ARIZONA DEPARTMENT OF TRANSPORTATION * MATERIALS GROUP

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CHANGE LETTER

MATERIALS TESTING MANUAL	CHANGE LETTER NO. 30
SUBJECT: Title Page; Table of Contents; Series 100 Cover Sheet; Series 200 Cover Sheet; Series 400 Cover Sheet; Series 700 Cover Sheet; Arizona Test Methods 105e, 246b, 417d, 424c, 427a, 428, 732a, 743, and 744.	EFFECTIVE DATE: April 19, 2013

SUMMARY:

NOTE: Unless otherwise specified, changes issued under this Change Letter are effective for projects with a bid opening date on or after April 19, 2013. Retain items removed from the Materials Testing Manual under this change letter for use as necessary on projects with a bid opening date prior to April 19, 2013.

1. TITLE PAGE - The Title Page has been revised to show the latest Change Letter number and revision date. Please replace the existing Title Page with the attached.

2. TABLE OF CONTENTS - The Table of Contents has been revised to reflect the changes made in this Change Letter. Please replace the existing Table of Contents with the attached.

3. The following items have been revised to reflect the changes made in this Change Letter. Please replace the existing items with the attached.

   Series 100 Cover Sheet - “SAMPLING”

   Series 200 Cover Sheet - “SOILS AND AGGREGATES”

   Series 400 Cover Sheet - “BITUMINOUS MIXTURES”

   Series 700 Cover Sheet - “CHEMICAL AND SPECIALTY”

4. The following test methods have been revised. When necessary, the revisions include the use of the newly adopted format for Arizona Test Methods. Please replace the existing test methods with the attached.

Arizona Test Method 105e - “SAMPLING SOILS AND AGGREGATES”

- Revisions have been made to Table 1 in Subsection 1.4 [previously paragraph 1(d)].
- A few editorial revisions have also been made to this test method.

Arizona Test Method 246b - “MOISTURE-DENSITY RELATIONSHIP USING TYPICAL MOISTURE-DENSITY CURVES (ONE POINT PROCTOR) ALTERNATE METHOD D”

- In Subsection 5.10 [previously paragraph 5(j)], revisions have been made to the equation, and also the corresponding definition of the term “W”.
- Table 1 has been revised to include column headings.
- A few editorial revisions have also been made to this test method.

Arizona Test Method 417d – “MAXIMUM THEORETICAL SPECIFIC GRAVITY AND DENSITY OF FIELD PRODUCED BITUMINOUS MIXTURES (RICE TEST)”

- In the Note following Subsection 1.1 [previously paragraph 1(a)], the reference to “Arizona Test Method 416, Section 9” has been revised to read “Arizona Test Method 424”.
- Revisions have been made to Subsection 5.4 [previously paragraph 5(d)].
- Revisions have been made to Subsections 7.2 and 7.3 [previously paragraphs 7(b) and 7(c)]. A new Note has also been inserted between Subsections 7.2 and 7.3.
- A few editorial revisions have also been made to this test method, including a revision to the presentation of the equation in Subsection 6.1 [previously paragraph 6(a)].

Arizona Test Method 424c – “DETERMINATION OF AIR VOIDS IN COMPACTED BITUMINOUS MIXTURES”

- An editorial revision (to delete repeated word “the”) has been made in Subsection 2.1.

Arizona Test Method 427a – “ASPHALT BINDER CONTENT OF ASPHALTIC CONCRETE MIXTURES BY THE IGNITION FURNACE METHOD”

- Revisions have been made throughout this test method.

Arizona Test Method 732a – “CALCIUM CARBONATE IN TOPSOIL (NEUTRALIZATION POTENTIAL OF TOPSOIL)”

- Revisions have been made throughout this test method.

5. The following new test methods have been added to the Materials Testing Manual.

Arizona Test Method 428 – “ASPHALT BINDER CONTENT OF ASPHALTIC CONCRETE MIXTURES CONTAINING RECLAIMED ASPHALT PAVEMENT (RAP) BY THE IGNITION FURNACE METHOD”

Arizona Test Method 743 – “TITANIUM DIOXIDE IN PAINTS AND THERMOPLASTICS”

Arizona Test Method 744 – “ROCK SALT IN CRASH BARREL SAND”

Bill Hurguy

Bill Hurguy, P.E.
Assistant State Engineer
Materials Group

Attachments

MATERIALS
TESTING MANUAL

SAMPLING AND TESTING PROCEDURES

PREPARED BY:
ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
MATERIALS GROUP

REVISED TO CHANGE LETTER NO. 30
(April 19, 2013)

April 19, 2013
(5 Pages)

MATERIALS TESTING MANUAL

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ARIZ 104d Sampling Bituminous Mixtures
ARIZ 105e Sampling Soils and Aggregates
ARIZ 108 Sampling Hydrated Lime and Lime Products
ARIZ 109 Sampling Metallic Materials
ARIZ 110 Sampling Miscellaneous Materials

** The above Arizona Test Methods, and also commonly used AASHTO procedures in this category, are shown on Series 100 Cover Sheet (April 19, 2013).

SERIES 200 SOILS AND AGGREGATES**

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****** The above Arizona Test Methods, and also commonly used AASHTO procedures in this category, are shown on Series 200 Cover Sheet (April 19, 2013).

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** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures in this category are show on Series 300 Cover Sheet (March 31, 2010).

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ARIZ 406c Moisture Content of Bituminous Mixtures
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ARIZ 411a Determination of Bituminous Distributor Truck Transverse Spread Rate
ARIZ 412b Density of Compacted Bituminous Mixtures by the Nuclear Method
ARIZ 413 Extraction of Asphalt from Bituminous Mixtures by Soxhlet Extraction
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** The above Arizona Test Methods, and also commonly used AASHTO procedures in this category, are show on Series 400 Cover Sheet (April 19, 2013).

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ARIZ 511 Recovery of Asphalt from Extraction Solution
ARIZ 512a Residue by Evaporation

****** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures and specifications are shown on Series 500 Cover Sheet (July 15, 2005).

SERIES 600 CEMENT AND RELATED MATERIALS**

****** Commonly used AASHTO and ASTM procedures in this category are show on Series 600 Cover Sheet (July 15, 2005).

SERIES 700 CHEMICAL AND SPECIALTY**

ARIZ 702a Testing of Paint, Varnish, Lacquer, and Related Material
ARIZ 714b Sampling and Sieving of Crumb Rubber
ARIZ 719c Heating and Drying Materials in Microwave Oven
ARIZ 725a Tensile Proof Dowel Test
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ARIZ 727a Chloride in Hardened Concrete
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****** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures in this category are show on Series 700 Cover Sheet (April 19, 2013).

SERIES 800 DESIGN**

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ARIZ 807 Design of Slurry Seal
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ARIZ 832a Marshall Mix Design Method for Asphaltic Concrete (Asphalt-Rubber) [AR-AC]
ARIZ 833 Marshall Mix Design Method for Asphaltic Concrete with Reclaimed Asphalt Pavement (RAP)

****** The above Arizona Test Methods are also shown on Series 800 Cover Sheet (February 22, 2013).

SERIES 900 MATERIALS QUALITY ASSURANCE PROGRAM
(January 7, 2011)

Appendix A - BLANK
Appendix B - BLANK
Appendix C - Sampling Guide Schedule

SERIES 1000 CERTIFICATES (July 15, 2005)

APPENDIX

APPENDIX A1 Rounding Procedure (July 15, 2005)
APPENDIX A2 Metric Guide (July 15, 2005)
APPENDIX A3 Equipment Calibration and Verification (September 28, 2012)

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April 19, 2013
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SERIES 100

SAMPLING

The following methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

TITLE	DESIGNATION
Sampling Bituminous Materials	ARIZ 103a
Sampling Bituminous Mixtures	ARIZ 104d
Sampling Soils and Aggregates	ARIZ 105e
Sampling Hydrated Lime and Lime Products	ARIZ 108
Sampling Metallic Materials	ARIZ 109
Sampling Miscellaneous Materials	ARIZ 110

Note: Sampling of crumb rubber is performed in accordance with Arizona Test Method 714.

AASHTO TEST METHODS:

TITLE	DESIGNATION
Sampling and Testing Brick	T 32
Sampling and Amount of Testing of Hydraulic Cement	T 127
Sampling Freshly Mixed Concrete	T 141
Reducing Samples of Aggregate to Testing Size	T 248

NOTE: It shall be assured that the appropriate methods as given in the project requirements are being adhered to.

NOTE: Refer to Series 900, “Materials Quality Assurance Program”, of the Materials Testing Manual for current guidelines on sampling of materials for acceptance, independent assurance, and correlation testing.

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(4 Pages)

SERIES 200

SOILS AND AGGREGATES

The following test methods and standards shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

TITLE	DESIGNATION
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Artificial Grading of Mineral Aggregate	ARIZ 244
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Moisture-Density Relationship using Typical Moisture-Density Curves (One Point Proctor) Alternate Method D	ARIZ 246b
Particle Shape and Texture of Fine Aggregate Using Uncompacted Void Content	ARIZ 247a

ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
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Remolded Ring Samples for Direct Shear, Swell, and Consolidation	ARIZ 249
Combined Coarse and Fine Aggregate Specific Gravity and Absorption	ARIZ 251a

AASHTO STANDARDS:

TITLE	DESIGNATION
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AASHTO STANDARDS: (continued)

TITLE	DESIGNATION
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Reducing Field Samples of Aggregates to Testing Size	T 248
Total Evaporable Moisture Content of Aggregate by Drying	T 255
Laboratory Determination of Moisture Content of Soils	T 265

NOTE: It shall be assured that the appropriate test methods and standards as given in the project requirements are being adhered to.

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April 19, 2013
(2 Pages)

SERIES 400

BITUMINOUS MIXTURES

The following test methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

TITLE	DESIGNATION
Moisture Content of Bituminous Mixtures………………………	ARIZ 406c
Compaction and Testing of Bituminous Mixtures Utilizing Four Inch Marshall Apparatus……………………………….	ARIZ 410e
Determination of Bituminous Distributor Truck Transverse Spread Rate…………………………………….	ARIZ 411a
Density of Compacted Bituminous Mixtures by the Nuclear Method…………………………………………..	ARIZ 412b
Extraction of Asphalt from Bituminous Mixtures by Soxhlet Extraction……………………………………......….	ARIZ 413
Bulk Specific Gravity and Bulk Density of Compacted Bituminous Mixtures………………………………………...	ARIZ 415c
Preparing and Splitting Field Samples of Bituminous Mixtures for Testing……………………..………………..…	ARIZ 416d
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ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
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Asphalt Binder Content of Asphaltic Concrete Mixtures by the Ignition Furnace Method……..………….………….	ARIZ 427a
Asphalt Binder Content of Asphaltic Concrete Mixtures Containing Reclaimed Asphalt Pavement (RAP) by the Ignition Furnace Method……………….…….	ARIZ 428

AASHTO TEST METHODS:

TITLE	DESIGNATION
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NOTE: It shall be assured that the appropriate test methods as given in the project requirements are being adhered to.

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Intermodal Transportation

April 19, 2013
(2 Pages)

SERIES 700

CHEMICAL AND SPECIALTY

The following test methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

TITLE	DESIGNATION
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Heating and Drying Materials in Microwave Oven	ARIZ 719c
Tensile Proof Dowel Test	ARIZ 725a
Reflectance, Dry Opacity, and Yellowness Index of Traffic Paint	ARIZ 726a
Chloride in Hardened Concrete	ARIZ 727a
Exchangeable Sodium in Topsoil	ARIZ 729b
Calcium Carbonate in Topsoil (Neutralization Potential of Topsoil)	ARIZ 732a
Sulfate in Soils	ARIZ 733a
Determination of Portland Cement Content in Cement Treated Base Material	ARIZ 734
Testing of Thermoplastic Pavement Marking Material	ARIZ 735a
Chloride in Soils	ARIZ 736a
Chloride in Concrete Admixtures	ARIZ 738
Mean Macrotexture Depth of Milled Pavement	ARIZ 742

ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
Titanium Dioxide in Paints and Thermoplastics……………..	ARIZ 743
Rock Salt in Crash Barrel Sand………………………………	ARIZ 744

AASHTO & ASTM TEST METHODS:

	DESIGNATION	
TITLE	AASHTO	ASTM
Quality of Water To Be Used in Concrete	T 26	
Sampling and Testing Brick	T 32	
Preformed Expansion Joint Filler for Concrete Construction	T 42	
Mass [Weight] of Coating on Iron or Steel Articles with Zinc or Zinc-Alloy Coatings	T 65	
Mechanical Testing of Steel Products	T 244	
Roundness of Glass Spheres		D 1155
Rubber Property - Durometer Hardness		D 2240
Water Permeability of Geotextiles by Permittivity		D 4491
Rockwell Hardness of Metallic Materials		E 18

NOTE: It shall be assured that the appropriate test methods as given in the project requirements are being adhered to.

ARIZ 105e
April 19, 2013
(7 Pages)

SAMPLING SOILS AND AGGREGATES

(An Arizona Method)

1. SCOPE

1.1 This method describes the methods which are to be used when sampling soils and aggregates.

1.2 Sampling is equally as important as the testing, and the individual doing the sampling shall use every precaution to obtain samples that will be representative of the materials being sampled.

1.3 This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

1.4 Table 1 shall be used to determine minimum sample weights based on the size of aggregate. The amount of material required may be greater depending on the tests that are to be performed on the material.

Table 1
Minimum Sample Sizes

Nominal Maximum Aggregate Size *	Sample Mass	
	kg	lbs
Fine Aggregate		
#8	10	22
#4	10	22
Coarse Aggregate		
3/8”	10	22
1/2”	15	35
3/4”	25	55
1”	50	110
1-1/2”	75	165
2”	100	220
2-1/2”	125	275
3”	150	330

* The smallest sieve opening through which the entire amount of material, by specification, is permitted to pass.

2. SAMPLING FROM STOCKPILES

2.1 In sampling materials from stockpiles it is difficult to ensure unbiased samples, due to the segregation which often occurs when the material is stockpiled with coarser particles rolling to the outside base of the pile. If power equipment is available then it would be advantageous to enlist the use of that equipment to develop a separate, small sampling pile composed of materials drawn from various levels and locations in the main stockpile. Once a small sampling pile has been established then a sample shall be taken from that pile by taking several increments and combining.

2.2 The stockpile may also be sampled by placing a wood or metal shield upslope from the point of sampling to prevent loose aggregate from sliding down into the sampling area. Remove approximately 3 to 6 inches of material from the sampling area. Utilizing a square point shovel, take a sample near the top, at the middle and near the bottom of the stockpile. The sample taken at each location shall be one shovelful of material. Repeat this operation at the sampling locations as shown in Figure 1, and combine all samples taken from the stockpile.

3. SAMPLING FROM BINS

3.1 A sample shall be taken by passing a sampling device through the entire cross-section of the flow of material as it is being discharged (see Figures 2 and 3). Sufficient material shall be allowed to pass at the beginning of discharge to ensure uniformity of material before the sample is taken. Repeat sampling procedure as necessary until the desired amount of material from each bin is obtained. Material from each bin shall be properly identified.

4. SAMPLING FROM A CONVEYOR BELT

4.1 Sampling from a conveyor belt may be performed either while the conveyor belt is running (by using a sampling device which diverts or intercepts the flow of material) or by taking a sample while the conveyor belt is stopped. The stopped belt method is also used when approving a sampling device used for sampling while the belt is running.

4.1.1 If the sample is obtained while the conveyor belt is running, samples of the aggregate shall be taken utilizing a sampling device to divert or intercept the entire flow of material in such a manner that all portions of the flow are diverted or intercepted for an equal amount of time.

4.1.2 Samples may be obtained by stopping the conveyor belt and sampling the full width of the belt utilizing a template which is shaped to the same contour of the belt. All material which is within the template area shall be removed, utilizing a brush to obtain all the fine aggregate material.

5. SAMPLING FROM A WINDROW

5.1 Figure 4 illustrates the method used to sample a windrow. At each point in the windrow where a sample is to be taken, remove sufficient material from the top of the windrow so that a representative sample can be obtained from the center of the freshly exposed top of the windrow using a square point shovel. The sample taken at each sampling location shall be one shovelful of material. Repeat the sampling as necessary, at the required number of locations in the windrow, to obtain the desired amount of material. The samples taken shall be combined.

6. SAMPLING FROM THE ROADWAY

6.1 In the case of sampling material in-place from the roadway, at least 3 samples shall be taken with a shovel at equally distributed locations across the width of the roadway. It may be necessary to use a hammer and chisel or similar tools to cut the hole in the compacted roadway. Care shall be taken to obtain all material from the hole which is dug. The samples taken shall be combined.

7. REDUCING FIELD SAMPLES TO TESTING SIZE

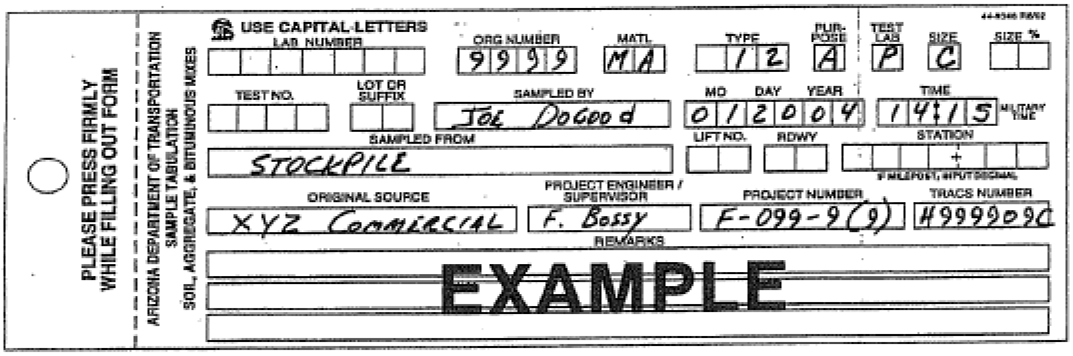
7.1 The reduction of samples to obtain the amount required for particular tests shall be performed in accordance with AASHTO T 248.

8. SAMPLE IDENTIFICATION

8.1 Each sample shall be identified by an accompanying ticket. Sample tickets shall be filled out as required to provide necessary information. The remarks area of the sample ticket should be used as necessary to provide additional information.

8.2 The source of the sample shall be the “original source” of the material, as indicated on the sample ticket.

8.3 An example of a completed sample ticket used by ADOT for construction projects is given below.



PLEASE PRESS FIRMLY
WHILE FILLING OUT FORM

ARIZONA DEPARTMENT OF TRANSPORTATION
SAMPLE TABULATION
SOIL, AGGREGATE, & BITUMINOUS MIXES

USE CAPITAL LETTERS

LAB NUMBER:
ORG NUMBER: 9999
MATL: MA
TYPE: 12
PURPOSE: A
TEST LAB: P
SIZE: C
SIZE %:

TEST NO.:
LOT OR SUFFIX:
SAMPLED BY: JOE DoGood
MO DAY YEAR: 01 20 04
TIME: 14:15 MILITARY TIME

SAMPLED FROM: STOCKPILE
LIFT NO.:
RDWY:
STATION: +
IF MILEPOST, INPUT DECIMAL

ORIGINAL SOURCE: XYZ COMMERCIAL
PROJECT ENGINEER / SUPERVISOR: F. Bossy
PROJECT NUMBER: F-099-9(9)
TRACS NUMBER: H999909C

REMARKS:

EXAMPLE

8.4 The sample ticket consists of three copies. The center copy in kept by the person submitting the sample, the original copy is included inside the sample container, and the third copy is attached to the sample container. When filling out sample tickets, make certain information is clear and easily read on all three copies.

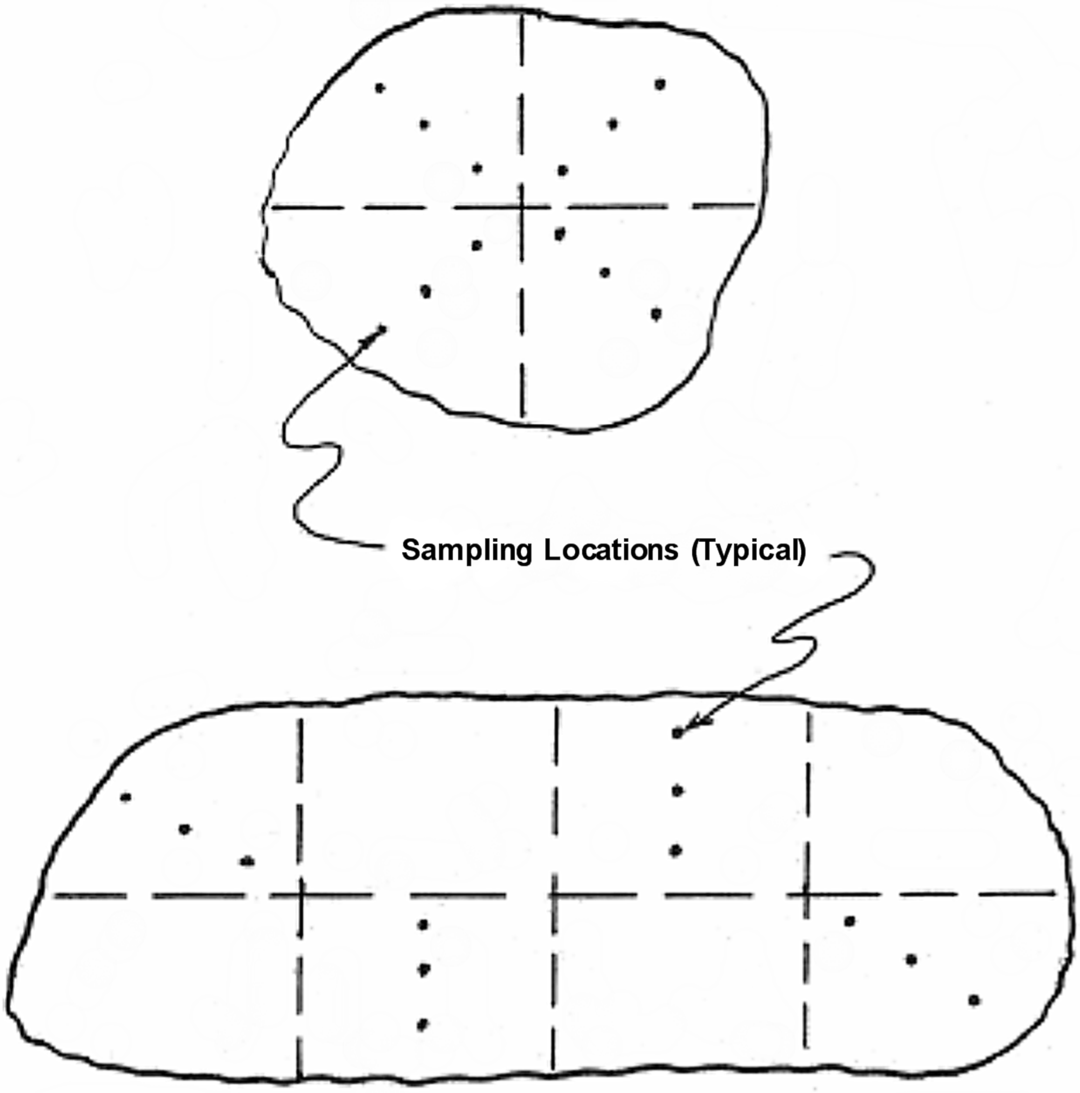
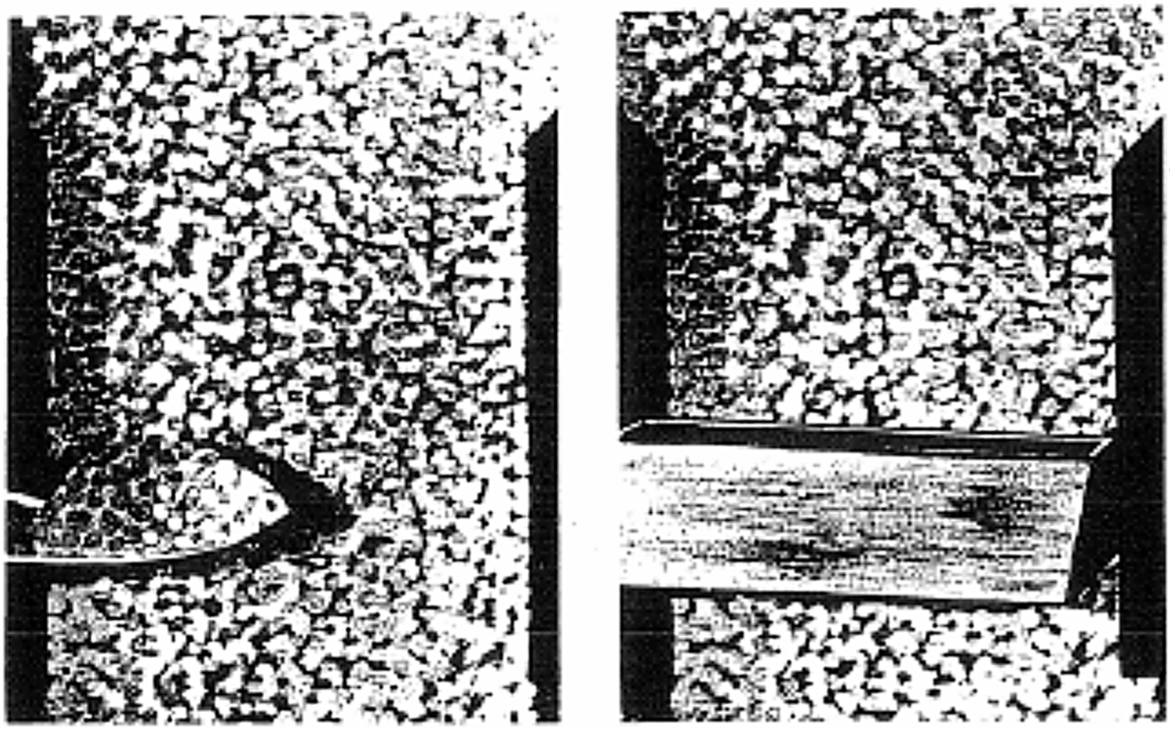


Illustration of Sampling Locations for Different Stockpile Types

FIGURE 1



WRONG

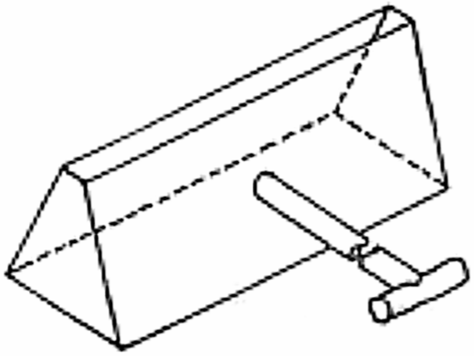
When aggregate is passed over a screen, the fines tend to drop through immediately and accumulate on one side of the hopper. A sample taken with a shovel or other small container will not be representative.

RIGHT

A sample taken by inserting the sampling device through the full flow of material will yield a representative sample. The restricted opening prevents the sampling device from filling all at once.

Illustration of Bin Sampling

FIGURE 2



Typical Bin Sampler

FIGURE 3

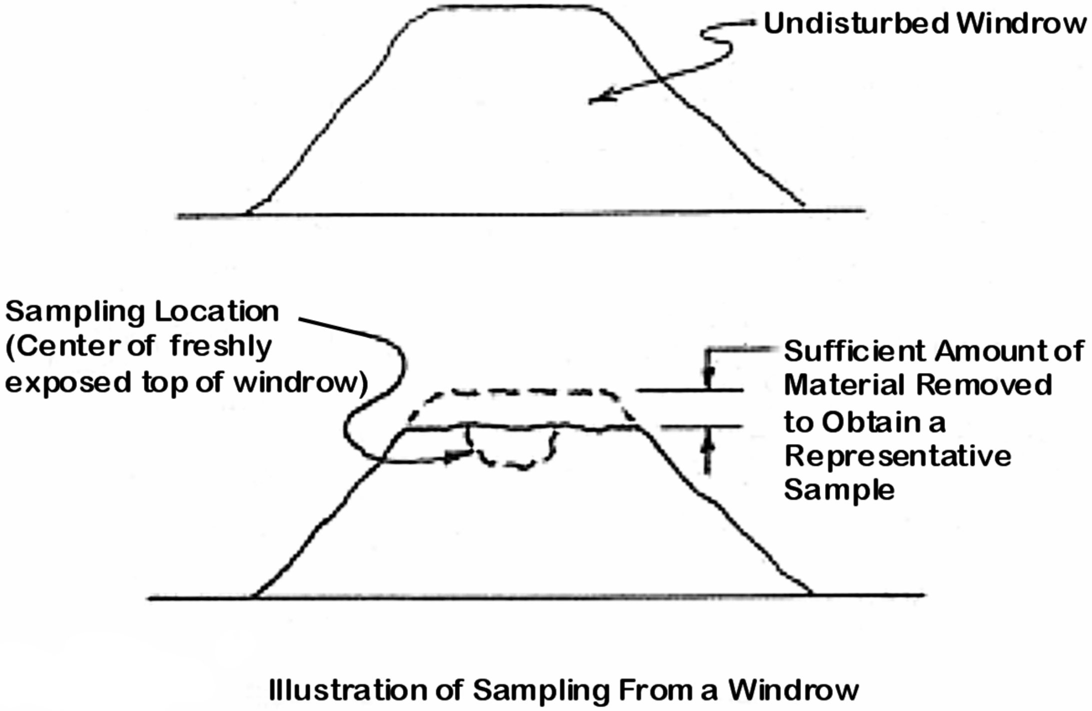


Illustration of Sampling From a Windrow

FIGURE 4

ARIZ 246b
April 19, 2013
(12 Pages)

MOISTURE - DENSITY RELATIONSHIP USING TYPICAL MOISTURE - DENSITY CURVES (ONE POINT PROCTOR) ALTERNATE METHOD D

(An Arizona Method)

1. SCOPE

1.1 This method of test is for the determination of the optimum moisture content and maximum dry density of a soil or soil-aggregate mixture utilizing one moisture-density determination on the portion of the sample passing the 3/4 inch sieve.

1.2 The one-point proctor is used with the typical moisture-density curves, shown on the back of the One Point Proctor Density Test Card (Figures 1 and 2); or by utilizing a family of moisture-density curves developed for the immediate local conditions.

1.3 This method is not to be used for volcanic cinders or light porous material on which the specific gravity cannot be determined with consistency or when the absorption of the coarse aggregate is greater than 4.0%.

1.4 This method may be used to determine if an existing proctor maximum density determination is valid for the soil being tested. If the existing proctor maximum density determination is not valid, a full proctor according to Arizona Test Method 245 should normally be run to determine the maximum density required for that soil type.

1.5 An example is provided in Section 7, and Figures 3 and 4, for the calculations and determinations referenced herein.

1.6 This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of who ever uses this test method to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. APPARATUS

2.1 The apparatus shall consist of the following:

2.1.1 The apparatus utilized for this test method shall conform to the apparatus requirements of Arizona Test Method 245.

2.1.1.1 Instead of the 230 ± 9 °F oven, a hot plate or stove capable of maintaining a temperature of approximately 230 °F may be used. A Speedy Moisture Tester with a conversion table or calibration curve may also be used for moisture determinations made in the field. Finally, a microwave oven may be used in accordance with Arizona Test Method 719.

2.1.1.2 Instead of the scale or balance capable of measuring the weight to be determined to at least one gram, a scale capable of measuring the weight to at least 0.01 pound may be utilized.

3. CALIBRATION OF MOLD

3.1 Molds shall be calibrated in accordance with APPENDIX A of Arizona Test Method 225.

4. SAMPLE

4.1 A representative sample of passing 3/4 inch material weighing approximately 5000 grams shall be obtained for each one-point proctor.

5. PROCEDURE

5.1 If the Speedy Moisture Tester is <u>not</u> to be used in making the moisture content determination, proceed to Subsection 5.4.

5.2 For testing performed in the field, the Speedy Moisture Tester (AASHTO T 217) may be used to make the moisture content determination. The approximate 5000 gram sample of pass 3/4 inch material is sieved over a No. 4 sieve. Calculate the percent of coarse aggregate or rock particles retained on the No. 4 sieve by the following:

$$\text{PR4} = \frac{\text{WR4}}{\text{WT}} \times 100$$

Where: PR4 = Percentage of coarse aggregate or rock particles retained on the No. 4 sieve.
WR4 = Weight of coarse aggregate or rock particles retained on the No. 4 sieve.
WT = Total Weight of material sieved.

5.3 Recombine and thoroughly blend the plus No. 4 material with the passing No. 4 material.

5.4 The approximate 5000 gram sample of passing 3/4 inch material shall be thoroughly mixed with sufficient water to bring the sample to slightly less than its optimum moisture content.

5.5 Form a specimen by compacting the prepared soil in the six inch mold (with extension collar attached) in three equal layers to give a total compacted depth of about 5 inches. Compact each layer with 56 uniformly distributed blows from the rammer, dropping free from a height of 12 inches. While each layer is being compacted, the remainder of material shall be in a pan covered by a damp cloth. During compaction, the mold shall rest firmly on a dense, uniform, rigid, and stable foundation.

Note: Each of the following has been found to be a satisfactory base on which to rest the mold during compaction of the soil: a block of concrete, weighing not less than 200 lbs., supported by a stable foundation; a sound concrete floor; and for field application, such surfaces as found in concrete box culverts, bridges, and pavements.

5.6 When compacting granular, free-draining materials, at moisture contents which are at or above optimum, the mold shall be prepared by first sealing the bottom of the mold with waterproofing grease. All excess grease shall be wiped from the mold and base plate.

5.7 Following compaction, carefully remove the extension collar. It may be necessary to use a follower to retain the soil in the mold while removing the collar to prevent damage or disturbance of the soil below the top of the mold. Carefully trim the compacted soil even with the top of the mold by means of the straightedge. If any voids are created during trimming, these shall be filled with fine material and smoothed off. Determine the weight of compacted specimen and mold. Determine the wet density, “WD”, of the compacted soil by the following:

$$\text{WD} = \frac{\text{M1} - \text{M2}}{\text{VM x } 453.6\ (\text{grams/lb.})\ *}$$

Where: WD = Wet density of compacted soil, lb./cu. ft.
M1 = Weight of compacted specimen and mold, grams or lbs.
M2 = Weight of the mold, grams or lbs.
VM = Volume of the mold, cu. ft. (See Section 3 of this procedure).

* If the weights of the compacted specimen and mold, M1, and the empty mold, M2, are measured in pounds, eliminate “453.6 (grams/lb.)” from the denominator of the above equation.

5.8 The moisture content of the sample is determined either by drying (See Subsection 5.9); or, when testing is performed in the field, the Speedy Moisture Tester may be used (See Subsection 5.10).

5.9 When the percent moisture is determined by drying, remove the material from the mold and slice vertically through the center. Take a representative minimum 600 gram sample from the full length and width of one of the cut faces. Record the weight of wet soil to the nearest 0.1 gram as “WW”. Dry the sample to constant weight at approximately 230 °F and record weight of dry soil to the nearest 0.1 gram as “DW”. The percent moisture shall be recorded to the nearest 0.1 percent. The equation below is used when the percent moisture is determined by drying the sample.

$$\%\,\text{Moisture} = \frac{\text{WW - DW}}{\text{DW}} \text{ x } 100$$

Where: WW = Wet weight of moisture sample.
DW = Dry weight of moisture sample.

5.10 For testing in the field, the percent moisture may be determined using the Speedy Moisture Tester. Remove the material from the mold and slice vertically through the center. Obtain a minimum of 600 grams of material from the full length and width of one of the cut faces. This material is screened over a No. 4 sieve as rapidly as possible to avoid drying of the sample. A representative sample of the pass No. 4 material shall be utilized and tested in accordance with the instructional manual for that apparatus. The percent moisture of the pass No. 4 material determined by the Speedy Moisture Tester is recorded to the nearest 0.1 percent as "W". The moisture content of the pass 3/4 inch material is determined and recorded as "TW" to the nearest 0.1 percent by the following:

$$\text{TW} = \frac{[\text{W}\ (100 - \text{PR4})] + \text{PR4}}{100}$$

Where: TW = % moisture in pass 3/4 material.
W = % moisture in pass No. 4 material (determined by Speedy).
PR4 = % rock retained on the No. 4 sieve (determined in Subsection 5.2).

6. MAXIMUM DENSITY DETERMINATION

6.1 The point representing the wet density and moisture content (dry basis) is then plotted on the Typical Moisture-Density Curves (Figure 2) and the maximum wet density and optimum moisture content determined. When this plotted point falls between two moisture-density curves, a minor interpolation is necessary. The maximum dry density in lb/cu. ft. and the corresponding percent optimum moisture is then read directly or interpolated from the chart. The family of typical moisture-density curves provided should be periodically verified for the local conditions. If it is ascertained that the family of curves provided by Figure 2 is of questionable reliability for given local conditions, then an independent family of curves should be established and used.

6.2 The plotted point for wet density and moisture content should be on the dry side of the curve at or near optimum, as it is difficult to interpolate between curves for friable soils when on the wet side of the peak.

6.3 If the plotted point representing the wet density and moisture content of the compacted material is on the right of the peak, the test should be repeated using a lower moisture content. An exception to this rule must be made for those soils having high clay contents and relatively flat curves. These soils cannot readily be dried to optimum in the field due to the creation of a cloddy condition which will cause voids in the proctor. Proctors for these materials should be made as near to optimum as possible.

7. EXAMPLE

7.1 An illustration of determining the maximum dry density and optimum moisture content is described below, and shown in Figures 3 and 4:

For:

Wet Density = 122.5 lb./cu. ft.
Moisture Content = 18.7%

By plotting this point on the Typical Moisture-Density Curves and interpolating to the peak, it shows a point which is approximately 20 percent of the distance from Curve P to Curve Q. From the chart, the dry density for Curve P is 104.7 lb./cu. ft. @ 19.2% moisture and the dry density for Curve Q is 102.4 lb./cu. ft. @ 20.3% moisture.

By interpolation:

Density: 104.7 - 102.4 = 2.3
0.20 X 2.3 = 0.5 lb./cu. ft. difference

Moisture: 20.3- 19.2 = 1.1
0.20 X 1.1 = 0.2% difference

Therefore:

Maximum dry density = 104.7 - 0.5
= 104.2 lb./cu. ft.

Optimum Moisture = 19.2 + 0.2 = 19.4%

7.1.1 As an alternate to performing the interpolation procedure above, TABLE 1 can be used to determine the maximum dry density and optimum moisture content when the plotted point falls between two moisture-density curves.

Note: The optimum moisture and maximum dry density determinations above are for the material passing the 3/4 inch sieve. When testing field samples for comparison to proctor optimum moisture and maximum dry density, a correction to the proctor optimum moisture and maximum dry density must be made, in accordance with Arizona Test Method 227, for the percent rock which the field sample contains.

8. REPORT

8.1 Record the moisture and density data on the laboratory test form along with the laboratory number, material source and type, and other information required.

TYPICAL MOISTURE-DENSITY TABLE

Curve Letter	Lb. Cu. Ft.	% Moist.	Curve Letter	Lb. Cu. Ft.	% Moist.	Curve Letter	Lb. Cu. Ft.	% Moist.	Curve Letter	Lb. Cu. Ft.	% Moist.	Curve Letter	Lb. Cu. Ft.	% Moist.
A	**141.8**	**6.6**	**F**	**129.3**	**9.7**	**K**	**117.0**	**13.5**	**P**	**104.7**	**19.2**	**U**	**92.1**	**25.8**
10%	141.5	6.7	**10%**	129.0	9.8	**10%**	116.8	13.6	**10%**	104.5	19.3	**10%**	91.9	26.0
20%	141.3	6.7	**20%**	128.8	9.9	**20%**	116.5	13.7	**20%**	104.2	19.4	**20%**	91.7	26.1
30%	141.0	6.8	**30%**	128.5	9.9	**30%**	116.3	13.8	**30%**	104.0	19.5	**30%**	91.4	26.3
40%	140.7	6.8	**40%**	128.2	10.0	**40%**	116.0	13.9	**40%**	103.8	19.6	**40%**	91.2	26.4
50%	140.5	6.9	**50%**	128.0	10.1	**50%**	115.8	14.1	**50%**	103.6	19.8	**50%**	91.0	26.6
60%	140.2	7.0	**60%**	127.7	10.2	**60%**	115.6	14.2	**60%**	103.3	19.9	**60%**	90.8	26.8
70%	139.9	7.0	**70%**	127.4	10.3	**70%**	115.3	14.3	**70%**	103.1	20.0	**70%**	90.6	26.9
80%	139.6	7.1	**80%**	127.1	10.3	**80%**	115.1	14.4	**80%**	102.9	20.1	**80%**	90.3	27.1
90%	139.4	7.1	**90%**	126.9	10.4	**90%**	114.8	14.5	**90%**	102.6	20.2	**90%**	90.1	27.2
B	**139.1**	**7.2**	**G**	**126.6**	**10.5**	**L**	**114.6**	**14.6**	**Q**	**102.4**	**20.3**	**V**	**89.9**	**27.4**
10%	138.8	7.3	**10%**	126.4	10.6	**10%**	114.3	14.7	**10%**	102.2	20.4	**10%**	89.7	27.6
20%	138.5	7.3	**20%**	126.1	10.6	**20%**	114.1	14.8	**20%**	101.9	20.5	**20%**	89.4	27.8
30%	138.3	7.4	**30%**	125.9	10.7	**30%**	113.8	15.0	**30%**	101.7	20.7	**30%**	89.2	28.0
40%	138.0	7.5	**40%**	125.6	10.8	**40%**	113.6	15.1	**40%**	101.4	20.8	**40%**	88.9	28.2
50%	137.7	7.6	**50%**	125.4	10.9	**50%**	113.3	15.2	**50%**	101.2	20.9	**50%**	88.7	28.5
60%	137.4	7.6	**60%**	125.2	10.9	**60%**	113.0	15.3	**60%**	100.9	21.0	**60%**	88.5	28.7
70%	137.1	7.7	**70%**	124.9	11.0	**70%**	112.8	15.4	**70%**	100.7	21.1	**70%**	88.2	28.9
80%	136.9	7.8	**80%**	124.7	11.1	**80%**	112.5	15.6	**80%**	100.4	21.3	**80%**	88.0	29.1
90%	136.6	7.8	**90%**	124.4	11.1	**90%**	112.3	15.7	**90%**	100.2	21.4	**90%**	87.7	29.3
C	**136.3**	**7.9**	**H**	**124.2**	**11.2**	**M**	**112.0**	**15.8**	**R**	**99.9**	**21.5**	**W**	**87.5**	**29.5**
10%	136.1	8.0	**10%**	124.0	11.3	**10%**	111.8	15.9	**10%**	99.7	21.6	**10%**	87.3	29.6
20%	135.9	8.0	**20%**	123.7	11.3	**20%**	111.5	16.0	**20%**	99.4	21.7	**20%**	87.0	29.7
30%	135.6	8.1	**30%**	123.5	11.4	**30%**	111.3	16.1	**30%**	99.2	21.9	**30%**	86.8	29.8
40%	135.4	8.1	**40%**	123.2	11.5	**40%**	111.0	16.2	**40%**	98.9	22.0	**40%**	86.5	29.9
50%	135.2	8.2	**50%**	123.0	11.6	**50%**	110.8	16.4	**50%**	98.7	22.1	**50%**	86.3	30.0
60%	135.0	8.3	**60%**	122.7	11.6	**60%**	110.6	16.5	**60%**	98.4	22.2	**60%**	86.0	30.1
70%	134.8	8.3	**70%**	122.5	11.7	**70%**	110.3	16.6	**70%**	98.2	22.3	**70%**	85.8	30.2
80%	134.5	8.4	**80%**	122.2	11.8	**80%**	110.1	16.7	**80%**	97.9	22.5	**80%**	85.5	30.3
90%	134.3	8.4	**90%**	122.0	11.8	**90%**	109.8	16.8	**90%**	97.7	22.6	**90%**	85.3	30.4
D	**134.1**	**8.5**	**I**	**121.7**	**11.9**	**N**	**109.6**	**16.9**	**S**	**97.4**	**22.7**	**X**	**85.0**	**30.5**
10%	133.9	8.6	**10%**	121.5	12.0	**10%**	109.4	17.0	**10%**	97.1	22.9	**10%**	84.8	30.6
20%	133.7	8.6	**20%**	121.2	12.1	**20%**	109.1	17.1	**20%**	96.8	23.0	**20%**	84.6	30.7
30%	133.5	8.7	**30%**	121.0	12.1	**30%**	108.9	17.3	**30%**	96.6	23.2	**30%**	84.4	30.8
40%	133.3	8.7	**40%**	120.7	12.2	**40%**	108.6	17.4	**40%**	96.3	23.4	**40%**	84.2	30.9
50%	133.1	8.8	**50%**	120.5	12.3	**50%**	108.4	17.5	**50%**	96.0	23.6	**50%**	84.0	31.0
60%	132.8	8.8	**60%**	120.3	12.4	**60%**	108.1	17.6	**60%**	95.7	23.7	**60%**	83.8	31.1
70%	132.6	8.9	**70%**	120.0	12.5	**70%**	107.9	17.7	**70%**	95.4	23.9	**70%**	83.6	31.2
80%	132.4	8.9	**80%**	119.8	12.5	**80%**	107.6	17.9	**80%**	95.2	24.1	**80%**	83.4	31.3
90%	132.2	9.0	**90%**	119.5	12.6	**90%**	107.4	18.0	**90%**	94.9	24.2	**90%**	83.2	31.4
E	**132.0**	**9.0**	**J**	**119.3**	**12.7**	**O**	**107.1**	**18.1**	**T**	**94.6**	**24.4**	**Y**	**83.0**	**31.5**
10%	131.7	9.1	**10%**	119.1	12.8	**10%**	106.9	18.2	**10%**	94.4	24.5	**10%**	82.8	31.6
20%	131.5	9.1	**20%**	118.8	12.9	**20%**	106.6	18.3	**20%**	94.1	24.7	**20%**	82.6	31.7
30%	131.2	9.2	**30%**	118.6	12.9	**30%**	106.4	18.4	**30%**	93.9	24.8	**30%**	82.4	31.8
40%	130.9	9.3	**40%**	118.4	13.0	**40%**	106.1	18.5	**40%**	93.6	25.0	**40%**	82.2	31.9
50%	130.7	9.4	**50%**	118.2	13.1	**50%**	105.9	18.7	**50%**	93.4	25.1	**50%**	82.1	32.0
60%	130.4	9.4	**60%**	117.9	13.2	**60%**	105.7	18.8	**60%**	93.1	25.2	**60%**	81.9	32.1
70%	130.1	9.5	**70%**	117.7	13.3	**70%**	105.4	18.9	**70%**	92.9	25.4	**70%**	81.7	32.2
80%	129.8	9.6	**80%**	117.5	13.3	**80%**	105.2	19.0	**80%**	92.6	25.5	**80%**	81.5	32.3
90%	129.6	9.6	**90%**	117.2	13.4	**90%**	104.9	19.1	**90%**	92.4	25.7	**90%**	81.3	32.4
F	**129.3**	**9.7**	**K**	**117.0**	**13.5**	**P**	**104.7**	**19.2**	**U**	**92.1**	**25.8**	**Z**	**81.1**	**32.5**

TABLE 1

ONE POINT PROCTOR DENSITY

Lab. No: ______________________ Org No.: ________________ Date: __________________
Project No. ________________________________ TRACS No. __________________________
Original Source: ____________________________ Type of Material: ______________________
Coarse Agg. % Absorp.: ________________ Coarse Agg. Bulk O.D. Sp. Gr.: _________________
Proctor Method Used: Method A ________________ Alternate Method D ____________________
Test Operator: ____ Date: __________________
Supervisor: ____ Date: __________________

Wet Density Determination

Volume of Mold = VM = ______________________ cu. ft.
Weight of Mold = M2 = __________ grams ________ pounds
Weight of Sample and Mold = M1 = __________ grams ________ pounds

$$\text{Wet Density} = \text{WD} = \frac{\text{M1} - \text{M2}}{\text{VM} \times 453.6\ (\text{grams/lb.})^{*}} = \underline{\hspace{6em}}\ \text{lb./cu.ft.}$$

*If M1 and M2 are in pounds, eliminate "453.6 (grams/lb.)" from denominator in above equation.

Percent Moisture Determination

For either Method A or Alternate Method D, when sample is oven dried:

Wet Weight of Moisture Sample = WW = ___________ grams
Dry Weight of Moisture Sample = DW = ___________ grams

$$\%\ \text{Moisture} = \frac{\text{WW} - \text{DW}}{\text{DW}} \times 100 = \underline{\hspace{4em}}\,\%$$

For Method A, when Speedie Moisture Tester is used:

% Moisture = ___________________ %

For Alternate Method D, when Speedie Moisture Tester is used:

WT = _____________ WR4 = ____________ PR4 = $\frac{WR4}{WT} \times 100$ = __________ %

% Moisture in Pass No. 4 material from Speedie = W = _____________ %

$$\text{Total \% Moisture} = \text{TW} = \frac{[\text{W}(100 - \text{PR4})] + \text{PR4}}{100} = \underline{\hspace{6em}}\,\%$$

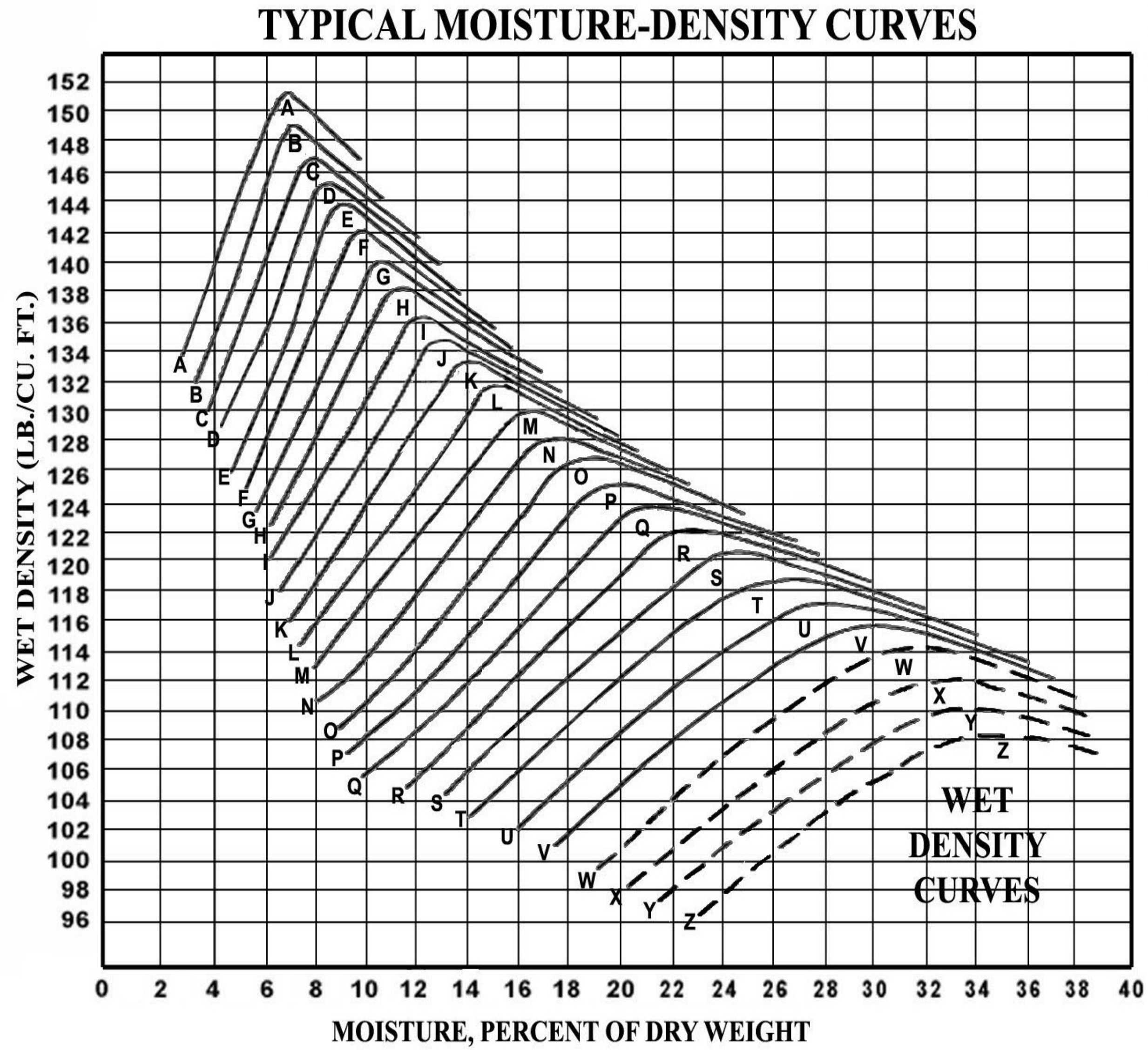
From Typical Moisture-Density Curves:

Maximum Dry Density = MD = _________ lb./cu. ft.
Percent Optimum Moisture = OM = _________ %

REMARKS: ____
____
____
____

FIGURE 1

FIGURE 2



Curve	Max Dry Wt. lbs/cu.ft.	Optimum Moisure
A	141.8	6.6
B	139.1	7.2
C	136.3	7.9
D	134.1	8.5
E	132.	9.0
F	129.3	9.7
G	126.6	10.5
H	124.2	11.2
I	121.7	11.9
J	119.3	12.7
K	117.0	13.5
L	114.6	14.6
M	112.0	15.8
N	109.6	16.9
O	107.1	18.1
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

ONE POINT PROCTOR DENSITY

Lab. No: ____________ Org No.: ____________ Date: ____________
Project No. ____________ TRACS No. ____________
Original Source: ____________ Type of Material: ____________
Coarse Agg. % Absorp.: ____________ Coarse Agg. Bulk O.D. Sp. Gr.: ____________
Proctor Method Used: Method A ____________ Alternate Method D **X**
Test Operator: ____________ Date: ____________
Supervisor: ____________ Date: ____________

Wet Density Determination

Volume of Mold = VM = **0.0758** cu. ft.
Weight of Mold = M2 = **6608** grams ________ pounds
Weight of Sample and Mold = M1 = **10820** grams ________ pounds

$$\text{Wet Density} = WD = \frac{M1 - M2}{VM \times 453.6 \text{ (grams/lb.)*}} = \underline{\mathbf{122.5}} \text{ lb./cu.ft.}$$

*If M1 and M2 are in pounds, eliminate “453.6 (grams/lb.)” from denominator in above equation.

Percent Moisture Determination

For either Method A or Alternate Method D, when sample is oven dried:

Wet Weight of Moisture Sample = WW = ________ grams
Dry Weight of Moisture Sample = DW = ________ grams

$$\% \text{ Moisture} = \frac{WW - DW}{DW} \times 100 = \underline{\quad\quad} \%$$

For Method A, when Speedie Moisture Tester is used:

% Moisture = ____________ %

For Alternate Method D, when Speedie Moisture Tester is used:

WT = **5736** WR4 = **1274** PR4 = $\frac{WR4}{WT} \times 100$ = **22** %

% Moisture in Pass No. 4 material from Speedie = W = **23.7** %

$$\text{Total \% Moisture} = TW = \frac{[W(100 - PR4)] + PR4}{100} = \underline{\mathbf{18.7}} \%$$

From Typical Moisture-Density Curves:

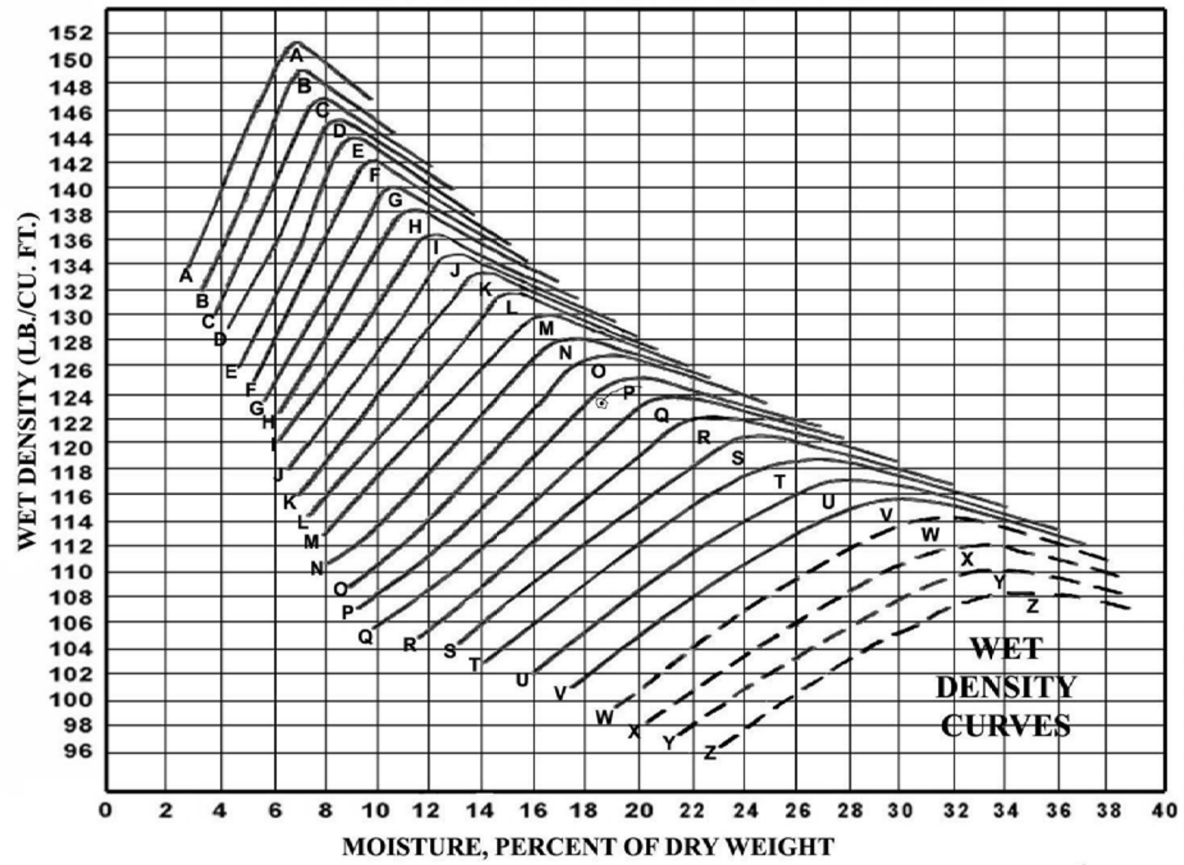
Maximum Dry Density = MD = **104.2** lb./cu. ft.
Percent Optimum Moisture = OM = **19.4** %

REMARKS: ____________

FIGURE 3

FIGURE 4

TYPICAL MOISTURE-DENSITY CURVES



Curve	Max Dry Wt. lbs/cu.ft.	Optimum Moisure
A	141.8	6.6
B	139.1	7.2
C	136.3	7.9
D	134.1	8.5
E	132.	9.0
F	129.3	9.7
G	126.6	10.5
H	124.2	11.2
I	121.7	11.9
J	119.3	12.7
K	117.0	13.5
L	114.6	14.6
M	112.0	15.8
N	109.6	16.9
O	107.1	18.1
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

Approx. 20% Below Curve P

Interpolated Max. Dry Density: 104.7 (Curve P)
- 102.4 (Curve Q)
2.3 X 0.20 = 0.5 lb./cu. ft. *104.7 - 0.5 = 104.2 lb. / cu. ft.*

Interpolated % Optimum Moisture: 20.3 (Curve Q)
- 19.2 (Curve P)
1.1 X 0.20 = 0.2% *19.2 + 0.2 = 19.4%*

ARIZ 417d
April 19, 2013
(10 Pages)

MAXIMUM THEORETICAL SPECIFIC GRAVITY AND DENSITY OF FIELD PRODUCED BITUMINOUS MIXTURES (RICE TEST)

(A Modification of AASHTO T 209)

1. SCOPE

1.1 This method of test is intended for determining the maximum specific gravity and density of uncompacted bituminous mixtures that have been field produced.

Note: Two methods are provided for determining the maximum specific gravity. The method given in Section 6 is for determining results without fan drying the samples. Section 7 describes the procedure which is used when fan drying is necessary. For the first four samples taken at the beginning of production on a project the maximum specific gravity shall be determined in accordance with Section 6 and also shall be fan dried and maximum specific gravity determined in accordance with Section 7. If the difference in resultant air voids, when determined as described in Arizona Test Method 424 is greater than 0.2% subsequent samples will be subjected to fan drying. During the course of the project comparisons should be made on approximate 10 sample intervals to determine need for fan drying. In case of dispute, fan drying shall be used.

1.2 This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

1.3 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

Note: Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual.

2.1 Balance - A balance capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance utilized shall be at least 0.1 gram.

2.2 Container - A heavy walled Erlenmeyer flask having a capacity of at least 1500 mL and strong enough to withstand a partial vacuum; the cover shall consist of a rubber stopper with a tight hose connection. A small piece of No. 200 wire mesh covering the hose opening shall be used to minimize the possibility of loss of fine material.

Note: If a procedure which subjects multiple flasks to a vacuum simultaneously is used, the vacuum gauge shall be placed beyond the last bottle to insure that all the bottles are being subjected to the same amount of vacuum.

2.3 Flat glass plate large enough to cover mouth of the flask.

2.4 Vacuum pump for evacuating air from the container.

2.5 All water used in this procedure shall be distilled or de-mineralized water.

3. CALIBRATION OF FLASK

3.1 Record the weight of the flask and flat glass plate separately to the nearest 0.1 gram on the work card. Using water at a temperature of 77 ± 1 °F, fill the flask to approximately 90% full. Using a long narrow rod, remove air bubbles adhering to the walls of the flask. Confirm that the temperature of the water is at 77 ± 1 °F. Fill to the top and slide the flat glass plate over the mouth of the flask. Verify that no air is trapped under the flat glass plate. Dry the outside of the flask and glass plate and weight to the nearest 0.1 gram. Subtract the weight of the glass plate and record the weight of the “flask and water” as "B".

4. PREPARATION OF SAMPLES

4.1 Obtain 3 representative 1050 ± 50 gram samples of the material, as described in Arizona Test Method 416.

Note: If necessary, heat the sample for not more than one hour at a maximum temperature of 285 °F ONLY until it is pliable enough to allow separation of the coated aggregate.

4.2 Spread each sample on a sheet of heavy paper or in a large flat bottom pan. Before the samples are completely cooled, separate the particles of the mixture, taking care not to fracture the coarse aggregate particles, so that the particles of the fine aggregate portion are not larger than 1/4 inch. Allow the samples to cool to room temperature.

5. PROCEDURE

5.1 Place the sample in the flask and determine the weight to the nearest 0.1 gram. Subtract the weight of the flask and record the “weight of sample in air" as "Wmm".

5.2 Add sufficient water to cover the sample. The water shall be at a temperature of approximately 77 °F and shall have been treated with a wetting agent.

Note: Aerosol OT in a concentration of 0.01%, or one mL of 10% solution per 1000 mL of water, has been found to be a suitable wetting agent and shall be used to facilitate the release of entrapped air.

5.3 Remove entrapped air by subjecting the contents of the flask to a partial vacuum with a minimum of 20 inches of mercury (gauge) for 15 ± 2 minutes, agitating the contents of the flask four times at evenly spaced intervals throughout this period.

CAUTION: Do not agitate the sample too frequently or vigorously, as that can cause stripping of the asphalt film from some particles, resulting in erroneous specific gravities.

5.4 After the evacuation period, fill the flask with water to approximately one inch below the top of the flask. Gently stir the sample with a long narrow rod in such a way to release any trapped air bubbles, avoiding breakage of the aggregates. Using the long narrow rod, carefully remove any air bubbles adhering to the walls of the flask. Fill completely to the top and confirm that the temperature is at 77 ± 2 °F. Slide the pre-weighed flat glass plate over the mouth of the flask. Verify that no air is trapped under the flat glass plate. Dry the outside of the flask and glass plate and weigh immediately to the nearest 0.1 gram. Subtract the weight of the glass plate and record the weight of the "flask + water + sample" as "C".

6. CALCULATIONS

6.1 The Volume of Voidless Mix, "Vvm", in mL, is determined for each sample by the following:

$$\text{Vvm} = \text{Wmm} + \text{B} - \text{C}$$

Where: Wmm = Wt. of Sample in Air
B = Wt. of Flask + Water
C = Wt. of Flask + Water + Sample

6.2 The Maximum Specific Gravity, "Gmm", is determined for each sample by the following:

$$\text{Gmm} = \frac{\text{Wmm}}{\text{Vvm}}$$

6.3 Compare the three individual values for maximum specific gravity. If the range of the three is within 0.024, all are used to determine the average maximum specific gravity as shown in Subsection 6.4. If the range is greater than 0.024, the average of two may be used if they are within a range of 0.012. If values are not achieved within the above criteria, the samples shall be discarded and a set of three new samples shall be tested. If material is not available, results should be used cautiously in the analysis of the bituminous mix. If results are used for specification compliance, additional material must be obtained for retesting.

6.4 The average maximum specific gravity of the bituminous mix is determined for the samples with acceptable maximum specific gravity values, and recorded to the nearest 0.001.

6.5 To determine the maximum density, the average maximum specific gravity is multiplied by 62.3 lbs./cu. ft.

7. PROCEDURE FOR FAN DRYING SAMPLES

7.1 The entire contents of the flask shall be poured into a nest of sieves consisting of a No. 40 and a No. 200 screen.

Note: If stripping has occurred, as evidenced by discoloration of water in the flask, significant loss of Minus No. 200 material may be expected. Provisions for the recovery and addition of this material to the Plus No. 200 material shall be made.

7.2 Allow the mix to drain through the sieves until excess moisture is removed from the mix. Separate the sieves and place both sieves in a tared pan. Place the pan in front of a fan (see Note below) and dry the material retained on the No. 40 and No. 200 sieves until the material can be easily removed from the sieves. Remove the material from the sieves and spread it in the pan. Determine and record the initial weight of the pan and the material.

Note: The air through the fan shall be at room temperature and no heat shall be used to dry the material.

7.3 Continue fan drying the material, determining and recording the weight of the pan and the material at 15 minute intervals. When the weight loss is 0.5 gram or less for a 15 minute interval, the mix is considered to be surface dry. Record the surface dry weight as "Wsd". Intermittent stirring of the sample is required during the drying period. Conglomerations of the mix shall be broken by hand. Care must be taken to prevent loss of particles of the mixture.

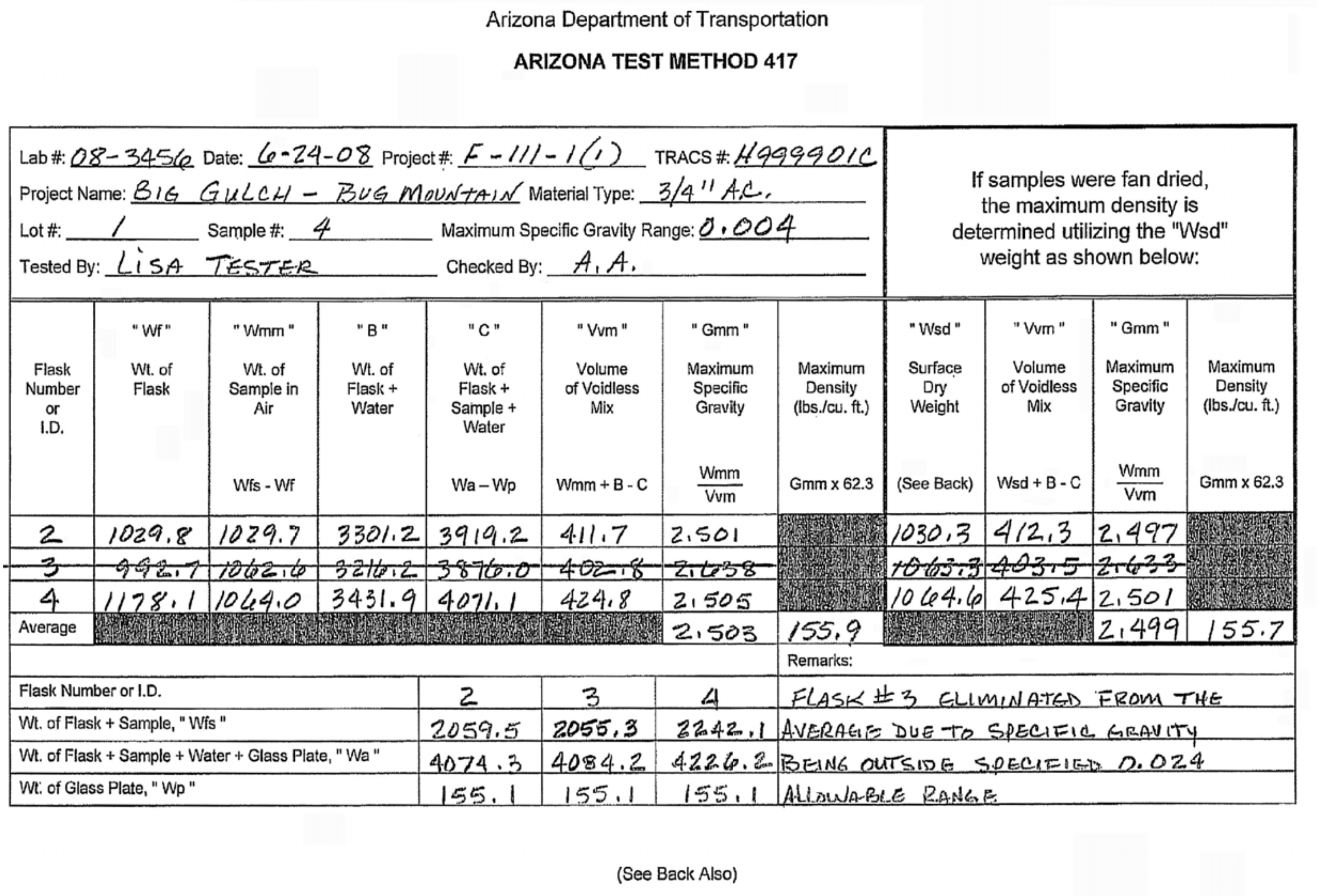
Note: If the "Wsd" weight for any of the three samples is less than its corresponding "Wmm" weight, the samples shall be discarded and a set of three new samples shall be tested. If material is not available, the maximum specific gravity shall be determined utilizing the "Wmm" weight and results should be used cautiously in the analysis of the bituminous mix. If results are used for specification compliance, additional material must be obtained for retesting.

7.4 To calculate the "Vvm" and maximum specific gravity, "Gmm", of each sample, the surface dry weight, "Wsd", is substituted for "Wmm" only in the equation given for "Vvm" in Subsection 6.1.

8. EXAMPLE

8.1 Examples of the calculations are shown in Figures 1 and 2.

8.2 Figures 3 and 4 are illustrations of the front and back of a blank form.



Arizona Department of Transportation

ARIZONA TEST METHOD 417

Lab #: 08-3456 Date: 6-24-08 Project #: F-111-1(1) TRACS #: H999901C
Project Name: BIG GULCH – BUG MOUNTAIN Material Type: 3/4" A.C.
Lot #: 1 Sample #: 4 Maximum Specific Gravity Range: 0.004
Tested By: LISA TESTER Checked By: A.A.

If samples were fan dried, the maximum density is determined utilizing the "Wsd" weight as shown below:

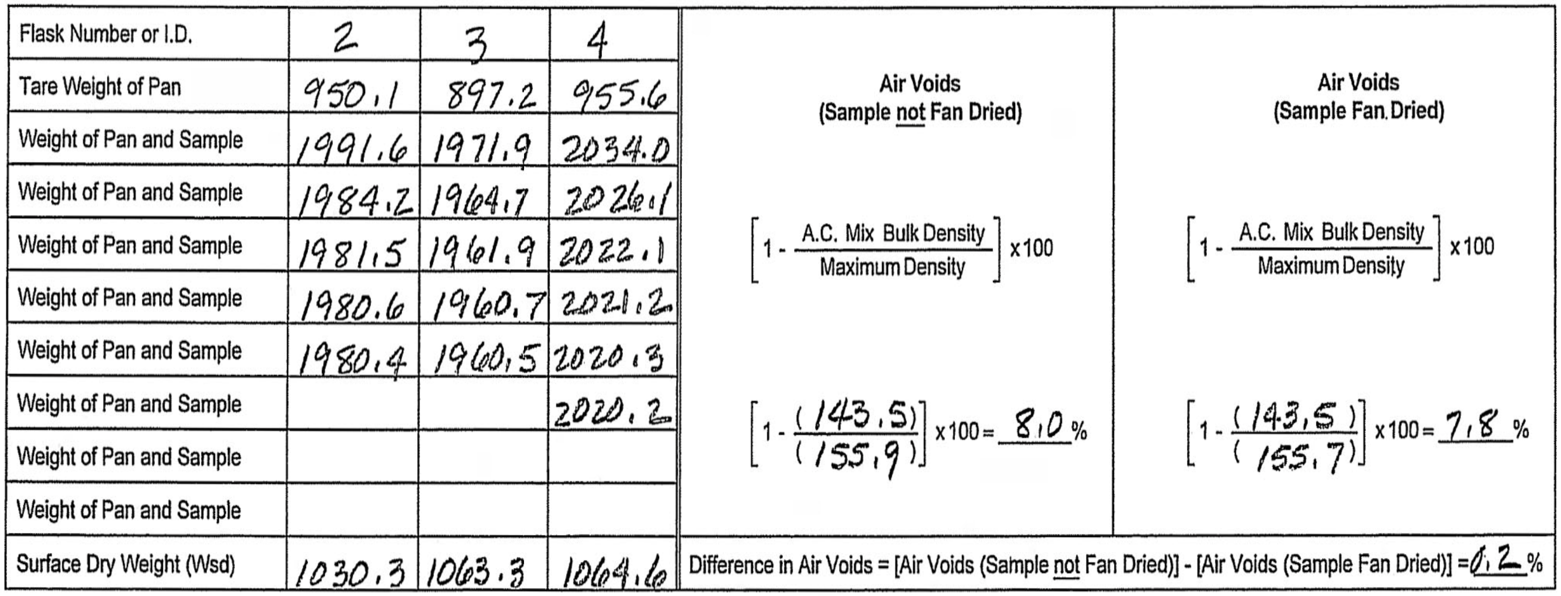
Flask Number or I.D.	" Wf " Wt. of Flask	" Wmm " Wt. of Sample in Air Wfs - Wf	" B " Wt. of Flask + Water	" C " Wt. of Flask + Sample + Water Wa – Wp	" Vvm " Volume of Voidless Mix Wmm + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3	" Wsd " Surface Dry Weight (See Back)	" Vvm " Volume of Voidless Mix Wsd + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3
2	1029.8	1029.7	3301.2	3919.2	411.7	2.501		1030.3	412.3	2.497	
~~3~~	~~992.7~~	~~1062.6~~	~~3216.2~~	~~3876.0~~	~~402.8~~	~~2.638~~		~~1063.3~~	~~403.5~~	~~2.633~~	
4	1178.1	1064.0	3431.9	4071.1	424.8	2.505		1064.6	425.4	2.501	
Average						2.503	155.9			2.499	155.7

				Remarks:
Flask Number or I.D.	2	3	4	FLASK #3 ELIMINATED FROM THE
Wt. of Flask + Sample, " Wfs "	2059.5	2055.3	2242.1	AVERAGE DUE TO SPECIFIC GRAVITY
Wt. of Flask + Sample + Water + Glass Plate, " Wa "	4074.3	4084.2	4226.2	BEING OUTSIDE SPECIFIED 0.024
Wt. of Glass Plate, " Wp "	155.1	155.1	155.1	ALLOWABLE RANGE

(See Back Also)

Figure 1

44-3941 R11/02



Flask Number or I.D.	2	3	4
Tare Weight of Pan	950.1	897.2	955.6
Weight of Pan and Sample	1991.6	1971.9	2034.0
Weight of Pan and Sample	1984.2	1964.7	2026.1
Weight of Pan and Sample	1981.5	1961.9	2022.1
Weight of Pan and Sample	1980.6	1960.7	2021.2
Weight of Pan and Sample	1980.4	1960.5	2020.3
Weight of Pan and Sample			2020.2
Weight of Pan and Sample			
Weight of Pan and Sample			
Surface Dry Weight (Wsd)	1030.3	1063.3	1064.6

Air Voids
(Sample not Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(143.5)}{(155.9)}\right] \times 100 = 8.0\ \%$$

Air Voids
(Sample Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(143.5)}{(155.7)}\right] \times 100 = 7.8\ \%$$

Difference in Air Voids = [Air Voids (Sample not Fan Dried)] - [Air Voids (Sample Fan Dried)] = 0.2 %

Figure 2

44-3941 R11/02 (Back)

Arizona Department of Transportation

ARIZONA TEST METHOD 417

Lab #: ____________ Date: ____________ Project #: ________________ TRACS #: ____________

Project Name: ________________________________ Material Type: ________________

Lot #: ____________ Sample #: ____________ Maximum Specific Gravity Range: ____________

Tested By: ________________________ Checked By: ________________________

If samples were fan dried, the maximum density is determined utilizing the "Wsd" weight as shown below:

Flask Number or I.D.	" Wf " Wt. of Flask	" Wmm " Wt. of Sample in Air Wfs - Wf	" B " Wt. of Flask + Water	" C " Wt. of Flask + Sample + Water Wa – Wp	" Vvm " Volume of Voidless Mix Wmm + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3	" Wsd " Surface Dry Weight (See Back)	" Vvm " Volume of Voidless Mix Wsd + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3
							▨				▨
							▨				▨
							▨				▨
Average	▨	▨	▨	▨	▨			▨	▨		

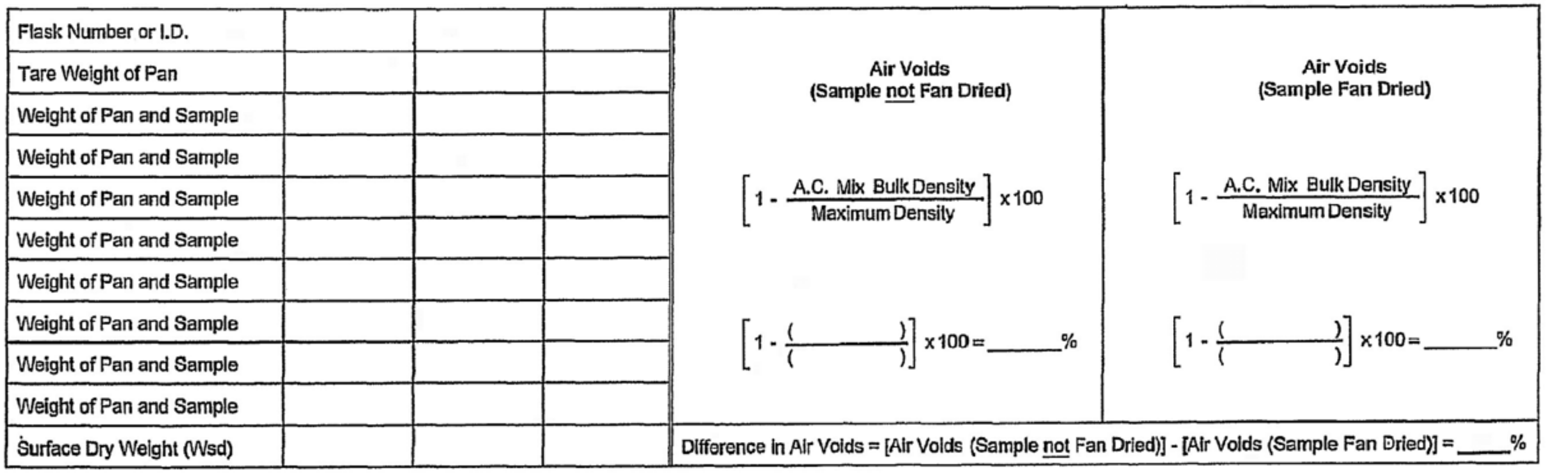
Flask Number or I.D.			
Wt. of Flask + Sample, " Wfs "			
Wt. of Flask + Sample + Water + Glass Plate, " Wa "			
Wt. of Glass Plate, " Wp "			

Remarks:

(See Back Also)

Figure 3

44-3941 R11/02



Flask Number or I.D.			
Tare Weight of Pan			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Weight of Pan and Sample			
Surface Dry Weight (Wsd)			

Air Voids
(Sample <u>not</u> Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(\qquad)}{(\qquad)}\right] \times 100 = \_\_\_\_\_\%$$

Air Voids
(Sample Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(\qquad)}{(\qquad)}\right] \times 100 = \_\_\_\_\_\%$$

Difference in Air Voids = [Air Voids (Sample <u>not</u> Fan Dried)] - [Air Voids (Sample Fan Dried)] = _____%

Figure 4

44-3941 R11/02 (Back)

ADOT
Intermodal Transportation

ARIZ 424c
April 19, 2013
(6 Pages)

DETERMINATION OF AIR VOIDS IN COMPACTED BITUMINOUS MIXTURES

(A Modification of AASHTO Designation T 269)

1. SCOPE

1.1 This procedure is used to determine the air voids in compacted bituminous mixtures. It is applicable for specimens which are either laboratory compacted or field compacted (for example, cores).

1.2 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. CALCULATION

2.1 For specimens which are either Marshall laboratory compacted or field compacted (e.g., cores), the percent air voids shall be calculated using the bulk density of the compacted bituminous mixture (Arizona Test Method 415) and maximum density of the mixture from the Rice Test (Arizona Test Method 417).

2.1.1 The percent air voids are calculated by the following equation:

$$\text{Percent Air Voids} = \left[1 - \frac{\text{Bulk Density}}{\text{Maximum Density}}\right] \text{ x } 100$$

2.1.1.1 An example of the calculations is given in Figure 1.

2.1.1.2 A blank form for perfoming the calculations is given in Figure 3.

2.2 For specimens which are gyratory laboratory compacted, the percent air voids shall be calculated using the average relative density of the compacted bituminous mixture at N_{design} (AASHTO T 312).

2.2.1 The percent air voids are calculated by the following equation:

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{design})

2.2.1.1 An example of the calculations is given in Figure 2.

2.2.1.2 A blank form for perfoming the calculations is given in Figure 4.

3. REPORT

3.1 The percent air voids shall be reported to the nearest 0.1%.

CALCULATION OF AIR VOIDS FOR MARSHALL LABORATORY COMPACTED SPECIMENS OR FIELD COMPACTED SPECIMENS

Specimens Compacted by: Hand ☐ Mechanical ☒ 4 inch ☒ 6 inch ☐; Core ☐

Specimen I.D.	1	2	3	Average
Specimen Height	2.516	2.515	2.519	
Bulk Specific Gravity, Bulk Density, and Absorption (Arizona Test Method 415: Method A ☒ or Method C ☐)				
A = Mass in grams of specimen in Air	1155.9	1155.4	1158.2	
B = Mass in grams of SSD specimen in Air	1156.9	1156.3	1159.2	
C = Mass in grams of specimen in Water	647.9	649.6	651.8	
G_{mb} = Bulk Specific Gravity = A/(B – C)	2.271	2.280	2.283	2.283
% Absorption = [(B – A)/(B – C)] x 100	0.20	0.18	0.20	
Bulk Density = (G_{mb} x 62.3 lbs./cu. ft.)	141.4	142.0	142.2	
Range of Bulk Density values (lbs./cu. ft.)	0.8			
Average Bulk Density = (Average G_{mb} x 62.3 lbs./cu. ft)				142.2
Maximum Density (lbs./cu. ft.) [from Rice Test]	149.4			

Notes:

The Individual specimen heights are reported to the nearest 0.001 inch.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The average bulk specific gravity is calculated, and reported to the nearest 0.001, using the individual bulk specific gravities which have been reported to the nearest 0.001.

The individual bulk densities are reported to the nearest 0.1 lb./cu. ft.

The average bulk density is reported to the nearest 0.1 lb./cu. ft.

The maximum density [from Rice Test] is reported to the nearest 0.1 lb./cu. ft.

$$\textbf{Percent Air Voids} = \left[1 - \frac{\textbf{Average Bulk Density}}{\textbf{Maximum Density from Rice Test}}\right] \times 100 = \left[1 - \frac{142.2}{149.4} \times 100\right] = 4.8\%$$

**EXAMPLE AIR VOIDS CALCULATION FOR
MARSHALL LABORATORY COMPACTED SPECIMENS**

FIGURE 1

CALCULATION OF AIR VOIDS FOR GYRATORY LABORATORY COMPACTED SPECIMENS

Specimen I.D.	1	2	Average
h_{ini} = Height, in mm, of specimen at N_{ini} (8 gyrations)	128.7	129.3	
h_{des} = Height, in mm, of specimen at N_{des} (100 gyrations)	117.0	117.4	
h_{max} = Height, in mm, of specimen at N_{max} (160 gyrations)	115.6	116.0	
Bulk Specific Gravity and Absorption (Arizona Test Method 415: Method A ☒ or Method C ☐)			
A = Mass, in grams, of specimen at N_{max} in Air	4747.4	4744.6	
B = Mass, in grams, of SSD specimen at N_{max} in Air	4759.4	4756.0	
C = Mass, in grams, of specimen at N_{max} in Water	2752.7	2751.2	
G_{mb} = Bulk Specific Gravity of specimen at N_{max} $= \frac{A}{B - C}$	2.366	2.367	
% Absorption = [(B – A)/(B – C)] x 100	0.60	0.57	
G_{mm} = Maximum Specific Gravity [from Rice Test]	2.449		
*Relative Density, %G_{mm}, of specimen at N_{ini}	86.8	86.7	86.8
*Relative Density, %G_{mm}, of specimen at N_{des}	95.5	95.5	95.5
*Relative Density, %G_{mm}, of specimen at N_{max}	96.6	96.7	96.7

$$* \text{Relative Density}, \% G_{mmx} = \frac{(G_{mb}) \times (h_{max})}{(G_{mm}) \times (h_x)} \times 100$$

Where: $\%G_{mmx}$ = Relative Density, %G_{mm}, of specimen at N_{ini}, N_{des}, or N_{max}
G_{mb} = Bulk Specific Gravity of specimen at N_{max}
h_{max} = Height, in mm, of specimen at N_{max}
G_{mm} = Maximum Specific Gravity [from Rice Test]
h_x = Height of specimen, in mm, at N_{ini}, N_{des}, or N_{max}

Notes:

The Individual specimen heights are reported to the nearest 0.1 mm.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The maximum specific gravity [from Rice Test] is reported to the nearest 0.001.

The individual relative densities are reported to the nearest 0.1 percent.

The average relative density for each set of specimens (at N_{ini}, N_{des}, and N_{max}) is calculated, and reported to the nearest 0.1 percent, using the corresponding individual relative densities which have been reported to the nearest 0.1 percent.

Three specimens are used when referee testing is performed.

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{des})

= 100 – 95.5 = 4.5%

EXAMPLE AIR VOIDS CALCULATION FOR GYRATORY LABORATORY COMPACTED SPECIMENS

FIGURE 2

CALCULATION OF AIR VOIDS FOR MARSHALL LABORATORY COMPACTED SPECIMENS OR FIELD COMPACTED SPECIMENS

Specimens Compacted by: Hand ☐ Mechanical ☐ 4 inch ☐ 6 inch ☐; Core ☐

Specimen I.D.				Average
Specimen Height				
Bulk Specific Gravity, Bulk Density, and Absorption (Arizona Test Method 415: Method A ☐ or Method C ☐)				
A = Mass in grams of specimen in Air				
B = Mass in grams of SSD specimen in Air				
C = Mass in grams of specimen in Water				
G_{mb} = Bulk Specific Gravity = A/(B – C)				
% Absorption = [(B – A)/(B – C)] x 100				
Bulk Density = (G_{mb} x 62.3 lbs./cu. ft.)				
Range of Bulk Density values (lbs./cu. ft.)				
Average Bulk Density = (Average G_{mb} x 62.3 lbs./cu. ft)				
Maximum Density (lbs./cu. ft.) [from Rice Test]				

Notes:

The Individual specimen heights are reported to the nearest 0.001 inch.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The average bulk specific gravity is calculated, and reported to the nearest 0.001, using the individual bulk specific gravities which have been reported to the nearest 0.001.

The individual bulk densities are reported to the nearest 0.1 lb./cu. ft.

The average bulk density is reported to the nearest 0.1 lb./cu. ft.

The maximum density [from Rice Test] is reported to the nearest 0.1 lb./cu. ft.

$$\textbf{Percent Air Voids} = \left[1 - \frac{\textbf{Average Bulk Density}}{\textbf{Maximum Density from Rice Test}}\right] \times 100 = \left[1 - \frac{(\qquad)}{(\qquad)} \times 100\right] = \_\_\_\%$$

FIGURE 3

CALCULATION OF AIR VOIDS FOR GYRATORY LABORATORY COMPACTED SPECIMENS

Specimen I.D.			Average
h_{ini} = Height, in mm, of specimen at N_{ini} (8 gyrations)			
h_{des} = Height, in mm, of specimen at N_{des} (100 gyrations)			
h_{max} = Height, in mm, of specimen at N_{max} (160 gyrations)			
Bulk Specific Gravity and Absorption (Arizona Test Method 415: Method A ☐ or Method C ☐)			
A = Mass, in grams, of specimen at N_{max} in Air			
B = Mass, in grams, of SSD specimen at N_{max} in Air			
C = Mass, in grams, of specimen at N_{max} in Water			
G_{mb} = Bulk Specific Gravity of specimen at N_{max} $= \frac{A}{B - C}$			
% Absorption = [(B – A)/(B – C)] x 100			
G_{mm} = Maximum Specific Gravity [from Rice Test]			
*Relative Density, $\%G_{mm}$, of specimen at N_{ini}			
*Relative Density, $\%G_{mm}$, of specimen at N_{des}			
*Relative Density, $\%G_{mm}$, of specimen at N_{max}			

$$* \text{Relative Density}, \% G_{mmx} = \frac{(G_{mb}) \times (h_{max})}{(G_{mm}) \times (h_x)} \times 100$$

Where: $\%G_{mmx}$ = Relative Density, $\%G_{mm}$, of specimen at N_{ini}, N_{des}, or N_{max}
G_{mb} = Bulk Specific Gravity of specimen at N_{max}
h_{max} = Height, in mm, of specimen at N_{max}
G_{mm} = Maximum Specific Gravity [from Rice Test]
h_x = Height of specimen, in mm, at N_{ini}, N_{des}, or N_{max}

Notes:

The Individual specimen heights are reported to the nearest 0.1 mm.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The maximum specific gravity [from Rice Test] is reported to the nearest 0.001.

The individual relative densities are reported to the nearest 0.1 percent.

The average relative density for each set of specimens (at N_{ini}, N_{des}, and N_{max}) is calculated, and reported to the nearest 0.1 percent, using the corresponding individual relative densities which have been reported to the nearest 0.1 percent.

Three specimens are used when referee testing is performed.

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{des})

= (100) – (_______) = ______%

FIGURE 4

ADOT
Intermodal Transportation

ARIZ 427a
April 19, 2013
(15 Pages)

ASPHALT BINDER CONTENT OF ASPHALTIC CONCRETE MIXTURES BY THE IGNITION FURNACE METHOD

(A Modification of AASHTO T 308)

1. SCOPE

1.1 This procedure describes the method for determining the percent asphalt binder content of asphaltic concrete mixtures, by use of an ignition furnace. The aggregate remaining after ignition can be used for sieve analysis, as indicated in Section 6.

1.1.1 This procedure does not address the use of reclaimed asphalt pavement (RAP) in asphaltic concrete mixtures. **See Arizona Test Method 428 when testing is to be performed on asphaltic concrete mixtures containing RAP.**

1.2 This test method involves hazardous material, operations, and equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.3 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

1.4 A listing of subsequent Sections and Figures in this procedure is given below:

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2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

2.1.1 Ignition Furnace - a forced-air ignition furnace that heats the sample by the convection method. The furnace must be capable of heating to temperatures up to 538 °C (1000 °F), and able to maintain a given temperature at ± 5 °C (± 9 °F). The furnace shall have an internal weighing system thermally isolated from the furnace chamber and accurate to 0.1 gram. The balance shall be capable of weighing a 3500 gram sample in addition to the sample baskets. A data collection system shall also be included so that the sample mass loss can be automatically determined to an accuracy of 0.1 gram and displayed during a test. The furnace shall provide a printout that includes, as a minimum, the initial sample mass, sample mass loss, test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the sample mass loss does not exceed 0.01 percent of the total sample mass for three consecutive one minute intervals. A filter capable of reducing emissions to an acceptable level shall also be incorporated into the furnace. The furnace shall be vented into a hood or to the outside and be set up properly so that there are no noticeable odors escaping into the laboratory. The furnace shall have a fan with the capability to pull air through the furnace to expedite the test and to reduce escape of smoke into the laboratory. The furnace shall be equipped so that the door cannot be opened until testing is complete.

2.1.2 Stainless Steel Perforated Baskets - the baskets shall be an appropriate size that allow the samples to be a thickness which allows air to flow up through and around the sample particles. The sample shall be completely enclosed with screen mesh, perforated stainless steel plate, or other suitable material. Screen mesh or other suitable material with openings of No. 8 has been found to perform well.

2.1.3 Stainless Steel Catch Pan - of sufficient size to hold the sample baskets so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.

2.1.4 Oven(s) - capable of heating to temperatures up to 350 °F, and able to maintain a given temperature at the tolerances specified herein.

2.1.5 Scale(s) or balance(s) - capable of measuring the maximum mass to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

2.1.6 Safety Equipment - safety glasses or face shield, high temperature gloves, and long sleeve jacket. Additionally, a heat resistant surface capable of withstanding 1200 °F and a protective cage capable of surrounding the sample baskets shall be provided.

2.1.7 Miscellaneous Equipment - a pan larger than the sample basket(s) for transferring samples after ignition, spatulas, bowls, spoons, and wire brushes.

2.1.8 Mixing apparatus - Mechanical mixing is recommended; 20 quart capacity mixer is required. (Hand mixing may be performed if desired.)

2.1.9 Thermometer - with a temperature range of 50 to 500 °F.

2.1.10 Hot plate - capable of heating to temperatures up to 350 °F, and able to maintain a given temperature at ± 5 °F.

2.1.11 For performing sieve analysis, apparatus as specified in Arizona Test Method 201.

3. SAMPLING

3.1 For preparing calibration samples, obtain representative samples of aggregates in accordance with Arizona Test Method 105. Samples shall be sufficiently large to provide enough material for calibration testing. The samples shall be adequately dried, if necessary, to a free-flowing condition in the portion passing the 4.75 mm (No. 4) sieve.

3.2 For testing field samples of asphaltic concrete, obtain a representative sample of the freshly produced mix in accordance with Arizona Test Method 104. Obtain representative test samples, in accordance with the appropriate sections of Arizona Test Method 416, for the determination of moisture content (if required) and asphalt binder content.

3.2.1 The size of the asphalt binder content test sample shall be within ± 150 grams of the sample size used for calibration and must also conform to the mass requirement shown in Table 1. When the mass of the test sample exceeds the capacity of the equipment used, the test sample shall be divided into suitable increments, tested, and the results appropriately combined.

TABLE 1	
Size of Test Sample	
Nominal Maximum Aggregate Size (See Note)	**Mass of Sample, grams**
1-1/2 in.	4000 – 4500
1 in.	3000 – 3500
3/4 in.	2000 – 2500
1/2 in.	1500 – 2000
3/8 in.	1200 – 1700
No. 4	1200 – 1700
Note: The smallest sieve opening through which the entire amount of material, by specification, is permitted to pass.	

4. CALIBRATION

4.1 Asphalt binder content results may be affected by the type of aggregate and binder in the mixture. A calibration factor for the asphalt binder content must be established for each mix design. Certain aggregate types may result in an unusually high calibration factor and erroneous gradation results due to aggregate breakdown. Such mixes should be calibrated and tested at a lower temperature as described in Subsection 4.14.

4.2 Dry the aggregate samples to constant mass at 290 ± 10 °F. Allow the material to cool.

4.3 Screen the aggregate stockpile samples and separate into individual sizes for No. 8 and larger, and minus No. 8 material.

Note: In lieu of screening the aggregate sample for each individual stockpile, a bulk-batched sample may be used as described in Subsection 4.3.1.

4.3.1 Using the aggregate stockpile percentages shown in the mix design composite, the material from the individual stockpiles may be bulk-batched in a single sample of an adequate amount of material necessary to prepare the required calibration samples. Screen the bulk-batched material and separate into individual sizes for No. 8 and larger, and minus No. 8 material.

4.4 Using the individual sizes of aggregate for No. 8 and larger, and minus No. 8 material, as obtained either by screening the material from the individual aggregate stockpiles or by screening the the bulk-batched sample, weigh up four aggregate samples representative of the mix design gradation without mineral admixture. These samples will be used for a gradation check, two calibration samples, and a butter mix. The appropriate type and quantity of mineral admixture (by weight of aggregate) shall be added to the aggregate, and thoroughly blended. The weight of the gradation check sample shall conform to the requirements of Table 1. The weight of the two calibration samples and the butter mix shall be such that when the required amount of asphalt binder is added, they conform to the requirements of Table 1.

4.5 Using the aggregate and mineral admixture sample prepared for the gradation check, perform a gradation analysis according to Section 6 to determine the actual gradation. The gradation shall be representative of the mix design gradation with mineral admixture. If the gradation is not representative of the mix design, four new aggregate and mineral admixture samples shall be prepared.

4.6 Using the remaining three aggregate and mineral admixture samples, two calibration samples and a butter mix are prepared as described below at the design asphalt binder content. The asphalt binder grade and type shall be the same as will be used in the asphalt concrete mixture to be tested during production. Heat the samples to the laboratory mixing temperature prescribed in the mix design. (See Note following Subsection 4.7). Allow the samples to cool. Weigh and determine the mass of each sample to the nearest 0.1 gram. If mass is lost during the heating of the samples, do not add make-up material, as this will change the gradation of the samples. The percent asphalt binder content is based on the mass of total mix. For each sample, the weight of asphalt binder to be used is determined by the following:

$$\begin{bmatrix}\text{Weight of}\\ \text{Asphalt Binder}\end{bmatrix} = \frac{\begin{bmatrix}\text{Weight of Aggregate}\\ \text{and Mineral Admixture}\end{bmatrix}}{100 - \begin{bmatrix}\text{Percent of}\\ \text{Asphalt Binder}\end{bmatrix}} \text{ x } \begin{bmatrix}\text{Percent of}\\ \text{Asphalt Binder}\end{bmatrix}$$

4.7 All bowls, sample pans, and mixing tools shall be preheated to approximately the laboratory mixing temperature prescribed in the mix design. At the time mixing of the samples begins, the temperature of the asphalt binder, aggregate, and mineral admixture shall be in accordance with the prescribed laboratory mixing temperature ± 5 °F. Each individual sample shall be thoroughly mixed. All samples shall be mixed at the same mixing temperature ± 5 °F.

Note: If the mix design laboratory mixing temperature is not specified, a temperature of 300 ± 5 °F shall be used for mixes which do not use asphalt-rubber, and 325 ± 5 °F for asphalt-rubber mixes.

4.8 Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or as modified in Subsection 4.14. Do not preheat the sample basket.

4.9 Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

4.10 The freshly mixed samples may be placed directly in the sample basket assembly. If the samples are allowed to cool, they must be reheated in a 290 ± 10 °F oven for 25 minutes.

4.11 Test samples in accordance with Subsections 5.6 through 5.14.

4.12 If the difference between the measured asphalt binder content of the two samples exceeds 0.07, repeat the test using two additional samples, and from the four results discard the high and the low values.

4.13 Subtract the actual asphalt binder content for each of the two samples from their respective measured asphalt binder content. The asphalt binder content calibration factor is the average of the two resultant values expressed in percent by mass of the asphalt mixture.

4.14 If the asphalt binder content calibration factor exceeds ± 1.0 percent, lower the test temperature to 482 ± 5 °C (900 ± 9 °F) and repeat the test to determine a new calibration factor. If the calibration factor continues to exceed ± 1.0 percent, lower the test temperature to 427 ± 5 °C (800 ± 9 °F) and repeat the test to determine a new calibration factor. Use the calibration factor obtained at 427 ± 5 °C (800 ± 9 °F) even if it exceeds ± 1.0 percent.

4.15 Perform a gradation analysis on the residual aggregate as indicated in Section 6. Subtract the actual percent passing the No. 200 sieve for each sample from the measured percent passing the No. 200 sieve (as determined in Subsection 4.5). Determine the average of the two values. If the resultant average value is greater than ± 0.50, an aggregate gradation correction factor (equal to the resultant average value) for the passing No. 200 material may be applied to the production field sample test results.

5. PROCEDURE

5.1 The moisture content of the asphaltic concrete shall be determined in accordance with Arizona Test Method 406. The moisture content sample shall be obtained at the same time and subjected to the same treatment prior to testing as the asphalt binder content test sample. As an alternate to performing the moisture determination, the test sample may be dried to a constant mass in an oven at 290 ± 10 °F.

5.2 Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or to the alternate temperature determined during the calibration (Subsection 4.14). Do not preheat the sample basket. Record the furnace temperature set point prior to the initiation of the test.

5.3 Record the asphalt binder content calibration factor, determined in accordance with Subsections 4.12 through 4.14, for the specific mix to be tested.

5.4 Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

5.5 Obtain the asphalt binder content test sample in accordance with Subsection 3.2, ensuring that the size of the test sample is within ± 150 grams of the sample size used for calibration and that the test sample conforms to the requirements shown in Table 1.

5.6 Evenly distribute the test sample over the center of the sample basket(s) and level the material. Use a spatula or trowel to pull material approximately one inch away from the outside edge of basket(s).

5.7 Weigh and record the mass of the sample and basket assembly to the nearest 0.1 gram.

5.8 Calculate and record the initial mass of the sample to the nearest 0.1 gram.

5.9 Set the ignition furnace controller print mode to give a printout of the test data required in Subsection 2.1.1. Input the initial mass of the sample into the ignition furnace controller. Verify that the correct mass has been entered.

5.10 Open the furnace door and place the sample and basket assembly so that it is centered in the chamber. After assuring that the sample basket assembly is not in contact with any wall, close the door. Initiate the test by pressing the start button. This will lock the furnace door and start testing.

5.11 Allow the test to continue until the stable light and audible stable indicator indicates the test is complete. The test is deemed complete when the measured mass loss does not exceed 0.01 percent of the sample mass for three consecutive one minute intervals. If required, press the stop button. This will unlock the furnace door and cause the printer to print out the test results.

5.12 Open the furnace door and remove the sample and basket assembly. Allow the sample to cool 30 ± 5 minutes in the basket assembly. Weigh and record the mass of the sample and basket assembly after ignition to the nearest 0.1 gram.

5.13 Calculate and record the mass of sample after ignition to the nearest 0.1 gram.

5.14 Calculate and record the corrected asphalt binder content of the sample, to the nearest 0.01%, as follows:

$$\%AC = \left[\frac{W_i - W_A}{W_i} \times 100 \right] - C_F - \%M$$

Where: $\%AC$ = measured (corrected) asphalt binder content in percent by mass of the sample
W_i = mass of the sample prior to ignition
W_A = mass of the sample after ignition
C_F = asphalt binder content calibration factor, percent by mass of the sample
$\%M$ = percent moisture in the sample

Note: During calibration, C_F and %M are zero.

5.14.1 If an ignition furnace correction (tank stab correction) is made, the %AC determined in Subsection 5.14 is adjusted by that correction.

5.15 Attach the original printed ticket to the back of the card.

5.16 Empty the contents of the baskets into a flat pan. Use a small wire sieve brush to ensure that any residual fines are removed from the baskets. Take care not to lose any material, as this will affect gradation results.

5.17 If needed, perform a gradation analysis of the residual aggregate according to Section 6.

6. SIEVE ANALYSIS OF AGGREGATE

6.1 If required, the aggregate shall be subjected to sieve analysis as described below. The coarse sieving shall be performed in accordance with Subsection 6.2, and the fine sieving in accordance with Subsection 6.3. The quantity of material on a given sieve at the completion of sieving shall not exceed the amount shown in Table 2.

TABLE 2

Sieve Size	**Maximum Mass Allowed (grams/sq. in.)**	**Maximum Mass Allowed (grams)**	
		8 inch Diameter Sieve	**12 inch Diameter Sieve**
1-1/2”	25	---	2827
1”	18	---	2036
3/4”	14	---	1583
1/2”	10	---	1131
3/8”	8	---	905
1/4”	6	---	679
No. 4	5	---	565
No. 8 and smaller	4	201	452

6.2 The coarse sieving of the aggregate shall be performed as follows:

6.2.1 Weigh and record the mass of the sample to be sieved to the nearest gram. Place sample on the top sieve of a nest of 12 inch sieves. The nest of sieves shall consist of sieves starting with the smallest size sieve that 100% of the material will pass, down through and including the No. 8 sieve and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

6.2.2 Weigh and record separately, to the nearest gram, the mass of the material retained on the individual sieves and in the pan. The material retained in the pan is recorded as the minus No. 8 material.

6.2.3 Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus No. 8 material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

6.2.4 Determine the coarse sieve factor by dividing 100 by the total mass sieved. Record the factor to six decimal places.

6.2.5 The percent passing for each sieve in the coarse sieve analysis is determined by multiplying the mass retained on that sieve by the coarse sieve factor, and subtracting the result from the unrounded % passing for the next larger sieve. Values for "mass retained multiplied by the coarse sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent.

6.2.6 As a check on the coarse sieve analysis, multiply the mass of minus No. 8 material by the coarse sieve factor. The result of this calculation, rounded to the nearest percent, should be the same as the value for percent passing the No. 8 sieve determined in Subsection 6.2.5 above.

6.2.7 The material passing the No. 8 sieve is split, if necessary, to obtain a minimum 500 gram sample for fine sieving; however, the sample size may be less than 500 grams if a minimum of 500 grams is not obtained from coarse sieving. If less than 800 grams passes the No. 8 sieve, the entire amount shall be subjected to fine sieving. The mass of the sample for fine sieving is recorded to the nearest gram as mass of pass No. 8 split.

6.3 The elutriation and fine sieving of the pass No. 8 material shall be performed as follows:

6.3.1 Subject sample to elutriation through a No. 200 screen either by hand or mechanical washing.

6.3.2 Dry sample to constant mass, allow to cool, then weigh and record the dry mass to the nearest gram.

6.3.3 Place sample on the top sieve of a nest of fine sieves. The nest of sieves shall consist of sieves starting with the No. 10 sieve, down through and including the No. 200 sieve and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

6.3.4 Weigh and record separately, to the nearest gram, the mass of material retained on the individual sieves and in the pan.

6.3.5 Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus No. 200 material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

6.3.6 Determine and record elutriation to nearest gram by determining the difference between the dry mass and the mass of the pass No. 8 split.

6.3.7 Determine a factor for calculating the fine sieve analysis by dividing the percent passing the No. 8 sieve (recorded to the nearest percent) by the mass of pass No. 8 split. Record the factor to six decimal places. If all the pass No. 8 material from coarse sieving was subjected to elutriation and fine sieving, a fine sieve factor is not determined. Rather, the coarse sieve factor is utilized and the calculation of the percent passing each sieve is continuous through the entire sieve analysis.

6.3.8 The percent passing for each sieve in the fine sieve analysis is determined by multiplying the mass retained on that sieve by the fine sieve factor, and subtracting the result from the unrounded % passing the next larger sieve, with the exception of the percent passing the No. 8 which has previously been recorded to the nearest percent. Values for "mass retained multiplied by the fine sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent, except the percent passing the No. 200 sieve is recorded to the nearest 0.1 percent.

6.3.9 As a check on the fine sieve analysis, the mass of material passing the No. 200 sieve is added to the elutriation mass, and this total is multiplied by the fine sieve factor. The result of this calculation, rounded to the nearest 0.1 percent, should be the same as the value for the percent passing the No. 200 sieve determined in Subsection 6.3.8 above.

6.3.10 If an aggregate gradation correction factor is utilized, the percent passing the No. 200 sieve shall be adjusted by subtracting the correction factor determined in Subsection 4.15.

6.4 Other methods may be used that differ from that specified in Subsections 6.2 and 6.3 above to determine % passing each sieve, so long as the method utilized has been proven to give equivalent results. However, any procedure which includes recording percent retained values prior to completing the calculation of all percent passing values is not allowed.

7. REPORT AND EXAMPLE

7.1 Report test information on the Asphaltic Concrete Tabulation – Ignition Furnace laboratory card. An example for the testing performed on a field sample is shown in Figure 1. Only the portion of the laboratory card relevant to the ignition furnace test is used for the example. A blank Asphaltic Concrete Tabulation – Ignition Furnace laboratory card is shown in Figure 2.

7.1.1 Mass of basket assembly.

7.1.2 Mass of sample and basket assembly.

7.1.3 Calculated initial mass of the sample.

7.1.4 Mass of sample and basket assembly after ignition.

7.1.5 Calculated mass of sample after ignition.

7.1.6 Asphalt binder content calibration factor.

7.1.7 Percent moisture from moisture test, if one was performed.

7.1.8 Corrected percent asphalt binder content.

7.1.9 Elapsed time of test.

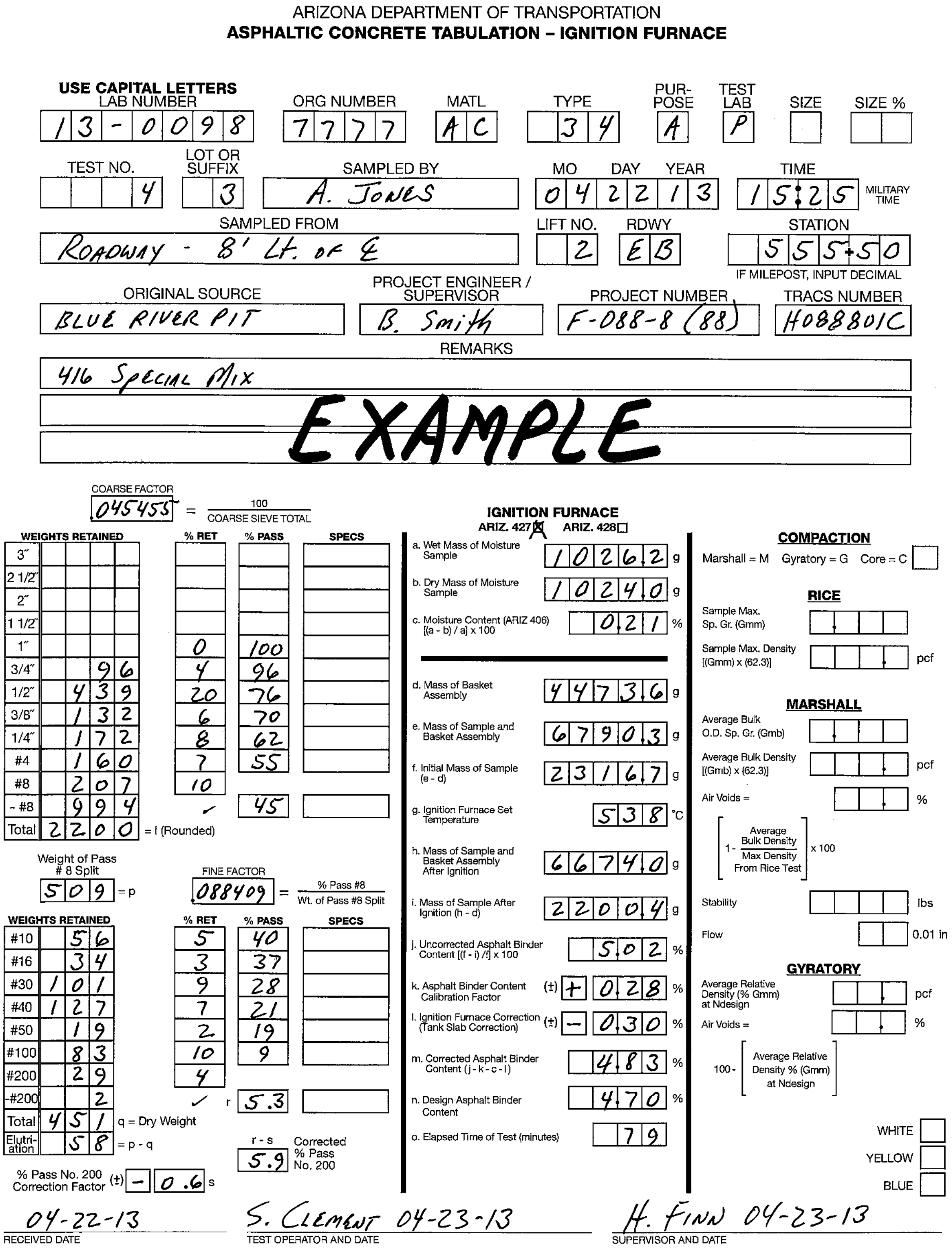
7.1.10 Name of the operator.

7.1.11 Sample test date.

7.1.12 Design percent asphalt binder content.

7.2.13 Ignition furnace set temperature.

7.2.14 If determined, the sieve analysis of the residual aggregate (corrected for passing the No. 200 sieve if applicable).



ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION – IGNITION FURNACE

USE CAPITAL LETTERS

LAB NUMBER	ORG NUMBER	MATL	TYPE	PURPOSE	TEST LAB	SIZE	SIZE %
13-0098	7777	AC	34	A	P		

TEST NO.	LOT OR SUFFIX	SAMPLED BY	MO	DAY	YEAR	TIME (MILITARY TIME)
4	3	A. JONES	04	22	13	15:25

SAMPLED FROM	LIFT NO.	RDWY	STATION (IF MILEPOST, INPUT DECIMAL)
ROADWAY - 8' Lt. of ℄	2	EB	555+50

ORIGINAL SOURCE	PROJECT ENGINEER / SUPERVISOR	PROJECT NUMBER	TRACS NUMBER
BLUE RIVER PIT	B. Smith	F-088-8 (88)	H088801C

REMARKS

416 Special Mix

EXAMPLE

COARSE FACTOR .045455 = 100 / COARSE SIEVE TOTAL

WEIGHTS RETAINED		% RET	% PASS	SPECS
3″				
2 1/2″				
2″				
1 1/2″				
1″		0	100	
3/4″	96	4	96	
1/2″	439	20	76	
3/8″	132	6	70	
1/4″	172	8	62	
#4	160	7	55	
#8	207	10		
- #8	994	✓	45	
Total	2200 = i (Rounded)			

Weight of Pass # 8 Split 509 = p

FINE FACTOR .088409 = % Pass #8 / Wt. of Pass #8 Split

WEIGHTS RETAINED		% RET	% PASS	SPECS
#10	56	5	40	
#16	34	3	37	
#30	101	9	28	
#40	127	7	21	
#50	19	2	19	
#100	83	10	9	
#200	29	4		
-#200	2	✓	r 5.3	
Total	451 q = Dry Weight			
Elutriation	58 = p - q			

% Pass No. 200 Correction Factor (±) − 0.6 s

r - s 5.9 Corrected % Pass No. 200

IGNITION FURNACE

ARIZ. 427☒ ARIZ. 428☐

a. Wet Mass of Moisture Sample	1026.2	g
b. Dry Mass of Moisture Sample	1024.0	g
c. Moisture Content (ARIZ 406) [(a - b) / a] x 100	0.21	%
d. Mass of Basket Assembly	4473.6	g
e. Mass of Sample and Basket Assembly	6790.3	g
f. Initial Mass of Sample (e - d)	2316.7	g
g. Ignition Furnace Set Temperature	538	°C
h. Mass of Sample and Basket Assembly After Ignition	6674.0	g
i. Mass of Sample After Ignition (h - d)	2200.4	g
j. Uncorrected Asphalt Binder Content [(f - i) /f] x 100	5.02	%
k. Asphalt Binder Content Calibration Factor (±)	+ 0.28	%
l. Ignition Furnace Correction (Tank Slab Correction) (±)	− 0.30	%
m. Corrected Asphalt Binder Content (j - k - c - l)	4.83	%
n. Design Asphalt Binder Content	4.70	%
o. Elapsed Time of Test (minutes)	79	

COMPACTION

Marshall = M Gyratory = G Core = C ☐

RICE

Sample Max. Sp. Gr. (Gmm) ☐

Sample Max. Density [(Gmm) x (62.3)] ☐ pcf

MARSHALL

Average Bulk O.D. Sp. Gr. (Gmb) ☐

Average Bulk Density [(Gmb) x (62.3)] ☐ pcf

Air Voids = ☐ %

$$\left[1 - \frac{\text{Average Bulk Density}}{\text{Max Density From Rice Test}}\right] \times 100$$

Stability ☐ lbs

Flow ☐ 0.01 in

GYRATORY

Average Relative Density (% Gmm) at Ndesign ☐ pcf

Air Voids = ☐ %

$$100 - \left[\text{Average Relative Density \% (Gmm) at Ndesign}\right]$$

WHITE ☐

YELLOW ☐

BLUE ☐

RECEIVED DATE	TEST OPERATOR AND DATE	SUPERVISOR AND DATE
04-22-13	S. CLEMENT 04-23-13	H. FINN 04-23-13

44-9372 R03/13

SEE BACK ALSO

FIGURE 1

ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION – IGNITION FURNACE

USE CAPITAL LETTERS

LAB NUMBER
ORG NUMBER
MATL
TYPE
PURPOSE
TEST LAB
SIZE
SIZE %

TEST NO.
LOT OR SUFFIX
SAMPLED BY
MO DAY YEAR
TIME : MILITARY TIME

SAMPLED FROM
LIFT NO.
RDWY
STATION +
IF MILEPOST, INPUT DECIMAL

ORIGINAL SOURCE
PROJECT ENGINEER / SUPERVISOR
PROJECT NUMBER
TRACS NUMBER

REMARKS

COARSE FACTOR $= \frac{100}{\text{COARSE SIEVE TOTAL}}$

WEIGHTS RETAINED		% RET	% PASS	SPECS
3″				
2 1/2″				
2″				
1 1/2″				
1″				
3/4″				
1/2″				
3/8″				
1/4″				
#4				
#8				
- #8				
Total	= i (Rounded)			

Weight of Pass # 8 Split = p

FINE FACTOR $= \frac{\text{\% Pass \#8}}{\text{Wt. of Pass \#8 Split}}$

WEIGHTS RETAINED		% RET	% PASS	SPECS
#10				
#16				
#30				
#40				
#50				
#100				
#200				
-#200			r .	
Total	q = Dry Weight			
Elutriation	= p - q		r - s .	Corrected % Pass No. 200

% Pass No. 200 Correction Factor (±) . s

IGNITION FURNACE

ARIZ. 427☐ ARIZ. 428☐

a. Wet Mass of Moisture Sample . g
b. Dry Mass of Moisture Sample . g
c. Moisture Content (ARIZ 406) [(a - b) / a] x 100 . %

d. Mass of Basket Assembly . g
e. Mass of Sample and Basket Assembly . g
f. Initial Mass of Sample (e - d) . g
g. Ignition Furnace Set Temperature °C
h. Mass of Sample and Basket Assembly After Ignition . g
i. Mass of Sample After Ignition (h - d) . g
j. Uncorrected Asphalt Binder Content [(f - i) /f] x 100 . %
k. Asphalt Binder Content Calibration Factor (±) . %
l. Ignition Furnace Correction (Tank Slab Correction) (±) . %
m. Corrected Asphalt Binder Content (j - k - c - l) . %
n. Design Asphalt Binder Content . %
o. Elapsed Time of Test (minutes)

COMPACTION

Marshall = M Gyratory = G Core = C ☐

RICE

Sample Max. Sp. Gr. (Gmm) .
Sample Max. Density [(Gmm) x (62.3)] . pcf

MARSHALL

Average Bulk O.D. Sp. Gr. (Gmb) .
Average Bulk Density [(Gmb) x (62.3)] . pcf
Air Voids = . %

$$\left[1 - \frac{\text{Average Bulk Density}}{\text{Max Density From Rice Test}}\right] \times 100$$

Stability lbs
Flow 0.01 in

GYRATORY

Average Relative Density (% Gmm) at Ndesign . pcf
Air Voids = . %

$$100 - \left[\text{Average Relative Density \% (Gmm) at Ndesign}\right]$$

WHITE ☐
YELLOW ☐
BLUE ☐

RECEIVED DATE
TEST OPERATOR AND DATE
SUPERVISOR AND DATE

44-9372 R03/13

SEE BACK ALSO

FIGURE 2

ARIZ 428
April 19, 2013
(33 Pages)

ASPHALT BINDER CONTENT OF ASPHALTIC CONCRETE MIXTURES CONTAINING RECLAIMED ASPHALT PAVEMENT (RAP) BY THE IGNITION FURNACE METHOD

(A Modification of AASHTO T 308)

1. SCOPE

1.1 This procedure describes the method for determining the percent asphalt binder content of asphaltic concrete mixtures containing reclaimed asphalt pavement (RAP), by use of an ignition furnace. The aggregate remaining after ignition can be used for sieve analysis, as indicated in Section 6.

1.1.1 The gradation, moisture content, and binder content of the RAP material are determined as described in Appendix A of this test method. The determination of the RAP aggregate gradation is also discussed in Appendix A. The procedure for determining the RAP binder content correction factor is described in Appendix B.

1.1.2 This procedure addresses the use of reclaimed asphalt pavement (RAP) in asphaltic concrete mixtures. **See Arizona Test Method 427 when testing is to be performed on asphaltic concrete mixtures which do not contain RAP.**

1.2 This test method involves hazardous material, operations, and equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.3 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

1.4 A listing of subsequent Sections and Figures in this procedure is given below:

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2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

2.1.1 Ignition Furnace - a forced-air ignition furnace that heats the sample by the convection method. The furnace must be capable of heating to temperatures up to 538 °C (1000 °F), and able to maintain a given temperature at ± 5 °C (± 9 °F). The furnace shall have an internal weighing system thermally isolated from the furnace chamber and accurate to 0.1 gram. The balance shall be capable of weighing a 3500 gram sample in addition to the sample baskets. A data collection system shall also be included so that the sample mass loss can be automatically determined to an accuracy of 0.1 gram and displayed during a test. The furnace shall provide a printout that includes, as a minimum, the initial sample mass, sample mass loss, test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the sample mass loss does not exceed 0.01 percent of the total sample mass for three consecutive one minute intervals. A filter capable of reducing emissions to an acceptable level shall also be incorporated into the furnace. The furnace shall be vented into a hood or to the outside and be set up properly so that there are no noticeable odors escaping into the laboratory. The furnace shall have a fan with the capability to pull air through the furnace to expedite the test and to reduce escape of smoke into the laboratory. The furnace shall be equipped so that the door cannot be opened until testing is complete.

2.1.2 Stainless Steel Perforated Baskets - the baskets shall be an appropriate size that allow the samples to be a thickness which allows air to flow up through and around the sample particles. The sample shall be completely enclosed with screen mesh, perforated stainless steel plate, or other suitable material. Screen mesh or other suitable material with openings of No. 8 has been found to perform well.

2.1.3 Stainless Steel Catch Pan - of sufficient size to hold the sample baskets so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.

2.1.4 Oven(s) - capable of heating to temperatures up to 350 °F, and able to maintain a given temperature at the tolerances specified herein.

2.1.5 Scale(s) or balance(s) - capable of measuring the maximum mass to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

2.1.6 Safety Equipment - safety glasses or face shield, high temperature gloves, and long sleeve jacket. Additionally, a heat resistant surface capable of withstanding 1200 °F and a protective cage capable of surrounding the sample baskets shall be provided.

2.1.7 Miscellaneous Equipment - a pan larger than the sample basket(s) for transferring samples after ignition, spatulas, bowls, spoons, and wire brushes.

2.1.8 Mixing apparatus - Mechanical mixing is recommended; 20 quart capacity mixer is required. (Hand mixing may be performed if desired.)

2.1.9 Thermometer - with a temperature range of 50 to 500 °F.

2.1.10 Hot plate - capable of heating to temperatures up to 350 °F, and able to maintain a given temperature at ± 5 °F.

2.1.11 For performing sieve analysis, apparatus as specified in Arizona Test Method 201.

3. SAMPLING

3.1 For preparing calibration samples, obtain representative samples of virgin aggregate and RAP material in accordance with Arizona Test Method 105. Samples of virgin aggregate and RAP material shall be sufficiently large to provide enough material for calibration testing.

3.2 For testing field samples of asphaltic concrete, obtain a representive sample of the freshly produced mix in accordance with Arizona Test Method 104. Obtain representative test samples, in accordance with the appropriate sections of Arizona Test Method 416, for the determination of moisture content (if required) and asphalt binder content.

3.2.1 The size of the asphalt binder content test sample shall be within ± 150 grams of the sample size used for calibration and must also conform to the mass requirement shown in Table 1. When the mass of the test sample exceeds the capacity of the equipment used, the test sample shall be divided into suitable increments, tested, and the results appropriately combined.

4. CALIBRATION

4.1 Asphalt binder content results may be affected by the type of aggregate and binder in the mixture. A calibration factor for the asphalt binder content must be established for each mix design. Certain aggregate types may result in an unusually high calibration factor and erroneous gradation results due to aggregate breakdown. Such mixes should be calibrated and tested at a lower temperature as described in Subsection 4.13.

TABLE 1

Size of Test Sample

Nominal Maximum Aggregate Size (See Note)	**Mass of Sample, grams**
1-1/2 in.	4000 – 4500
1 in.	3000 – 3500
3/4 in.	2000 – 2500
1/2 in.	1500 – 2000
3/8 in.	1200 – 1700
No. 4	1200 – 1700

Note: The smallest sieve opening through which the entire amount of material, by specification, is permitted to pass.

4.2 Spread the RAP material from each individual RAP stockpile to be used for the calibration in separate pans at 1 to 1-1/2 inches in depth and dry overnight at 140 ± 10 °F, and continue drying until the mass, after successive one-half hour periods of drying, indicates no change in mass. Allow the material to cool. Screen the RAP material from the individual stockpiles and separate into individual sizes for No. 8 and larger sieves, and minus No. 8 material. The RAP material shall be screened for 5 minutes ± 15 seconds per Arizona Test Method 240 to prevent excessive breakdown of the RAP agglomerations.

4.3 Dry the individual virgin aggregate stockpile samples to constant mass at 290 ± 10 °F. Allow the material to cool. Screen the virgin aggregate from the individual stockpiles and separate into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

Note: In lieu of drying and screening the virgin aggregate samples for each individual stockpile, a bulk-batched sample may be used as described in Subsection 4.3.1.

4.3.1 Using the adjusted stockpile percentages shown in Mix Design Composite #2 (Virgin Aggregate Composite), the material from the individual stockpiles may be bulk-batched into a single sample of an adequate amount of material necessary to prepare the required calibration samples. Dry the bulk-batched sample to constant mass at 290 ± 10 °F. Allow the material to cool. Screen the bulk-batched material and separate into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

4.4 The RAP aggregate [extracted aggregate (AASHTO T 164 - Method A) from the RAP material] shall be dried to constant mass at 290 ± 10 °F. Allow the material to cool. Screen the RAP aggregate material from the individual stockpiles and separate into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

Note: The batching of samples described below in Subsection 4.5 and Subsection 4.6 is based on the mix design weigh-up information, as shown in the example in Figure 1.

4.5 A gradation check sample is batched using:

- The virgin mineral aggregate component (individual stockpile material or bulk-batched material), which has been screened into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

- The RAP aggregate component, which has been screened into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

- Mineral admixture.

4.5.1 Batch the virgin aggregate portion to Mix Design Composite #2 (Virgin Aggregate Composite). If the individual virgin aggregate stockpiles were screened, batch to the individual accumulative weights required for each individual stockpile, as shown in the example in Figure 2. If bulk-batched virgin aggregate material is used, batch to the accumulative weights required for the total batch weight as shown in the example in Figure 2.

4.5.1.1 The weight of the virgin aggregate portion is determined as follows:

$$W_{va} = \left(\frac{100 - T_{pra}}{100} \right) x \; (W_{ta})$$

Where:

W_{va} = Weight of virgin aggregate
T_{pra} = Total percent of RAP aggregate in mix design
W_{ta} = Weight of total aggregate desired (combined virgin aggregate and RAP aggregate)

Example:

$$W_{va} = \left(\frac{100 - (15 + 10)}{100} \right) x \; (2200) = 1650 \text{ grams}$$

4.5.2 Batch the RAP aggregate portion to Mix Design Composite #1 (Virgin Aggregate and RAP Aggregate Composite), utilizing the accumulative weights required for each individual RAP aggregate material, as shown in the example in Figure 2.

4.5.2.1 The weight of RAP aggregate portion required for each RAP stockpile is determined as follows:

$$W_{ra} = \left(\frac{P_{ra}}{100} \right) x \; (W_{ta})$$

Where:

W_{ra} = Weight of RAP aggregate for each RAP stockpile
P_{ra} = Percent of RAP aggregate used in mix design
W_{ta} = Weight of total aggregate desired (combined virgin aggregate and RAP aggregate)

Example (for fine RAP aggregate):

$$W_{ra} = \left(\frac{15}{100}\right) \text{ x } (2200) = 330.0 \text{ grams}$$

Example (for coarse RAP aggregate):

$$W_{ra} = \left(\frac{10}{100}\right) \text{ x } (2200) = 220.0 \text{ grams}$$

4.5.3 Add the required type and amount of mineral admixture to the virgin aggregate and RAP aggregate and blend thoroughly.

4.5.3.1 The weight of mineral admixture is determined as follows:

$$W_{ad} = \left(\frac{P_{ad}}{100}\right) \text{ x } \left(W_{ta}\right)$$

Where:

W_{ad} = Weight of mineral admixture
P_{ad} = Percent mineral admixture
W_{ta} = Weight of total aggregate desired (combined virgin aggregate and RAP aggregate)

Example:

$$W_{ad} = \left(\frac{1.0}{100}\right) \text{ x } (2200) = 22 \text{ grams}$$

4.5.4 The weight of the combined virgin aggregate, RAP aggregate, and mineral admixture for the gradation check sample shall conform to the requirements of Table 1.

4.5.5 Perform a gradation analysis on the gradation check sample in accordance with Section 6 to determine the actual gradation.

4.6 Two calibration (burn) samples and also a “butter mix” sample are batched using:

- The virgin mineral aggregate component (individual stockpile material or bulk-batched material), which has been screened into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

- The RAP material (dry screened RAP) component, which has been screened into individual sizes for No. 8 and larger sieves, and minus No. 8 material.

- Mineral admixture.

4.6.1 Batch the virgin aggregate portion to Mix Design Composite #2 (Virgin Aggregate Composite). If the individual virgin aggregate stockpiles were screened, batch to the individual accumulative weights required for each individual stockpile, as shown in the example in Figure 3. If bulk-batched virgin aggregate material is used, batch to the accumulative weights required for the total batch weight as shown in as shown in the example in Figure 3.

4.6.1.1 The weight of the virgin aggregate portion is detemined as shown in Subsection 4.5.1.1.

4.6.2 Add the required type and amount of mineral admixture to each of the batched virgin aggregate samples and blend thoroughly.

4.6.2.1 The weight of the mineral admixture is detemined as shown in Subsection 4.5.3.1.

4.6.3 Form a shallow crater in the center of each of the blended virgin aggregate/mineral admixture samples.

4.6.4 Batch the dry screened RAP portion to Mix Design Composite #3 (Virgin Aggregate and Dry Screened RAP Composite), utilizing the accumulative weights required for each individual dry screened RAP material, as shown in the example in Figure 3.

4.6.4.1 The weight of the dry screened RAP portion from each RAP stockpile is determined as follows:

$$W_{rap} = \left(\frac{W_{ra}}{1 - \frac{P_{br}}{100}} \right)$$

Where:

W_{rap} = Weight of dry screened RAP from each RAP stockpile
W_{ra} = Weight of RAP aggregate for each RAP stockpile
P_{br} = Percent binder content of each RAP stockpile

Example (for fine RAP stockpile):

$$W_{rap} = \left(\frac{330.0}{1 - \frac{5.82}{100}} \right) = 350.4 \text{ grams}$$

Example (for coarse RAP stockpile):

$$W_{rap} = \left(\frac{220.0}{1 - \frac{3.43}{100}} \right) = 227.8 \text{ grams}$$

4.6.5 Place the dry screened RAP material in the crater formed in each of the blended virgin aggregate/mineral admixture samples.

4.6.6 The weight of the combined virgin aggregate, dry screened RAP, and mineral admixture for each calibration sample and the “butter mix” sample shall be such that when the required amount of virgin asphalt binder is added, they conform to the requirements of Table 1.

Note: It is recommended that an initial calibration sample be prepared and tested in accordance with the requirements of Subsection 4.6.7 prior to the preparation of additional samples. Doing so may help avoid the waste of the limited amount of dry screened RAP material.

4.6.7 Prior to the addition of the virgin binder, record the weight of the combined virgin aggregate, dry screened RAP, and mineral admixture for each calibration sample to the nearest 0.1 gram as the “Weight of Initial Charge Before Drying”. Dry each charge to constant mass at 290 ± 10 °F, allow to cool, and record the weight to the nearest 0.1 gram as the “Weight of Initial Charge After Drying”. If the loss from drying is greater than

25 grams, discard the charge and prepare a new charge using the same procedure, except the dry screened RAP shall be initially dried overnight at 160° ± 3 °F, and drying continued at 160° ± 3 °F until the mass, after successive one-half hour periods of drying, indicates no change in mass. Do not add make-up material to account for any loss from drying, as doing so will change the gradation of the samples.

Note: The extended drying at the increased temperature (from 140 ± 10 °F to 160° ± 3 °F) specified above is to ensure that all moisture is removed from the dry screened RAP material.

4.6.8 Two calibration samples and the butter mix are prepared as described below at the design total asphalt binder content. The asphalt binder grade and type shall be the same as will be used in the asphalt concrete mixture to be tested during production. The percent total asphalt binder content is based on the mass of the total mix. For each sample, the weight of virgin asphalt binder to be added is determined using the calculations in Subsections 4.5.1.1, 4.5.3.1, and 4.5.6.1 in conjunction with Subsections 4.6.8.1, 4.6.8.2, and 4.6.8.3.

4.6.8.1 The weight of binder contributed by the RAP material from each RAP stockpile is determined as follows:

$$W_{rb} = \left(\frac{P_{br}}{100} \right) \text{ x } \left(W_{rap} \right)$$

Where:

W_{rb} = Weight of binder contributed by each RAP stockpile
P_{br} = Percent binder content of each RAP stockpile
W_{rap} = Weight of RAP from each RAP stockpile

Example (for fine RAP stockpile):

$$W_{rb} = \left(\frac{5.82}{100} \right) \text{ x } (350.4) = 20.39 \text{ grams}$$

Example (for coarse RAP stockpile):

$$W_{rb} = \left(\frac{3.43}{100} \right) \text{ x } (227.8) = 7.81 \text{ grams}$$

4.6.8.2 The weight of total binder is determined as follows:

$$W_{tb} = \left(\frac{W_{va} + T_{wra} + W_{ad}}{100 - P_{tb}} \right) \text{ x } (P_{tb})$$

Where:

W_{tb} = Weight of total binder
W_{va} = Weight of virgin aggregate
T_{wra} = Total weight of RAP aggregate
W_{ad} = Weight of mineral admixture
P_{tb} = Percent total binder (mix design percent binder content)

Example:

$$W_{tb} = \left(\frac{1650 + (330 + 220) + 22}{100 - 5.4} \right) \text{ x } (5.4) = 126.84 \text{ grams}$$

4.6.8.3 The weight of virgin asphalt binder to be added is determined as follows:

$$W_{vb} = (W_{tb}) - (W_{trb})$$

Where:

W_{vb} = Weight of virgin asphalt binder to be added
W_{tb} = Weight of total binder
W_{trb} = Total weight of binder contributed by RAP stockpiles

Example:

$$W_{vb} = (126.84) - (20.39 + 7.81) = 98.6 \text{ grams}$$

Note: If desired, the percent of the total binder which is contributed by RAP can be calculated as follows:

$$\begin{bmatrix} \text{Percent of Total} \\ \text{Binder Contributed} \\ \text{by RAP} \end{bmatrix} = \left(\frac{W_{trb}}{W_{tb}} \right) \text{ x } (100)$$

Where:

W_{trb} = Total weight of binder contributed by RAP stockpiles
W_{tb} = Weight of total binder required

Example:

$$\begin{bmatrix} \text{Percent of Total} \\ \text{Binder Contributed} \\ \text{by RAP} \end{bmatrix} = \left(\frac{(20.39 + 7.81)}{126.84} \right) \text{ x } (100) = 22.23\%$$

4.6.8.4 All bowls, sample pans, and mixing tools shall be preheated to approximately the laboratory mixing temperature prescribed in the mix design. At the time mixing of the samples begins, the temperature of the asphalt binder, virgin aggregate, RAP, and mineral admixture shall be in accordance with the prescribed laboratory mixing temperature ± 5 °F. Each individual sample shall be thoroughly mixed. All samples shall be mixed at the same mixing temperature ± 5 °F.

Note: If the mix design laboratory mixing temperature is not specified, a temperature of 300 ± 5 °F shall be used.

4.7 Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or as modified in Subsection 4.13. Do not preheat the sample basket.

4.8 Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

4.9 The freshly mixed samples may be placed directly in the sample basket assembly. If the samples are allowed to cool, they must be reheated in a 290 ± 10 °F oven for 25 minutes.

4.10 Test samples in accordance with Subsections 5.6 through 5.14.

4.11 If the difference between the measured asphalt binder content of the two samples exceeds 0.07, repeat the test using two additional samples, and from the four results discard the high and the low values.

4.12 Subtract the actual asphalt binder content for each of the two samples from their respective measured asphalt binder content. The asphalt binder content calibration factor is the average of the two resultant values expressed in percent by mass of the asphalt mixture.

4.13 If the asphalt binder content calibration factor exceeds ± 1.25 percent, lower the test temperature to 482 ± 5 °C (900 ± 9 °F) and repeat the test to determine a new calibration factor. If the calibration factor continues to exceed ± 1.25 percent, lower the test temperature to 427 ± 5 °C (800 ± 9 °F) and repeat the test to determine a new calibration factor. Use the calibration factor obtained at 427 ± 5 °C (800 ± 9 °F) even if it exceeds ± 1.25 percent.

4.14 Perform a gradation analysis on the residual aggregate as indicated in Section 6. Subtract the actual percent passing the No. 200 sieve for each sample from the measured percent passing the No. 200 sieve (as determined in Subsection 4.5.5). Determine the average of the two values. If the resultant average value is greater than ± 0.50, an aggregate gradation correction factor (equal to the resultant average value) for the passing No. 200 material may be applied to the production field sample test results.

5. PROCEDURE

5.1 The moisture content of the asphaltic concrete shall be determined in accordance with Arizona Test Method 406. The moisture content sample shall be obtained at the same time and subjected to the same treatment prior to testing as the asphalt binder content test sample. As an alternate to performing the moisture determination, the test sample may be dried to a constant mass in an oven at 290 ± 10 °F.

5.2 Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or to the alternate temperature determined during the calibration (Subsection 4.13). Do not preheat the sample basket. Record the furnace temperature set point prior to the initiation of the test.

5.3 Record the asphalt binder content calibration factor, determined in accordance with Subsections 4.11 through 4.13, for the specific mix to be tested.

5.4 Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

5.5 Obtain the asphalt binder content test sample in accordance with Subsection 3.2, ensuring that the size of the test sample is within ± 150 grams of the sample size used for calibration and that the test sample conforms to the requirements shown in Table 1.

5.6 Evenly distribute the test sample over the center of the sample basket(s) and level the material. Use a spatula or trowel to pull material approximately one inch away from the outside edge of basket(s).

5.7 Weigh and record the mass of the sample and basket assembly to the nearest 0.1 gram.

5.8 Calculate and record the initial mass of the sample to the nearest 0.1 gram.

5.9 Set the ignition furnace controller print mode to give a printout of the test data required in Subsection 2.1.1. Input the initial mass of the sample into the ignition furnace controller. Verify that the correct mass has been entered.

5.10 Open the furnace door and place the sample and basket assembly so that it is centered in the chamber. After assuring that the sample basket assembly is not in contact with any wall, close the door. Initiate the test by pressing the start button. This will lock the furnace door and start testing.

5.11 Allow the test to continue until the stable light and audible stable indicator indicates the test is complete. The test is deemed complete when the measured mass loss does not exceed 0.01 percent of the sample mass for three consecutive one minute intervals. If required, press the stop button. This will unlock the furnace door and cause the printer to print out the test results.

5.12 Open the furnace door and remove the sample and basket assembly. Allow the sample to cool 30 ± 5 minutes in the basket assembly. Weigh and record the mass of the sample and basket assembly after ignition to the nearest 0.1 gram.

5.13 Calculate and record the mass of sample after ignition to the nearest 0.1 gram.

5.14 Calculate and record the corrected asphalt binder content of the sample, to the nearest 0.01%, as follows:

$$\%AC = \left[\frac{W_i - W_A}{W_i} \times 100 \right] - C_F - \%M$$

Where: %AC = measured (corrected) asphalt binder content in percent by mass of the sample
W_i = mass of the sample prior to ignition
W_A = mass of the sample after ignition
C_F = asphalt binder content calibration factor, percent by mass of the sample
%M = percent moisture in the sample

Note: During calibration, C_F and %M are zero.

5.14.1 If an ignition furnace correction (tank stab correction) is made, the %AC determined in Subsection 5.14 is adjusted by that correction.

5.15 Attach the original printed ticket to the back of the card.

5.16 Empty the contents of the baskets into a flat pan. Use a small wire sieve brush to ensure that any residual fines are removed from the baskets. Take care not to lose any material, as this will affect gradation results.

5.17 If needed, perform a gradation analysis of the residual aggregate according to Section 6.

6. SIEVE ANALYSIS OF AGGREGATE

6.1 If required, the aggregate shall be subjected to sieve analysis as described below. The coarse sieving shall be performed in accordance with Subsection 6.2, and the fine sieving in accordance with Subsection 6.3. The quantity of material on a given sieve at the completion of sieving shall not exceed the amount shown Table 2.

6.2 The coarse sieving of the aggregate shall be performed as follows:

6.2.1 Weigh and record the mass of the sample to be sieved to the nearest gram. Place sample on the top sieve of a nest of 12 inch sieves. The nest of sieves shall consist of sieves starting with the smallest size sieve that 100% of the material will pass, down through and including the No. 8 sieve and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

6.2.2 Weigh and record separately, to the nearest gram, the mass of the material retained on the individual sieves and in the pan. The material retained in the pan is recorded as the minus No. 8 material.

TABLE 2			
Sieve Size	**Maximum Mass Allowed (grams/sq. in.)**	**Maximum Mass Allowed (grams)**	
		8 inch Diameter Sieve	**12 inch Diameter Sieve**
1-1/2”	25	---	2827
1”	18	---	2036
3/4”	14	---	1583
1/2”	10	---	1131
3/8”	8	---	905
1/4”	6	---	679
No. 4	5	---	565
No. 8 and smaller	4	201	452

6.2.3 Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus No. 8 material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

6.2.4 Determine the coarse sieve factor by dividing 100 by the total mass sieved. Record the factor to six decimal places.

6.2.5 The percent passing for each sieve in the coarse sieve analysis is determined by multiplying the mass retained on that sieve by the coarse sieve factor, and subtracting the result from the unrounded % passing for the next larger sieve. Values for "mass retained multiplied by the coarse sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent.

6.2.6 As a check on the coarse sieve analysis, multiply the mass of minus No. 8 material by the coarse sieve factor. The result of this calculation, rounded to the nearest percent, should be the same as the value for percent passing the No. 8 sieve determined in Subsection 6.2.5 above.

6.2.7 The material passing the No. 8 sieve is split, if necessary, to obtain a minimum 500 gram sample for fine fine sieving; however, the sample size may be less than 500 grams if a minimum of 500 grams is not obtained from coarse sieving. If less than 800 grams passes the No. 8 sieve, the entire amount shall be subjected to fine sieving. The mass of the sample for fine sieving is recorded to the nearest gram as mass of pass No. 8 split.

6.3 The elutriation and fine sieving of the pass No. 8 material shall be performed as follows:

6.3.1 Subject sample to elutriation through a No. 200 screen either by hand or mechanical washing.

6.3.2 Dry sample to constant mass, allow to cool, then weigh and record the dry mass to the nearest gram.

6.3.3 Place sample on the top sieve of a nest of fine sieves. The nest of sieves shall consist of sieves starting with the No. 10 sieve, down through and including the No. 200 sieve and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

6.3.4 Weigh and record separately, to the nearest gram, the mass of material retained on the individual sieves and in the pan.

6.3.5 Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus No. 200 material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

6.3.6 Determine and record elutriation to nearest gram by determining the difference between the dry mass and the mass of the pass No. 8 split.

6.3.7 Determine a factor for calculating the fine sieve analysis by dividing the percent passing the No. 8 sieve (recorded to the nearest percent) by the mass of pass No. 8 split. Record the factor to six decimal places. If all the pass No. 8 material from coarse sieving was subjected to elutriation and fine sieving, a fine sieve factor is not determined. Rather, the coarse sieve factor is utilized and the calculation of the percent passing each sieve is continuous through the entire sieve analysis.

6.3.8 The percent passing for each sieve in the fine sieve analysis is determined by multiplying the mass retained on that sieve by the fine sieve factor, and subtracting the result from the unrounded % passing the next larger sieve, with the exception of the percent passing the No. 8 which has previously been recorded to the nearest percent. Values for "mass retained multiplied by the fine sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent, except the percent passing the No. 200 sieve is recorded to the nearest 0.1 percent.

6.3.9 As a check on the fine sieve analysis, the mass of material passing the No. 200 sieve is added to the elutriation mass, and this total is multiplied by the fine sieve factor. The result of this calculation, rounded to the nearest 0.1 percent, should be the same as the value for the percent passing the No. 200 sieve determined in Subsection 6.3.8 above.

6.3.10 If an aggregate gradation correction factor is utilized, the percent passing the No. 200 sieve shall be adjusted by subtracting the correction factor determined in Subsection 4.14.

6.4 Other methods may be used that differ from that specified in Subsections 6.2 and 6.3 above to determine % passing each sieve, so long as the method utilized has been proven to give equivalent results. However, any procedure which includes recording percent retained values prior to completing the calculation of all percent passing values is not allowed.

7. REPORT AND EXAMPLE

7.1 Report test information on the Asphaltic Concrete Tabulation – Ignition Furnace laboratory card. An example for the testing performed on a field sample is shown in Figure 4. Only the portion of the laboratory card relevant to the ignition furnace test is used for the example. A blank Asphaltic Concrete Tabulation – Ignition Furnace laboratory card is shown in Figure 5.

7.1.1 Mass of basket assembly.

7.1.2 Mass of sample and basket assembly.

7.1.3 Calculated initial mass of the sample.

7.1.4 Mass of sample and basket assembly after ignition.

7.1.5 Calculated mass of sample after ignition.

7.1.6 Asphalt binder content calibration factor.

7.1.7 Percent moisture from moisture test, if one was performed.

7.1.8 Corrected percent asphalt binder content.

7.1.9 Elapsed time of test.

7.1.10 Name of the operator.

7.1.11 Sample test date.

7.1.12 Design percent asphalt binder content.

7.1.13 Ignition furnace set temperature.

7.1.14 If determined, the sieve analysis of the residual aggregate (corrected for passing the No. 200 sieve if applicable).

Ignition Furnace Calibration
Mix Design Weigh-Up Information

Weight of Total Virgin Aggregate Required if Bulk Batching is Used (grams) (Furnace Calibration, Aggregate Properties Testing, etc.)	10000
Total Weight of Aggregate Charge (grams) (Virgin + RAP Aggregate needed for each Gradation Check and Burn)	2200

EXAMPLE

Total Binder Content (% by wt of total mix)	5.40
Virgin Binder Content (% by wt of total mix)	4.20
RAP Binder Content (% by wt of total mix)	1.20

Total Virgin Aggregate (% by weight of total aggregate)		75.0
Total RAP Aggregate (% by weight of total aggregate)		25.0
	Total	100.0
Admixture (% by weight of total aggregate)		1.0

	Virgin Aggregate Stockpiles (Composite #2)					Adjusted
	Sieve Analysis (Percent Passing)					Virgin
Stockpile Description	WCF	CF	3/8	3/4	Total	Composite
Percent Used (w/o Admix)*	35.0	13.0	8.0	19.0	75.0	100.00
Adjusted Percent Used	46.67	17.33	10.67	25.33	100.00	
Sieve Size						
1.5"	100.0	100.0	100.0	100.0		100.00
1"	100.0	100.0	100.0	100.0		100.00
3/4"	100.0	100.0	100.0	82.0		95.44
1/2"	100.0	100.0	100.0	13.6		78.11
3/8"	100.0	100.0	100.0	4.0		75.68
1/4"	100.0	100.0	59.0	1.6		70.70
#4	97.1	98.8	22.5	1.6		65.24
#8	60.8	70.1	1.3	1.5		41.04

* If unadjusted percent virgin agggregate stockpile use is not shown in Compostite #2, see Composite #1.

					Total
Total Weight Required from each Stockpile if Bulk Batching Virgin Aggregates	4666.7	1733.3	1066.7	2533.3	10000.0

	Dry Screened RAP (Composite #3)		RAP Aggregate (Composite #1)		
	Sieve Analysis (Percent Passing)		Sieve Analysis (Percent Passing)		
Stockpile Description	Fine	Coarse	Fine	Coarse	Total
Percent Used (w/o Admix)			15.0	10.0	25.0
Adjusted Percent Used			60.0	40.0	100.0
Sieve Size					
1.5"	100.0	100.0	100.0	100.0	
1.25"	100.0	100.0	100.0	100.0	
1"	100.0	100.0	100.0	100.0	
3/4"	100.0	94.4	100.0	100.0	
1/2"	100.0	57.1	100.0	63.0	
3/8"	100.0	13.7	100.0	10.5	
1/4"	68.1	8.0	93.3	8.0	
#4	54.5	4.9	77.6	6.0	
#8	24.8	2.2	66.1	5.0	

NOTE: Overall, Composite #2 (RAP Aggregate) will be finer than Composite #3 (Dry Screened RAP).

RAP Mat'l Binder Content (%)	5.82	3.43

FIGURE 1

Ignition Furnace Calibration
Weigh-Up Requirements for Gradation Check

	Virgin Aggregate Stockpiles (Composite #2)				
Stockpile Description	WCF	CF	3/8	3/4	Total
Percent Used (w/o Admix)	35.0	13.0	8.0	19.0	75.0
Adjusted Percent Used	46.67	17.33	10.67	25.33	100.00
Sieve Size	Accumulative Weights Required (grams)				
1.5"	0.0	0.0	0.0	0.0	0.0
1"	0.0	0.0	0.0	0.0	0.0
3/4"	0.0	0.0	0.0	75.2	75.2
1/2"	0.0	0.0	0.0	361.2	361.2
3/8"	0.0	0.0	0.0	401.3	401.3
1/4"	0.0	0.0	72.2	411.3	483.5
#4	22.3	3.4	136.4	411.3	573.5
#8	301.8	85.5	173.7	411.7	972.8
-#8	770.0	286.0	176.0	418.0	1650.0

NOTE: Use individual stockpile accumulative weights if Virgin Aggregate is not Bulk Batched. Use total accumulative weights if Virgin Aggregate is Bulk Batched prior to sieving.

	Dry Screened RAP (Composite #3)		RAP Aggregate (Composite #1)		
Stockpile Description	Fine	Coarse	Fine	Coarse	Total
Percent Used (w/o Admix)			15.0	10.0	25.0
Adjusted Percent Used			60.0	40.0	100.0
Sieve Size	Accumulative Weights Required (grams)		Accumulative Weights Required (grams)		
1.5"	N/A	N/A	0.0	0.0	
1.25"	N/A	N/A	0.0	0.0	
1"	N/A	N/A	0.0	0.0	
3/4"	N/A	N/A	0.0	0.0	
1/2"	N/A	N/A	0.0	81.4	
3/8"	N/A	N/A	0.0	196.9	
1/4"	N/A	N/A	22.1	202.4	
#4	N/A	N/A	73.9	206.8	
#8	N/A	N/A	111.9	209.0	
-#8	N/A	N/A	330.0	220.0	
RAP Mat'l Binder Content (%)	5.82	3.43			

EXAMPLE

Gradation Check Material Requirements

Total Virgin Aggregate Weight Required (grams)	1650.0
Total RAP Aggregate Weight Required (grams)	550.0
Admixture Weight Required (grams)	22.0
Final Charge Weight (grams)	2222.0

FIGURE 2

Ignition Furnace Calibration
Weigh-Up Requirements for Burn 1 & 2

	Virgin Aggregate Stockpiles (Composite #2)				
Stockpile Description	WCF	CF	3/8	3/4	Total
Percent Used (w/o Admix)	35.0	13.0	8.0	19.0	75.0
Adjusted Percent Used	46.67	17.33	10.67	25.33	100.00
Sieve Size	Accumulative Weights Required (grams)				
1.5"	0.0	0.0	0.0	0.0	0.0
1"	0.0	0.0	0.0	0.0	0.0
3/4"	0.0	0.0	0.0	75.2	75.2
1/2"	0.0	0.0	0.0	361.2	361.2
3/8"	0.0	0.0	0.0	401.3	401.3
1/4"	0.0	0.0	72.2	411.3	483.5
#4	22.3	3.4	136.4	411.3	573.5
#8	301.8	85.5	173.7	411.7	972.8
-#8	770.0	286.0	176.0	418.0	1650.0
	NOTE: Use individual stockpile accumulative weights if Virgin Aggregate is Bulk Batched. Use total accumulative weights is Virgin Aggregate is Batched prior to sieving.				

	Dry Screened RAP (Composite #3)		RAP Aggregate (Composite #1)	
Stockpile Description	Fine	Coarse	Fine	Coarse
Percent Used (w/o Admix)			N/A	N/A
Adjusted Percent Used			N/A	N/A
Sieve Size	Accumulative Weights Required (grams)		Accumulative Weights Required (grams)	
1.5"	0.0	0.0	N/A	N/A
1.25"	0.0	0.0	N/A	N/A
1"	0.0	0.0	N/A	N/A
3/4"	0.0	12.8	N/A	N/A
1/2"	0.0	97.7	N/A	N/A
3/8"	0.0	196.6	N/A	N/A
1/4"	111.8	209.6	N/A	N/A
#4	159.4	216.7	N/A	N/A
#8	263.5	222.8	N/A	N/A
-#8	350.4	227.8	N/A	N/A

RAP Mat'l Binder Content (%)	5.82	3.43	
Total Wt. of RAP Mat'l (grams)	350.4	227.8	
			Total
Weight of RAP Binder (grams)	20.39	7.81	28.20

Weight of Total Binder (grams)	126.84
RAP Binder Content (% by weight of total binder)	22.23
Total RAP Aggregate (% by weight of total aggregate)	25.00

EXAMPLE

Burn 1 & 2 Material Requirements

Total Virgin Aggregate Weight Required (grams)	1650.0
Total RAP Material Weight Required (grams)	578.2
Admixture Weight Required (grams)	22.0
Virgin Binder Weight Required (grams)	98.6
Final Charge Weight (grams)	2348.8

FIGURE 3

ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION – IGNITION FURNACE

USE CAPITAL LETTERS

LAB NUMBER: 13-0079
ORG NUMBER: 5555
MATL: AC
TYPE: RC
PUR-POSE: A
TEST LAB: P
SIZE:
SIZE %:

TEST NO.: 3
LOT OR SUFFIX: 5
SAMPLED BY: BETTY BOOP
MO DAY YEAR: 05 02 13
TIME: 14:15 MILITARY TIME

SAMPLED FROM: ROADWAY - 10' Rt. of ℄
LIFT NO.: 1
RDWY: NB
STATION: 999+00 0
IF MILEPOST, INPUT DECIMAL

ORIGINAL SOURCE: RED RIVER VALLEY PIT
PROJECT ENGINEER / SUPERVISOR: Bob Headman
PROJECT NUMBER: F-099-9(99)
TRACS NUMBER: H09990IC

REMARKS: 416 3/4" SPECIAL MIX (WITH RAP)

EXAMPLE

COARSE FACTOR .043860 = 100 / COARSE SIEVE TOTAL

WEIGHTS RETAINED					% RET	% PASS	SPECS
3"							
2 1/2"							
2"							
1 1/2"							
1"					0	100	
3/4"			9	1	4	96	
1/2"		3	1	9	14	82	
3/8"		1	6	0	7	75	
1/4"		1	8	2	8	67	
#4		1	3	7	6	61	
#8		4	3	3	19		
- #8		9	5	8	✓	42	
Total	2	2	8	0	= i (Rounded)		

Weight of Pass # 8 Split: 493 = p

FINE FACTOR .085193 = % Pass #8 / Wt. of Pass #8 Split

WEIGHTS RETAINED				% RET	% PASS	SPECS
#10		4	6	4	38	
#16	1	6	2	14	24	
#30		8	1	7	17	
#40		3	9	3	14	
#50		2	4	2	12	
#100		3	3	3	9	
#200		4	5	4		
-#200		3	1	✓	r 5.4	
Total	4	6	1	q = Dry Weight		
Elutri-ation		3	2	= p - q		

r - s Corrected % Pass No. 200: 4.8

% Pass No. 200 Correction Factor (±) + 0.6 s

IGNITION FURNACE

ARIZ. 427☐ ARIZ. 428☒

a. Wet Mass of Moisture Sample: 1023.2 g
b. Dry Mass of Moisture Sample: 1020.5 g
c. Moisture Content (ARIZ 406) [(a - b) / a] x 100: 0.26 %

d. Mass of Basket Assembly: 3057.3 g
e. Mass of Sample and Basket Assembly: 5471.5 g
f. Initial Mass of Sample (e - d): 2414.2 g
g. Ignition Furnace Set Temperature: 538 °C
h. Mass of Sample and Basket Assembly After Ignition: 5337.3 g
i. Mass of Sample After Ignition (h - d): 2280.0 g
j. Uncorrected Asphalt Binder Content [(f - i) /f] x 100: 5.56 %
k. Asphalt Binder Content Calibration Factor (±) + 0.23 %
l. Ignition Furnace Correction (Tank Slab Correction) (±) - 0.17 %
m. Corrected Asphalt Binder Content (j - k - c - l): 5.24 %
n. Design Asphalt Binder Content: 5.40 %
o. Elapsed Time of Test (minutes): 67

COMPACTION

Marshall = M Gyratory = G Core = C ☐

RICE

Sample Max. Sp. Gr. (Gmm): ☐.☐☐☐
Sample Max. Density [(Gmm) x (62.3)]: ☐☐☐.☐ pcf

MARSHALL

Average Bulk O.D. Sp. Gr. (Gmb): ☐.☐☐☐
Average Bulk Density [(Gmb) x (62.3)]: ☐☐☐.☐ pcf
Air Voids = ☐☐.☐ %

$$\left[1 - \frac{\text{Average Bulk Density}}{\text{Max Density From Rice Test}}\right] \times 100$$

Stability ☐☐☐☐ lbs
Flow ☐☐ 0.01 in

GYRATORY

Average Relative Density (% Gmm) at Ndesign: ☐☐.☐ pcf
Air Voids = ☐☐.☐ %

$$100 - \left[\text{Average Relative Density \% (Gmm) at Ndesign}\right]$$

WHITE ☐
YELLOW ☐
BLUE ☐

05-02-13
RECEIVED DATE

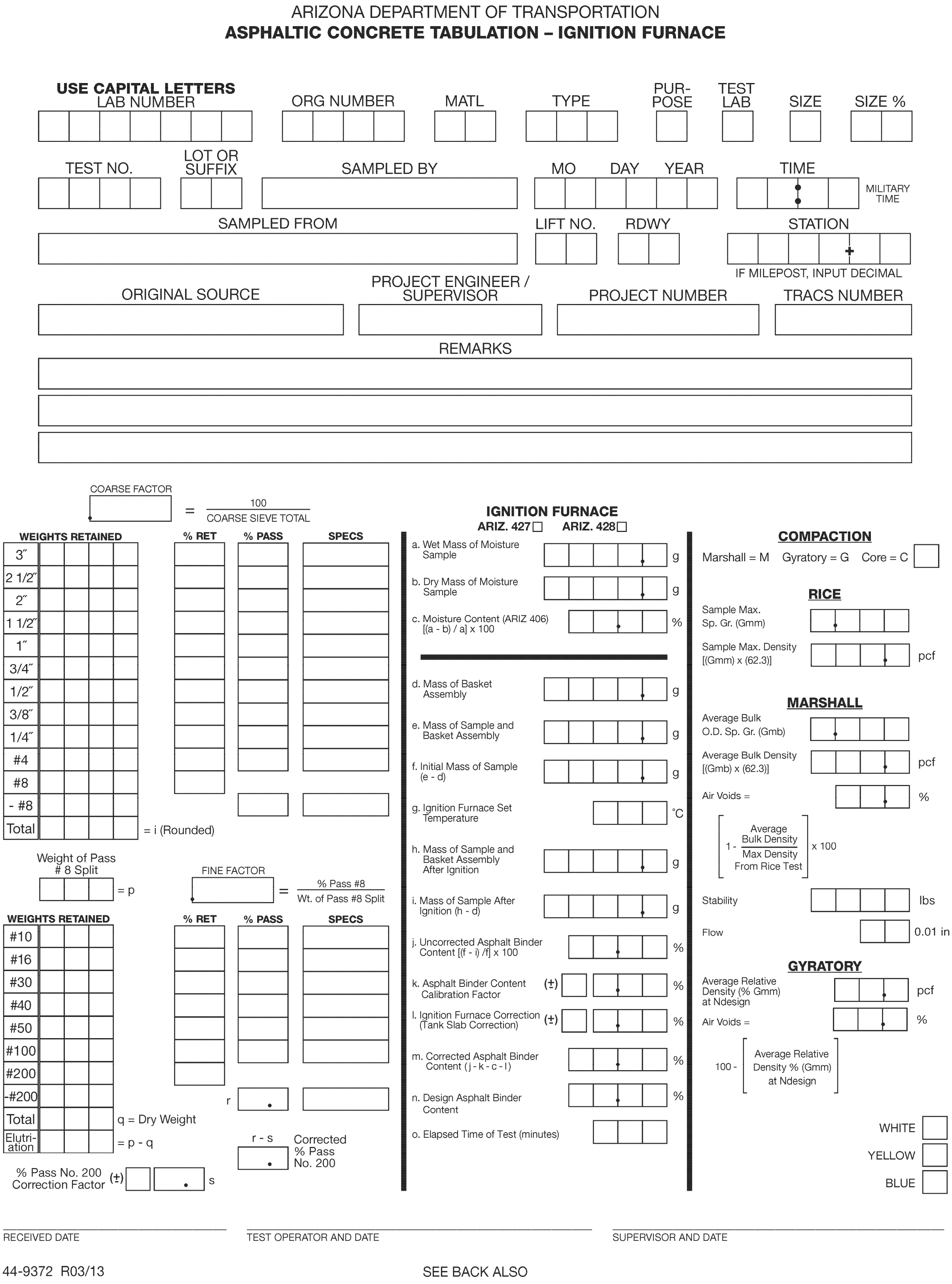
M. Twain 05-03-13
TEST OPERATOR AND DATE

T. Sawyer 05-03-13
SUPERVISOR AND DATE

44-9372 R03/13

SEE BACK ALSO

FIGURE 4



ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION – IGNITION FURNACE

USE CAPITAL LETTERS

LAB NUMBER | ORG NUMBER | MATL | TYPE | PURPOSE | TEST LAB | SIZE | SIZE %

TEST NO. | LOT OR SUFFIX | SAMPLED BY | MO DAY YEAR | TIME (MILITARY TIME)

SAMPLED FROM | LIFT NO. | RDWY | STATION (IF MILEPOST, INPUT DECIMAL)

ORIGINAL SOURCE | PROJECT ENGINEER / SUPERVISOR | PROJECT NUMBER | TRACS NUMBER

REMARKS

COARSE FACTOR $= \frac{100}{\text{COARSE SIEVE TOTAL}}$

WEIGHTS RETAINED		% RET	% PASS	SPECS
3″				
2 1/2″				
2″				
1 1/2″				
1″				
3/4″				
1/2″				
3/8″				
1/4″				
#4				
#8				
- #8				
Total	= i (Rounded)			

Weight of Pass # 8 Split = p

FINE FACTOR $= \frac{\text{\% Pass \#8}}{\text{Wt. of Pass \#8 Split}}$

WEIGHTS RETAINED		% RET	% PASS	SPECS
#10				
#16				
#30				
#40				
#50				
#100				
#200				
-#200			r	
Total	q = Dry Weight			
Elutriation	= p - q		r - s	Corrected % Pass No. 200

% Pass No. 200 Correction Factor (±) s

IGNITION FURNACE

ARIZ. 427 ☐ **ARIZ. 428** ☐

a. Wet Mass of Moisture Sample — g

b. Dry Mass of Moisture Sample — g

c. Moisture Content (ARIZ 406) [(a - b) / a] x 100 — %

d. Mass of Basket Assembly — g

e. Mass of Sample and Basket Assembly — g

f. Initial Mass of Sample (e - d) — g

g. Ignition Furnace Set Temperature — °C

h. Mass of Sample and Basket Assembly After Ignition — g

i. Mass of Sample After Ignition (h - d) — g

j. Uncorrected Asphalt Binder Content [(f - i) /f] x 100 — %

k. Asphalt Binder Content Calibration Factor (±) — %

l. Ignition Furnace Correction (Tank Slab Correction) (±) — %

m. Corrected Asphalt Binder Content (j - k - c - l) — %

n. Design Asphalt Binder Content — %

o. Elapsed Time of Test (minutes)

COMPACTION

Marshall = M Gyratory = G Core = C ☐

RICE

Sample Max. Sp. Gr. (Gmm)

Sample Max. Density [(Gmm) x (62.3)] — pcf

MARSHALL

Average Bulk O.D. Sp. Gr. (Gmb)

Average Bulk Density [(Gmb) x (62.3)] — pcf

Air Voids = — %

$$\left[1 - \frac{\text{Average Bulk Density}}{\text{Max Density From Rice Test}}\right] \times 100$$

Stability — lbs

Flow — 0.01 in

GYRATORY

Average Relative Density (% Gmm) at Ndesign — pcf

Air Voids = — %

$$100 - \left[\text{Average Relative Density \% (Gmm) at Ndesign}\right]$$

WHITE ☐

YELLOW ☐

BLUE ☐

RECEIVED DATE | TEST OPERATOR AND DATE | SUPERVISOR AND DATE

44-9372 R03/13

SEE BACK ALSO

FIGURE 5

APPENDIX A

DETERMINATION OF GRADATION, MOISTURE CONTENT, AND BINDER CONTENT OF THE RAP MATERIAL

A.1 Obtain a representative sample of the RAP material in accordance with Arizona Test Method 105. When multiple RAP stockpiles are used, a separate representative sample shall be obtained from each stockpile.

A.1.1 The sample shall be split to provide a sufficient amount of material for gradation testing, moisture content testing, and binder content testing.

A.2 The entire split sample of RAP material from each stockpile is dried at 140 °F and the percent moisture content determined as described below.

Note: A higher drying temperature is not appropriate because it will soften the binder causing the RAP material to break into smaller particles and adhere to the drying pan.

A.2.1 The weight of the RAP material from each stockpile is determined and recorded to the nearest 0.1 gram.

A.2.2 The material is dried to constant weight at 140 ± 10 °F.

Note: Drying to constant weight at 140 °F will typically take overnight.

A.2.3 After drying to constant weigtht at 140 ± 10 °F, cover the material and allow to cool 30 ± 10 minutes at room temperature. The weight of the RAP material is then determined and recorded to the nearest 0.1 gram.

A.2.4 The percent moisture content of the RAP material from each stockpile is determined and recorded to the nearest 0.01 percent by the following:

$$\begin{bmatrix}\text{Percent Moisture}\\ \text{Content}\end{bmatrix} = \left[\frac{\begin{pmatrix}\text{Weight of Material}\\ \text{Prior to Drying}\end{pmatrix} - \begin{pmatrix}\text{Weight of Material}\\ \text{After Drying}\end{pmatrix}}{\begin{pmatrix}\text{Weight of Material}\\ \text{After Drying}\end{pmatrix}}\right] \text{x } 100$$

A.3 After drying and determining the moisture content at 140 °F, the RAP material shall be tested for gradation, moisture content (at 290 °F), and binder content.

A.3.1 The gradation of the RAP material from each stockpile shall be determined as described below.

A.3.1.1 Split out a representative sample of the RAP material from each stockpile which conforms to the size specified in Table 3.

TABLE 3	
Maximum Size of Particle (See Note)	**Minimum Weight of Sample, grams**
3/4 in. and larger	5000
1/2 in.	2000
3/8 in.	1000
Note: The smallest sieve opening through which the entire amount of material will pass.	

A.3.1.2 Dry sieve the material in accordance with Arizona Test Method 240, with the exception that the No. 8 sieve shall be used as the smallest sieve. (Arizona Test Method 240 limits the time for shaking the sample to 5 minutes ± 15 seconds to control breakdown of the particles of RAP material into smaller size fractions.) The gradation of the RAP material from each stockpile is then determined in accordance with Arizona Test Method 248, Alternate #2.

A.3.2 The percent moisture content of the RAP material from each stockpile shall be determined by drying at 290 °F as described below.

Note: The sample for determining the moisture content at 290 °F shall be obtained at the same time and subjected to the same treatment prior to testing as the sample obtained for determining the RAP binder content.

A.3.2.1 Split out a representative 1000 ± 50 gram sample of the RAP material from each stockpile. The weight of each sample is determined and recorded to the nearest 0.1 gram.

A.3.2.2 Each sample is dried at 290 ± 10 °F to constant weight. Constant weight is defined as the weight at which further drying does not alter the weight more than 0.1 gram at intervals of a minimum of 30 minutes.

A.3.2.3 After drying to constant weight at 290 ± 10 °F, cover the sample and allow to cool 30 ± 10 minutes at room temperature. The weight of the sample is then determined and recorded to the nearest 0.1 gram.

A.3.2.4 The percent moisture content of the RAP material from each stockpile is determined and recorded to the nearest 0.01 percent by the following:

$$\begin{bmatrix}\text{Percent Moisture}\\ \text{Content}\end{bmatrix} = \left[\frac{\begin{pmatrix}\text{Weight of Material}\\ \text{Prior to Drying}\end{pmatrix} - \begin{pmatrix}\text{Weight of Material}\\ \text{After Drying}\end{pmatrix}}{\begin{pmatrix}\text{Weight of Material}\\ \text{Prior to Drying}\end{pmatrix}}\right] \text{x } 100$$

A.3.3 The total percent moisture content of the RAP material from each stockpile is determined by adding the percent moisture content by drying at 140 °F (Subsection A.2) to the percent moisture content by drying at 290 °F (Subsection A.3.2).

A.3.4 The binder content of the RAP material from each stockpile shall be determined as described below.

A.3.4.1 Split out a representative sample of the RAP material from each stockpile which conforms to the size specified in Table 4.

TABLE 4

Nominal Maximum RAP Aggregate Size (See Notes)	Mass of Sample, grams
1 in.	2500 – 3000
3/4 in.	2000 – 2500
1/2 in.	1500 – 2000
3/8 in.	1200 – 1700
No. 4	1200 – 1700

Note: The nominal maximum RAP aggregate size is defined as: One size larger than the first sieve that retains more than 10 percent RAP aggregate.

Note: To determine the nominal maximum RAP aggregate size, the RAP aggregate gradation of each RAP stockpile, as shown in the mix design or as detemined from previous testing, may provide information.

A.3.4.2 Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F). Do not preheat the sample basket.

A.3.4.3 Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

A.3.4.4 Perform ignition furnace testing on the RAP material from each stockpile in accordance with Subsections 5.6 through 5.13.

A.3.4.5 Calculate and record the binder content of the material from each RAP stockpile, to the nearest 0.01%, as follows:

$$\%AC = \left[\frac{W_i - W_A}{W_i} \times 100 \right] - \%M$$

Where:
$\%AC$ = measured RAP binder content in percent by mass of the sample
W_i = mass of the sample prior to ignition
W_A = mass of the sample after ignition
$\%M$ = percent moisture in the sample (determined by drying at 290 °F, per Subsection A.3.2)

A.3.4.5.1 Retain the original printed ticket and save with other test documentation.

A.3.4.6 Each measured binder content test result, as determined in Subsection A.3.4.5, is adjusted by the appropriate RAP binder content correction factor (See Appendix B). This adjustment is made by adding the RAP binder correction factor to each measured binder content. The corrected RAP binder content is recorded to the nearest 0.01%.

A.4 If needed, determine the RAP aggregate gradation by performing a sieve analysis of the residual aggregate in accordance with Section 6.

Note: Subsection 6.3.10 does not apply when determining the RAP aggregate gradation.

A.5 Report test information on the “RAP Material Tabulation - Ignition Furnace” laboratory card. An example is shown in Figure 6. A blank “RAP Material Tabulation - Ignition Furnace” laboratory card is shown in Figure 7.

ARIZONA DEPARTMENT OF TRANSPORTATION
RAP MATERIAL TABULATION – IGNITION FURNACE
(Arizona Test Method 428 - Appendix A)

WHITE ☐
YELLOW ☐
BLUE ☐

USE CAPITAL LETTERS

LAB NUMBER: 13-0027
ORG NUMBER: 5555
MATL: RP
TYPE: C
PURPOSE: A
TEST LAB: P
SIZE:
SIZE %:

TEST NO.:
LOT OR SUFFIX:
SAMPLED BY: BETTY BOOP
MO DAY YEAR: 04 29 13
TIME: 10:35 MILITARY TIME

SAMPLED FROM: STOCKPILE
LIFT NO.:
RDWY:
STATION: +
IF MILEPOST, INPUT DECIMAL

ORIGINAL SOURCE: EXISTING ROADWAY MILLINGS
PROJECT ENGINEER / SUPERVISOR: Bob Headman
PROJECT NUMBER: F-099-9(99)
TRACS NUMBER: H099901C

REMARKS:

EXAMPLE

RAP Material Moisture Content @ 140°F

p. Wet Mass of RAP Material: 10185.5 g
q. Dry Mass of RAP Material: 10134.8 g
r. Moisture Content @ 140°F [(p - q) / q] x 100: 0.50 %

RAP Material Gradation (ARIZ 240 / ARIZ 248, Alt. #2)

FACTOR .015293 = 100 / TOTAL

WEIGHTS RETAINED		% RET	% PASS	SPECS
3″				
2 1/2″				
2″				
1 1/2″				
1 1/4″		0	100	100
1″	134	2	98	
3/4″	455	7	91	
1/2″	1942	30	61	
3/8″	2977	45	16	0-25
1/4″	585	9	7	
#4	129	2	5	
#8	140	2		
- #8	177	✓	3	
Total	6539			

Total RAP Material Moisture Content

r. Moisture Content @ 140°F: 0.50 %
c. Moisture Content @ 290°F: 0.16 %
s. Total Moisture Content (r + c): 0.66 %

Ignition Furnace

a. Wet Mass of Moisture Sample: 989.3 g
b. Dry Mass of Moisture Sample: 987.7 g
c. Moisture Content @ 290°F [(a - b) / a] x 100: 0.16 %

d. Mass of Basket Assembly: 3045.7 g
e. Mass of Sample and Basket Assembly: 5631.3 g
f. Initial Mass of Sample (e - d): 2585.6 g
g. Ignition Furnace Set Temperature: 538 °C
h. Mass of Sample and Basket Assembly After Ignition: 5525.3 g
i. Mass of Sample After Ignition (h - d): 2479.6 g
j. Measured RAP Binder Content {[(f - i) /f] x 100} - c: 3.94 %
k. RAP Binder Content Correction Factor (±): - 0.37 %
l. Corrected RAP Binder Content (j + k): 3.57 %
m. Elapsed Time of Test (minutes): 43

RAP Aggregate Gradation

COARSE FACTOR .040323 = 100 / Total [i (Rounded)]

WEIGHTS RETAINED		% RET	% PASS
3″			
2 1/2″			
2″			
1 1/2″			
1″		0	100
3/4″	24	1	99
1/2″	794	32	67
3/8″	1287	52	15
1/4″	75	3	12
#4	49	2	10
#8	102	4	
- #8	149	✓	6
Total	2480 = i (Rounded)		

Weight of Pass # 8 Split: -- = n
FINE FACTOR: — = % Pass #8 / n

WEIGHTS RETAINED		% RET	% PASS
#10	29	1	5
#16	13	1	4
#30	9	0	4
#40	20	1	3
#50	7	0	3
#100	16	1	2
#200	20	1	
-#200	17	✓	1.4
Total	131 o = Dry Weight		
Elutriation	18 = n - o		

04-29-13
RECEIVED DATE

M. Twain 04-30-13
TEST OPERATOR AND DATE

T. Sawyer 04-30-13
SUPERVISOR AND DATE

44-9379 03/13

FIGURE 6

ARIZONA DEPARTMENT OF TRANSPORTATION

RAP MATERIAL TABULATION – IGNITION FURNACE

(Arizona Test Method 428 - Appendix A)

WHITE ☐
YELLOW ☐
BLUE ☐

USE CAPITAL LETTERS

LAB NUMBER	ORG NUMBER	MATL	TYPE	PUR-POSE	TEST LAB	SIZE	SIZE %

TEST NO.	LOT OR SUFFIX	SAMPLED BY	MO	DAY	YEAR	TIME (MILITARY TIME)
						:

SAMPLED FROM	LIFT NO.	RDWY	STATION (IF MILEPOST, INPUT DECIMAL)
			+

ORIGINAL SOURCE	PROJECT ENGINEER / SUPERVISOR	PROJECT NUMBER	TRACS NUMBER

REMARKS

RAP Material Moisture Content @ 140°F

p. Wet Mass of RAP Material ____ g

q. Dry Mass of RAP Material ____ g

r. Moisture Content @ 140°F [(p - q) / q] x 100 ____ %

RAP Material Gradation (ARIZ 240 / ARIZ 248, Alt. #2)

FACTOR ____ = 100 / TOTAL

WEIGHTS RETAINED		% RET	% PASS	SPECS
3″				
2 1/2″				
2″				
1 1/2″				
1 1/4″				
1″				
3/4″				
1/2″				
3/8″				
1/4″				
#4				
#8				
- #8				
Total				

Total RAP Material Moisture Content

r. Moisture Content @ 140°F ____ %

c. Moisture Content @ 290°F ____ %

s. Total Moisture Content (r + c) ____ %

Ignition Furnace

a. Wet Mass of Moisture Sample ____ g

b. Dry Mass of Moisture Sample ____ g

c. Moisture Content @ 290°F [(a - b) / a] x 100 ____ %

d. Mass of Basket Assembly ____ g

e. Mass of Sample and Basket Assembly ____ g

f. Initial Mass of Sample (e - d) ____ g

g. Ignition Furnace Set Temperature ____ °C

h. Mass of Sample and Basket Assembly After Ignition ____ g

i. Mass of Sample After Ignition (h - d) ____ g

j. Measured RAP Binder Content {[(f - i) /f] x 100} - c ____ %

k. RAP Binder Content Correction Factor (±) ____ %

l. Corrected RAP Binder Content (j + k) ____ %

m. Elapsed Time of Test (minutes) ____

RAP Aggregate Gradation

COARSE FACTOR ____ = 100 / Total [i (Rounded)]

WEIGHTS RETAINED		% RET	% PASS
3″			
2 1/2″			
2″			
1 1/2″			
1″			
3/4″			
1/2″			
3/8″			
1/4″			
#4			
#8			
- #8			
Total	= i (Rounded)		

Weight of Pass # 8 Split ____ = n

FINE FACTOR ____ = % Pass #8 / n

WEIGHTS RETAINED		% RET	% PASS
#10			
#16			
#30			
#40			
#50			
#100			
#200			
-#200			
Total	o = Dry Weight		
Elutri-ation	= n - o		

RECEIVED DATE

TEST OPERATOR AND DATE

SUPERVISOR AND DATE

44-9379 03/13

FIGURE 7

APPENDIX B

DETERMINATION OF THE RAP BINDER CORRECTION FACTOR

B.1 A RAP binder content correction factor is determined for each RAP stockpile used in the asphaltic concrete mixture.

B.2 At the start of asphaltic concrete production, the first two samples of RAP material from each stockpile are split and tested for asphalt binder content; one split is tested by ignition furnace as described in Subsections A.3.4.2 through A.3.4.5.1, and the other split is tested by solvent extraction in accordance with AASHTO T 164.

Note: Generally, 9000 grams of RAP material from each stockpile will be adequate to obtain the split samples for determining the RAP binder content correction factor.

Note: At the discretion of the Engineer, the RAP binder correction factor may be determined prior to the start of asphaltic concrete production provided representative RAP samples are available.

B.3 The average asphalt binder content determined by ignition furnace is recorded to the nearest 0.001%.

B.4 The average asphalt binder content determined by solvent extraction is recorded to the nearest 0.001%.

B.5 The RAP binder content correction factor is determined by subtracting the average ignition furnace result from the average solvent extraction result. The RAP binder content correction factor is recorded to the nearest 0.01%.

B.6 A new RAP binder correction factor may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances.

B.7 Report the determination of the RAP binder content correction factor on the “RAP Binder Content Correction Factor” laboratory card. An example is shown in Figure 8. A blank “RAP Binder Content Correction Factor” laboratory card is shown in Figure 9.

ARIZONA DEPARTMENT OF TRANSPORTATION

RAP BINDER CONTENT CORRECTION FACTOR

(Arizona Test Method 428 - Appendix B)

Project Number: F-099-9 (99)

TRACS Number: H09901C

RAP Material Type: COARSE

Sample # : 1 Sampled By: Jack B. Nimble Sampled From: STOCKPILE

Date Sampled: 04-23-13 Time Sampled: 8:28

Sample # : 2 Sampled By: MARY MUFFETT Sampled From: STOCKPILE

Date Sampled: 04-24-13 Time Sampled: 14:26

RAP BINDER CONTENT CORRECTION FACTOR
(Ignition Furnace vs. Solvent Extraction)

Sample #	RAP Binder Content (%)		**RAP Binder Content Correction Factor** (Average Solvent Extraction Value) Minus (Average Ignition Furnace Value)
	Ignition Furnace (ARIZ 428)	Solvent Extraction (AASHTO T 164)	
1	3.81	3.39	
2	3.96	3.65	
Average	3.885	3.520	(±) − 0.37

Remarks:

EXAMPLE

04-24-13
Received Date

M. Twain
Test Operator and Date

T. Sawyer
Supervisor and Date

44-9380 03/13

FIGURE 8

ARIZONA DEPARTMENT OF TRANSPORTATION

RAP BINDER CONTENT CORRECTION FACTOR

(Arizona Test Method 428 - Appendix B)

Project Number: ______________________________

TRACS Number: ______________________________

RAP Material Type: ______________________________

Sample # : ________ Sampled By: ____________________ Sampled From: ____________________

Date Sampled: ____________________ Time Sampled: ____________________

Sample # : ________ Sampled By: ____________________ Sampled From: ____________________

Date Sampled: ____________________ Time Sampled: ____________________

RAP BINDER CONTENT CORRECTION FACTOR
(Ignition Furnace vs. Solvent Extraction)

Sample #	RAP Binder Content (%)		**RAP Binder Content Correction Factor** (Average Solvent Extraction Value) Minus (Average Ignition Furnace Value)
	Ignition Furnace (ARIZ 428)	Solvent Extraction (AASHTO T 164)	
	☐☐.☐☐■	☐☐.☐☐■	
	☐☐.☐☐■	☐☐.☐☐■	
Average	☐☐.☐☐☐	☐☐.☐☐☐	■ (±) ☐ ☐.☐☐■

Remarks:

Received Date ____________________ Test Operator and Date ____________________ Supervisor and Date ____________________

44-9380 03/13

FIGURE 9

ARIZ 732a
April 19, 2013
(3 Pages)

CALCIUM CARBONATE IN TOPSOIL (NEUTRALIZATION POTENTIAL OF TOPSOIL)

(An Arizona Method)

1. SCOPE

1.1 This test method is used to determine the acid-consumption capacity or alkalinity of a topsoil as defined by the conditions of the test itself. The principal mineral components of the topsoil which give rise to this alkalinity are generally taken to be alkali and alkaline earth metal carbonates. They are represented by calcium carbonate, the most abundant member of the group.

1.2 A large excess of Hydrochloric Acid Standard Solution is added to ensure complete decomposition of the Calcium Carbonate. Then, the residual acid is backtitrated out with Sodium Hydroxide Standard Solution.

1.3 This test method involves hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

1.4 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

2.1.1 25 mL, volumetric pipette, accurate to ± 0.05 mL.

2.1.2 A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.01 gram.

2.1.3 Filter paper equivalent to Whatman No. 40.

2.1.4 Filtration funnel, 7.5 cm, 60°, long stem.

2.1.5 300 mL beaker, tall form, graduated.

2.1.6 25 mL burette, accurate to ± 0.01 mL.

2.1.7 Stirring rod (glass or plastic).

3. REAGENTS

3.1 1.00 ± 0.10 Normal Hydrochloric Acid Standard Solution. Label this solution "Reagent 1" or "R_1" on the bottle. This reagent is available from laboratory chemical suppliers as a standardized solution. Its normality should be checked regularly against "Reagent 2" below, as required by frequency of use. Record the actual normality of this solution as "N_1".

3.2 1.00 ± 0.10 Normal Sodium Hydroxide Standard Solution. Label this solution "Reagent 2" or "R_2" on the bottle. This reagent is available from laboratory chemical suppliers as a standardized solution. Its normality should be checked regularly against primary standard Potassium Biphthalate, as required by frequency of use. Record the actual normality of this solution as "N_2".

3.3 Phenolphthalein Indicator (1% Phenolphthalein in 50% Isopropyl Alcohol).

3.4 Demineralized Water.

4. PROCEDURE

4.1 Weigh 1.00 ± 0.01 gram of soil passing a No. 12 sieve into a 300 mL beaker.

4.2 Pipette 25.00 ± 0.05 mL Hydrochloric Acid Solution (Reagent 1) into the 300 mL beaker.

4.3 Stir thoroughly with a stirring rod.

4.4 Let the mixture stand undisturbed for 15 minutes, or, if significant bubbling is observed, 30 minutes.

4.5 Filter the entire contents of the 300 mL beaker into another 300 mL beaker and rinse three times with demineralized water, being careful to keep the total volume at or under 100 mL.

4.6 Dilute to 100 mL, if necessary, with demineralized water, and add one drop of Phenolphthalein Indicator.

4.7 Backtitrate the residual Hydrochloric Acid with Sodium Hydroxide Solution (Reagent 2) to a Phenolphthalein endpoint.

4.8 Record the volume of Reagent 2 delivered, to the nearest 0.05 mL, as “V_2”.

5. CALCULATIONS AND REPORT

5.1 Calculate Calcium Carbonate, in percent, using the following formula:

$$\text{Calcium Carbonate, \%} = 5 \text{ x } \left[25 - \frac{N_2 \text{ x } V_2}{N_1} \right] \text{ x } N_1$$

5.2 Report Calcium Carbonate to the nearest 0.1%.

ARIZ 743
April 19, 2013
(4 Pages)

TITANIUM DIOXIDE IN PAINTS AND THERMOPLASTICS

(An Arizona Method)

1. SCOPE

1.1 This test method may be used to make a rapid estimation of the amount of Titanium Dioxide pigment in paints and thermoplastics, particularly those of white color used for traffic control markings.

1.2 The method is a non-instrumental, gravimetric method, which involves removing, successively, all accompanying constituents of the material, leaving only the Titanium Dioxide analyte. The isolated analyte is weighed directly.

1.3 The method is applicable for paints and for thermoplastics, with or without glass beads.

1.4 **The procedure in this method consists of two parts. Part A is for paints; Part B is for thermoplastics.**

1.5 This test method involves hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

1.6 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

2.1.1 600 mL beaker, graduated.

2.1.2 Whatman No. 40 ashless filter paper, 125 mm, or equivalent.

2.1.3 A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except that the readability and sensitivity of any balance or scale utilized shall be at least 0.0001 gram.

2.1.4 50 mL porcelain crucible.

2.1.5 Filtration funnel, 7.5 cm, 60°, long stem.

2.1.6 Watch glass, 3 inch.

2.1.7 Glass stirring rod.

2.1.8 Muffle furnace, capable of maintaining a constant temperature of 450 °C.

2.1.9 Drying oven, capable of maintaining a constant temperature of 110 °C.

2.1.10 Dessicator.

2.1.11 Hot plate.

3. REAGENTS

3.1 Concentrated Hydrochloric Acid Solution.

3.2 Concentrated Nitric Acid Solution.

3.3 Demineralized water.

4. PROCEDURE

4.1 <u>PART A (FOR PAINTS):</u>

4.1.1 Weigh 5.0000 ± 0.2500 grams of paint into a crucible. Record the weight of the paint specimen as “B” to the nearest 0.0001 gram.

4.1.2 Place crucible and specimen into the drying oven at temperature of 110 °C.

4.1.3 After 2 hours, remove crucible, place into cold muffle furnace, and set the temperature to 450 °C.

4.1.4 Ignite specimen at 450 °C for 1 hour after the temperature of 450 °C is attained.

4.1.5 Remove crucible with ignition residue and allow to cool to room temperature.

4.1.6 Place crucible with residue into 300 mL beaker.

4.1.7 Cautiously, dropwise, add 30 mL Concentrated Hydrochloric Acid to crucible.

4.1.8 Cautiously add 10 mL Concentrated Nitric Acid to crucible.

4.1.9 After digestion of the residue is complete, add 250 mL of demineralized water to beaker, add 1 boiling chip, cover with watchglass, and place on the hot plate.

4.1.10 Heat beaker contents to boiling and boil for 15 minutes.

4.1.11 Remove beaker from hotplate and filter contents, carefully washing and decanting titanium dioxide, leaving boiling chip and glass beads, if any, in the beaker. Wash thoroughly with demineralized water.

4.1.12 Tightly fold filter and place into tared crucible. Record crucible weight as “A,” to the nearest 0.0001 gram.

4.1.13 Place crucible and contents into cold furnace and set temperature to 450 °C.

4.1.14 Ignite specimen at 450 °C for 1 hour after temperature of 450 °C is attained.

4.1.15 Remove crucible and allow to cool to room temperature in dessicator.

4.1.16 Weigh crucible and contents. Record weight as “C,” to the nearest 0.0001 gram.

4.2 **PART B (FOR THERMOPLASTICS):**

4.2.1 Weigh 5.0000 ± 0.2500 grams of thermoplastic into a crucible. Record the weight of the thermoplastic specimen as “B” to the nearest 0.0001 gram.

4.2.2 Place crucible and specimen into cold muffle furnace and set the temperature to 450 °C.

4.2.3 Proceed as specified in Subsections 4.1.4 through 4.1.16.

5. CALCULATIONS AND REPORT

5.1 Calculate Titanium Dioxide, in percent, using the following formula:

$$\text{Titanium Dioxide, \%} = \frac{\text{C - A}}{\text{B}} \text{ x } 100$$

5.2 Report Titanium Dioxide to the nearest 0.001%.

ARIZ 744
April 19, 2013
(3 Pages)

ROCK SALT IN CRASH BARREL SAND

(An Arizona Method)

1. SCOPE

1.1 This test method is used to determine the amount of rock salt which has been mixed with sand for use in crash barrel cushions.

1.2 The method is a non-instrumental, gravimetric method, which involves removing the salt from the sand/salt mixture by dissolution and washing away the salt using demineralized water. The salt content is then determined by weight loss after drying.

1.3 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

2.1.1 1000 mL heavy-duty glass beaker, graduated; KIMAX No. 14005, or equivalent.

2.1.2 A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except that the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

2.1.3 Stirring rod (glass, steel, or plastic).

2.1.4 Drying oven, capable of maintaining a constant temperature of 110 °C.

2.1.5 Spot plate (black).

3. REAGENTS

3.1 Silver Nitrate Test Solution, 1%. Weigh approximately 0.5 gram of Silver Nitrate crystals into a 100 mL beaker and dilute to 50 mL. Stir to dissolve, and transfer contents to an amber dropping bottle.

3.2 Demineralized water.

4. PROCEDURE

4.1 Weigh a clean beaker. Record the weight as “A” to the nearest 0.1 gram.

4.2 Weigh 500.0 ± 5.0 grams of sand/salt mixture into the beaker. Record the weight of the sand/salt mixture as “B” to the nearest 0.1 gram.

4.3 Add enough demineralized water to cover the specimen and fill the beaker to the 750 mL mark.

4.4 Stir the contents of the beaker vigorously and let the mix stand for one hour.

4.5 Decant and discard the supernatant extract solution.

4.6 Repeat Subsections 4.3 and 4.4, and then continue to Subsection 4.7.

4.7 Test two drops of the extract solution for the presence of chloride with two drops of the silver nitrate solution, in the spot plate.

4.8 If the test indicates the presence of chloride (by a white cloudy solution), repeat Subsections 4.3, 4.4, and 4.7. If the test indicates the absence of chloride, decant and discard the extract solution.

4.9 Place the beaker and wet sand residue into the drying oven. Dry thoroughly at 110 °C.

4.10 After drying, remove the beaker with dry sand residue from the oven and allow to cool to room temperature.

4.11 Weigh the beaker and contents. Record the weight as “C” to the nearest 0.1 gram.

5. CALCULATIONS AND REPORT

5.1 Calculate the salt content, in percent, using the following formula:

$$\text{Salt, \%} = \frac{(A + B) - C}{B} \times 100$$

5.2 Report as Percent Rock Salt, to the nearest 0.1%.