



# **Critical Review of ADOT's Hot Mix Asphalt Specifications**

## **Final Report 630**

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16. Abstract The Arizona Department of Transportation (ADOT) has developed specifications and procedures to ensure the quality of the hot mix asphalt materials purchased by the Department. The document recording these specifications and procedures is the <i>Standard Specifications for Road and Bridge Construction</i> . The 2008 Standard Specifications is the reference used throughout this document. Specifications, however, are constantly changing as technology advances, materials change, and mix design criteria change. The objectives of this project are to: review the state-of-the-industry in Arizona with a focus on equipment and technologies currently being used; review ADOT's construction operations conformance history reports to identify probable causes of non-conformance; perform a critical review of the asphaltic concrete sections of the current standard specifications; recommend asphaltic concrete specification changes; and prepare a report of the activities. These objectives were met by holding a series of workshops in Arizona with both ADOT and contractor personnel participating. The workshops gave participants an opportunity to discuss issues and concerns with details of the existing specifications. Based on this input, a critical review of the existing specifications was prepared and recommendations for revising the specifications to national state-of-the-practice were made. In addition, recommendations were made for revisions to ADOT's construction operations conformance history reporting system.					
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## SI\* (MODERN METRIC) CONVERSION FACTORS

<b>APPROXIMATE CONVERSIONS TO SI UNITS</b>				<b>APPROXIMATE CONVERSIONS FROM SI UNITS</b>			
Symbol	When You Know	Multiply By	To Find	Symbol	When You Know	Multiply By	To Find
<b><u>LENGTH</u></b>							
in	inches	25.4	millimeters	mm	millimeters	0.039	inches
ft	feet	0.305	meters	m	meters	3.28	feet
yd	yards	0.914	meters	m	meters	1.09	yards
mi	miles	1.61	kilometers	km	kilometers	0.621	miles
<b><u>AREA</u></b>							
in <sup>2</sup>	square inches	645.2	square millimeters	mm <sup>2</sup>	Square millimeters	0.0016	square inches
ft <sup>2</sup>	square feet	0.093	square meters	m <sup>2</sup>	Square meters	10.764	square feet
yd <sup>2</sup>	square yards	0.836	square meters	m <sup>2</sup>	Square meters	1.195	square yards
ac	acres	0.405	hectares	ha	hectares	2.47	acres
mi <sup>2</sup>	square miles	2.59	square kilometers	km <sup>2</sup>	Square kilometers	0.386	square miles
<b><u>VOLUME</u></b>							
fl oz	fluid ounces	29.57	milliliters	mL	milliliters	0.034	fluid ounces
gal	gallons	3.785	liters	L	liters	0.264	gallons
ft <sup>3</sup>	cubic feet	0.028	cubic meters	m <sup>3</sup>	Cubic meters	35.315	cubic feet
yd <sup>3</sup>	cubic yards	0.765	cubic meters	m <sup>3</sup>	Cubic meters	1.308	cubic yards
NOTE: Volumes greater than 1000L shall be shown in m <sup>3</sup> .							
<b><u>MASS</u></b>							
oz	ounces	28.35	grams	g	grams	0.035	ounces
lb	pounds	0.454	kilograms	kg	kilograms	2.205	pounds
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")	megagrams (or "metric ton")	1.102	short tons (2000lb)
<b><u>TEMPERATURE (exact)</u></b>							
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature
<b><u>ILLUMINATION</u></b>							
fc	foot candles	10.76	lux	lx	lux	0.0929	foot-candles
fl	foot-Lamberts	3.426	candela/m <sup>2</sup>	cd/m <sup>2</sup>	candela/m <sup>2</sup>	0.2919	foot-Lamberts
<b><u>FORCE AND PRESSURE OR STRESS</u></b>							
lbf	poundforce	4.45	newtons	N	newtons	0.225	poundforce
lbf/in <sup>2</sup>	poundforce per square inch	6.89	kilopascals	kPa	kilopascals	0.145	poundforce per square inch

SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380

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Project ID: SPR 630

Project Name: A Critical Review of Hot Mix Asphalt Specifications

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## EXECUTIVE SUMMARY

The Arizona Department of Transportation (ADOT) has developed specifications and procedures to ensure the quality of the hot mix asphalt materials that it purchases. The document recording these specifications and procedures is *Standard Specifications for Road and Bridge Construction*. Specifications, however, are constantly changing as technology advances, as materials change and as changes in mix design criteria are accepted. The objectives of this project are to:

- Review the state of the industry in Arizona, with a focus on equipment and technologies currently being used;
- Review ADOT's construction operations conformance history reports to identify probable causes of non-conformance;
- Perform a critical review of ADOT *Standard Specification* Sections 403, 406, 407, 409, 411, 413, 414, 415, 416, and 417;
- Recommend asphaltic concrete specification changes; and
- Prepare a report of the activities.

The project began with the formation of a Technical Advisory Committee (TAC). The TAC elected to develop a series of one-day workshops at various locations in Arizona to solicit feedback from key stakeholders who are using the ADOT Specifications. To obtain unbiased comments, the workshops were held with two different audiences — one for agency personnel and another for contractor personnel. The workshops were held in Tucson, Phoenix, and Flagstaff during October 2007, with an open invitation to each of the stakeholder groups. Dale Decker served as facilitator for the workshops, with Rita Leahy and Amanda McGennis serving as recorders.

This report provides the Principal Investigator's (PI) recommendations based on review of the workshop comments, input from the TAC and personal experience.

At the workshops, Section 403 was reviewed in detail and Section 416 was used as a template for a detailed review of the remaining sections. Most of the comments on 416 also were applicable to other asphaltic concrete sections. Key questions asked of each participant were:

- Is the specification fair?
- Is the specification reasonable?
- Is the specification enforceable?

The key objective of the workshops was to challenge the participants regarding the total number of specifications in use by ADOT for asphaltic concrete. The current ADOT specifications have nine unique specification sections, plus other online stored specifications for asphaltic concrete. The workshop team recorded key comments and issues made at the workshops for subsequent evaluation.

The workshops provided significant guidance on issues in the specifications that both ADOT and the contractors believed were important and needed to be addressed. Based on the input received and detailed review of the specifications, a commentary on the

specifications was prepared. The commentary is provided in bullet form for ease of reference. The bullets address a specific recommendation on a section/paragraph of the existing standard specification. Each bullet is therefore an individual recommendation on the particular specification.

Key recommendations that resulted from the specification review are:

- The number of asphaltic concrete specification sections should be reduced from nine to four as follows:
  - Dense Graded Asphaltic Concrete
  - Gap Graded Asphaltic Concrete
  - Asphaltic Concrete Friction Course
  - Miscellaneous Asphaltic Concrete Paving
- A statewide asphaltic concrete plant certification program should be developed based on either the Arizona Rock Products Association (ARPA) or National Asphalt Pavement Association (NAPA) models.
- A stand-alone asphaltic concrete materials section should be developed rather than having a materials section in each of the asphaltic concrete specification sections.
- The specifications should be updated to national asphaltic concrete industry state-of-the-practice.
- The revised specifications should include a section for Warm Mix Asphalt.

A review of the ADOT construction operations conformance reporting (CR) system was conducted. The CR process reportedly includes a site review by experienced and knowledgeable engineers and senior technicians who specialize in the products they are inspecting. One of the products of the site review is a conformance history report. A conformance questionnaire was created by a team of specialists consisting of designers, engineers, inspectors, contractors, suppliers, and manufacturers who have extensive knowledge of the products' requirements.

Some key issues that were identified from the review of the conformance reports are:

- The conformance report concept is valid but the process needs to be updated and streamlined.
- This process should be renamed construction process audit.
- Product attribute reports that are generated by the inspectors need to be revised to be useful for quality improvement.
- The inspection check list of questions needs to be revised to remove subjectivity from the process.
- Plant and field operations should be separated in the questionnaire.
- Feedback to the contractor from the audit should be provided.

Based on this project, the next step is to use the commentary recommendations to make the appropriate and approved changes to the ADOT Standard Specifications. This revision process should be a collaborative effort between ADOT personnel and Association of General Contractors (AGC) members.



## I. INTRODUCTION

ADOT has developed specifications and procedures to ensure the quality of the hot mix asphalt materials purchased by the department. The document recording these specifications and procedures is the *Standard Specifications for Road and Bridge Construction*. Specifications, however, are constantly changing as technology advances, materials change, and mix design criteria change. The objectives of this project are to:

- Review the state of the industry in Arizona with a focus on equipment and technologies currently being used;
- Review ADOT's construction operations conformance history reports to identify probable causes of nonconformance;
- Perform a critical review of Sections 403, 406, 407, 409, 411, 413, 414, 415, 416, and 417 of the current standard specifications;
- Recommend asphaltic concrete specification changes; and
- Prepare a report of the activities.

The review for this project will utilize the 2008 Edition of the Standard Specifications. The project began with the formation of a TAC. The TAC initially met 19 July 2007. The TAC elected to develop a series of one-day workshops at various locations in Arizona to solicit feedback from key stakeholders who are using the ADOT Specifications. In order to obtain unbiased comments, the workshops were held with two different audiences — one was for agency personnel and another for contractor personnel. The workshops were held in Tucson, Phoenix, and Flagstaff during October 2007, with an open invitation to each of the stakeholder groups. Dale Decker served as facilitator for the workshops, with Rita Leahy and Amanda McGennis serving as recorders.

At the workshops, Section 403 was reviewed in detail and Section 416 was used as a template for reviewing the remaining sections. Most of the comments on 416 also were applicable to other asphaltic concrete sections. Key questions asked of each participant were:

- Is the specification fair?
- Is the specification reasonable?
- Is the specification enforceable?

A key issue raised at the workshops was to challenge the participants regarding the total number of specifications in use by ADOT for asphaltic concrete. The current ADOT specifications have nine unique specification sections plus other online stored specifications for asphaltic concrete.

The workshop team recorded key comments and issues for subsequent evaluation. Issues raised on mix design and pay factors at the workshops were recorded, although the issues were generally outside the scope of the project.

This report provides recommendations based on review of the workshop comments, input from the TAC, and personal experience of the PI. This report is divided into the following commentary sections:

- Commentary on Conformance Reports;
- Commentary on Section 403 on Hot Plant Requirements;
- Commentary on Section on Dense Graded Asphaltic Concrete;
- Commentary on Section on Gap Graded Asphaltic Concrete;
- Commentary on Section on Asphaltic Concrete Friction Course;
- Commentary on Section on Miscellaneous Paving;
- Proposal for Section on Materials for Asphaltic Concrete;
- Proposal for Section on Warm Mix Asphalt;
- Description of Future Work; and
- Concluding Remarks.

The commentary is provided in bullet form for ease of reference. The bullets address a recommendation on a specific section/paragraph of the existing standard specification. Each bullet is an individual recommendation.

## II. COMMENTARY ON CONFORMANCE REPORTS

The current specification referenced throughout this report is the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction (2008).

### **Conformance Reports**

ADOT's Construction Operations Group operates a project review process. This process reportedly includes a site review by experienced and knowledgeable engineers and senior technicians who specialize in the products they are inspecting. It was reported that the conformance questionnaire was created by a team of specialists consisting of designers, engineers, inspectors, contractors, suppliers, and manufacturers who have extensive knowledge of the products' requirements. ADOT currently has five independent reviewers who perform these inspections. The independent reviewers are expected to perform a minimum of one review per organizational unit (ORG) statewide, including consultants. This process would typically be considered a construction audit.

Apparently the field offices are free to share the conformance reports with the contractor. However, at the TAC meeting, contractor representatives were not aware the conformance reports existed. The conformance reports should be shared with the contractor so that areas needing improvement could be addressed.

During the site visit, the inspector completes a product attribute report. Since the report is an audit process, either the condition under review is satisfied or it is not. Close enough is not an acceptable response for an audit. Product attribute reports (PAR) are completed for the following topics: Asphaltic Concrete Friction Course (A-R); Asphaltic Concrete – End Product; Asphalt Drum Plant; Asphaltic Concrete (406); Asphaltic Concrete (EP) SHRP; Asphalt Rubber Blending and Hot Mix Plant; and Bituminous Tack Coat. The questions in the report vary from safety issues about access steps at the plant to cleanliness of the pavement prior to paving to the number of roller passes.

One of the products of the site review is a conformance history report. This report provides an overview of the conformance to ADOT specifications for specific issues.

Task 2 of this project required a review and commentary on the conformance history reports. This section of the report addresses that issue. The following comments are presented for consideration:

- The concept for an independent assurance review of construction operations is excellent. The objective is to improve the quality of pavement construction throughout Arizona. The process has been in place for several years within ADOT. As with any review system, each year improvements are made to obtain better information from the review process.
- The conformance reports (CR) reviewed for this effort were from 1 January 2005 to 22 October 2007. These were provided by Guillermo Silva of ADOT.

- The documents reviewed were the PAR and the conformance report by product. The PAR's are a list of questions that are completed by the inspector.
- The weighting for the specific question in the PAR should be reviewed. As an example in the asphalt rubber blending and hot mix plant PAR, the first question is regarding adequate and safe stairways for material sampling. While this is important, it is given a weight of 8, while later in the report the weighting for proper bin loading is a 2. For a PAR, the weighting should be more heavily focused on what it takes to get a good product. This observation leads to the conclusion that separate conformance reports should be prepared for safety and product quality.
- There are many not applicable (N/A) responses in the CR's. These responses confound the review and could skew the analysis of the information. If the response to the question is N/A, it is likely that the wrong question is being asked for the specific project. For example, in the asphalt drum plant PAR, one of the questions is "Are the platform truck scales certified?" Eight responses were N/A. If an asphalt drum plant is being inspected, the scales should be calibrated or the plant should not be operating. Another example is "Are the trucks equipped with tarps or covers?" In both of these examples, N/A seems to be an inappropriate response. Another example is in the Asphalt Rubber-Asphalt Concrete Friction Course (A-R), the second question is regarding the cleanliness of the trench. There were two "Yes" responses, zero "No" responses, and 18 "N/A" responses, giving a 100 percent conformance (percent conformance is the percentage "Yes" divided by the total of "Yes" and "No"). There are dozens of such examples. For an independent assurance (IA) audit, it is recommended that the questions be revised to accommodate either a yes or no response. Separating field and plant issues in the PAR may help resolve this issue as well.
- Many questions require the inspector to subjectively evaluate the contractor's operations. As an example, in the asphalt drum plant PAR, one of the questions is "Are the stockpiles managed effectively to prevent contamination and segregation?" This type of question should be revised to ensure a consistent response by the inspector. More specific questions might be: Are the stockpiles separated either by space or by bulkheads? — Is the loader operator retrieving material from the stockpile in a manner to avoid segregation? — Are the stockpiles managed to ensure uniformity of moisture content of the aggregate delivered to the plant?
- Some questions are extremely difficult to answer for the inspector. For example, in the ACFC (A-R) PAR, one of the questions is "Follow up compactor is operating as close as possible behind the breakdown rollers?" The determination of the position of the roller is dependent on many mix and environmental factors. How does the inspector determine "as close as possible" to evaluate the contractor?

- Some of the PAR's have a category of "other" with responses of either "No" or "N/A". It is appropriate for the inspector to have a comment section, but a category of "other" does not appear to be of much value in an IA audit.
- There are a disturbing number of items that have very low conformance percentages. This situation could be indicative of poor performance on the part of the field personnel or inappropriate questions being asked by the inspector, or both. An abbreviated list of low-conformance items includes:
  - *An approved mix design was not available.* This could indicate that the technician simply did not have it in his/her possession, but it could also mean that there was not an approved mix design for the job. A copy of the approved mix design must be on the site as a part of the audit process.
  - *Tarps not being used for hauling.* Best practice includes the use of tarps on the trucks. However, ADOT does not currently require the use of tarps. This CR requirement is therefore misleading.
  - *Proper loading of the haul trucks.* New verbiage in Section 403 addresses this issue.
  - *Approved release agents not being used.* For AR, it was as low as 17 percent conformance.
  - *Poor stockpile management is a pervasive issue.* Specific questions should be devised to evaluate stockpile management.
  - *Lack of certificates of compliance/analysis for mineral admixture, asphalt binder, or tack coat.* It is possible that the certificate exists, but the inspector simply did not have a copy.
  - *Documentation of rolling pattern and number of coverages.* These are items that the inspector should document.
- The PAR questions include both plant and field operations in the same report. Field and plant operations should be separated to ensure consistency of the audit.
- It is interesting to note that the two CR's with the highest percentage conformance are for AC (SHRP) and AC (End Product) with 73.4 and 74.7 percent respectively. A possible explanation is that the SHRP product is not used extensively throughout the state (estimated at 25 percent overall). As a result, the contractor may be placing greater attention to detail on the SHRP and End Product applications, as both specifications put greater responsibility on the contractor.

Based on review of the CR's, the following recommendations are made:

- This audit process could provide significant input to ADOT on how to improve both the construction process and the standard specifications. However, the system needs to be revamped. The revamping should include both how the audit is performed and how the results are used to improve construction processes in Arizona. This revision effort should be a cooperative activity between ADOT and AGC members.

- A thorough review of the questions used by the inspectors needs to be conducted by a team of ADOT and contractor personnel. Particularly, the questions need to be focused for a “Yes” or “No” response. “N/A” is not helpful in determining issues that need to be addressed. Including a “Comments” section is an excellent way to record additional information.
- Inspector questions need to be written so that there is as little room for subjectivity as possible. An independent assurance audit must be a black and white issue — either the condition under review exists or it does not.
- Because of the vast range of topics, it is recommended to change the title of the CR to Construction Process Audit.
- Field and plant operations should be separated to ensure consistency of the audit and a completely separate audit should be conducted for safety issues.
- Questions should be focused on getting as consistent a response as possible, regardless of the inspector on the site.
- Feedback from the CR should be provided promptly to the ADOT personnel on the project and the contractor.

### **III. COMMENTARY ON SECTION 403 – ASPHALTIC CONCRETE HOT PLANT REQUIREMENTS**

Asphaltic concrete hot plant requirements have previously been moved from individual asphaltic concrete specification sections into this stand-alone section. The following comments address recommended changes to the existing specification:

- Verifying that the plant has the capability of producing a quality product is critical. Historically verification has been done by ADOT. Given the budget and personnel requirements for plant inspection, the responsibility for maintaining proper plant production is being placed on the mix producer.

Arizona Rock Products Association (ARPA) recognized this issue many years ago and instituted the ARPA certification of hot mix asphalt production facilities plan. The company applying for the certification must be a member of ARPA. The certification inspection must be performed by a professional engineer. The ARPA program needs to be updated to reflect current plant production technology.

The National Asphalt Pavement Association (NAPA) has developed a plant quality commendation program. The NAPA program is a self-assessment by the mix producer but does require endorsements from product users. The NAPA program has a broad scope of inspection items. Given the move within the asphaltic concrete industry for increased emphasis on end-product performance, inclusion of the NAPA program in an ADOT specification would be viable. The producer does not need to be a member of NAPA to participate in the program.

The ARPA and NAPA programs are examples of different approaches to achieving the same goal. Both the ARPA and NAPA programs offer a mechanism to review plant production to ensure that quality products can be produced. The ARPA program has an advantage that the review/inspection is performed by a PE in the area in which the plant operates. The disadvantages of the ARPA program are that the plan needs to be updated to reflect current technology with improved detail to the inspection and that the producer must be a member of ARPA. The NAPA program is in its infancy, although it is modeled after the very successful Diamond Achievement program that NAPA has had in place for many years.

It is noted that both programs provide only a snapshot of production operations. The mix producer must be committed to quality production and to keeping the plant operating at a level to achieve quality mix. Coupled with the CR's previously discussed, both ADOT and the mix producer will have some assurance that the plant can produce a product meeting specified requirements.

It is recommended that a certification program be required for all asphaltic concrete producers on ADOT projects. The program should enable ADOT to use a local supplier in a rural area for a small quantity of mix, but for larger jobs, the mix producer would have to meet the production certification requirements. Modifying the ARPA program and using a local PE to perform the inspections

would provide a local appeal to the process. Some provision should be made for producers who are not ARPA members.

Although the certification requirement is not in the true spirit of a performance specification, it does provide a minimum assurance that the plant used for ADOT projects has the capability of producing quality mix. ADOT needs to review the project size and/or tonnage limit for the asphaltic concrete supplier to be required to have certification.

- A mass flow meter should be required on all continuous asphaltic concrete plants. This recommendation came from both the workshops and the TAC.
- The current specification requires the addition of lime or cement into the asphaltic concrete to enhance stripping resistance. In the laboratory, it has been shown that the addition of lime and/or cement dramatically improves stripping resistance. It is, however, difficult to confirm the addition of lime or cement into the mix at the plant.

The Federal Highway Administration (FHWA) has developed an infrared procedure to detect the presence of lime. It is described by FHWA as “an extremely rapid method, yielding qualitative or semi-quantitative results” that requires little preparation of the sample (Arnold et al. 2005). This procedure was reviewed as part of this project. The test developed has a high degree of repeatability. However, the test must be done in an analytical chemistry laboratory and is therefore not applicable to a construction materials field laboratory. There is no experience with using this procedure as a process control tool. The FHWA procedure is not recommended at this time for process control.

Since there is not a procedure that has been rigorously evaluated, it is recommended that current practices continue to determine the presence of lime.

- The current specification requires “The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.” The purpose of the moisture in the mineral aggregate is to activate the reaction for the lime to bond to the aggregate, thereby minimizing the mineral admixture that becomes airborne during production. There is no current method to verify that moisture addition satisfies the specification requirement of three percent.

Since there is not an accepted procedure, it is recommended that current practices continue to determine the percentage of moisture added.

- The current specification requires the mix producer to “provide daily documentation of the proportion of each individual component incorporated into the mix.” The specification should be clarified to indicate that the report is for one shift of production. In addition, the specification requires “a copy of the pyrometer reading shall be provided to the Engineer daily.” Participants in the



workshops indicated frustration at the timeliness of delivery for these reports that are required by the standard specifications. Delay of the reports slows down the required approval process.

Based on these comments and discussion in the TAC, it is recommended that a penalty be assessed to the mix producer if reports are not submitted to ADOT as required. Failure of the contractor to submit the reports within the specified time frame would result in a penalty as described in Subsection 3.2 of ADOT Bidding Schedule Item 9240170 – Contractor Quality Control.

- A new paragraph should be added to Section 403 on the issue of hauling units for asphaltic concrete. Example verbiage is as follows:
  - The asphaltic concrete shall be transported to the work site in hauling units previously cleaned of all foreign material. The contents of each load shall be completely covered with suitable material of sufficient size to protect it from the weather and contamination. Each unit shall have convenient access from ground level to insert a thermometer for the inspector to determine mix temperature.
  - The inside surface of all hauling units shall be treated with an approved release agent that will not contaminate or alter the characteristics of the asphaltic concrete. Petroleum derivatives such as fuel oil or diesel shall not be permitted.
  - Asphaltic concrete shall be loaded into the hauling unit in a manner that ensures segregation will be minimized. Asphaltic concrete industry best practice recommends using a three-drop loading for end dump trucks and a five-drop system for belly dumps, with the truck changing position between drops to ensure uniform product delivery into the truck (TRB 2000, 100-102).
- Add a new paragraph on calibration:
  - “Measuring devices on the asphaltic concrete plant shall be calibrated after any extended shut down, when the plant is relocated and at least once each year thereafter. All measuring devices, meters, dispensers, test weights, and other measuring devices shall be inspected, tested, and certified to be in proper operating condition by competent testing agencies approved by the Engineer. Certificates of inspection shall be posted in a prominent place in the plant and a copy shall be promptly submitted to the Engineer.”
  - *NOTE: This could be incorporated into the plant certification program.*
- The ADOT Construction Operations conformance report system could be used as an audit for the plant certification process.
- One consistent message heard at all the workshops was to ensure consistency in specification enforcement. Both non-enforcement and inconsistent enforcement are equally contrary to the objectives of a well-written specification.

#### **IV. COMMENTARY ON SECTION XXDG – DENSE GRADED ASPHALTIC CONCRETE**

A new Section XXDG of the specifications should be developed as a combination of old sections 406, 416 and 417. The new section will be focused on all dense graded mixes. The following bullets identify the changes recommended:

- Paragraphs 406-1, 416-1 and 417-1 are identical except for the last sentence of 417-1. It is recommended that 417-1 wording be maintained for Section XXDG on Dense Graded Asphaltic Concrete.
  - “The type of asphaltic concrete mix shall be specified in the Special Provisions” is the sentence in Section 417 that is not in the others.
- The only difference between Section 406-2 and 416-2 is that the latter includes a 1/2” mix size. The table from Section 416-2 should be used in the Section XXDG on Dense Graded Asphaltic Concrete except that the columns “Without Admixture” should be deleted as ADOT requires mineral admixture in all mixes. This table should be labeled Asphaltic Concrete Mix Design Criteria - Marshall.
- Table 417-1 presents mix design criteria for the Superpave (SHRP) mix design method. This table should remain in the Section XXDG with an adjustment to the title. The new title of the table should be Asphaltic Concrete Mix Design – SHRP. If SHRP is fully implemented in Arizona in the future, the Marshall table can be omitted from the specifications.
- A requirement for dust to bitumen ratio is currently included in the project Special Provisions. It is recommended that ADOT review this approach to determine if it would be more appropriate to have the dust to bitumen ratio requirements in the standard specifications rather than the special provisions.
- Table 417-2 should remain in the new section and be titled Mix Design Grading Limits for SHRP Mixes. The two columns for mix “Without Admixture” should be deleted since ADOT requires mineral admixture in all mixes.
- The Materials Sections of all three specifications should be removed and placed in a stand-alone section. For the most part, the information presented in all Materials Sections is the same. Minor modifications will be necessary to accommodate Marshall vs. SHRP mix design procedures.

It is noted that the TAC recommended that the materials requirements remain a part of each individual specification. The PI does not agree with this recommendation for the following reasons. With all the material requirements in the same specification section, easy reference is provided to the user. The producer will be able to more easily identify adjustments that may be made in production from one product to another. Many DOT standard specifications have materials as a separate section in order to reduce repetition in the individual

specifications. This concept was used by ADOT to create a new Section 403 on Plant Requirements and has worked well. ADOT has also used this approach for bituminous materials.

- The TAC recommended that the Mix Design section for each product remain with the individual specification section due to the diversity of mix types and specific mix design requirements for the different types of mixes.
- All references to the materials paragraphs will need to be changed to XXMAT references.
- The Mix Design Criteria Tables for Sections 406, 416, and 417, Subsections 2 have specification requirements for absorbed asphalt. The Mineral Aggregate Tables for Sections 406, 416, and 417, Subsections 3 have specification requirements for combined water absorption. These requirements are intended to limit the use of highly absorptive aggregates in asphaltic concrete. The specification requirements for both water and asphalt absorption are redundant. It is recommended that historical material test results for both properties be reviewed in detail to determine if one of the specification requirements could be omitted. If both tests always eliminate potentially problematic aggregates, it is not necessary to have both specification requirements. The water absorption test is much easier to perform in the laboratory.
- The text from Section 406-3.01 for mineral aggregate should be used for Section XXMAT on asphaltic concrete materials. Sections 416-3.01 and 417-3.01 contain additional verbiage, but Section 406-3.01 contains the essential items to ensure that the aggregate is of adequate quality.
  - It is highlighted that Section 406 requires 85/92 percent (two/one fractured faces). The 45 percent uncompacted void content is recommended for all mixes.
- Aggregate processing may occur many months or years in advance of mix production. It is therefore necessary to have testing performed on the individual aggregate products during the crushing operation as required in Section 1001-4.02. For mixture evaluation, aggregate tests are performed on the combined gradation.
- The mineral aggregate specification should be rewritten to universally permit reclaimed asphalt pavement (RAP) in all mixes. As a first step, 15-20 percent RAP could be used as a specification requirement. Higher percentages of RAP could be allowed as experience is gained with the introduction, with the caveat that the volumetric properties of the mix must be met. Ownership of the millings should go to the contractor to ensure that RAP is used in the most cost effective manner.
  - Inclusion of RAP can be accomplished by rewording Paragraphs 2 and 3 of 406-3.01 as follows:

“Coarse Mineral aggregate shall consist of crushed gravel, crushed rock, reclaimed asphalt pavement (RAP), or other approved inert material...”

“Fine mineral aggregate shall be obtained from crushed gravel, crushed rock or reclaimed asphalt pavement (RAP)...”

- Because ADOT pays for asphalt cement as a separate item, it will be necessary to develop a fair and reasonable approach to account for the asphalt cement in the RAP product. Both the contractor and the agency should realize benefits if the RAP addition is to be successful. It is recommended that ADOT and AGC work cooperatively to develop a process to be used. It is noted that the FHWA Expert Task Group on RAP is addressing this issue and is planning to develop a recommendation.
- The text in Paragraph 406-3.02, 416-3.02, and 417-3.02 on mineral admixture should be moved to Section XXMAT on Materials with the following change:
  - It was noted at the workshops that a discrepancy exists in the payment of the mineral admixture specification. Paragraph 416-3.02 requires 1 percent mineral admixture but allows up to 2 percent if necessary to meet moisture susceptibility requirements. However, it was reported by some workshop participants that the contractor is paid for 1 percent, regardless of the amount used. In Paragraph 416-8, the statement is made that “Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 416-6” (it is noted that this reference should be to 403-3.02). These requirements are in conflict with each other. It is recommended that this be reworded to pay the contractor for the mineral admixture necessary to achieve the moisture susceptibility requirements of the mix design. It was verified to the PI by ADOT personnel that the policy is that the contractor is paid for the amount of mineral admixture used provided the mix design demonstrates a required amount. This minimizes the possibility that the contractor might use excess mineral admixture to achieve volumetric properties of the mixture. The following verbiage is suggested:
    - “Mineral admixture will be required. The amount used shall be determined by laboratory testing to demonstrate the quantity of mineral admixture required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design.”
    - The remainder of this subparagraph can be used as written in the current specification.
- Paragraphs 406-3.03, 416-3.03, and 417-3.03 – Bituminous Material – should be moved to Section XXMAT on Asphaltic Concrete Materials. The text in all of these sections is the same.

- Paragraph 406-4, 416-4, and 417-4 on Mix Design should all be moved to Section XXMAT on Asphaltic Concrete Materials. The text in all of these sections is the same.
- It was noted in the workshops that all mix requirements may not be noted both in the Special Provisions and on the plans. In order for the mix designer to know all the requirements, all special requirements for the mix should be on both the Special Provisions and the Plans. Coordination with other groups within ADOT should be done to ensure this occurs.
- Sections 406-5, 416-5, and 417-5 have the same text for Contractor Quality Control. This text should be used in Section XXDG on Dense Graded Asphaltic Concrete.
- Sections 406-6, 416-6, and 417-6 have the same text for Construction Requirements. This text, with the recommended changes in the following bullets, should be used in the Section XXDG on Dense Graded Asphaltic Concrete. It is recommended that the new section be divided into subsections with possible titles of Mixture Production, Mixture Placement, Joint Construction, and Sampling. This arrangement would facilitate referencing specific subsections of the section.
- Concerns were expressed at the workshops about the rumble strip being on the longitudinal joint. Section 416-6 of the current specification clearly states that “any longitudinal joint (should be) approximately one foot away from the travel lane side of the rumble strip.” There is no ambiguity in what is currently in the specification. No change is recommended.
- Add a new sentence at the end of the first paragraph:
  - “Hauling units for asphaltic concrete shall meet the requirements in Section 403.”
- After the paragraph that begins “The temperature of asphaltic concrete...”, the following paragraph should be added:
  - “Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps or migration of the bituminous material.”
- In the paragraph that begins “Before asphaltic concrete is placed...” the text from current Section 415 should be added to the end of the paragraph as follows:
  - “...cleaned of objectionable material” and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications.  
**The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.**

- The current specification contains the following statement: “Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.” This sentence should be deleted and replaced with the following:
  - “Both longitudinal and transverse joints in successive courses shall be staggered so that one is not above the other. Transverse joints shall be staggered by the length of the paver except where precluded by pavement geometrics. Longitudinal joints shall be staggered a minimum of 12 in.”
  
- The current specification contains the following statement: “Joints shall be formed by a slope shoe or hot-lapped and shall result in an even, uniform surface.” This sentence should be deleted and replaced with the following information:
  - “Longitudinal joints shall be constructed to provide a continuous bond between the joint surfaces. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. Acceptable longitudinal joint construction procedures include unconfined edge joints, a tapered joint with or without a notch, a cutback joint or use of an edge compactor. Other methods may be approved by the Engineer based on local experience.”
    - Additional information on joint construction may be found in Quality Improvement Series 121 (Brock and Skinner 1997), published by the National Asphalt Pavement Association.
  
- The current specification provides only one option for construction of a transverse joint — a cutback joint. Discussions at the workshops indicate that the cutback joint is rarely used. The paragraph “Before a surface course is placed...” should be deleted and replaced with the following information:
  - “Transverse joints shall be constructed to provide a continuous bond between the joint surfaces. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. Acceptable transverse joint construction procedures include a bulkhead butt joint, a feathered joint, a tapered joint or a cutback joint. Other methods may be approved by the Engineer based on local experience. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint. The contractor shall have a 10-foot straight edge on site at all times during paving for this purpose.”
  - Additional information on joint construction may be found in Quality Improvement Series 121, published by the National Asphalt Pavement Association.

- The current specification states: “A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.” This sentence should be replaced with the following:
  - “Tack coat shall be applied as directed by the Engineer to all edges or vertical surfaces against which asphaltic concrete is to be placed. Tack coat for edges and vertical surfaces is considered an incidental item to the asphaltic concrete placement.”
  
- The current specification states “The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent.” Based on comments from workshop participants, this requirement is rarely verified. The typical specification for the asphaltic concrete industry throughout the country would have the moisture content requirement at the plant. A 0.5 percent moisture content at the paver would allow substantially more moisture at the plant, depending on the haul time and type of mix.
  
- Paragraphs 406-7.01, 416-7.01, and 417-7.01 are all identical. The text can be used as currently written for Section XXDG.
  
- Paragraphs 406-7.02, 416-7.02, and 417-7.02 are the same except for the requirement of uncompacted void content in 416. The current 416 standard requires the uncompacted void content only for Special Mix. Both 406 and 417 specify uncompacted void content for all mixes. It is recommended that uncompacted void content be specified for all mixes and the text from 406-7.02 or 417-7.02 be used in Section XXDG.
  
- Paragraphs 416-7.03 and 417-7.03 contain the same text. This paragraph is blank in 406. The material spread is a surrogate for yield of mix placed on the pavement. This is an important measurement tool during construction. It is recommended that this requirement be a part of Section XXDG with the following modification. **It is recommended that the bulk density value used for the calculation be the running average of current production bulk density values rather than a mix design value. By using a current bulk density value, the calculation will be more accurate, fair, and reasonable.**
  
- The text in Paragraphs 406-7.04, 416-7.04, and 417-7.04 is the same except for the last two paragraphs and the table of Upper and Lower Limits. It is recommended to use the existing text for Section XXDG except for the last two paragraphs which should be revised to read:
  - “The target values for gradation, asphalt cement content and effective voids are given in the contractor’s mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics for mixes designed using the Marshall mix design procedure are as follows:”
    - Replicate the table from 406-7.04/416-7.04

- “The target values for gradation, asphalt cement content and effective voids are given in the contractor’s mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics for mixes designed using the SHRP mix design procedure are as follows:”
    - Replicate table from 417-7.04
  - “The Engineer will determine the PT of each measured characteristic in accordance with Subsection XXX-X.XX and utilizing the appropriate table, will determine pay factors for each measured characteristic.”
- The third paragraph of 416-7.04 should be revised to mandate the use of a computerized mass flow meter. The specification should read as follows: “A computerized mass flow meter shall be used to determine asphalt cement addition to the mix. Documentation of its calibration...”
    - It is noted that a calibration procedure should be developed.
  - Paragraphs 406-7.05, 416-7.05, and 417-7.05 contain the same text. Part (A) of all sections references courses 1-1/2 inches or less in nominal thickness. Part (A) is a method specification that instructs the contractor what equipment to use and the number of coverages to make with the roller. The TAC recommended maintaining the <1-1/2” section of the specification. However, upon detailed review, it is recommended that Part (A) be deleted in its entirety. Part (A) does not coordinate with ADOT’s move to performance and/or end result specifications in many elements of the construction process. Part (A) places all the risk for the mix on ADOT because it is a method specification.
  - Part (B) of the respective sections should be retained for Section XXDG with the following additions/changes:
    - The titles from (A) and (B) will be deleted. The paragraph heading should be Compaction.
    - Delete the second paragraph that begins “All edges shall be rolled with a pneumatic tired compactor...” This requirement results in equipment ranging from a garden roller to a dump truck on the edge of the pavement. The improvement in density and/or sealing of the joint is questionable. In addition, it is possible to damage the pavement edge in the process of this angled rolling. Comments at the workshops indicate that the requirement is not routinely performed or enforced.
  - In the fourth paragraph of 416-7.05(B) (page 397), there is a discussion about core sampling of the asphaltic concrete. Reference is made to the ADOT Testing Manual, Arizona Test Method 104, Section 3. This test method should be revised to provide specific detail regarding the cutting and handling of the cores.
  - Paragraph 406-7.06, 416-7.06, and 417-7.06 contain the same text. The text can be used as currently written for Section XXDG.



- Paragraphs 406-8, 416-8, and 417-8 contain the same text. The text can be used as currently written for Section XXDG.
- Paragraphs 406-9, 416-9, and 417-9 contain the same text except for subparagraph (A). 406 does not include the Spread Lot Pay Factor requirements. If on a specific project ADOT chooses to not use the Spread Lot Pay Factor, it can be eliminated in the Special Provisions rather than maintaining a completely separate specification to address a relatively uncommon occurrence. It is recommended that the text from either 416 or 417 be used in Section XXDG. It is noted that this project was not focused on pay factors, so this paragraph was not reviewed in technical detail.

## **V. COMMENTARY ON SECTION XXGG – GAP GRADED ASPHALTIC CONCRETE**

This new section is a combination of old Sections 413 and 415. Reportedly Section 413 is no longer being specified. The new Section will be XXGG – Gap Graded Asphaltic Concrete.

- The TAC recommended using the term “Gap Graded” although Sections 413 and 415 deal specifically with Asphalt Rubber products. Using the title “Gap Graded” provides an opportunity to include SMA specifications at a later date.
- Paragraphs 413-1 and 415-1 are very similar in content. It is recommended that the text from 415-1 be used for the new specification.
- Paragraphs 413-2 and 415-2 describe the required mix design process for Gap Graded Asphaltic Concrete. Except for the effective voids range, the information in both sections is essentially the same. The tighter voids range listed in 415 is the preferred design range. Table 415-1 will be re-titled “Asphaltic Concrete Mix Design Criteria – Gap Graded”.
- All references to materials paragraphs will need to be changed to XXMAT references.
- Tables 413-2 and 415-1 include the same gradation requirements. The column for mix “Without Admixture” should be deleted as ADOT requires mineral admixture in all mixes. The gradation requirements should be moved into the mineral aggregate subparagraph of Section XXMAT.
- Paragraphs 413-3 and 415-3 should be moved into the Section XXMAT on materials and identified as aggregates for GGAC.
- Paragraphs 413-3.02 and 415-3.03 are the same. Use the existing text for the Section XXMAT.
- It was noted at the workshops that a discrepancy exists in the payment of the mineral admixture specification. Paragraph 415-3.03 requires 1 percent mineral admixture. However, in Paragraph 415-8, the statement is made that “Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 415-6” (it is noted that this reference should be to 403-2). These requirements are in conflict with each other. It was reported at the TAC meeting that AR mixes always use 1 percent lime. In the specification, a specific requirement for AR mixes can be identified if desired. However, if this specification is to be flexible enough to include SMA in the future, the issue of moisture susceptibility should be addressed in a more specific manner. It is recommended that this subparagraph be reworded to pay the contractor for the

mineral admixture necessary to achieve the moisture susceptibility requirements of the mix design. The following is suggested:

- “Mineral admixture will be required. The amount used shall be determined by laboratory testing to demonstrate the quantity of mineral admixture required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design.”
    - It is noted that appropriate protocols for ARAC testing and criteria need to be established in order for this to be implemented.
  - The remainder of this subparagraph can be used as written in the current specification.
- 
- Paragraphs 413-3.03 and 415-3.04 are the same except that 413-3.03 requires the percent of asphalt-rubber in the mix to be specified by the engineer. It is recommended that the text from 415-3.04 be used in the Section XXGG.
  - Paragraphs 413-3.04 and 415-3.05 contain the same text. The text can be used as currently written for the Section XXGG.
  - The text in Paragraph 415-5 should be used in Section XXGG on Gap Graded Asphaltic Concrete.
  - Add a new sentence at the end of the first paragraph in Paragraph 415-6:
    - “Hauling units for asphaltic concrete shall meet the requirements in Section 403.”
  - Paragraph 415-6 of the current specification contains the following statement: “Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.” This sentence should be deleted and replaced with the following:
    - “Both longitudinal and transverse joints in successive courses shall be staggered so that one is not above the other. Transverse joints shall be staggered by the length of the paver. Longitudinal joints shall be staggered a minimum of 12 in.”
  - Paragraph 415-6 of the current specification contains the following statement: “Joints shall be formed by a slope shoe or hot-lapped and shall result in an even, uniform surface.” This sentence should be deleted and replaced with the following:
    - “Longitudinal joints shall be constructed to provide a continuous bond between the old and new surfaces. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. Acceptable longitudinal joint construction procedures include unconfined edge joints, a tapered joint with or without a notch, a

cutback joint or use of an edge compactor. Other methods may be approved by the Engineer based on local experience.”

- Paragraph 415-6 of the current specification provides only one option for construction of a transverse joint – a cutback joint. Discussions at the workshops indicate that the cutback joint is rarely used. The paragraph “Before a surface course is placed...” should be deleted and replaced with the following:
  - “Transverse joints shall be constructed to provide a continuous bond between the old and new surfaces. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. Acceptable transverse joint construction procedures include a bulkhead butt joint, a feathered joint, a papered joint or a cutback joint. Other methods may be approved by the Engineer based on local experience. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint. The contractor shall have a 10-foot straight edge on site at all times during paving for this purpose.”
- Paragraph 415-6 of the current specification states: “A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.” This sentence should be replaced with the following:
  - “Tack coat shall be applied as directed by the Engineer to all edges or vertical surfaces against which asphaltic concrete is to be placed.”
- Paragraph 415-6 of the current specification states “The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent.” Based on comments from workshop participants, this requirement is rarely verified. The typical specification for the asphaltic concrete industry throughout the country would have the moisture content requirement verified at the plant. A 0.5 percent moisture content at the paver would allow substantially more moisture at the plant, depending on the haul time and type of mix.
- Paragraph 415-7.01 of the current specification can be used as written in Section XXGG.
- Paragraph 415-7.02 of the current specification can be used as written in Section XXGG.
- Paragraph 415-7.03 discusses Material Spread. The material spread is a surrogate for yield of mix placed on the pavement. This is an important measurement tool during construction. It is recommended that this paragraph be a part of Section XXGG with the following modification. It is recommended that the bulk density value used for the calculation be the running average of current production bulk density values rather than a mix design value. By using a reasonably current bulk density value, the calculation will be more accurate, fair, and reasonable.

- Paragraph 415-7.04 of the current specification can be used as written in Section XXGG.
- Paragraph 415-7.05 of the current specification can be used as written in Section XXGG.
- Paragraph 415-7.06 of the current specification can be used as written in Section XXGG.

The text in Paragraph 415-9 is recommended to be used in Section XXGG. It is noted that this project was not focused on pay factors so this paragraph was not reviewed in technical detail.

## **VI. COMMENTARY ON SECTION XXACFC – ASPHALTIC CONCRETE FRICTION COURSE**

This is a combination of current Sections 407, 411, and 414. The new section will be XXACFC – Asphaltic Concrete Friction Course.

- Sections 407 and 414 are identical except for the type of binder used and associated specification requirements. As such, this commentary will address the use of Section 414 with appropriate adjustments to account for use of both asphalt-rubber binder and neat asphalt binder. It was reported that the vast majority of ADOT friction courses are placed under Section 414 of the standard specifications.
- Section 411 is a method specification for ACFC, used infrequently for small tonnage jobs. It is recommended that Section 411 be deleted in its entirety. If ADOT has a small project that requires such an application, the specification changes can be handled through Special Provisions or stored specifications.
- It is recommended that the text in Section 414-1 be used for Section XXACFC. It is recommended that the paragraphs be modified as follows:
  - 414-1 Description
    - “Asphaltic Concrete Friction Course shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of an aggregate material, mineral admixture, and a bituminous material to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications, and as directed by the Engineer.”
  - 414-1.01 Asphaltic Concrete Friction Course (Asphalt-Rubber)
    - “The bituminous material for Asphalt-Rubber mixtures shall be asphalt-rubber conforming to the requirements of Section 1009-2.01 (A).”
    - “The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.”
  - 414-1.02 Asphaltic Concrete Friction Course
    - “The bituminous material for mixtures with conventional asphalt cement shall be Performance Grade PG XX-XX asphalt cement conforming to the requirements of Section 1005.”
- Paragraph 414-2 text can be used as currently written with the following modification:
  - The second sentence should read: “The allowable range of percent absorbed bituminous material shall be 0-1.0, when tested in accordance with Arizona Test Method 806.”

- Paragraph 414-3 should be moved to Section XXMAT (See Section VIII) with the following changes:
  - The first sentence “There is no Department-furnished source of mineral aggregate.” should be deleted.
  - The second sentence should be modified to read:
    - “The contractor shall provide a source in accordance with the requirements of Sections 106 and 1001 of the specifications.”
  - The mix design grading limits in Table 414-1 should be used in the revised specification. The grading in Section 414 is slightly coarser than for Section 407 but as such will provide a better friction course. The column for mix “Without Admixture” should be deleted as ADOT requires mineral admixture in all mixes.
  
- Paragraph 414-3.03 Bituminous Material should be reorganized as follows:
  - 414-3.03 General
    - The percent of bituminous material used shall be based on the weight of total mix (asphalt binder, mineral aggregate and mineral admixture).
    - The percent of bituminous material to be used will be determined by the mix design or may be specified by the Engineer.
  - 414-3.03.01 Asphaltic Concrete Friction Course (Asphalt-Rubber)
    - Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009-2.01 (A).of the specifications. The type of asphalt-rubber shall be as shown in the Special Provisions.
    - The crumb rubber additive shall be CRA Type B conforming to the requirements of Section 1009-2.01 (B).
    - In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated will be rejected.
    - Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.
  - 414-3.03.02 Asphaltic Concrete Friction Course
    - Asphalt cement shall be an asphalt binder performance grade PG XX-XX, conforming to the requirements of Section 1005.
  
- Paragraphs 414-6.01, 414-6.02, and 414-6.03 (all pertaining to Acceptance of Materials) can be duplicated in their entirety in Section XXMAT with the following modification:
  - Paragraph 414-6.03 (B) should have a new title of: Bituminous Material Content. The word “asphalt-rubber” in the third sentence of the first paragraph should be changed to “Bituminous Material”.
  
- Paragraphs 414-7.01, 414-7.02, and 414-7.03 can be duplicated in their entirety in Section XXACFC.

- In Paragraph 414-7.04(A) add the following sentence after the first sentence of the first paragraph of the General Requirements:
  - “Hauling units for asphaltic concrete shall meet the requirements in Section 403.”
- In Paragraph 414-7.04(A) (1) there is a discussion of Placement Dates and Weather Requirements. The TAC recommended retaining these requirements.
- Paragraph 414-7.04(A)(2) should be revised as follows:
  - “Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps or migration of the bituminous material. Should any one or more of these conditions be evident in the material delivered to the screed unit, the contractor will institute one or more of the following procedures:
    - (a) Cover the haul units with tarpaulins;
    - (b) Discharge material directly into the paver using an end-dump truck;
    - (c) Incorporate a material transfer vehicle into the paving train; or
    - (d) Reduce the haul distance from the plant to the laydown site.

“Should these efforts not eliminate the condition, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the asphaltic concrete in the condition as described above. Other measures proposed by the contractor which will deliver asphaltic concrete meeting the above requirements will be considered by the Engineer.”

- Paragraphs 414-7.04(B), (C), and (D) and 414-7.06 (A), (B), and (C) are method specifications for asphaltic concrete placement. Such specifications place an undue amount of risk on ADOT if there is a problem with the pavement. By directing the contractor in the means and methods of placing the material, ADOT has little recourse when and if a problem occurs.

However, there is currently no technology available to adequately determine the quality of the ACFC mix at the time of placement other than asphalt content and gradation. Some agencies use a field permeability test but the variability of the test is very high. Therefore, the method requirements as currently written represent the state-of-the-practice for placement of ACFC type mixes.

- Paragraph 414-7.05 can be duplicated in its entirety for Section XXACFC.
- Paragraph 414-7.06 can be duplicated in its entirety for Section XXACFC.
- Paragraph 414-7.07 can be duplicated in its entirety for Section XXACFC.
- Paragraph 414-7.08 can be duplicated in its entirety for Section XXACFC.



- Paragraph 414-7.09 can be duplicated in its entirety for Section XXACFC.
- In Paragraph 414-8, the follow modifications should be made:
  - The first sentence should be changed as follows:
    - “Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, mineral admixture and bituminous material.”
  - The second paragraph should be changed as follows
    - “Bituminous material will be measured by the ton.”
  - The third paragraph should be changed as follows:
    - “If asphalt-rubber is used as the bituminous material, the weight of the asphalt-rubber material...”
- In the second paragraph of Paragraph 414-9, the following changes are recommended:
  - In the first sentence:
    - “Payment for the bituminous material will be made by the ton.”
  - Add a new second sentence:
    - “For mixes with asphalt-rubber, payment for the asphalt-rubber will include asphalt cement and crumb rubber.”
  - The remainder of the second paragraph can be used as currently written.

## VII. COMMENTARY ON SECTION XXMISC – ASPHALTIC CONCRETE FOR MISCELLANEOUS PAVING

This is a revision of current Section 409. The new Section will be XXMISC.

- The TAC recommended that this Section be kept separate from XXDG. However, on detailed review, it is recommended that this section be included in XXDG. Generally the application for Section 409 is for temporary roadways that may carry very heavy traffic for several months. Most of the materials properties are the same. If the XXDG specification were used for these applications, the following modifications should be made for the Miscellaneous Applications:
  - The VMA and air voids criteria should be the same as for dense graded mixes for the miscellaneous application.
  - For temporary applications, the requirement to meet index of retained strength criterion may be waived by the Engineer.
  - Instead of having a compaction method specification, Section 416 could be used with a change in the volumetric criteria for miscellaneous applications. The target volumetric properties could be adjusted to recognize the temporary nature of the application.

**The remainder of this commentary is written as if 409 will remain a free-standing section of the specification.**

- Paragraph 409-2 on Materials should be moved to the new Section XXMAT with the following changes:
- Paragraph 409-2.03 requires 2 percent mineral admixture but allows a minimum of 1 percent if necessary to meet moisture susceptibility requirements. Currently the contractor is paid by the ton for mix produced under the 409 specification. If the specification remains in use only for temporary applications, it may not be necessary to include the mineral admixture. This matter will need to be reviewed by ADOT personnel. The subparagraph can be used as written in the current specification.
- Paragraph 409-2.04 can be duplicated in its entirety for Section XXMISC.
- Paragraph 409-3.01 can be duplicated in its entirety for Section XXMISC with the following exceptions.
  - The paragraph that begins with “The moisture content...” shall be reworded as follows:
    - “The moisture content of the asphaltic concrete at the paver shall not exceed 0.5 percent.”
  - The paragraph that begins with “Asphaltic concrete immediately behind...” shall be reworded as follows:
    - “Asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.”

- Paragraph 409-3.02 describes compaction processes to be used. This is a method specification. As previously discussed, it is recommended that the compaction be completed in the same manner as with Section 416 but with different acceptance criteria.
- Paragraphs 409-3.03, 409-4, and 409-5 can be duplicated in their entirety for Section XXMISC if the ADOT chooses to maintain Section 409.

## **VIII. PROPOSAL FOR SECTION XXMAT – MATERIALS FOR ASPHALTIC CONCRETE**

- The new stand-alone Section XXMAT on Materials should have the following subsections:
  - Mineral Aggregate
  - Mineral Admixture
  - Bituminous Material

Each of these subsections will have the specific product quality requirements for the different mix types with the changes recommended previously. By having all the material specifications in one section, the producer can easily see what the differences are between products. The user also has easier access to the specifications necessary for mix production.

## **IX. PROPOSAL FOR SECTION XXWMA – WARM MIX ASPHALT**

Warm Mix Asphalt is anticipated to be a significant element of the future asphaltic concrete industry. It is recommended that a section of the revised specification be assigned for this topic. Future efforts within the industry will determine the contents of the section.

## **X. FUTURE WORK**

Review of the Conformance Reports indicated that revision of the reports is appropriate in order to have the reports reflect current industry practice. The PAR questions need to be revised to ensure consistency in the inspection process. It is recommended that a joint ADOT/contractor workshop discuss the scope and objectives of the conformance reports. These reports can provide value to both ADOT and to the contractor.

A significant effort will be required to incorporate the recommended specification changes into the ADOT Standard Specifications. This effort can be accomplished through a combination of ADOT, contractor and/or consultant activities.

## **XI. CONCLUDING REMARKS**

Project SPR630 was developed to provide a critical review of ADOT's Hot Mix Asphalt Specifications. The effort has identified ADOT Standard Specification changes recommended from the agency and industry workshops held in October 2007 and from the experience of the project PI. The recommendations in the report represent the state-of-the-practice in the asphalt industry in the United States. It is, however, recognized that some of the recommendations may not be applicable to the Arizona experience. It is therefore recommended that new ideas be verified within the confines of the Arizona asphaltic concrete community.

## REFERENCES

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Transportation Research Board (TRB). 2000. *Hot Mix Asphalt Paving Handbook*. Federal Aviation Administration Advisory circular AC150/5370-14 (Supplement). Washington, DC: Transportation Research Board, et al.