per each evaluation.

6.4 The mix shall be re-heated to a minimal degree. The material shall be stirred while cooling as specified in AASHTO T 209.

6.5 Four (4) Rice specimens shall be obtained for each laboratory's Rice apparatus according to AASHTO T 209. Each individual operator shall perform all four (4) Rice tests to determine the maximum theoretical specific gravity (Gmm).

7 REPORTING

7.1 *Phase 1: Initial Evaluation*–The results of each laboratory shall be compiled in a similar manner as shown in Table 1.

Table 1–Rice Evaluation Form

Laboratory						
Operator's Name						
Rice Method	Flask _	Rice _	Other _			
Oven	Make:	Model:				
Mix Designation						
Mix Type	Lab _	Production _	OMRL _			
Mixing Temp., °C	Specified Range:	Actual:				
Comments						
Rice	Maximum Theoretical Specific Gravity (Gmm)					
	A	B	C	D	Ave. ($\bar{x}$)	Std. Dv. (s)
Recorded Observations:						

7.2 The sample average ($\bar{x}$) and the sample standard deviation (s) shall be calculated based on the four (4) Rice specimens' Gmm as shown in equations 7.3 and 7.4.

7.3 Sample average,

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \text{(Equation 7.3)}$$

Where,

i = Specimen number, and
n = Total number of specimens.

Report the sample average ($\bar{x}$) to four (4) significant digits.

7.4 Sample standard deviation,

$$s = \left(\frac{\sum_{i=1}^{n} (\bar{x} - x_i)^2}{n-1} \right)^{0.5} \quad \text{(Equation 7.4)}$$

Report the sample standard deviation (s) to four (4) significant digits.

7.5 The sample standard deviations for Gmm for each laboratory should be within the typical values indicated in Table 2.

Table 2–Typical standard deviations for Gmm of Rice specimens AASHTO T 209.

Rice Method	Typical Standard Deviation
Flask	0.006

Note 1–Values for tables 2 and 3 are based on four (4) specimens.
Note 2–Values for tables 2 and 3 are based on AASHTO T 209 precision statements.

7.6 The absolute difference of the averages ($\bar{x}_1$) between any two laboratories should be within the typical values indicated in Table 3.

Table 3–Typical absolute difference of the averages in Gmm values for two laboratories and tested according to AASHTO T 209.

Rice Method	Typical Standard Deviation
Flask	0.019

8 PROCEDURE: PHASE II - SINGLE OPERATOR EVALUATION

8.1 If one or more of the Rice apparatus evaluated is not providing results within the typical ranges as indicated in the appropriate tables above, the second phase of the evaluation should be employed.

8.2 A meeting between the laboratory operators will be held to identify and discuss within procedure differences; see section 9 for discussion topics. The specifying agency should establish a uniform procedure to address the identified differences. This should be based on the consensus of the group.

8.3 Repeat section 6 with the following exceptions:

8.3.1 A single operator shall be used throughout the evaluation.

8.3.2 An evaluation mix as in section 6.3 shall be used. It shall be split according to AASHTO T 248 by Method B–Quartering. The split samples shall be uniformly handled and reheated.

8.3.3 Table 1 or similar forms shall be used to summarize the evaluation data.

8.3.4 A statistical evaluation shall be conducted using the typical values provided in tables shown in section 7.5 and 7.6.

8.4 If one or more of the Rice apparatus evaluated still does not provide results within the typical ranges, the single operator should re-verify the calibration of the Rice flasks. The Rice apparatus should be checked for leaks, manometer operation and other items as shown in AASHTO T 209.

9 DISCUSSION TOPICS

9.1 Within procedure differences that may impact the field management of asphalt mixes. The following provides topics for discussion in identifying potential differences. This is by no means a complete list.

9.1.1 *Rice Flask Calibration*–Proper calibration of the Rice flask is essential to properly conduct Rice tests. A change in water properties can have significant effects. Distilled water should be used during the second phase.

9.1.2 *Sample Segregation*–If segregation occurs during the sampling or splitting process, significant errors will occur. This aspect may be verified by performing a gradation analysis. Extraction of the aggregate can be accomplished though either a solvent or ignition oven method according to OHD L-26.

9.1.3 *Reheating*–Logistics may require some of the Rice specimens to be reheated. Reheating may result in higher absorption of the asphalt binder. The lower effective asphalt content can cause stripping of the asphalt binder from the aggregate. This can be a significant factor for the more absorptive mixtures. If the difference between the mix design's Gse and Gsb is greater than 0.025 then one can expect the mixture's aggregate to absorb more asphalt.

9.1.4 *Different Mix*–The evaluators may wish to include a different mix in the evaluation, ex. a coarse vs. a fine mix.

9.2 *Apparatus Setup*–The Rice apparatus should be setup as shown in AASHTO T 209.

9.3 Water Vapor–The water vapor pressure may affect the degree of vacuum. Check water temperature.

9.4 Agitation–The level of agitation can affect test results.

9.5 Manometer–The manometer should be setup properly to ensure the proper vacuum pressure is applied according to AASHTO T 209.