# CHANGE LETTER

<table>
<thead>
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<th>POLICY AND PROCEDURE DIRECTIVES MANUAL</th>
<th>CHANGE LETTER NO. 16</th>
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<tr>
<td>SUBJEC T:</td>
<td>EFFECTIVE DATE:</td>
</tr>
<tr>
<td>Title Page; Table of Contents; Policy and Procedure Directives No. 15a and No. 20a.</td>
<td>April 19, 2013</td>
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## 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 Policy and Procedure Directives 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 Policy and Procedure Directives have been revised. Please replace the existing Policy and Procedure Directives with the attached.

   P.P.D. No. 15a - “SUBMITTAL AND APPROVAL OF PORTLAND CEMENT CONCRETE MIX DESIGNS”
   - Editorial revisions and changes in the numbering of the Subsections in Section 1 have been made.
   - Editorial revisions and changes in the paragraph identifiers in Subsection 3.3 have been made.
   - Subsection 5.1.1 has been revised.
   - In Subsection 5.2.4, the existing reference to Section 1.9 has been revised to reference Subsection 1.8.
   - Editorial revisions have been made to Attachment #1.
   - A few other editorial revisions have also been made to this Policy and Procedure Directive.
P.P.D. No. 20a - “GUIDANCE ON THE USE OF RECLAIMED ASPHALTIC PAVEMENT (RAP) IN ASPHALTIC CONCRETE”

- Revisions have been made throughout this Policy and Procedure Directive.

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

Attachments
# MATERIALS

## POLICY AND PROCEDURE

### DIRECTIVES MANUAL

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1. GENERAL

1.1 This Policy and Procedure Directive outlines the procedure to be followed for the submittal and approval of new, and previously approved or used, Portland cement concrete (P.C.C.) mix designs.

1.2 A previously approved or used mix design is defined as either:

   (a) One that has been approved, or used successfully, on an ADOT project within the past 24 months and is recorded in the ADOT Concrete Cylinder Report (CCR) program.

   (b) One that has been used successfully on a non-ADOT project within the past 24 months, and meets the criteria specified herein.

1.3 A trial batch shall be required for any mix design that does not meet the requirements specified in Subsection 1.2.

1.4 All mix designs, for other than precast or prestressed concrete, must be approved by the Regional Materials Engineer. See Section 3 for additional information.

1.4.1 The Regional Materials Engineer (RME) will maintain a list of all approved P.C.C. mix designs, for other than precast or prestressed concrete, in the ADOT Concrete Cylinder Report (CCR) program. The RME will also have the responsibility of entering all such approved mix designs in the CCR program for review by project personnel and other authorized individuals.

1.5 All mix designs for precast or prestressed concrete must be approved by the Materials Structural Testing Section. See Section 4 for additional information.

1.5.1 The Materials Structural Testing Section will maintain a list of all approved P.C.C. mix designs for precast or prestressed concrete in the ADOT Concrete Cylinder Report (CCR) program. The Materials Structural Testing Section will also have the responsibility of
entering all such approved mix designs in the CCR program for review by project personnel and other authorized individuals.

1.6 Approval of mix designs shall not relieve the contractor of full responsibility for the results obtained.

1.7 Concrete mix design submittals will be required from the prime contractor for the project records. Qualified subcontractors on the project may use mix designs that have been identified by the prime contractor as proposed for use on the project and approved by the Engineer.

1.8 Each new or previously used mix design must include a product code, plant designation, and supplier, along with all data required in Subsection 1006-3.02 of the Specifications. A single product code may include multiple sources of aggregate, cement, fly ash, natural pozzolan, and silica fume. When multiple sources of material are used under one product code, documentation must be provided which shows similar performance using materials from each source. Multiple sources of material must be listed on the mix design as alternative sources.

1.9 An example of a typical P.C.C. mix design is given in Attachment #3. The actual mix design submittal format from individual concrete suppliers will vary. A checklist is provided in Attachment #4 that may be used to verify that all required items are included in the mix design.

2. MINIMUM OVER-DESIGN REQUIREMENTS

2.1 The minimum over-design requirement for all classes and strengths of concrete shall be established for 28-day compressive strength, unless otherwise specified. Trial batch results, prior to the specified compressive strength acceptance age, may be used if they meet the minimum over-design requirement for the specified acceptance age. When production data is available in accordance with Subsection 2.1.3, the over-design requirement may be established by either using that data or by adhering to a minimum 20% over-design. When production data is used to determine the over-design requirement, the performance of the proposed mix design must equal or exceed the over-design requirement determined in Table B. When production data is not available, or if otherwise desired, the over-design requirement shall be a minimum of 20% of the specified design compressive strength. Trial mixtures may be from laboratory trial batches or full-scale trial batches. Laboratory trial batches are defined in Note 2 of Attachment #1 and Attachment #2. Full-scale trial batches are defined in Note 1 of Attachment #1 and Attachment #2.

2.1.1 The water/cementitious material ratio (w/cm) and cementitious material content for each class and strength of concrete must be in compliance with the specified requirements.
2.1.2 Trial mixtures shall have slump results within the range specified for the proposed work. When air-entrained concrete is specified, the air content shall be in compliance with the specified requirements.

2.1.3 When a production facility has strength test records from an ADOT approved laboratory, which are not more than 24 months old, a sample standard deviation ($s_s$) may be used to establish the required over-design. Test records shall comply with the following criteria:

(a) Shall represent materials, quality control procedures, and conditions similar to those expected on the project.

(b) Shall represent concrete produced to meet a compressive strength, or strengths, within 1000 psi of the specified design compressive strength.

(c) Shall consist of at least 15 consecutive strength tests that span a period of not less than 45 days. If the test record consists of at least 30 consecutive tests, the standard deviation ($s_s$) of those tests is used. If the test record consists of 15 to 29 consecutive tests, the standard deviation of those tests shall be modified in accordance with Table A.

<table>
<thead>
<tr>
<th>No. of tests *</th>
<th>Modification factor for sample standard deviation †</th>
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<tbody>
<tr>
<td>&lt; 15</td>
<td>Minimum 20% over-design</td>
</tr>
<tr>
<td>15</td>
<td>1.16</td>
</tr>
<tr>
<td>20</td>
<td>1.08</td>
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<tr>
<td>25</td>
<td>1.03</td>
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<tr>
<td>30 or more</td>
<td>1.00</td>
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* For 15 to 29 tests, interpolate for intermediate number of tests.

† Modified sample standard deviation, $s_s$, to be used to determine the required minimum over-design compressive strength, $f'_{cr}$, in Table B.

2.1.3.1 The required minimum over-design compressive strength shall be determined by the equations shown in Table B.
Table B

<table>
<thead>
<tr>
<th>Specified design compressive strength, psi</th>
<th>Required minimum over-design compressive strength, psi</th>
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</thead>
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<tr>
<td>( f'_{c} \leq 5000 )</td>
<td>Use the larger value computed from these two equations:</td>
</tr>
<tr>
<td></td>
<td>( f'<em>{cr} = f'</em>{c} + 1.34s_{s} )</td>
</tr>
<tr>
<td></td>
<td>( f'<em>{cr} = f'</em>{c} + 2.33s_{s} - 500 )</td>
</tr>
<tr>
<td>( f'_{c} &gt; 5000 )</td>
<td>Use the larger value computed from these two equations:</td>
</tr>
<tr>
<td></td>
<td>( f'<em>{cr} = f'</em>{c} + 1.34s_{s} )</td>
</tr>
<tr>
<td></td>
<td>( f'<em>{cr} = 0.90 f'</em>{c} + 2.33s_{s} )</td>
</tr>
</tbody>
</table>

\( f'_{c} = \) Specified design compressive strength.
\( f'_{cr} = \) Required minimum over-design compressive strength.
\( s_{s} = \) Standard deviation, or modified standard deviation, as determined in Subsection 2.1.3(c) and Table A.

2.1.4 Trial mixtures with a range of proportions that will produce a corresponding range of compressive strengths encompassing the minimum over-design compressive strength may be used to determine the specified mix design proportions. This will require multiple trial batches with different mixture proportions. Documentation must be submitted which clearly indicates how the compressive strength is related to the different mixture proportions.

3. PROJECT/REGIONAL MATERIALS ENGINEER RESPONSIBILITIES

3.1 Attachment #1, “P.C.C. Mix Design Submittal and Approval Process for other than Precast or Prestressed Concrete”, provides the submittal and approval process for both new and previously used mix designs for other than precast or prestressed concrete. All mix designs will require approval for the intended use on a project. For previously used mix designs, this will include a check of the intended use as well as a review of the mix history in the CCR program.

3.2 Mix designs, for other than precast or prestressed concrete, must be prepared by or under the direction of, and signed by, an individual with one of the following qualifications:
(a) A registered professional engineer.

(b) A NICET (National Institute for Certification in Engineering Technologies) Level III or higher certified technician in the concrete subfield.

(c) A NRMCA (National Ready Mixed Concrete Association) Level 3 Certified Concrete Technologist.

(d) An ACI (American Concrete Institute) Certified Concrete Laboratory Testing Technician Level 2 or Grade II.

3.2.1 Individuals preparing and submitting mix designs, for other than precast or prestressed concrete, shall have experience in the development of such mix designs and mix design testing.

3.3 The following outlines the process that is to be followed for submittal and approval of P.C.C. mix designs for other than precast or prestressed concrete:

(1) The Resident Engineer receives the mix design submittal from the prime contractor and reviews the mix design submittal for accuracy, completeness, and identification/appropriateness of its intended use. For mix designs that have previously been used successfully on non-ADOT projects within the past 24 months, the mix design submittal must include supporting test data meeting the requirements of Subsection 2.1.3 from an ADOT approved laboratory. For mix designs that have previously been approved, or used successfully, on ADOT projects within the past 24 months, it may be required that the mix design submittal include supporting data from an ADOT approved laboratory.

(2) Within two working days after receiving the mix design submittal, the Resident Engineer sends a copy to the Regional Materials Engineer.

(3) The Regional Materials Engineer reviews the mix design submittal for accuracy and completeness. In addition, the Regional Materials Engineer reviews mix history if available. The Regional Materials Engineer will determine if a trial batch will be required in accordance with Attachment #1. When a trial batch is required, it must meet the requirements of Section 2. The mix design will be approved only after the receipt of all data, including the test results for compressive strength.
(4) The Regional Materials Engineer will approve or disapprove the use of the mix design and notify the Resident Engineer within five working days of receiving all required information, including the trial batch results.

(5) The Regional Materials Engineer enters approved mix designs into the CCR program as soon as possible.

3.4 The Resident Engineer may accept a letter listing specific previously approved mix designs that the contractor intends to use on the project. Such a list shall clearly identify the project name and number (including TRACS number), contractor, mix design product codes, intended use, supplier, and primary plant and back-up plants. Such letter shall certify that the current plant production of the mix design proposed for the use does not deviate from the previously approved mix design by more than the limits stated in Section 5. Copies of mix designs and current production plant batch weights are not required to be included with the letter.

4. MATERIALS STRUCTURAL TESTING SECTION RESPONSIBILITIES

4.1 Attachment #2, “P.C.C. Mix Design Submittal and Approval Process for Precast or Prestressed Concrete”, provides the submittal and approval process for both new and previously used mix designs for precast or prestressed concrete. All mix designs will require approval for the intended use on a project. For previously used mix designs, this will include a check of the intended use as well as a review of the mix history in the CCR program.

4.2 Mix designs for precast or prestressed concrete must be prepared by or under the direction of, and signed by, an individual with one of the following qualifications:

(a) A registered professional engineer.

(b) A NICET (National Institute for Certification in Engineering Technologies) Level III or higher certified technician in the concrete subfield.

(c) A NRMCA (National Ready Mixed Concrete Association) Level 3 Certified Concrete Technologist.

(d) An ACI (American Concrete Institute) Certified Concrete Laboratory Testing Technician Level 2 or Grade II.

(e) A PCI (Precast/Prestressed Concrete Institute) Quality Control Technician/Inspector Level II or higher.
4.2.1 Individuals preparing and submitting mix designs for precast or prestressed concrete shall have experience in the development of such mix designs and mix design testing.

4.3 The following outlines the process that is to be followed for submittal and approval of P.C.C. mix designs for precast or prestressed concrete:

1. The Materials Structural Testing Section receives the mix design submittal from the precast or prestressed manufacturer. For mix designs that have previously been used successfully on non-DOT projects within the past 24 months, the mix design submittal must include supporting test data meeting the requirements of Subsection 2.1.3 from an ADOT approved laboratory. For mix designs that have previously been approved, or used successfully, on ADOT projects within the past 24 months, it may be required that the mix design submittal include supporting data from an ADOT approved laboratory.

2. If the Resident Engineer receives the mix design submittal from the prime contractor, the Resident Engineer sends a copy of the mix design submittal to the Materials Structural Testing Section.

3. The Materials Structural Testing Section reviews the mix design submittal for accuracy and completeness. In addition, the Materials Structural Testing Section reviews mix history if available. The Materials Structural Testing Section will determine if a trial batch will be required in accordance with Attachment #2. When a trial batch is required, it must meet the requirements of Section 2. The mix design will be approved only after the receipt of all data, including the test results for compressive strength.

4. The Materials Structural Testing Section will approve or disapprove the use of the mix design and notify the Resident Engineer within five working days of receiving all required information, including the trial batch results.

5. The Materials Structural Testing Section enters approved mix designs into the CCR program as soon as possible.

5. MODIFICATION TO MIX DESIGNS AND PRODUCT CODES

5.1 Modifications that will not require a change in the product code:

5.1.1 Modifications which do not result in batch target weights for the fine aggregate or combined coarse aggregates changing by more than 5 percent from the approved mix design.
5.1.2 Modifications to the percentage of coarse aggregate fractions that do not change the total coarse aggregate volume.

5.1.3 Modifications to dosages of chemical or air-entraining admixtures, within the manufacturer’s recommendations.

5.2 Modifications that may require a change in the product code or performance verification:

5.2.1 The incorporation or elimination of chemical admixtures which are listed on the mix design to effect a change in the time-of-set (retarders or accelerators).

5.2.2 Modification of the type, or the incorporation or elimination, of a chemical or air-entraining admixture.

5.2.3 Modification to the percentage of fly ash, natural pozzolan, or silica fume.

5.2.4 Modifications made in accordance with the provisions of Subsection 1.8.

5.3 Modifications that will require a change in the product code and may require performance verification:

5.3.1 Modification to the class of concrete per Table 1006-A of the Specifications.

5.3.2 Modification to the type/class of cement, fly ash, natural pozzolan, or silica fume.

5.3.3 Modification to a coarse aggregate size designation.

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

Attachments (4)
The Resident Engineer receives the mix design submittal from the prime contractor and reviews the mix design submittal as described in paragraph (1) of Subsection 3.3.

The Resident Engineer sends a copy of the mix design submittal to the Regional Materials Engineer.

The Regional Materials Engineer reviews the mix design submittal.

Has the mix design been approved, or used successfully, on an ADOT project within the past 24 months?

Yes

Mix design may be approved without a trial batch. It may be required that the mix design submittal include supporting test data from an ADOT approved laboratory. The mix design requires the signature of a P.E. or qualified technician (Subsection 3.2).

No

Has the mix design been used successfully on a non-ADOT project within the past 24 months?

Yes

Mix design may be approved without a trial batch. The mix design submittal must include supporting test data meeting the requirements of Subsection 2.1.3 from an ADOT approved laboratory. The mix design requires the signature of a P.E. or qualified technician (Subsection 3.2).

No

Trial batch is required. For all trial batches, the signatory, as per Subsection 3.2, will be responsible to determine all mix design properties in accordance with this PPD.

Perform one of the following options.

- Full-scale trial batch (Note 1) per Section 2, witnessed by ADOT. ADOT tests cylinders. The mix design requires the signature of a P.E. or qualified technician (Subsection 3.2).
- Full-scale trial batch (Note 1) per Section 2, without ADOT oversight. The mix design requires the signature of a P.E. (Subsection 3.2).
- Lab trial batch (Note 2) per Section 2. The mix design requires the signature of a P.E. (Subsection 3.2).

The Regional Materials Engineer will approve or disapprove the use of the mix design, and notify the Resident Engineer.

The Regional Materials Engineer enters approved mix designs into the CCR program.

Note 1: The materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in production.

Note 2: Proportionally reduced quantities of the materials that are to be used in production, mixed in a portable or laboratory concrete mixer.

**PCC Mix Design Submittal and Approval Process**

*for other than Precast or Prestressed Concrete*
The Materials Structural Testing Section receives the mix design submittal from the precast or prestressed manufacturer.

If the Resident Engineer receives the mix design submittal from the prime contractor, the Resident Engineer sends a copy of the mix design submittal to the Materials Structural Testing Section.

The Materials Structural Testing Section reviews the mix design submittal.

Has the mix design been approved, or used successfully, on an ADOT project within the past 24 months?

Yes

Mix design may be approved without a trial batch. It may be required that the mix design submittal include supporting test data from an ADOT approved laboratory. The mix design requires the signature of a P.E. or qualified technician (Subsection 4.2).

No

Has the mix design been used successfully on a non-ADOT project within the past 24 months?

Yes

Mix design may be approved without a trial batch. The mix design submittal must include supporting test data meeting the requirements of Subsection 2.1.3 from an ADOT approved laboratory. The mix design requires the signature of a P.E. (Subsection 4.2).

No

Trial batch is required. For all trial batches, the signatory, as per Subsection 4.2, will be responsible to determine all mix design properties in accordance with this PPD.

Perform one of the following options.

Full-scale trial batch (Note 1) per Section 2, witnessed by ADOT. ADOT tests cylinders. The mix design requires the signature of a P.E. or qualified technician (Subsection 4.2).

Full-scale trial batch (Note 1) per Section 2, without ADOT oversight. The mix design requires the signature of a P.E. (Subsection 4.2).

Lab trial batch (Note 2) per Section 2. The mix design requires the signature of a P.E. (Subsection 4.2).

The Materials Structural Testing Section will approve or disapprove the use of the mix design, and notify the Resident Engineer.

The Materials Structural Testing Section enters approved mix designs into the CCR program.

Note 1: The materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in production.

Note 2: Proportionally reduced quantities of the materials that are to be used in production, mixed in a portable or laboratory concrete mixer.

P.C.C. Mix Design Submittal and Approval Process for Precast or Prestressed Concrete
### XYZ Concrete Ready Mix

**Product Code:** XYZ123456  
**Class and Strength:** ADOT CLASS S – 4000 psi @ 28 Days  
**Intended Use:** Caissons, Columns, Abutments  
**Project Name:** Big Head – Small Feet  
**Project Number:** F-099-99(9)  
**TRACS Number:** H999901C  
**Contractor:** ABC Contracting  
**Ready Mix Plant:** XYZ Concrete Ready Mix - Dobson Plant #1  
**Address:** 999 E. Happy Days Drive  
**Scottsbluff, AZ 99999**

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<th>Material</th>
<th>Weight per Cubic Yard</th>
<th>Specific Gravity</th>
<th>Volume</th>
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</thead>
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<tr>
<td>Cement</td>
<td>494 lbs</td>
<td>3.15</td>
<td>2.51 c.f.</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>164 lbs</td>
<td>2.10</td>
<td>1.25 c.f.</td>
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**Aggregate Ratios:**
- 50% 1" Coarse Aggregate
- 8% 3/8" Coarse Aggregate
- 58% Total Coarse Aggregate (AASHTO Size No. 57)
- 42% Fine Aggregate

**Allowable Water:** 36 Gallons  
**Total Weight per Cubic Yard:** 3782 lbs

**Admixtures:**
- Pozzolith 220N
- Pozzolith NC 534
- 5% Air - Micro Air (4 - 7%)

**WCM Ratio:** 0.46  
**Unit Weight:** 140.1 pcf

**Slump:** 4.0" +/- 1"  
**Total Volume:** 27.00 c.f.

**Materials**
- **Cement:** SRMG Type I/II/V low alkali, Clarkdale Plant
- **Fly ash:** SRMG Cholla Class F, Joseph City, AZ  
  SRMG Four Corners Class F, Fruitland, NM
- **1" Coarse Aggregate:** SRMG Dobson Facility, CM2218  
  SRMG Higley Pit, CM2055
- **3/8" Coarse Aggregate:** SRMG Dobson Facility, CM2218  
  SRMG Higley Pit, CM2055
- **Fine Aggregate:** SRMG Dobson Facility, CM2218  
  SRMG Higley Pit, CM2055
- **Pozzolith 220N:** BASF, C494 WRA Type A/B/D  
  (2 - 5 oz/cwt of CM -- AS NEEDED)
- **Pozzolith NC 534:** BASF, C494 Accelerating Type C  
  (0 - 45 oz/cwt of CM -- AS NEEDED)
- **Micro Air:** BASF, C260 Air Entrainment  
  (ADJUST AS NEEDED)

**Mix Designed by:**  
Hank Concreteman, XYZ Ready Mix  
Technical Services Manager  
NRMCA Level 3 Certified Concrete Technologist

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**Example of a Typical P.C.C. Mix Design**
### PCC Mix Design Checklist

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<tr>
<th>Requirement</th>
<th>Basis</th>
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**Notes:**

12/09/2008
## POLICY AND PROCEDURE DIRECTIVE

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<td>GUIDANCE ON THE USE OF RECLAIMED ASPHALT PAVEMENT (RAP) IN ASPHALTIC CONCRETE</td>
<td>April 19, 2013</td>
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### 1. GENERAL

1.1 Reclaimed asphalt pavement (RAP) may be used in asphaltic concrete provided it is allowed per Specification.

1.2 This Policy and Procedure Directive was developed to provide guidance to those involved in the production of asphaltic concrete containing RAP. It assumes the reader has a general understanding of the requirements for mixtures which do not contain RAP.

1.3 References contained herein to “ARIZ 428” are defined as “Arizona Test Method 428”.

### 2. TERMS

2.1 Asphaltic concrete with RAP consists of a mixture of virgin aggregate, virgin binder, RAP, and mineral admixture.

2.1.1 Virgin aggregate consists of mineral aggregate not previously used.

2.1.2 Virgin binder consists of asphalt cement not previously used.

2.1.3 RAP consists of salvaged, milled, pulverized, broken, or crushed asphalt pavement. For purposes of the Specification, RAP is made up of two main components: RAP aggregate and RAP binder.

2.1.3.1 RAP aggregate consists of the aggregate portion of the reclaimed asphalt pavement.

2.1.3.2 RAP binder consists of the binder, or asphalt cement, portion of the reclaimed asphalt pavement.
2.2 When the term “aggregate” is used without being further described as “RAP” or “Virgin”, the intended meaning is the total aggregate used in the mixture. Also note that the term “aggregate” is used interchangeably with “mineral aggregate”.

2.3 When the term “binder” is used without being further described as “RAP” or “Virgin”, the intended meaning is the total binder used in the mixture. Also note that the term “binder” is use interchangeably with “bituminous material”, “asphalt cement”, and “asphalt”.

2.4 The specifications are very deliberate in their use of the terms “RAP” and “Virgin” when describing aggregate or binder. Therefore, it is important that the user be familiar with these definitions and read the specifications carefully.

3. LIMITS ON RAP USAGE

3.1 The amount of RAP material allowed in asphaltic concrete is limited by both a maximum RAP aggregate contribution and a maximum RAP binder contribution to the mixture. In addition, production and testing requirements vary depending on the amount of RAP aggregate and RAP binder in the mixture.

3.1.1 A maximum of 25% RAP aggregate, by weight of total aggregate in the mix, may be used in mixes placed in a lower lift (minimum 2” below finished surface). A maximum of 20% RAP aggregate, by weight of total aggregate in the mix, may be used at all other locations.

3.1.2 A maximum of 25% RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2” below finished surface). A maximum of 20% RAP binder, by weight of total binder in the mix, may be used at all other locations.

3.2 When less than or equal to 15% RAP aggregate is used, by weight of the total aggregate in the mix, all RAP material must pass the 1¼ inch sieve.

3.3 When more than 15% RAP aggregate is used, by weight of the total aggregate in the mix, the RAP must be processed into uniform coarse and fine stockpiles meeting the gradation requirements of the specifications, and such that there will be a minimum amount of fines.

3.4 When less than or equal to 15% RAP binder is used, by weight of the total binder in the mix, no testing is required on the RAP binder properties during the mix design process.

3.5 When more than 15% RAP binder is used, by weight of the total binder in the mix, the RAP binder must be extracted, recovered, and tested during the mix design process. Depending on the results of these tests, the grade of virgin binder supplied to the project may need to be different than the grade specified in the bid documents. A different virgin binder
grade may be required to ensure the blend of virgin and RAP binder meets the grade specified in
the bid documents. The virgin binder grade delivered to the project shall be as specified in the
approved mix design.

3.6 There are no specific restrictions on the source of RAP material for a project. However, the contractor is responsible to determine the suitability of the RAP proposed for use regardless of its source.

4. SAMPLING AND TESTING

4.1 The sampling and testing of asphaltic concrete containing RAP is similar to
non-RAP mixtures, with some important differences. These differences deal primarily with
aggregate properties and asphalt cement content. For mixtures containing RAP, the RAP binder
must be tracked separately from the virgin binder. This requires additional sampling, testing,
data collection, and calculations.

4.2 During production of asphaltic concrete, sampling and testing is required on the
following materials:

4.2.1 Mineral Aggregates (See Section 5 for details.)

4.2.2 Virgin Binder (See Section 6 for details.)

4.2.3 RAP Material (See Sections 7 and 8 for details.)

4.2.4 Asphaltic Concrete (See Section 9 for details.)

4.3 Additional contractor quality control is required for an asphaltic concrete
mixture containing RAP. See the project specifications for specific requirements.

5. SAMPLING AND TESTING OF MINERAL AGGREGATES

5.1 Virgin mineral aggregate will be sampled in accordance with Arizona Test
Method 105.

5.2 Requirements for the sand equivalent and uncompacted void content are on the
composite of the virgin aggregates only. Samples will be obtained from the cold feed belt prior
to the addition of admixture, or from the stockpiles when sampling from the cold feed belt is not
possible.

5.3 The requirement for fractured coarse aggregate particles is on the composite of
the virgin aggregate and RAP aggregate material. The aggregate material for determining
fractured coarse aggregate particles will normally come from an asphaltic concrete sample taken
and tested for binder content and gradation in accordance with ARIZ 428. However, if the
engineer determines that excessive breakdown of the aggregate has occurred due to the use of
the ignition furnace, the fractured coarse aggregate particles testing will be performed on a
composite of RAP aggregate obtained in accordance with ARIZ 428, and virgin mineral
aggregate. The virgin mineral aggregate will be obtained from the cold feed belt prior to the
addition of admixture, or from the stockpiles when sampling from the cold feed belt is not
possible. The virgin aggregate and RAP aggregate shall be batched per Composite #1 in the mix
design.

6. SAMPLING AND TESTING OF VIRGIN BINDER

6.1 Virgin binder will be sampled and tested in the same way as it is done for
non-RAP mixtures. However, as mentioned in Subsection 3.5, the virgin binder grade required
may be different than what is specified in the bid documents to ensure the blend of virgin and
RAP binder meet the grade specified. This will be determined during the mix design process.
Sample labels shall indicate the actual grade of virgin binder provided to the project.

7. SAMPLING AND TESTING OF RAP MATERIAL FOR GRADATION,
MOISTURE CONTENT, AND BINDER CONTENT

7.1 RAP material must be sampled and tested to ensure it meets the gradation
requirements in the specifications. The intent of the RAP material gradation requirements is to
prohibit the use of oversized (+1¼ inch) material, improve consistency, and minimize
segregation. RAP material must also be sampled and tested for moisture content and RAP
binder content. Virgin binder and RAP binder contents must be tracked separately in order to
determine correction factors, validate and/or determine payments for asphalt cement, and to
properly apply asphalt price adjustments.

7.2 RAP material will be sampled in accordance with Arizona Test Method 105.
The sample shall be split to provide a sufficient amount of material for gradation testing,
moisture content testing, and binder content testing. When multiple RAP stockpiles are used,
RAP material shall be sampled separately from each stockpile.

7.3 Each RAP stockpile will be sampled and tested for gradation, moisture content,
and binder content at a minimum frequency of one sample per lot of asphaltic concrete
production. When more than one RAP sample is tested for moisture content and binder content,
for a given lot and stockpile, the average of the results will be used.

7.4 Prior to testing the RAP material for gradation and binder content, the weight of
the RAP material is recorded and the material is then dried at 140 °F to a constant weight.
A higher temperature is not appropriate because it will soften the binder causing the RAP
material to break into smaller particles and adhere to the pan. Drying to a constant weight
at 140 °F will typically take overnight. The percent moisture content by drying at 140 °F shall
be determined and recorded. After drying and determining the moisture content at 140 °F, the
material shall be allowed to cool and then be tested for gradation and binder content.
7.5 The gradation of the RAP material will be determined by first dry sieving the material in accordance with Arizona Test Method 240, but utilizing the No. 8 sieve as the smallest sieve. To control breakdown of the particles of salvaged material into smaller size fractions, Arizona Test Method 240 limits the time for shaking the sample to 5 minutes ± 15 seconds. The gradation of the RAP material is then determined in accordance with Arizona Test Method 248 (Alternate #2).

7.6 The RAP binder content, including the determination of moisture content at 290 °F, of each RAP stockpile will be determined in accordance with ARIZ 428.

7.7 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 7.4) to the percent moisture content by drying at 290 °F (Subsection 7.6).

7.8 The total moisture content and RAP binder content results will be used to determine the total quantity of RAP binder used in each lot, as well as in the calculation of a tank stab correction (See Subsection 9.2.2).

8. RAP BINDER CONTENT CORRECTION FACTOR

8.1 A RAP binder content correction factor will be applied to each RAP binder content result determined in accordance with Subsection 7.6. A correction factor is required for each RAP stockpile and is determined as follows:

8.1.1 At the start of asphaltic concrete production, the first two samples of RAP material from each stockpile will be split and tested for binder content; one split is tested in accordance with ARIZ 428 (Ignition Furnace) and the other split is tested in accordance with AASHTO T 164 (Solvent Extraction). A RAP binder content correction factor will be determined by subtracting the average ignition furnace result from the average solvent extraction result. The appropriate correction factor shall be added to each RAP binder content test result determined on the material from each RAP stockpile in accordance with ARIZ 428 to determine the RAP binder content. At the discretion of the Engineer, the correction factor may be determined prior to the start of asphaltic concrete production provided representative RAP samples are available. A new correction factor may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. See Attachment #1 for an example calculation for determining the RAP binder content correction factor.
8.1.2 When splitting RAP material to determine the RAP binder content correction factor for the respective stockpile, it is extremely important that a representative split be obtained because the correction factor will be applied to all RAP binder content test results for that RAP stockpile. To help ensure a good split is obtained the sample should first be reduced to the approximate size required to perform both procedures (ARIZ 428 and AASHTO T 164). 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. The sample shall be split and each half visually observed to verify that both halves appear similar in composition. One half of the split is then tested by the acceptance laboratory in accordance with ARIZ 428. The other half is sent to the Central Laboratory to have tested accordance with AASHTO T 164. Split samples must be sent to the Central Laboratory as quickly as possible to ensure that the RAP binder correction factor for each RAP stockpile and a subsequent ignition furnace correction (tank stab correction) can be calculated in a timely manner.

**Note:** ADOT does not currently perform AASHTO T 164. Therefore, the Central Laboratory will send their split of the RAP material to an on-call independent laboratory for the required testing.

9. **SAMPLING AND TESTING OF ASPHALTIC CONCRETE**

9.1 Asphaltic concrete containing RAP is sampled in the same manner as asphaltic concrete without RAP.

9.2 Testing for gradation, total asphalt content by ignition furnace, effective voids, stability, and compaction for asphaltic concrete containing RAP is done in the same manner as asphaltic concrete without RAP with the following exceptions:

9.2.1 The ignition furnace calibration is performed in accordance with ARIZ 428.

9.2.2 An ignition furnace correction (tank stab correction) must be determined by the Engineer for all mixtures containing RAP. If the correction is greater than 0.1%, it shall be applied to the ignition furnace results. Applying the correction is not optional as is the case for mixtures that do not contain RAP. The tank stab correction is defined as the average difference between the asphalt cement content as measured by the ignition furnace testing and the actual asphalt cement content for the first five lots of production. The “actual” asphalt cement content is determined by adding the virgin asphalt cement content to the RAP binder content, both expressed as a percent of the total mix. See Attachment #2 for an example calculation for determining the tank stab correction when one RAP stockpile is used. See Attachment #3 for an example calculation for determining the tank stab correction when two RAP stockpiles are used.

9.2.3 Asphalt content results for mixtures containing RAP are not subject to referee testing because a tank stab correction cannot be established for referee results.
10. MEASUREMENT AND PAYMENT FOR ASPHALT CEMENT

10.1 Asphaltic cement will be measured by the ton, for each lot of asphaltic concrete accepted, in one of the following ways:

10.1.1 Asphalt cement may be measured by multiplying the average asphalt cement content (from the Mix/Compaction Report) by the total tons of asphaltic concrete in that lot.

10.1.2 Asphalt cement may be measured by adding invoice quantities for virgin binder to the RAP binder used, adjusted as necessary for waste. The invoice quantities should be shown on the hot plant reports and substantiated by certified weights. RAP binder used shall be determined by multiplying the RAP binder content determined in Subsection 7.6 by the number of tons of dry RAP materials used in that lot. The tons of RAP material shall be a measured value (i.e., from a belt scale) rather than a calculated value. The measured tons of RAP material shall be shown on the hot plant report. When multiple RAP stockpiles are used, the RAP quantities and RAP binder contents must be determined separately for each stockpile.

10.2 In no case shall the measured amount of asphalt cement for payment be greater than the quantity determined in Subsection 10.1.2 above, adjusted for waste.

11. OTHER CONSIDERATIONS

11.1 Asphalt cement penalties and price adjustments only apply to the virgin binder in the mixture.

11.2 During production, the percent RAP aggregate shall be maintained to within plus 2 percent and minus 5 percent of the mix design values, not to exceed the maximum allowed by specification. When more than one RAP stockpile is used, this tolerance shall apply to the total percent RAP aggregate in the mixture, as well as the percent RAP aggregate from each stockpile.

11.3 For mixes containing RAP, an asphalt cement tank shall be dedicated to the project for each shift of asphalt concrete production. This is necessary in order to accurately track virgin binder usage for the project and to establish an accurate tank stab correction.

11.4 At least five days prior to the start of asphaltic concrete production, a copy of the mix design and representative samples of the virgin mineral aggregate, RAP aggregate, mineral admixture, and asphalt cement used in the mix design must be submitted by the contractor for calibration of the ignition furnace, and determination of aggregate properties. A minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent extracted RAP aggregate shall be submitted. If the RAP is fractionated, the RAP material and RAP aggregate from each stockpile shall be kept separate. All materials must be submitted in sufficient quantity to perform an ignition furnace calibration by both the acceptance lab and a referee lab if
necessary. If referee testing is performed, the referee testing laboratory will only be required to perform the ignition furnace calibration to determine a minus No. 200 correction factor.

11.5 The contractor shall provide daily documentation of the weight, determined by a belt scale, and proportion of material from each individual RAP stockpile incorporated into the mix. The percent moisture content of the RAP material from each stockpile shall also be determined and provided daily by the contractor.

11.6 A pre-activity meeting shall be held approximately two weeks prior to the start of paving. The agenda should include discussion items dealing with the production of asphaltic concrete containing RAP.

Attachments (3)
### Project Number: F-011-1(11)

### TRACS Number: H011101C

### RAP Material Type: Fine

#### Sample # 1
- **Sampled By:** Barb B. Que
- **Sampled From:** Stockpile
- **Date Sampled:** 04/22/13
- **Time Sampled:** 9:25

#### Sample # 2
- **Sampled By:** Jack Frost
- **Sampled From:** Stockpile
- **Date Sampled:** 04/23/13
- **Time Sampled:** 14:50

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**Notes:**
1) Shaded fields contain data input by the user. All other numerical fields are calculated values.
2) The RAP binder contents and RAP binder content correction factor in this example are high due to the recycling of ARAC.

**EXAMPLE RAP BINDER CONTENT CORRECTION FACTOR DETERMINATION**
### Example Ignition Furnace Correction (Tank Stab Correction) Determination

When one RAP stockpile is used

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<td>Tons of Coarse RAP Material in the Lot</td>
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<td>Tons of Dry Coarse RAP Material used in the Lot</td>
<td>Coarse RAP binder content from lab (corrected)</td>
<td>Percent Binder Content from Ignition Furnace (Lot average from Pay Factor report)</td>
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<td>Calculated Total Actual Percent Binder and Virgin Binder used in the Lot</td>
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**Tank Stab Correction = -0.26**

Notes:
1. Shaded columns contain data input by the user. All other columns are calculated values.
2. Column B is the tons of asphaltic concrete produced for the given lot.
3. Column C is the tons of virgin binder in the lot (per the hot plant report, verified by certified weights).
4. Column D is the tons of fine RAP material used in the lot (if only one RAP stockpile is used, the tons of RAP used is entered in Column D).
5. Column E is the total percent moisture content of the fine RAP material (the sum of percent moisture contents from drying at 140 °F and 250 °F).
6. Column F is the tons of dry fine RAP material used in the given lot. \( F = D \times \left( \frac{100 - E}{100} \right) \)
7. Column G is the percent binder content of the fine RAP material, as determined by ARIZ 426 and corrected by the RAP binder content correction factor (see Attachment #1).
8. Columns H, I, J and K are used in the same way as columns D, E, F and G when a second RAP stockpile is used (See Attachment #3).
9. Column L is the average percent binder content in the lot as measured by the ignition furnace (ARIZ 426).
10. Column M is the tons of RAP binder used in the lot. \( M = \left[ \left( \frac{G}{F} \times \frac{100}{100} \right) + \left( \frac{K}{J} \times \frac{100}{100} \right) \right] \)
11. Column N is the actual tons of total binder (tons of RAP binder plus tons of virgin binder) used in the lot. \( N = C + M \)
12. Column O is the calculated total actual percent binder content used in the lot. \( O = \frac{N}{B} \times 100 \)
13. Column P is the difference between the percent binder content measured by the ignition furnace and the calculated total actual percent binder content. \( P = L - O \)
14. The tank stab correction is the average of the five values in Column P.
15. The above values include waste at the plant and grade. Waste must be deducted prior to payment for binder and mix.
16. This example is for a mixture with one RAP stockpile. An example of a tank stab correction when two RAP stockpiles are used is given in Attachment #3.
<table>
<thead>
<tr>
<th>Lot #</th>
<th>Tons of Asphalts of Concrete in the Lot (including waste)</th>
<th>Tons of Virgin Binder in the Lot</th>
<th>Tons of Fine RAP Material in the Lot</th>
<th>Total Percent Moisture Content of Fine RAP Material</th>
<th>Tons of Dry Fine RAP Material used in Lot</th>
<th>Fine RAP binder content from lab (corrected)</th>
<th>Tons of Coarse RAP Material in the Lot</th>
<th>Total Percent Moisture Content of Coarse RAP Material</th>
<th>Tons of Dry Coarse RAP Material used in Lot</th>
<th>Coarse RAP binder content from lab (corrected)</th>
<th>Percent Binder Content from Ignition Furnace (Lot average from Pay Factor report)</th>
<th>Tons of RAP Binder used in the Lot</th>
<th>Actual Tons of RAP Binder and Virgin Binder used in the Lot</th>
<th>Calculated Total Actual Percent Binder</th>
<th>Difference between the Percent Binder Content from the Ignition Furnace Pay Factor Report and the Calculated Total Actual Percent Binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1390 19</td>
<td>62.31</td>
<td>145.53</td>
<td>2.07</td>
<td>142.52</td>
<td>4.85</td>
<td>144.90</td>
<td>0.57</td>
<td>144.07</td>
<td>3.57</td>
<td>5.12</td>
<td>11.77</td>
<td>74.08</td>
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<td>-0.21</td>
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<tr>
<td>2</td>
<td>2005.32</td>
<td>86.12</td>
<td>191.66</td>
<td>3.44</td>
<td>185.47</td>
<td>4.51</td>
<td>191.89</td>
<td>1.26</td>
<td>189.47</td>
<td>3.58</td>
<td>5.24</td>
<td>15.15</td>
<td>101.27</td>
<td>5.34</td>
<td>-0.10</td>
</tr>
<tr>
<td>3</td>
<td>1099 05</td>
<td>48.30</td>
<td>109.68</td>
<td>3.37</td>
<td>105.95</td>
<td>4.53</td>
<td>111.51</td>
<td>1.86</td>
<td>109.45</td>
<td>3.49</td>
<td>5.04</td>
<td>8.03</td>
<td>68.93</td>
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<tr>
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<td>2195 36</td>
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<td>218.50</td>
<td>2.83</td>
<td>212.32</td>
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<td>220.03</td>
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<td>216.97</td>
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<td>17.94</td>
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<tr>
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<td>2248 38</td>
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<td>217.15</td>
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<td>18.97</td>
<td>120.99</td>
<td>5.38</td>
<td>-0.19</td>
</tr>
</tbody>
</table>

Notes:
1. Shaded columns contain data input by the user. All other columns are calculated values.
2. Column B is the tons of asphalts concrete produced for the given lot.
3. Column C is the tons of virgin binder in the lot (per the hot plant report, verified by certified weights).
4. Column D is the tons of fine RAP material used in the lot (if only one RAP stockpile is used, the tons of RAP used is entered in Column D).
5. Column E is the total percent moisture content of the fine RAP material (the sum of percent moisture contents from drying at 140 °F and 290 °F).
6. Column F is the tons of dry fine RAP material used in the given lot. F = D x [(100-E) / 100]
7. Column G is the percent binder content of the fine RAP material, as determined by ARIZ 428 and corrected by the RAP binder content correction factor (see Attachment #1).
8. Columns H, I, J and K are used in the same way as columns D, E, F and G when a second RAP stockpile is used.
9. Column L is the average percent binder content in the lot as measured by the ignition furnace (ARIZ 428).
10. Column M is the tons of RAP binder used in the lot. M = [(C x F) / 100] + [(K x J) / 100]
11. Column N is the actual tons of total binder (tons of RAP binder plus tons of virgin binder) used in the lot. N = C + M
12. Column O is the calculated total actual percent binder content used in the lot. O = (N / B) x 100
13. Column P is the difference between the percent binder content measured by the ignition furnace and the calculated total actual percent binder content. P = L - O
14. The tank stab correction is the average of the five values in Column P.
15. The above values include waste at the plant and grade. Waste must be deducted prior to payment for binder and mix.
16. This example is for a mixture with two RAP stockpiles. An example of a tank stab correction when one RAP stockpile is used is given in Attachment #2.